University of Reading

FOOD SECURITY, DIETARY DIVERSITY AND HEALTH IN ARTISANAL AND SMALL-SCALE MINING (ASM) HOUSEHOLDS IN GHANA

Thesis submitted in partial fulfilment of the requirements
for the degree of Doctor of Philosophy

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March, 2025

ABSTRACT

To what extent artisanal and small-scale mining (ASM) influences food security, health, and nutrition in rural households in Ghana remains an important question to be answered due to diverse and mixed conclusions surrounding the impact of ASM in Africa. Using data from the Ghana Living Standards Survey (GLSS 7), this research seeks to understand the relationship between ASM and food security, nutrition, and health in rural households in Ghana to contribute towards improved policy making. Also, this research explores how ASM affects women who are directly and indirectly engaged in ASM activities. A mixed-methods approach was employed to address the study objectives. Household-level data of 1,617 households from the GLSS 7 survey were mapped to areas with ASM operations. The quantitative analysis entailed the application of three linear regression models to evaluate the effects of ASM on food security, health, and nutrition. Key indicators of food security, health, and nutrition, along with other variables, were constructed from the GLSS 7 modules based on insights from relevant literature. For the qualitative component, in-depth interviews were conducted with 63 women respondents in one of the GLSS survey areas to gain additional insights into the effects of ASM on women. Issues related to the preconceived themes of gender, food security, health, and nutrition as well as how other socio-economic factors of female mine workers interact to shape their experiences, were analyzed through the contemporary lens of intersectionality in social theory. Results revealed that ASM is associated with lower levels of food security, health (proxied by absence due to illness, injury, or both), and nutrition outcomes while controlling for other socio-economic factors exerting varied and differential levels of influence on the dependent variables. Specifically, food security, health, and nutrition appear to be associated with land size, education, wealth, and household size, with larger land and education linked to improving food security, while ASM and urban living are associated with health and nutrition outcomes. Results from the qualitative study revealed that many women in ASM areas neglect their health needs and there also pertains to be limited understanding of female reproductive health issues. Even though ASM

offers economic opportunities for women, it also exposes them to occupational health risks and socio-cultural challenges, such as menstruation-related taboos and gender disparities. Food security in ASM communities remains a critical concern. Economically, ASM enhances women's creditworthiness. However, due to the informal nature, the economic, financial, and social risks associated with ASM activities, it tends to limit women's access to formal loans. To promote sustainable livelihoods, it is essential to address the negative impacts of ASM on food security, health, and nutrition. Additionally, a deeper understanding of gender dynamics is crucial to fostering inclusion and diversity within the ASM sector. Although the GLSS 7 data identified ASM households in the sample, it lacked specific details that are essential to have a deeper understanding of the impact of ASM and may have underestimated its scale of impacts. Integrating localized ASM-specific data, and incorporation of ASM-focused information in GLSS modules and satellite imagery, are recommended to enable in-depth and explore ASM's macro- and micro-level impacts on food security, health, and nutrition as well as livelihoods of participating and/or non-participating households in ASM areas or its neighborhoods. Tailored policies should address the social, economic, and environmental impacts of ASM by promoting sustainable agriculture, alternative livelihoods, and land-use regulations that balance mining with food production. Additionally, strengthening nutrition, healthcare access, and gender-responsive policies will ensure better food security, health outcomes, and sustainable community development in ASM-affected areas.

DECLARATION

I confirm that this is my own work and the use of all materials from other sources has been properly and fully acknowledged.

ADUSEI PEASAH KWADWO

10TH March, 2025

DEDICATION

TO GOD BE ALL THE GLORY FOR HIS UNFAILING MERCIES AND STRENGTH GIVEN ME TO COMPLETE THIS PHD THESIS SUCCESSFULLY. I AM FOREVER GRATEFUL TO GOD

‘FAITHFULL IS HE THAT HAS PROMISED’

ACKNOWLEDGEMENT

To the Almighty God be all the Glory for the strength and tenacity given me in this study. I would like to express my sincere gratitude to my able supervisors, Prof Chittur C.S Srinivasan and Prof Sanzidur Rahman for the diligent excellent supervision, advice, guidance and encouragement rendered to me during the entire period of my study.

To the Ghana Scholarship Secretariat (GSS), I say a very big thank you for all the financial sponsorship rendered to me to complete this course. I really appreciate this kind gesture from the Government of Ghana. May God continually bless my homeland Ghana. Special thanks to Pastor Lebene and wife, Dr. Abena Osei-Akoto, Dr. Yaw Adjei, Prince, Dr. Paul Osei, Pastor Moses, and Dr Gabriel for all the technical support and assistance.

My profound gratitude also goes to Evangelist Abboah Offei, Rev Isaac Osei Bonsu and Elder Kobina for all the prayers and support given to enable me to finish my dissertation. I am most grateful to my cousins Kwame Gyimah, Kwasi Asare, Frank Gyimah, Nana Anim, and my twin Adwoa, for their unflinching moral support and hospitality during my study.

To my family especially my parents Daasebre Adusei Peasah IV and Mrs. Mary Adusei Peasah as well as my wife and children, I am forever grateful for your prayers and moral support that has enabled me to come this far. To my wife Rahael and son Nyameani, may God continually bless you so much for always being with me through this journey.

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ACRONYMS

ASM……..……Artisanal and Small-Scale Mining

ATSDR…… Agency for Toxic Substances and Disease Registry

CFSI……Composite Food Security Index

DPA……..…….Direct Participating Agent

DOLS……..Dynamic Ordinary Least Square Estimators

ECM……Error Connection Method

EFA……..Exploration Factor Analysis

EEA…….European Environmental Agency

EPA…….Environmental Protection Authority

ESF…….Ecosystem Services Framework

FMOLS……..…… Fully Modified Ordinary Least Square Estimators

GLSS…….……..Ghana Living Standards Survey

GMM…….……Generalized Method of Moments

GSS……...……..Ghana Statistical Service

ICT……Information and Communication Technology

IMF……..…….……International Monetary Fund

IPA…….Indirect Participating Agent

IRMF……..……...Integrated Risk Management Framework

LSMS……..……..….Living Standards and Measurement Survey

LSE…….Least Square Estimators

OHS…….Occupational Health and Safety

OLS……..……...Ordinary Least Square

PPS…..……..Proportional to Population Size

PSU…..……..Primary Sampling Unit

SSU……..……..Secondary Sampling Unit

SAP……..…….....Structural Adjustment Program

SLF…….……...…… Sustainable Livelihood Framework

SDH…….……...Social Determinants of Health Framework

SDG……..…….Sustainable Development Goal

WFP…….……....World Food Programme

2SLS…….…….……Two-Stage Least Square Estimators

1.0 INTRODUCTION

1.1 Background to Artisanal and Small-Scale Mining (ASM)

Artisanal and small-scale mining (ASM) is an essential livelihood strategy for millions of people all over the world (Morante-Carballo *et al.*, 2022). As far as the United Nations Sustainable Development Goal (SDG#1) is concerned, ASM is known to provide various forms of livelihoods to many people which in no small way minimizes poverty levels, especially in resource-rich communities (Hilson and Maconachie, 2020).

Despite its substantial contribution to local economies coupled with the provision of a significant share of the global mineral output, ASM which is primarily distinguished by its informal nature (Ofosu and Sarpong, 2022), has sparked pressing and serious concerns with regard to its overarching implications in socio-economic contexts, environmental sustainability, and well-being. Globally, ASM has been particularly prevalent in developing countries across Africa, Asia, and Latin America, which are mostly characterized by limited economic alternatives (Hilson *et al.*, 2020b). In addition to its economic advantages and implications, ASM is mostly conducted with minimal regulation, limited technology, and inadequate safety protocols in regions and communities where it is being practiced (Ofosu *et al.*, 2024c). This has led to an increasing amount of research documenting the connection between ASM and its impacts on surrounding communities (Quarm *et al.*, 2022; Nordhagen *et al.*, 2022; Ofosu, 2022b; Marume, 2023). Taking this into account, this thesis explores these intricate relationships, emphasizing the effects of ASM on these well-being outcomes such as food security, nutrition, and health.

There has been much focus on the environmental effects of ASM with regards to deforestation, pollution, and land degradation, whereas a notable gap in gaining full comprehension on how these environmental impacts translate into challenges regarding food security, nutrition, and health remains understudied (Cossa, 2023). Moreover, ASM communities tend to be

characterized by complex food environments where processed foods are available with limited access to nutritious and healthy options, which eventually impacts food security, health, and nutrition (Nordhagen *et al.*, 2022). Emerging research has proven that through the environmental effects of ASM, which consequently result in land dispossession, water pollution, reduced agricultural productivity, and labor competition, ASM becomes a predisposing factor for the disruptions of the local food system and altered dietary patterns (Obodai *et al.*, 2024). More so, the migration of labor from agriculture to ASM has resulted in a reduced workforce available for food production, leading to decreased agricultural output(Ofosu *et al.*, 2020).. This shift not only affects food security but also alters household income dynamics and nutritional intake

These factors contribute to heightened food insecurity and health challenges, accentuating the need to broaden the focus beyond environmental impacts to encompass the multifaceted effects of ASM on community well-being. By expanding the focus to contain these dimensions, the study aims to give a more comprehensive understanding of the impacts of ASM, informing policies and interventions that address not only environmental concerns but also the critical aspects of food security, nutrition, and health outcomes in affected communities. Moreover, food security, health and nutrition are immediate life-sustaining needs which, aside the environmental effects, ASM is the epicenter of these issues regarding these welfare outcomes; one of the reasons why recent studies have started shedding light on its socio-economic effects, particularly concerning food security and health (Meutia *et al.*, 2022; Poignant, 2023; Wongnaa *et al.*, 2024; Adranyi *et al.*, 2023).

Moreso, ASM can disturb local agricultural practices. Through the diversion of labor and land resources among other salient factors, the practice of ASM amounts to food security issues, especially in places where mining is prevalent as reported by a number of studies (Ofosu *et al.*, 2020; De Haan *et al.*, 2020; Nunoo *et al.*, 2023). This assertion in the context of food security also connects with the UN sustainable goal (SDG#2) which lays much emphasis on zero hunger

(Leal Filho *et al.*, 2020). In this regard, this study seeks to project the interplay between ASM and SDG goals like food security. Not only that but also, ASM is known to have the potential to jeopardize the health of workers by exposing them to occupational hazards (Cossa *et al.*, 2021). Some of these hazards are in the form of toxic substances such as mercury, and cyanide, among others (Schwartz *et al.*, 2021b). This has the capacity to amount to long-term health issues, which undermines the SDG (#3) which has to do with good health and wellbeing (Arthur-Holmes *et al.*, 2022b). This study is interested in the ASM-health nexus and its associated implications.

Although a substantial body of literature has focused on the environmental and health hazards of ASM through several means, the use of national-level data in such studies is quite scarce (Cossa *et al.*, 2021; Fritz *et al.*, 2022; Landrigan *et al.*, 2022). In other words, there is a paucity of research with regard to investigations relating to ASM implications on food security, health, and nutrition using national-level data such as the Ghana Living Standards Survey (GLSS). The Ghana Living Standards Survey (GLSS) 7 gives a formidable dataset that studies these aspects, particularly at a nationally representative level, considering its broad information on household food security, health outcomes, and income levels among, other variables (Awoyemi *et al.*, 2023). The GLSS is known to possess detailed information on key indicators that intersect with ASM's impacts (Asaki *et al.*, 2024). This puts it in the position of being a valuable resource for evaluating this sector's implications. As such, through the leveraging on GLSS 7 data, this study aims to explore these multi-faceted impacts of ASM on food security, health, and nutrition in Ghana. The presence of direct and indirect factors such as household income, access to food, health service usage, and dietary patterns as shown in the GLSS 7 makes the dataset, and an ideal framework to assess how mining influences these livelihood outcomes (Asaki *et al.*, 2024).

ASM relates to these livelihood outcomes in several ways. Most of these communities in ASM-dependent areas are more often subjected to environmental deterioration in the form of deforestation, soil pollution, and water pollution (Tolonen, 2015). This phenomenon poses a

direct danger to food security and agricultural output (Rai *et al.*, 2023). ASM activities mostly occur on land and water bodies which could be utilized for agricultural purposes, reducing the amount of food produced locally and increasing dependence on imported food (Gilbert and Albert, 2016). Furthermore, ASM activities can destroy surrounding water supplies with dangerous substances like cyanide and mercury (Manzila, 2022). This potentially endangers both human health and the viability of agriculture as asserted by Malone *et al.* (2023). In these ASM populations, dietary deficits and increased food insecurity result from these environmental changes that lower food availability and quality (Zhang *et al.*, 2024).

ASM has the potential to result in various health hazards for those directly involved as well as those nearby (Schwartz *et al.*, 2021b). More so, the physical demands of ASM, coupled with the limited availability of safety equipment, increase the risk of injuries and other work-related health issues among miners (Landrigan *et al.*, 2022; Singo *et al.*, 2022; Arthur-Holmes and Busia, 2022b).

Women on the other hand, engaged in ASM and other ancillary roles such as processing minerals and managing household responsibilities, are particularly vulnerable to these health risks, which can be exacerbated by limited access to healthcare services (Mensah, 2024). Moreover, ASM activities have the potential to disrupt social structures and contribute to economic insecurity, with consequences on food accessibility as well as essential healthcare services, thereby impacting overall community health and resilience (Zhang *et al.*, 2020; Schwartz *et al.*, 2021a; Ros–Tonen *et al.*, 2021). Studies on the effects of ASM through the employment of health and nutrition lens gives way to deeper gendered and intersectional analysis which is often overlooked in broader environmental studies (Geenen *et al.*, 2022)

Characteristically, men more often take over the most visible and physically intensive roles in ASM such as digging, shoveling, and excavating (Ofosu *et al.*, 2022). On the other hand, women

are more exposed to a distinct set of vulnerabilities, which are not hidden but profoundly consequential (Stokes-Walters *et al.*, 2021). These vulnerabilities emerge from the intersection of gender norms, lack of decision-making power, and systemic inequalities influencing women's lives in ASM settings (Arthur-Holmes *et al.*, 2023b).

Moreover, women's experiences in ASM are not homogenous, and their roles often extend beyond extraction to include auxiliary, informal, or reproductive tasks (Paschal and Kauangal, 2023). The fact that these roles remain unpaid or poorly paid (Ofosu *et al.*, 2022) despite exposure to toxic chemicals, dust, and harsh physical conditions, accentuating the need for deeper studies in such susceptibilities.

Moreover, women are exposed to all forms of marginalization in the ASM industry which plays out through gender discrimination, economic exclusion and social inequalities (Kansake *et al.*, 2021). Meanwhile, it must be realized that marginalization is not just symbolic as it manifests in hunger, malnutrition, and chronic health outcomes, highlighting food security and nutrition concerns (Schwartz *et al.*, 2021a). This means nutrition and food insecurity are deeply gendered but remain unexplored.

In addition, whereas ASM studies have looked at the sociocultural marginalization of women and the interconnections between food security, health, and well-being among ASM participants (Baddianaah, 2023; Ofosu *et al.*, 2024a; Marume, 2023), these studies do not explore how gender role differ in ASM, the compounded nutritional vulnerabilities women face due to their reproductive roles and economic precarity, and the impact of the direct and indirect involvement of women’s in ASM in the light of food security, nutrition, and health. These studies do not distinctly investigate into the diversity of gender and the context-dependent role of women in ASM.

As an aspect of this study, this thesis adopts a gender-sensitive approach to understanding how ASM affects food security, health, and nutrition (Bansal *et al.*, 2023). Through the examination of how gender, socio-economic status, and other intersecting identities influence the impact of ASM, this study aims to highlight the unique vulnerabilities faced by women. In the process, the study seeks to bridge existing knowledge gaps through the provision insights that can inform policies and interventions targeted at improving the livelihoods and well-being of ASM communities. Through this lens, the thesis will address critical questions about the pathways through which ASM affects food security, health, and nutrition, identify the gendered dimensions of these impacts, and explore strategies for mitigating these risks to support sustainable development in mining-dependent regions.

1.2 ASM Impact on Livelihoods (different pathways of impact)

Artisanal and small-scale mining (ASM) has several ways by which it impacts livelihoods, which further tend to yield positive or negative outcomes in the end (Arthur *et al.*, 2016b). Some of the positive impacts on livelihoods come in the form of income generation particularly in areas where there tend to be scarce livelihood opportunities (Isung, 2021). ASM has also resulted in labor opportunities through the employment of millions of workers all over the world irrespective of the socioeconomic background (Ajith *et al.*, 2021). This has resulted in the inclusivity of marginalized groups like women and the youth who get involved in this revenue-generating venture. On a broader scope, ASM has empowered individuals in the various ASM communities to harness and profit from local mineral resources without reliance on large corporations (Brain, 2017).

On the contrary, ASM negatively impacts livelihoods through land degradation, which often results in loss of arable land and agricultural productivity (Bansah *et al.*, 2024). Dossou Etui *et al.* (2024) reported that ASM causes the disruption and destruction of ecosystems, which may have rippling effects on occupations like farming and fishing which particularly rely on the

ecosystem. There are also a number of occupational hazards as well as community health issues related to ASM. Economic vulnerability whereby people engaged in ASM experience an unstable flow of income from ASM happens to be one of the inimical impacts of ASM from a livelihood perspective. Moreover, ASM activities are associated with insolvency and debt accruals because of the high costs of these simple mining equipment and other logistics (Purnomo *et al.*, 2021).

In addition, issues of conflicts and inequality are quite rampant with ASM activities (Malone *et al.*, 2021). This results from the misunderstandings proceeding from the struggle for access to resources such as disputes have the potential to spark tensions among miners and non-miners as well as migrants and indigenous people according to a body of knowledge (Rubbers, 2020; Coderre-Proulx *et al.*, 2016; Sánchez-Vázquez *et al.*, 2016). Issues of gender dynamics could also amount to various forms of inequality issues and exacerbated gender conflicts as women involved in these ASM activities are confronted with unequal access to resources and additional domestic responsibilities (Kotsadam and Tolonen, 2016). Over-reliance on ASM could also have a long-term impact on livelihoods and render communities vulnerable, particularly in times of fluctuation in mineral prices (Kumah *et al.*, 2020). Wilson (2018) posits that the absence of proper regulation as characterized by ASM, leaves communities without any viable livelihood alternatives in situations where the mineral resources are depleted from the mining sites. The extent of these impacts is dependent on factors such as geographical location, socioeconomic circumstances, and existing environmental regulations (Macháček, 2019).

1.3 Problem Statement

Although ASM has recorded an increasing significance as far as its contribution to livelihoods is concerned (Arthur *et al.*, 2016b), there is limited empirical evidence on its multifaceted and overall welfare impacts such as food security, health, nutrition, and gender dynamics, as these areas remain underexplored according to extensive range of research (Hilson and Maconachie,

2020; Buss *et al.*, 2017; Cossa *et al.*, 2021; Arora, 2020; Buss and Rutherford, 2022). Although a wide array of academic studies based on ASM have focused on the environmental, socio-economic as well as health implication, these studies are normally devoid of disaggregated and context-specific data especially at the household levels as asserted by Long *et al.* (2015) and Fritz *et al.* (2022). While looking at the broad overview of ASM like environmental degradation and economic benefits, the aspects of the cumulative impacts on ecosystems, agricultural productivity as well as the effects on vulnerable populations like women have not received adequate attention (Cossa *et al.*, 2021; Byizigiro *et al.*, 2020).

In addition, this is coupled with inadequate empirical support on the socioeconomic and nutritional effects of ASM activities as reported by Zhang *et al.* (2020), especially in areas where ASM had resulted in the conversion of most arable lands for the purposes of ASM (Eludoyin *et al.*, 2017). Besides, there is poor comprehension in terms of the role of women who form a substantial proportion when it come to ASM workforce, especially in the area of food security, health, and other domestic responsibilities (Jackline, 2022). These pose a hindrance to the effective development of comprehensive, gender-responsive, and sustainable interventions.

The purpose of this research aims to bridge and address critical knowledge gaps through the examination of the nuanced interplay regarding ASM and other socio-economic factors with a particular focus on food security, nutrition, and health outcomes in households, and on women directly and indirectly participating in ASM activities. The study seeks to leverage on comprehensive indicators and an empirical approach in the provision of more evidence-based insights into the effects of ASM and offer more informed strategies for the minimization of its adverse impacts while improving the livelihoods of affected households and communities.

1.4 Research Gaps

In recent times, there have been growing concerns regarding the environmental, health, and livelihood impacts of artisanal and small-scale mining (ASM), emphasizing the overlooked

nexus between ASM, agriculture, food security, nutrition, and health (Nyantakyi-Frimpong et al., 2023). This underscores the fact that the nexus between ASM, food security, nutrition, and health has not received the needed attention, although they are inextricably related in many ways. This is coupled with the scarcity of detailed, disaggregated data on ASM's socio-economic status as reported (Hilson and Maconachie, 2020). Although several studies have offered general insights without examining specific demographic impacts or long-term socio-economic consequences, there is a need for further research into ASM's evolving influence on livelihoods and explore its externalities (Ofosu *et al.*, 2020; Pijpers, 2024). Addressing these contextual gaps will deepen understanding of ASM's multifaceted interactions and guide sustainable interventions (Hilson and Maconachie, 2020).

It is worth noting that in Ghana, there is an overlap between agro-ecological zones and mineral-rich areas (Obodai *et al.*, 2023; Moomen *et al.*, 2019; Wongnaa *et al.*, 2024). This has raised significant environmental and food security challenges due to ASM activities. Particularly in situations where ASM has resulted in large-scale soil degradation, deforestation, and ecosystem destruction, with farmlands being particularly affected. This has amounted to food access challenges in ASM communities, increasing the reliance on ready-to-eat foods, particularly in developing countries as reported by Zhang (2020). This accentuates the gap which lies in the need for a nuanced understanding of how this overlap deepens the impact of ASM on livelihood outcomes like food security and nutrition (Arthur *et al.*, 2016b).

The increasing rate of ASM has ignited debates about its impact on land use, resource competition, and related issues like food security and health (Ofosu *et al.*, 2020; Fagariba *et al.*, 2024). Notably, the effects of land conversions on various socioeconomic groups remain underexplored, despite their significant and complex impact on food security (Payton *et al.*,

2021). This assertion supports the demand for more research into the consequences of land conversion for purposes such as ASM.

The focus of most ASM studies in Ghana has been driven by its inherent economic, socio-legal, and environmental concerns, however, not many have been able to draw the link when it comes to food security, health, and nutrition (Nyantakyi-Frimpong *et al.*, 2016; Schwartz *et al.*, 2021b). Although, Onifade *et al.* (2024) reported that research on sustainable mining practices and their effectiveness in reducing environmental damage and promoting long-term livelihood sustainability is still emerging, many ASM studies focus on specific environmental impacts (Obodai, 2022; Mensah, 2024; Mimba *et al.*, 2023) considering the effects of these impacts on ecosystems and livelihoods. These assertions are being supported by Zhang *et al.* (2020) who reported that the broader impact of ASM on some of these livelihood outcomes, like nutrition, remains inadequately researched as the study unveiled a limited scholarship gap in addressing issues of nutritional quality and dietary diversity regarding the ASM communities as well as that of migrant populations (WHO, 2016).

Studies such as Kemp and Owen (2019); Adeola (2020) have documented the significant impact of ASM on human health outcomes and community well-being. However, there is not sufficient empirical literature to back this assertion regarding health as far as ASM studies are concerned. Moreover, while some research highlights the health risks associated with ASM, there is a need for more thorough studies that cover a wider range of health outcomes, as such, this accentuates the need for further studies regarding the ASM-health nexus (Basu *et al.*, 2015).

Methodologically, few studies have employed national-level data such as the GLSS regarding ASM-related studies (Guenther, 2018). Interestingly, while qualitative studies are prevalent in the area of ASM-related studies, there is also a growing trend toward integrating quantitative methods and innovative approaches (Smith *et al.*, 2016; Buss *et al.*, 2019; Osumanu, 2020).

However, the use of GLSS in generating ASM indicators particularly, as well as other wellbeing outcomes like food security and nutrition remains an unexplored area in ASM studies.

The participation of women in ASM as an alternative livelihood intervention has become a subject of discussion in the extractive industry in recent times (Buss *et al.*, 2017; Weldegiorgis *et al.*, 2018b; Shangase, 2022). However, ASM has been experiencing a process of 'feminization' as an increasing number of women continue to build up the labor force in the ASM industry (Mensah, 2024). Notably, how these women are impacted along the mining value chain remains an ongoing debate (Lutz-Ley and Buechler, 2020) some of which are debates are the effect of the labor-shift to ASM. Although there have been several discussions on why women get involved in ASM in Ghana, few have focused on how ASM impacts the direct and indirect participation of women involved in ASM (Paschal *et al.*, 2024). This presents a gap regarding the gender-specific impacts of ASM. Research needs to focus more on how ASM affects men and women differently as asserted and observed in the works of Tobalagba and Vijeyarasa (2020) and Danielsen and Hinton (2022) particularly in terms of economic benefits, health risks, and social roles.

Wegenast and Beck (2020) suggested the existence of underlying inequalities in access to resources, opportunities, and decision-making power for which reason why women experience reduced food availability and nutritional diversity. This gap necessitates further research into how ASM impacts on women as Weldegiorgis *et al.* (2018b) recommended a more comprehensive approach into studies pertaining to these ASM-gender mechanisms.

1.5 Research Objective and Research Questions

The objective of this research is to understand the welfare impacts and gender dimensions of ASM with regard to food security, nutrition, and health outcomes in Ghana and contribute to improved policymaking.

To attempt to fill the gaps in this study, we propose to examine the following three questions:

1. How does artisanal and small-scale mining (ASM) impact food security at the household level in Ghana?
2. How does artisanal and small-scale mining (ASM) impact health and nutrition at the household level in Ghana?
3. How women are affected by their direct and indirect participation in artisanal and small-scale mining (ASM) activities?

1.6 Research Design, Methods, and Data

This study combined both qualitative and qualitative research approaches for the achievement of the objectives of this study. The quantitative approach was used to address how ASM impacts food security and nutrition in Ghana. The study leveraged on the Ghana Living Standards Survey (GLSS), which is a comprehensive household survey data collected by the Ghana Statistical Service (GSS). Basically, this data contains information on the living conditions, socio-economic status, and well-being of households. Often, researchers, policymakers, and international organizations leverage on the GLSS to gain full comprehension of issues regarding poverty, education, health, housing, employment, and access to basic services in Ghana.

The qualitative method was used to address how women are affected by virtue of their direct and indirect involvement in ASM activities. This involved the use of in-depth interviews collected on women involved in ASM in a specified study area. The data contained how women are affected by direct and indirect engagement in ASM activities.

Moreover, the DPSIR (Driving forces, Pressure, State, Impact, and Responses) model was employed as its conceptual framework (see Chapter 3 for a detailed discussion of this framework). This model offered a more structured approach in understanding the relationships between ASM activities and their impact on food security, health and nutrition. By the use of

this model, policymakers and researchers tend to have a comprehensive view of the complex issues caused by ASM activities so as to come out with effective strategies in addressing them.

1.7 Significance of Study

This study is significant for several reasons. This is because this is an interdisciplinary subject that intersects economics, environmental science, public health, and development studies. Eventually, this topic offers rich opportunities for research and policy formulation. The significance of this study could be observed in several ways as well.

For many households in Ghana among other countries, ASM is a source of supplementary income (Eniowo, 2024). This additional revenue can be critical for covering basic needs, especially in regions with high levels of poverty. In some areas, ASM contributes significantly to local economies, providing income not only to miners but also to those involved in ancillary activities such as equipment supply, transportation, and trade. ASM offers an alternative livelihood to agriculture, which can be crucial in areas suffering from land degradation, poor agricultural yields, or seasonal fluctuations in farming (Lydia *et al.*, 2022). For instance, in countries like Ghana and Burkina Faso, ASM is a significant source of livelihood for many, especially in rural areas where formal employment opportunities are scarce. In Ghana, ASM provides employment to over one million people and contributes substantially to the local economy (Pokorny *et al.*, 2019). This makes studies into ASM and its interactions with well-being outcomes very important.

In Indonesia for instance, ASM supports livelihoods by providing employment and income opportunities in remote and rural areas. In Indonesia, ASM provides livelihoods for thousands of miners and their families, particularly in areas where other economic activities are limited (Pokorny *et al.*, 2019). In countries like Colombia and Peru, ASM is a crucial economic activity, especially in regions with limited access to formal economic opportunities (Pantoja Timarán and Pantoja Barrios, 2016). In Colombia just like other countries where ASM is prevalent, ASM is a

significant source of income in rural areas, helping to alleviate poverty and providing an alternative to other forms of subsistence (Jiménez *et al.*, 2022).

Diversifying into ASM can help mitigate economic risks for households that rely solely on agriculture or other vulnerable sectors. Income from ASM often flows into local communities, supporting businesses and services such as markets, schools, and healthcare facilities. In some cases, the revenue from ASM leads to improved local infrastructure, including roads, schools, and health centres (Siaciti and Masinja, 2022). ASM can empower marginalized groups, including women and youth, by providing them with economic opportunities and a means to contribute to household income. The shared activity of mining can foster community cohesion and collaboration among local miners and their families. ASM often requires relatively low initial investment compared to large-scale mining operations. This lower barrier to entry allows more people to participate. ASM operations can be adapted to different environmental and geological conditions, making it a viable livelihood option in diverse regions (Huntington and Marple-Cantrell, 2022).

Considering the contribution of ASM enumerated above, studying ASM effects on food security, health, and nutrition helps understand how this economic activity influences broader socio-economic conditions, including poverty and wealth distribution. This research seeks to reveal how income from ASM could be used to influence household food security, health and nutrition. This is a household-level study that provides detailed data on how specific factors affect individual households. This helps in understanding the nuanced impacts of ASM on various aspects such as income distribution, food security, and health. especially in regions where formal employment opportunities are limited. More so, it must be realised that this household level study captures the local context, including socio-economic conditions, cultural practices, and access to resources (Lydia *et al.*, 2022), which can vary widely even within the same region. This research

also seeks to reveal the various coping mechanisms with regards to ASM activities and other occupations in the various households (Arthur-Holmes, 2020).

ASM is associated with various health risks, including exposure to toxic substances like mercury and lead (Landrigan *et al.*, 2022). Investigating these risks can highlight the health impacts on miners and surrounding communities. More so, understanding the health effects of ASM can guide the development of targeted public health interventions and policies to mitigate adverse health outcomes (Cossa, 2023).

ASM implications are very important in nutrition studies, especially in ASM-prevalent areas. ASM activities have the capacity to lead to changes in dietary patterns due to shifts in income and lifestyle in effect. Analyzing some of these changes is a prelude to assessing the impact on nutritional outcomes and food diversity in mining communities. In addition, this study seeks to unravel how resources from mining are allocated within households and its effect on diet quality and nutrition (Liu *et al.*, 2022). Another significance of this study has to do with environmental and ecological considerations. It is known that ASM often leads to environmental degradation (Ofosu *et al.*, 2020), which can affect agriculture and local food sources. As such, researching these effects helps understand the broader ecological impacts of ASM. More so, studying the sustainability of ASM practices can inform strategies for minimizing environmental harm while optimizing benefits to communities (Nordhagen *et al.*, 2022).

In terms of policy implications, this study will contribute to the development of better regulatory frameworks for ASM, aiming to balance economic benefits with health and environmental protection. Furthermore, it must be realised that findings of this study can support the design of social protection programs and health interventions tailored to communities affected by ASM as reported by (Gandy *et al.*, 2023). Academically, this topic seeks to integrate various disciplines, including economics, public health, environmental science, and development studies, promoting

interdisciplinary research approaches. This study also contributes to specific fields like development economics, public health, and environmental management by providing empirical data on the effects of ASM. This research will allow for comparative studies between regions with different levels of ASM activity, providing insights into varying impacts and responses. Notably, ASM's effects can be contextualized within global development frameworks, offering insights into local issues with broader implications.

1.8 Structure of the Thesis

This thesis consists of seven chapters. Chapter 1 entails the background of the research, the problem statement, the aim, and the objectives of the research. Thereafter, Chapter 2 focuses on the background of this ASM study while Chapter 3 entails a conceptual framework and literature review related to ASM impact studies. Chapter 4 of this study describes the methodology for the research as well as some ethical considerations for the conduction of this research. The fifth chapter of this research entails the results and discussion of the quantitative aspect of this work which is related to the first two objectives. The sixth chapter entails the results and discussion of the qualitative part of this thesis which is related to the third objective on how ASM affects women directly and indirectly. Chapter 7 consists of various conclusions and recommendations as well as further areas of research as far as this study is concerned based on the results of this study. In addition, there is an appendix section that contains additional information that is relevant to this study such as questionnaires, ethical clearance form and sample transcriptions. All these together will contribute toward this holistic research study on the implications of artisanal and small-scale mining on food security, health and nutrition.

2.0 ASM: DEFINITIONAL ISSUES, ITS HISTORY AND IMPORTANCE IN GHANA

2.1 Introduction

Artisanal and Small-Scale Mining (ASM) is a significant livelihood activity that is found in many low-and middle-income countries around the world as reported by several studies (Ofosu *et al.*, 2020; Fritz *et al.*, 2022; Jiménez *et al.*, 2024). Considering the informal nature of ASM compounded by its use of unrefined techniques and practices, ASM has the potential to significantly cause environmental and social changes that could impact surrounding communities in diverse ways (Yankson and Gough, 2019). Regarding these, the consequences of ASM on nutrition, health, and food security have become important issues in contemporary ASM-related discourse. In most ASM-centric communities, local communities are reliant on agriculture for their subsistence living. However, these communities are affected by land degradation, various forms of pollution, and reduced agricultural productivity.

Additionally, ASM communities are often confronted with challenges in gaining access to nutritious diets, particularly with markets close to ASM site offering fewer fruits and vegetables in comparison to the parts of the community further from the ASM sites (Zhang *et al.*, 2020). There are a number of health risks in ASM such as child labor, violence, and psychological issues (Allan-Blitz *et al.*, 2022; Kwesi *et al.*, 2024).

In addition, the rapid growth of the ASM sector tends to have inimical effects on agriculture as perpetrated through land and water pollution as well as labor shifts from agriculture to ASM (Ofosu et al., 2020). These ASM-related environmental effects have the capacity to jeopardize the health and nutritional well-being of such communities. Although ASM supports households with relevant livelihoods, there are associated vulnerabilities created. These findings project the complex relationship existing between ASM and community well-being. This underlines the need for comprehensive research and policy interventions.

For that matter, the purpose of this literature review is to synthesize existing research regarding the complex and multifaceted impacts of ASM on food security, health, and nutrition. Through the vivid analysis of the linkages persisting between ASM and these salient factors, this literature review highlights the broader and nuanced consequences of ASM which goes beyond economic contributions and seeks to deepen the demand for more sustainable approaches which tend to balance mining with community welfare. To comprehend the disparate effects of ASM on different community members, the review will also point out gaps in the literature, such as the paucity of studies on gendered and intersectional consequences. This evidence synthesis will inform policies that promote both the socio-economic benefits of ASM and the health and nutritional security of mining communities.

2.2 Definitions of Artisanal and Small-Scale Mining (ASM)

Although there is no clear-cut and clear consensus regarding the definition of ASM as claimed by a body of literature (Morante-Carballo *et al.*, 2022; Moomen *et al.*, 2020; Byizigiro *et al.*, 2020), there is a need to fully establish the exact perspective of mining being looked at in this current study, which is artisanal and small-scale mining (ASM). Moreover, there is a need to clarify related nuances regarding its definition so as to ensure a more vivid definition of ASM (Weng and Margules, 2022). This will help set our study in the right direction and context.

Several narratives have come out with a variety of definitions when it comes to ASM and its associated nuances. For instance, Artisanal Small-Scale Mining and Small-scale Mining are very similar in definition and have mostly been substituted for each other by most scholars, however, Mulenga *et al.* (2024) asserted that the latter lays emphasis on the use of more technologically advanced techniques in the extraction process, whereas the former refers to the traditional, low-level mechanized way of mining.

Specifically, the definition of ASM could depend on the level of mechanization being implemented as it is being done in countries such as Ghana, Brazil, and Sri Lanka (Lahiri-Dutt, 2018b). This corroborates the assertion that the process of mining without mechanization defines Artisanal Small-scale Mining (Hilson and Maconachie, 2020) . This definition falls within the criteria of how the World Bank views ASM as it enumerates levels of mechanization as part of its definition criteria (Schneider *et al.*, 2020). This means mechanization is a predominant important indicator in the definition of ASM.

In addition, ASM could also be classified based on the size of the concessions as its being done in Ghana and Zambia again (Kumi-Boateng and Stemn, 2020). Over here, the size of the ASM concessions are just small fractions of the large-scale mines. This means the size of the concession plays a major role with it comes to the definition of ASM as being corroborated in other narratives on the extractive industry (Kemp and Owen, 2019).

Another factor for ASM definition is based on the amount of capital investment (Rwiza *et al.*, 2023). Mostly, ASM is characterized by its low capital investment. This is one of the major factor inputs in ASM. The growth of the entire ASM industry is hinged on the amount of capital involved (Lahiri-Dutt, 2018b). There are several capital expenditures involved in this case. However, the risk capital and the production capital are the two main ones in the mining business. The risk capital is relevant to the initial exploration and development of the business, whereas production capital will ensure the running of the business (Lilford and Guj, 2020).

The depth of working, capital investment, amount of employment offers and production levels are all basis of definition of ASM in countries such as Chile, Philipines, Senegal, South Africa, Pakistan and Thailand (Jerie, 2013). Furthermore, legislation has a role to play as far as the definition of ASM is concerned. For instance, artisanal small-scale mining is more associated with illegal activities and reduced mechanization while small-scale mining is related to semi-mechanization and organization (Jerie, 2013). As such, artisanal and small-scale mining is a

combination of host of factors such illegalities, semi-mechanization and organization that has to do with this operation (Jerie, 2013).

Despite all these explanations of ASM above, it is being argued that ASM lacks a universal definition (Jerie, 2013). However, the research assented to the fact that the definitions of ASM are country specific despite numerous factors such as scale of mining, capital involved, production rates, concession sizes, volumes of deposits and labor requirements. In consonance with these assertions that ASM's definition is country-specific, the details on Table 2.2 below by the International Labor Organization, ILO, expounds it further.

Table 2.2: Definition of ASM by various countries according to ILO

Country/ Organisation	Criteria
Cote d'Ivoire	Level of mechanisation
Ethiopia	Annual production, level of mechanization
Ghana	Capital investment, number of participants
Guinea	Type of minerals exploited
Senegal	Depth of working, crude production levels
South Africa	Capital investment
Tanzania	Capital investment, labour and technology requirements
United Nations	Annual production capacity
Zambia	Size of concession
Zimbabwe	Size of concession and capital investment

Source: (Jerie, 2013)

On the other hand, the amount of minerals mined has been a defining factor for the United Nations. Based on several extended research by the United Nations, the definition of ASM has also been focused on the technical aspects related to the industry. From the above and latter discussions, every country sees ASM in a unique way just like other researchers have reported (Veiga and Marshall, 2019). In some West African countries like Mali, Niger and Burkina Faso, factors like fixed installations in mining sites are some of the defining factors. These country-specific definitions highlight the various inherent locally relevant developments pertaining to the countries (Deb *et al.*, 2008).

Nonetheless, the debates surrounding the definition of ASM have been an unabating one. For instance, there has been a whole argument about the use of the word 'artisan' in the mining definition. The argument stems from the fact that since an 'artisan' refers to a person engaged in skilled work, it does not necessarily fit within the premises of small-scale mining (Mwakaje, 2012). In other words, the mining process involves the use of basic skills and simple implements improvised within the trade, which may not require any special skills to operate such as excavating as deep as 100m – 150m pits, the ability to hoist materials, and implements, washing of 'load' and fetching water onto the 'board' (Mallo, 2012).

From the above definitions of ASM, it could be seen as a low-mechanized, poverty-driven industry that lacks the requisite attention as far as policymaking is concerned (Hilson *et al.*, 2021b). From the 1970s to date, ASM has gone through various transitional stages with regard to its definitions and interactions in so many areas. From Table 2.3, below, it can be realized that the description and holistic definition of ASM is an integration of several factors. These emanate from technological perspectives, legal, social, gender, child labor issues, environmental, economic, and sustainability issues.

Table 2.3: Focus of ASM Debate and Intervention

Period	**ASM focus**
1970s	Definitional Issues
1980s	Technical Issues
Early 1990s	Towards integration of technical, environmental, legal, social and economic issues
1990s	Special attention on legalisation of ASM sectors
Mid late to 1990s	Relation between large mining companies and ASM Gender and child labour issues
2000	Community related issues and sustainable livelihoods

Source: (Hilson, 2016b)

2.3 ASM in Global Perspective and its Associated Features

Over the years, more than 40 million people worldwide have been directly involved in ASM activities (Finn *et al.*, 2024). In recent times in Sub-Saharan Africa and most places where there are mineral deposits, studies have proven that ASM has experienced a fast growth in importance as a source of livelihood for people and has established itself as a vital source of employment and income (Arthur *et al.*, 2016b; Zvarivadza, 2018; Hilson and Maconachie, 2020; Moyo *et al.*, 2022; Ofosu and Sarpong, 2022). On a larger scale, ASM has been able to employ millions of people aside from the millions of jobs in ancillary industries in sub-Saharan Africa (Ofosu, 2022a). These assertions corroborate the fact that ASM has been a major global poverty reduction strategy over the years (Hilson and Maconachie, 2020). As far as livelihood diversification strategies are concerned, it has been asserted that mining-associated activities could be undertaken advantageously to fill in the gaps within the value chain. ASM can become a source of identity and cultural belonging for most of the rural population. More so, it possesses the capacity to alleviate the inimical impacts of rural-urban migration (Arthur-Holmes and Busia, 2022c) through the provision of an income source for a greater part of the rural populace with limited livelihood alternatives. In view of this, there is a need to pay critical attention to it as far as planning and policymaking among all other attendant ASM-related issues are concerned as it possesses the potential to ensure more sustainable livelihood opportunities (Hilson, 2016a) son, 2016a).

Viewing ASM from a typical livelihood perspective, ASM is poverty-driven by nature, characterized by unskilled labor and varying levels of income (Hruschka, 2015). In some countries dominated by ASM like India, Indonesia, Ethiopia, Burkina Faso, and China among other places, the spate of ASM is influenced by factors such as economic recessions, seasonality of agricultural activities, gender issues, gold rushes, and poverty (Clifford, 2022). More so, it is worth noting that ASM has emanated from a myriad of socio-economic and environmental

pressures. Among these are issues of climate change, increase in population, land use land cover changes, and increasing demand for land and natural resources (Adranyi *et al.*, 2023). All these factors have contributed to the rapid proliferation of ASM activities globally, most especially in developing economies (Kahupi *et al.*, 2023) This has furthermore culminated in various ASM-related debates regarding issues of competition for resources use, labor issues, environmental issues, gender issues, food security, health and nutrition. Environmentally, ASM communities are seen to be at the receiving end of all the dangers ASM poses to the environment while the surrounding communities remain at the 'mercy' of the spill-over effects(Poignant, 2023). This environmental devastation originates from deforestation and soil contamination, which makes soil deficient in supporting crop plants. An equally worrying one has to do with the contamination of water bodies which ends up disturbing the aquatic habitats (Mabe et al., 2021). The competition for factor inputs such as land, labor, and capital significantly demanded by both the mining and agriculture industries remains an ongoing debate (Ofosu et al., 2020). More so, there are diverse perspectives as to how ASM impacts food security, the environment, and livelihoods. ASM is seen to promote income-earning opportunities for better livelihoods and food security by increasing the purchasing power of households. On the other hand, ASM has exposed households to various environmental hazards, destroying cultivable lands and resulting in food insecurity thereby among other predisposing effects.

Despite all these, ASM has been known as a better 'survival mechanism' for safeguarding the shocks of the economy(Osei *et al.*, 2021). ASM has a positive impact on the financial assets of the individuals involved, which is one of the most prominent livelihood assets. Similarly, individuals within the ASM fraternity have increased access to credit, income, and other inherent benefits associated with mineral proceeds sales. Despite these financial assets, ASM has caused a shortage of labor for farming and agricultural activities. The sharing of common labor resources highlights the intricate relationship ASM has with agricultural activities. Furthermore, the

continuous shift of migration of agricultural labor to mining could lead to a socio-economic and ecological breakdown with effects on food security, health, and nutrition (Li *et al.*, 2021a). Nonetheless, ASM has the capacity to contain the trade-off to support small-holder farmers with quick income, seasonality, market price fluctuations of agricultural produce, and unpredictable returns of agricultural investments (Baffour-Kyei *et al.*, 2021; Hilson *et al.*, 2025).

Another important feature is that ASM is characterized by high informalities as there are deepened debates by national governments plan to incorporate it into a formal economy (Ofosu *et al.*, 2020). Formalizing the ASM industry is seen as an antidote for surmounting the shortcomings of ASM and buttressing it to come to terms with modernization with enhanced benefits. However, the formalization process is riddled with several challenges. Among these challenges are land tenure issues, and bureaucracy among others (Atienza *et al.*, 2023). Other issues are the dearth of public data and geological services in potential mining areas. As far as formalization is concerned, there have been several efforts to integrate land tenure issues in diverse ways. To recognize such systems of land ownership which could be found in the form of customary owned lands, vested lands, and state-owned lands (Boamah, 2014), the land tenure systems have become very complex, varied, and bureaucratic (Geyer, 2023). The formalization of ASM could have led to the inculcation of various customary laws and land tenancy systems (Huntington and Marple-Cantrell, 2021; Mensah, 2021). However, the ASM industry is devoid of detailed official policy documents on such interventions. Moreover, the ineffective decentralized process involved in the process of acquisition of license questions the active participation and involvement of various stakeholders such as traditional authorities in the formalization process. The inclusivity of these stakeholders into the formalization scheme will leverage on the rich knowledge resource of the stakeholders who are well-versed in the local terrain and are much abreast with the day-day operations of the ASM activities (Rubbers, 2023). Additionally, part of the many ASM discussions around the formalization scheme of ASM is the

cohabitation of formal mining companies and artisanal miners and the kind of effects they exert (Smith *et al.*, 2017). These discussions emanate from the increasing interaction between the two divides as well as mounting sustainability issues despite their significant contribution to the economies of the world (Sauerwein, 2023).

It is worth noting that mining has been one of the major industries riddled with numerous challenges, leading to a myriad of debates and disputes as far as land use is concerned. For instance, the effect of mining on agricultural productivity is an aged conundrum. Within the extractive industry, mining has led to the destruction of various agricultural/farmlands (Ofosu *et al.*, 2020). Over a period of five years, ASM activities have degraded several hectares of land and forest reserves in some mining communities in Ghana (Boadi *et al.*, 2016). This, in effect, has made farming an unattractive economic activity. However, the relevance of farming in generating food to the satisfaction of household consumption demands can never be erased. As such, making the impact of ASM activities on agricultural lands, food production, and health an unending conversation.

Notably, ASM contrasts with Large Scale Mining (LSM) in several ways. These two industries differ in terms of scale, scope, and production volume (Kemp and Owen, 2019). In terms of scope, ASM entails individuals or small groups of miners, unlike LSM which is made up of large corporations which are mostly multinational. When it comes to scope, ASM mostly focuses of minerals such as gold, diamonds, and gemstones. LSM deals with minerals like coal, iron ore, copper and gold. In terms of production volume, ASM could have a small volume but has significant amounts of minerals like gold and gemstones. However, LSM has more advanced technologies for extraction and processing. Mostly, ASM relies on manual labor, simple tools, and traditional techniques, unlike LSM which deals with high levels of technology and use mechanized and sophisticated mining techniques.

2.4 History of ASM in Ghana

In Ghana, ASM, which is locally known as "galamsey," has a long history. Evidence points to the pre-colonial era as the time of gold extraction, with small-scale mining playing a significant role in regional economies and cultures (Tuffour, 2023). Dating back to the 15th century, some of the colonial governments like the Portuguese among other Europeans had so much concentration on gold mining. This led to the establishment of several gold mines in the country. Although this colonial administration tried introducing regulations that were targeted at controlling and taxing gold mining activities, many local miners carried on operating informally.

Right after Ghana gained independence, the then government tried to harness the mineral resources to promote economic development. Nonetheless, these actions were confronted with artisanal practices. In the 1960s and beyond, some of these mines were nationalized but, the activities of ASM thrived, especially in rural areas (Ankamah, 2022). Most of these activities fell outside the tenets of formal mining frameworks. Also, during the economic downturns of the 1980s in the history of Ghana, most of the citizenry resorted to ASM for their survival. This move was aggravated by the Structural Adjustment Programs (SAP) which was placed on Ghana by the International Monetary Fund (IMF) (Terry, 2019). More so, the increase in gold prices on the global market was a major incentive for these ASM activities. In other words, the financial benefits accrued from this trade were a major motivator (Verbrugge and Geenen, 2019).

These local people extracted gold using conventional techniques like panning and shallow pit mining. Many Ghanaian communities have integrated mining into their socioeconomic fabric because of these techniques have been passed down through the centuries. It was around this time that the use of mercury for gold processing became common, regardless of the health and environmental threats it posed (Saim, 2021).

This introduction is a means to establish the context of this study as it introduces the primary issues regarding this study, clarifies the focus, and also examines ASM’s effects. It also

highlights the study's significance and outlines its objectives as it sets the stage for a comprehensive exploration of ASM's impact on community health, nutrition, and food security.

Especially in developing nations like Ghana, ASM is deeply ingrained in many communities' cultural and social fabric. ASM is strongly ingrained in regional customs and cultural history in many places. Mining-related cultural identity is kept through the generational transfer of techniques and practices. Communities' social ties can be reinforced through ASM activities. A sense of solidarity and group identity are fostered by shared labor and the community aspect of mining activities (Bansah *et al.*, 2023).

Another cultural dimension of ASM is the fact that women are heavily involved in various areas. They work at several phases of the mining process, which includes extraction, processing, and trading. ASM can give women the chance to support their families and become financially empowered as asserted by Hilson *et al.* (2018a). In Ghana, ASM continues to be an important industry that supports many people's livelihoods and is vital to the national economy. For instance, many women still find employment with ASM, especially in rural areas where there are few other employment options. It must be emphasized that the ASM significantly contributes to women's well-being in terms of household incomes, with many families depending on it for their well-being.

2.5 The Rise of ASM in Ghana

Over the years, studies have shown that the ASM sector has functioned as a means of escape for the majority of those who wish to evade the 'agricultural poverty' syndrome (Hilson and Hu, 2022). In Ghana, ASM activities has always been on the ascendency since the 1990s (Ofosu-Mensah, 2017). According to research, between the year 1990 and 2016, gold production from ASM was recorded to have increased from 16,000 ounces to 1.6 million ounces (Owusu *et al.*, 2019). This attests to the increasing nature of the ASM industry in Ghana. This increase in ASM could be attributed to several factors. For instance, despite the informal nature of ASM, there are

‘career miners’ who have taken up the ASM work as their main occupation (Ofosu-Mensah, 2017). These groups of people have been specifically described as ‘people who pursue a career within ASM with mineral-led spatial mobility strategies, social mobility aspirations, and collective identity characteristics, whose goal is to become successful miners or businessmen, not to return to agriculture’(Bryceson *et al.*, 2022). These career miners are distinguished by the level of occupational engagement and levels of concentration on the ASM as well as their readiness to respond to the erratic nature of the mineral availabilities in various geographical spaces(Perks, 2011). As far as these career miners are concerned, their activities could be categorized into permanent artisanal mining, seasonal artisanal mining (caused by migration due to undulating agricultural seasons), and the rush type which is motivated by migration and the shock push which is poverty-driven (Mabe *et al.*, 2021).

ASM is seen as a coping mechanism by most people as far as their livelihood is concerned, hence its proliferation over the years (Mabe *et al.*, 2021). This coping mechanism is a consequence of ‘Push and Pull factor’ that has succeeded in making people find an alternative source of income (Mkubukeli and Tengeh, 2016). These push factors literally force farmers to engage in other non-farm activities to make a living. On the other hand, pull factors are generally the advantages that have the capacity to lure farmers to actively partake in non-farm activities. This stands to say that people indulge in ASM for several reasons as far as sustaining their livelihood is concerned.

Moreover, ASM could be viewed in another dimension by virtue of its recognition by the state (Bansal *et al.*, 2023). This brings to the fore mining activities that have been formally registered and those that are not which belong to illegal mining. ASM activities in most countries are devoid of proper organization and regulation, especially in sub-Saharan countries like Ghana. This has urged the government to encourage the formalization of the sector so as to ensure its effective management and thereby, minimizing the inimical effects that come with it (Bansal *et al.*, 2023). Despite the merits of this formalization agenda, there are research works that support the posture

of the government to enervate these miners within the ASM fraternity so as to dominate and gain absolute control(Siwale and Siwale, 2017). Some other researchers are also of the view that formalization of the sector has no demarcated advantages for the actors therein (Salo *et al.*, 2016). More so, there have been several recommendations geared towards ensuring more inclusiveness as far as mineral tenure and labor issues are concerned.

In addition, ASM is viewed to play a more complementary role for farmers with regards to their economic activities. This is in consonance with the view of ASM as a poverty alleviation 'fighter' in most sub-Saharan economies where minerals abound (Asori *et al.*, 2023). By this way, people like farmers can secure enough income to cater for their farming activities. The relevance of ASM can be realized from the above discussions which is evidentially proven through its social implications, economic contribution as well as the challenges therein. Nonetheless, the comprehensive understanding of ASM's impact lies in its significant and interactions with the broader ecosystem (Macháček, 2019). As such, the following section explores these interactions, highlighting the complex relationships and nuances pertaining to ASM.

2.6 Features and Significance of ASM

ASM by nature of its heterogenous nature in the livelihood perspective and nations' economies, is characterized by various interactions and relationships (Bikubanya and Geenen, 2023). These relationships cut across several facets of livelihood diversification strategies. There are some narratives that view some of these relationships as competitive, complimentary and antagonistic amounting to the intricate nature of ASM relationship (Ofosu *et al.*, 2020; Poignant, 2023; Adranyi *et al.*, 2024). ASM shares this kind of relationship in several domains which could be agricultural in nature, climatic, economics among others.

For instance, Pijpers (2014) argues that the relationship existing between ASM and agriculture can be seen as a co-existing one instead of an incompatible one. According to the paper, viewing

this relationship beyond the realm of competition is a comprehensive way of managing the prospects of the two industries.

This relationship stems from the fact that the two industries operate in a way that benefits the players within the industry. For instance, the proceeds from ASM are used to support agricultural activities while agriculture serves as a source of food security as well as a form of backup for farmers in seasons when much profits is not realized from mining. More so, these two industries have a strong coexistence when it comes to the use of shared labor, another complimentary relationship. The effective comprehension of this intricate relationship highlights the complementarities that define ASM interactions synonymous to the linkages between mining and farming in the area of alternative livelihood choices, land-use and the values placed on both industries by people affected by these two industries as narrated by (Pijpers, 2014).

By way of providing an alternative livelihood, ASM and agriculture present an exemplary scenario. For instance, in the case of farming in sub-Saharan Africa, there are several alternatives' people resort to when the farming occupation is unable to meet their economic and social demands. In this wise, especially in areas where there is abundance of natural mineral resources, people tend to diversify and resort to ASM as a source of living among other livelihoods as discussed by Bryceson and Fisher (2013).

Diversifying of sources of livelihood happens for a number of reasons such as seasonality. For instance, by way of increasing their sources of livelihood, farmers have inculcated ASM as one of their alternative livelihoods. This is done by farmers to make up for any economic shock that comes with the seasonality of their agricultural trade. In other words, the seasonality of crop production gives the impetus for alternative livelihoods. This means that there is a need to view mining and agriculture as inseparable activities rather than alternatives (Hilson and Maconachie, 2020). This springs from the fact that earlier publications on ASM could not emphasize much its role in this development.

Wealth accumulation has been cited as one of the reasons for diversification from farming to ASM. According to Pijpers (2014), the proceeds that accrue from land revenues circulates between the two main industries. The flow of investment from mining to farming and vices is a common phenomenon as far as this nexus is concerned (Maconachie and Binns, 2007). As a matter of fact, this accumulation of wealth has helped revived agrarian economies and networks over the years in countries like Ghana and Sierra Leone where both industries are thriving (Hilson et al., 2011).In other words, monetary returns from farming activities is used to finance non-farming activities like mining especially by some farmers who are who are also engaged in mining at the same time as reported by (Ofosu et al., 2020). This phenomenon emanates from the fact that some of the livelihood diversification alternatives like cocoa farming are more cost intensive as compared to ASM which comparatively does not require so much capita. Even with the mineral industry, research in Sierra Leone proves that surpluses from gold mining activities could be invested in farming (Pijpers, 2014).

In the past decades, Ghana used to be one the major 'gold hubs' in West Africa where Gold was barter traded with salt among other commodities that were not common in areas mining areas (Bryant and Mitchell, 2021). However, after the introduction of cocoa into the Ghana agricultural landscape, much concentration was given to cocoa cultivation. Nonetheless, there were people who still indulged in ASM since the cocoa took a longer time to yield (Eshun et al., 2021). When the mining operations were over, the landowner cultivated oil palms to put the soil back to shape for about 3-4 years. Thereafter, the farmer goes back into cocoa farming. This kind of interaction between cocoa and mining points to the fact that mining and farming comprise formidable livelihood strategies.

In some places, parts of the land are rented out for farming purposes while other parts of the land are used for mining. This is a clear demonstration of the co-existence between mining and farming within a particular locality (Dankwah *et al.*, 2024).Similarly, there are instances where

certain concessions of land are influenced by activities such as sand-wining, mining and other activities.

Another land use that favors the co-existence between mining and farming is known as vertical integration. This is common in areas where there is deep shaft mining. Since this form of mining is done in the deeper layers of the soil, the upper part of the land is used for farming crops such as cocoa or other annuals. This could also be a very congenial form of mining for all types of surface mining and agriculture to co-exist (Sikor and Lund, 2009). The examples are in support of the fact that the type of mining and farming have so much effect on the level of coexistence between the two industries and not necessarily the mere persistence of both activities.

Nonetheless, the claim and use of land are subject to various forms of negotiations pertaining to the existing regulations as dictated by governing authorities. Importantly, national policies are bound to influence the outcome of such negotiations. Other factors such as price fluctuations, land accessibility and the ability to diversify land use play a critical role in such decisions (Sikor and Lund, 2009).

According to some reports (Mi *et al.*, 2020), the type of mining, scale of mining and crops cultivated have an effect on the interaction between mining and agriculture. In the case of farming in sub-Saharan Africa, there are several alternatives people resort to when unable to meet their economic and social demands. In areas where there is abundance of natural mineral resources, people resort to ASM as a source of livelihood (Bryceson and Fisher, 2013). Other factors could also necessitate this diversification of resources.

Seasonality is one major reason for diversification of resources. Farmers have inculcated ASM as one of their alternative livelihoods. This is done by farmers to make up for any economic shock that comes with the seasonality of their agricultural trade. The seasonality of crop production gives the impetus for alternative livelihoods. This means that there is a need to view

mining and agriculture as inseparable activities rather than alternatives (Hilson and Maconachie, 2020).

Another reason for diversification of resources is improvisationalism. In situations where resource opportunities are used up, farmers respond by improvising. IRIN (2009) reported a typical situation in Sierra Leone whereby the fall in the production of diamonds led to the diversification from mining to crop production. This shift creates a drop in production in the ASM industry as majority of the labor is shifted to activities like cocoa farming especially when cocoa prices are shooting up. Livelihood diversification from agriculture to ASM comes with other rippling consequences. Livelihood diversifications from agriculture to mining has impacts on food security as well as rural socioeconomics (Bansah *et al.*, 2023)

2.7 Recent Developments in ASM in Ghana

In recent times, the government has introduced the Community Mining Scheme (CMS) in Ghana (Adu-Baffour *et al.*, 2021). This scheme seeks to formalize the ASM activities in various communities. This initiative aims at promoting job creation avenues and also, ensuring safer and environmentally sustainable mining activities (Mensah *et al.*, 2024). Community mining in Ghana was designed to formalize and regulate small-scale mining operations to benefit local communities. This initiative aims to mitigate environmental degradation and social issues commonly associated with artisanal small-scale mining (ASM) while promoting sustainable development. Community mining is part of Ghana's broader strategy to formalize ASM, ensuring that these activities comply with legal and environmental regulations. This helps in minimizing illegal mining and its associated negative impacts. The initiative emphasizes the participation of local communities in mining activities. This involvement ensures that the benefits of mining, such as employment and economic growth, are directly felt by those living in mining areas. Community mining programs promote sustainable mining practices that reduce environmental harm. This includes proper land reclamation, pollution control, and the use of safer mining

techniques. By providing legal avenues for mining, community mining empowers local populations economically (Baddianaah, 2024b). This can lead to improved living standards, reduced poverty, and better access to services and infrastructure.

The introduction of this mining scheme operations helps in reducing conflicts between small-scale miners, large mining companies, and the government. Clear regulations and recognized rights can help in mitigating disputes over land and resources. The government, in collaboration with various stakeholders, provides training and support to community miners. This includes technical assistance, financial aid, and education on sustainable and safe mining practices (Adranyi *et al.*, 2023).

Currently, in Ghana, ASM is thought to directly involve about a million individuals which people who are fully engaged in the extraction, processing, and transportation of minerals. Through associated businesses and services including food distribution, equipment sales, and transportation, the industry also provides indirect support to an additional 4.5 million people (Ofosu and Sarpong, 2022).

Men, women, and children make up the broad demography involved in ASM in Ghana (Baah-Boateng *et al.*, 2022). While males are usually involved in the more physically hard duties of excavation and mining, women are frequently involved in diverse positions, such as processing and trading minerals. ASM is predominantly a rural activity, providing critical income in areas where other forms of employment are limited (Ofosu and Sarpong, 2022).

In Ghana, ASM operations are prevalent throughout several regions, with notable concentrations in the Western, Ashanti, Eastern, and Northern regions with pockets of is operations being observed in other parts of the country (Ofosu-Mensah, 2021). These areas are well known for having abundant mineral resources, especially gold. The sector supports local economies by creating demand for goods and services, thus generating income for local businesses.

ASM produced several ounces of gold in 2014, a high percentage of the nation's total gold production according to the Ghanaian Minerals Commission. According to the Ghana Chamber of Mines estimate, 1.98 million ounces of gold, or around 43% of Ghana's total gold production, were produced through ASM activities (Adomako-Kwakye and Mensah, 2022). According to data from Ghana's Minerals Commission, ASM production was estimated to be 2.1 million ounces, accounting for 42–45% of the country's total gold production. According to other reports, ASM produces over 1.6 million ounces of gold or 30% of the country's total production. However, this amount varies depending on the market and regulatory developments (Yoshimura *et al.*, 2021).

Particularly in developing nations, artisanal and small-scale Mining (ASM) is vital to local economies. In many rural communities with little other options, ASM is a major source of employment. Millions of miners worldwide receive direct employment from it, and many more are indirectly supported. The cash generated by ASM operations helps miners and their families to live better. This money is utilized for other important services like healthcare, education, and daily necessities. ASM provides a different kind of employment for areas that are mostly dependent on agriculture or other isolated sectors. This diversity can improve economic resilience and lessen reliance on a single industry (Zvarivadza *et al.*, 2024). ASM promotes the expansion of regional companies that serve mining towns with goods and services, including food vendors, equipment suppliers, and transportation providers.

Investments in neighborhood infrastructure, such as roads, schools, hospitals, and housing, may be made possible by the money earned from ASM. The general quality of life is raised through the investments made by miners and their communities in these kinds of upgrades. Nonetheless, it must be recognized that formalized activities can help local governments raise money through taxes and license fees, even if ASM is frequently an informal sector. The money raised here can be put back into neighborhood improvement initiatives.ASM initiatives integrate miners into the

local economy by generating demand for regional products and services. This demand helps several industries, including retail and agriculture.

Significant economic gains can be obtained from artisanal and small-scale mining (ASM), especially in underdeveloped nations. It does, however, also bring with it a number of social and environmental difficulties. To ensure that ASM can minimize its negative effects while maximizing its positive contributions to local economies, it is imperative that these challenges are addressed (Adranyi *et al.*, 2023).

Workers in the mining industry are frequently exposed to dangerous substances like cyanide and mercury, which can cause neurological damage, respiratory disorders, and mercury poisoning, among other major health concerns. Numerous ASM activities operate without the necessary safety equipment and standards, which frequently leads to mishaps, injuries, and fatalities. Children work in mining operations in some areas, frequently in dangerous situations. Their general well-being, education, and health are all impacted by this. Children who work in mining may experience disrupted schooling and limited possibilities in the future as stated by Longfield (2024).

Due to income fluctuations caused by changes in mineral supply and prices, ASM can be economically unstable. The miners' and their families' financial security may be impacted by this volatility. Miners may not have access to official financial institutions, legal safeguards, or social safety nets because many ASM operations are informal. Particularly when miners encroach on agricultural property or places designated for protection, ASM can result in disputes over land ownership and use (Helenius, 2024) .

Particularly when it comes to resource access and environmental management, there may be conflicts between ASM miners and large-scale mining firms or local government. ASM participants who are women frequently experience prejudice and unfair treatment in comparison

to their male counterparts. Their access to resources, opportunities for training, and decision-making processes could be restricted. It is possible for women in ASM to be excluded from the official economic perks and protections accorded to men (Güiza-Suárez and Kaufmann, 2024).

The legal and regulatory frameworks that oversee artisanal and small-scale mining (ASM) exhibit significant variation among nations, owing to disparities in legal customs, economic imperatives, and developmental stages. The Minerals and Mining Act, 2006 (Act 703) is one of Ghana's laws. This is the main piece of legislation that controls Ghana's mining industry. It lays forth the licensing criteria, environmental standards, and community interactions for both large- and small-scale mining. Ghana passed the Small-Scale Gold Mining Law, 1989 (PNDCL 218) earlier. Although more contemporary rules have taken its place, this previous legislation particularly addresses small-scale mining enterprises. It contains clauses pertaining to small-scale miners' registration and licensing. The regulatory body in charge of mining supervision, including ASM operation monitoring and licensing, is the Minerals Commission. Furthermore, it is the responsibility of the Environmental Protection Agency (EPA) to guarantee that mining operations adhere to environmental guidelines and requirements (Acheampong, 2022).

3.0 LITERATURE REVIEW

3.1 Introduction

This part of the study reviews several related conceptual frameworks that apply to ASM and further settles on one more suitable and appropriate for this study. This chapter also reviews a number of empirical studies regarding ASM impacts in the areas of food security, nutrition, health, and gender.

3.2 Pathways of the Impact of ASM

Broadly, the impact of ASM could be examined by virtue of several pathways as seen in Fig 3.2. These pathways of impact fall within categories such as environmental, economic, and social pathways as observed by a range of studies (Bank, 2020; Tampushi *et al.*, 2022; Gasparinnetti *et al.*, 2024; Bakr, 2018). Even more, there are several effects exerted on the environment and entire livelihoods of households when it comes to each of these pathways of ASM according to several bodies of literature (Ofosu *et al.*, 2020; Collins and Lawson, 2018; Schwartz *et al.*, 2021b; Morante-Carballo *et al.*, 2022). These range from impacts on land degradation and water pollution to biodiversity loss with rippling effects on climate change.

Other effects from environmental pathways are linked to reduced agricultural productivity and contaminated soil and water (Gilbert, 2022). Adranyi *et al.* (2024) asserted that the effect of reduced agricultural productivity could further escalate into food security and nutrition issues. Still more, Bansah *et al.* (2024) reported that ASM activities through the environmental pathways are associated with the clearing of forests to have access to mineral-rich areas. These activities consequently tend to cause disruptions in ecosystems. Moreover, ASM exposes topsoil, increasing its susceptibility to erosion (Asare *et al.*, 2024). Such degraded land makes it unsuitable for agriculture with consequent effects on food crop production. More so, these destruction of habitats results in the displacement and extinction and species as reported by a

number of studies (Payton *et al.*, 2021; Markham and Sangermano, 2018; Mujere and Isidro, 2016). Excavation and washing activities practiced in ASM tend to increase sediment loads among other chemical residues in the air, land, and other aquatic bodies according to Verbrugge and Thiers (2021) and Darko *et al.* (2023).

In terms of economic pathways, income shifts that are associated with ASM occur in several ways which tend to demonstrate both the opportunities and risks as reported by (Stokes-Walters *et al.*, 2021). O'Faircheallaigh and Regan (2017) observed that minimal capital is required in addition to skills as far as ASM activities are concerned. In this way, economically disadvantaged groups can engage in ASM and generate some income eventually. In addition, income derived from ASM activities tends to complement seasonal agricultural work providing an additional income stream during the off-season (Hilson and Maconachie, 2020). In comparison to traditional agriculture as well as other informal jobs, ASM is related with higher, albeit volatile, earnings which are mostly realized in the short term (Orleans-Boham *et al.*, 2020) (Orleans-Boham *et al.*, 2020). The youth do find opportunities in ASM as an alternative when they are confronted with issues of unemployment as observed by a body of knowledge (Arthur-Holmes and Busia, 2022c; De Haan *et al.*, 2020; Clifford, 2022).

In like manner, variability in mineral yields and weather conditions tend to result in unpredictable income streams in ASM (Hilson and Maconachie, 2020). ASM is also characterized by income inequality whereby, some workers earn significant profits from ASM, while others like laborers and women in secondary roles receive disproportionately lower wages. This in turn has the capacity to affect food security and nutrition of the household (Serwajja and Mukwaya, 2020; Paschal *et al.*, 2024; Arthur-Holmes *et al.*, 2023b)

As far as social pathways are concerned, ASM engages women in various roles allows them to earn incomes for the support of their household needs as some studies have reported (Ofosu *et*

al., 2024b; Tobalagba and Vijeyarasa, 2020; Jackline, 2022). Along with that, ASM activities also attract migrant workers from far and near communities (Afferi, 2024; Arthur-Holmes and Busia, 2022c; Bashwira and van der Haar, 2022). This leads to a surge in population growth in mining areas which comes with consequences on local infrastructure like housing, water supply, food security, and healthcare (Arthur-Holmes and Busia, 2022c; Malone *et al.*, 2021).

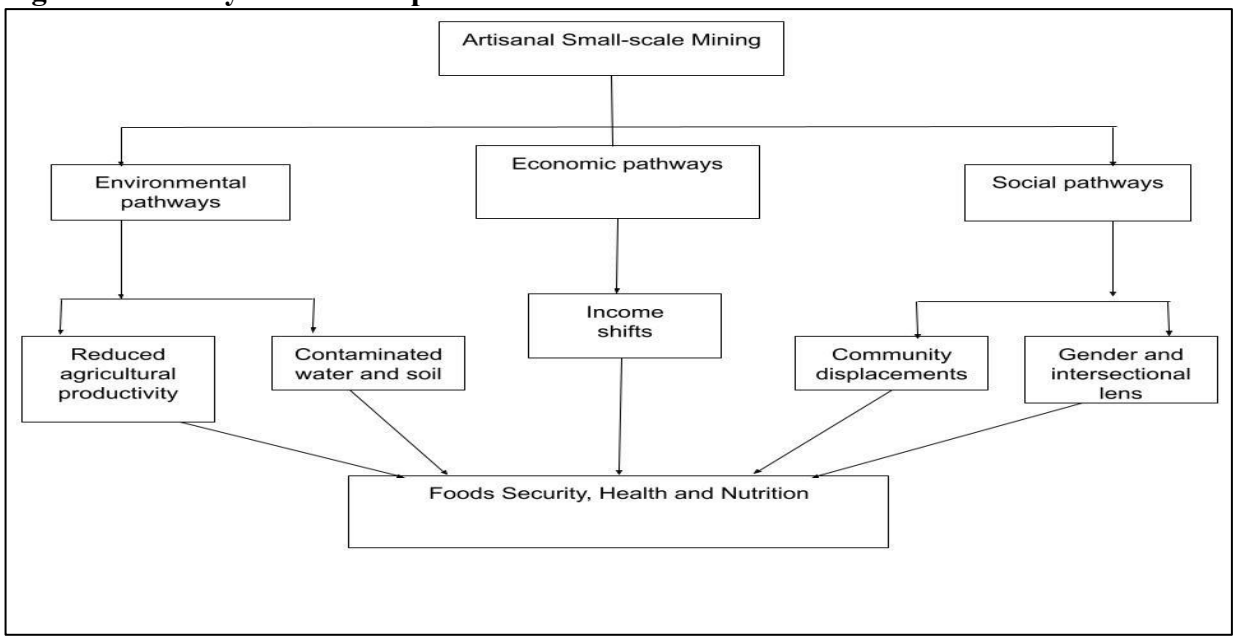
In addition to gender issues, the displacement caused by the activities of ASM leads to the disruption of community structures and cultural ties as a result of the kind of associated physical, social, and economic upheavals it come with (Annan, 2024). The need for ASM causes the destruction of communities which could disintegrate families and neighbors who lived together (Laing and Pinto, 2023). This could result in the dispersal of populations and the weakening of social ties and communal networks.

Some communities are also associated with sentimental spiritual and cultural linkages to their land. As such, displacement causes severance of such ties and this could result in the loss of cultural identity and traditional practices (Mensah *et al.*, 2024). In addition, sacred sites used for certain traditional ceremonies would no longer be available, consequently, eroding cultural continuity (Osei, 2023). Some communities displaced by the activities of ASM lose access to sacred sites which tends to cause a disruption of their cultural identity and spiritual practices (Vallejos *et al.*, 2020).

Ayinpoya Akafari *et al.* (2021) observed that there ASM has caused displacement of farming communities as well as traditional family units, while the youth have migrated to urban areas in search of work, leaving elders isolated. The detrimental loss of cohesive community structures due to the spate of ASM activities affects such displaced populations and aggravates their already deplorable situations. Resettled communities after being displaced by ASM activities are likely to compete for limited resources such as land, water, food and jobs in new locations. This makes

them more vulnerable to exploitation, poverty, and marginalization (Smith *et al.*, 2016; Finn *et al.*, 2024; Baddianaah, 2024b). Fig 3.2 depicts a broader framework as far as the impacts of ASM on health, food security and nutrition are concerned.

Fig. 3.2: Pathways of ASM impact



Source: (Bank, 2020; Tampushi *et al.*, 2022; Gasparinnetti *et al.*, 2024; Bakr, 2018; Ofosu *et al.*, 2020)

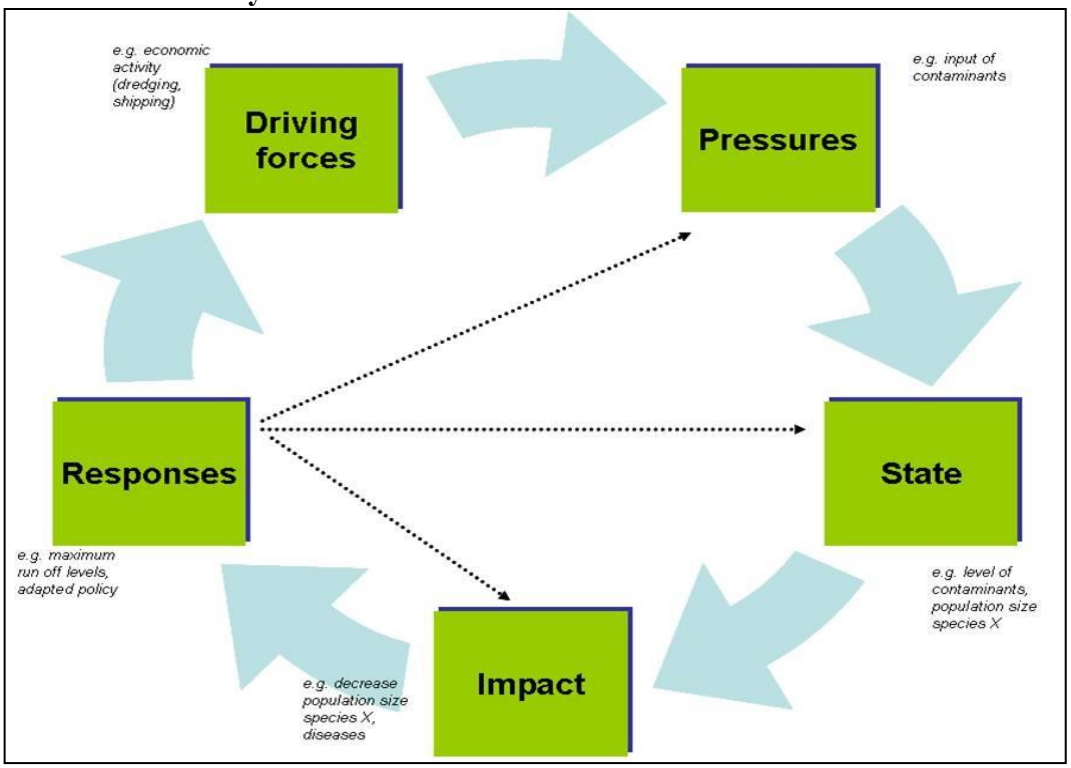
3.3 The DPSIR Framework

There are a number of frameworks that are related to this study namely Sustainable Livelihood Framework (Baah-Ennumh *et al.*, 2020), Political Ecology (Hirons, 2011), Integrated Risk Management (Wang *et al.*, 2010), Human Development (Greenfield, 2018), Social Determinants of Health (Park *et al.*, 2020) and DPSIR (Driving forces, Pressures, State, Impact, and Response) (Gatì *et al.*, 2024). However, The DPSIR gives a comprehensive analysis of the interconnected pathways by which ASM affects well-being outcomes such as food security, nutrition and health. The European Environmental Agency (EEA) as well as other Environmental Protection Agencies (EPAs) all over the globe have mostly resorted to the DPSIR model (Drivers, Pressures, State, Impacts, and Responses) when it comes to environmental and livelihood linkages (Antonescu, 2018). The purpose is to assist in the development of environmental

assessments, identification of indicators as well as the communication of results (Lewison *et al.*, 2016). It is a very good platform for national and international initiatives as it is commonly utilized by the European Environment Agency for the propagation of integrated environmental risk assessment studies. This enlightens one in the assessment of forces that control dynamism in an ecosystem.

The major driving forces of the model are socioeconomic and sociocultural forces driving human activities which in one way or the other, puts pressure on the environment (Moktadir and Ren, 2023). The 'P' stands for the pressures which are imposed by human activities such as pollutant emission. The 'I' stands for the Impacts or the effects of environmental degradation such as biodiversity while the 'R' stands for Responses by the society to the environmental situation.

Fig 3.3: The DPSIR Analytical Framework



Source: (Antonescu, 2018)

This framework as shown in Fig. 3.3.11 helps in designing assessments, identifying indicators, and communicating results as well as supporting improved environmental monitoring and information. One of the main advantages of this framework is that it helps understand the real

drivers which are local/situational specific. More so, it is meant to enable one to implement the most effective responses to minimize the pertaining pressures/influences thereby. This framework enhances one's comprehension of cause-effect relationships, key gaps in prioritizing research work, identification of drivers as well as effective rationalization of resources. In the process of identifying effective responses by the use of DPSIR, it is worth noting that situations will only improve if the responses are efficiently implemented and reinforced (Yussif *et al.*, 2023). The DPSIR is a causal framework that can describe the interactions between society and the environment (Kyere-Boateng and Marek, 2021). In other words, it is known as a tool for structuring our thinking. It is a structure within which indicators are presented. This aids in giving quality feedback as far as environmental quality is concerned (Yang *et al.*, 2023). Some of the factors that fall within the Driving Forces are mining, population, transport, etc. Subsequently, these Driving forces exert pressures on the environment due to production or consumption processes which fall into three main categories namely excessive use of environmental resources, changes in land use, emissions of waste, chemicals among others into air, water and soil (Zhao *et al.*, 2023). Some motivating factors in the context of ASM are poverty and economic necessity (Aizawa, 2016). Since there are few other options for generating revenue, many people turn to ASM in resource-rich but economically underdeveloped areas. The expansion of ASM operations is motivated by this quest for economic prospects. ASM operations are frequently propelled by the rising demand for precious metals and minerals, such gold, on a worldwide scale. There are incentives for people and groups to participate in ASM because of this need and the lax regulations in many areas (Otoijamun *et al.*, 2021).

Thereafter these 'pressures' are felt, and the condition of the resulting environment is known as the State (Kanianska, 2016). Examples of these states are polluted water, degraded land, and deforested areas. These tend to have inimical effects on human health, socioeconomic activities, and the well-being of the environment. As a result of this state of the environment, there is an

Impact due to a combination of variable States. All these lead to the vulnerability of people and the environment. As a result of all these, Responses from the environment are triggered. These are societal actions taken to overcome, reduce, and prevent negative environmental impacts (Carnohan *et al.*, 2023). The environment is significantly impacted by ASM activities, which include soil erosion, water contamination, and deforestation. Water bodies are contaminated using mercury and other hazardous chemicals in mining operations, which also harms aquatic ecosystems and taints food and water sources.

ASM puts strain on human health by exposing workers to dangerous working circumstances, such as risky mining methods, and by contaminating nearby habitats with hazardous materials like mercury, which can build up in food chains and result in major health issues (Aram *et al.*, 2024). Degraded ecosystems and contaminated water sources are examples of how ASM pressures alter the state of the environment. The availability of natural resources, such as clean water and arable land, which are crucial for food security and nutrition, is directly impacted by these environmental changes. Public health conditions in ASM communities are frequently a reflection of pollution exposure and environmental deterioration. ASM activities are characterized by places with high rates of respiratory illnesses, waterborne infections, and mercury poisoning (Ondayo *et al.*, 2024).

In response to the effects of ASM, governments and international organizations may enact regulations meant to prevent environmental degradation and safeguard public health. These could involve formalizing ASM operations, encouraging safer mining techniques, and enforcing environmental restrictions more strictly. It must be realized that, when programs are borne out of the community influence, these programs tend to adopt more environmentally friendly methods. These community-led programs also seek to ensure degraded lands are well restored, and, promote food security. This is attained through the institution of alternative livelihood options through which income is derived. More so, community-led influences have the

possibility of promoting public health concerns by ensuring good access to safe drinking water and better health care.

In examining the ways by which ASM impacts on food security, health and nutrition, the DPSIR framework plays a very critical role (Atampugre *et al.*, 2024). Effective comprehension and managing the effects of ASM could be made easier through the employment of DPSIR framework. This framework plays a major role in outlining the causal relationships between ASM activities, and its effects on the communities and ecosystems. This is achieved by recognizing the driving forces, pressures, impacts and reactions inherent with these driving forces. Moreover, it must be realized that DPSIR model has been widely used (Antonescu, 2018).

In the realms of ASM, the linearity of the framework and how it simplifies some intricate connections have been critiqued. More so, its emphasis is seen to be more reactive than proactive. This is because, this framework is more applicable to situations that have already happened as compared to preventing future occurrences. DPSIR is more driven by observed impacts and tends to have a backward-looking analysis. Moreover, it can be realized that social and political concerns are not addressed in the framework, although these are very important in addressing the effects of ASM on food security, health, and nutrition. Irrespective of these shortcomings of the framework, the DPSIR remains a very useful resource, especially in ASM studies and its associated impacts on food security, health, and nutrition (Rai *et al.*, 2019).

3.3.12 Critiques of the DPSIR Model

According to Elliott and O'Higgins (2020), this framework does not put much emphasis on non-linear interactions, particularly in socio-ecological systems. It is argued that social and economic systems tend to be underrepresented in the DPSIR framework. However, the DPSIR model has been critiqued regarding its insufficient consideration of the unintended consequences of interventions. Nonetheless, it must be realized that the model gives a more organized means of

conceptualizing the chain of cause-and-effect relationships. This provides a means of breaking down the complex dynamics of systems into convenient and adaptable components (Labianca *et al.*, 2020). This means the DPSIR model has a way of generating a pathway when it comes to analyzing complex relationships. By this way, certain components could be used for some interventions. This will allow for flexibility in the addressing of certain content-related issues. In the context of this study for example, the environmental pressure exerted by ASM in a particular area where deforestation is of important concern, could be mutually and exclusively tackled as compared to another area where there is a problem of water contamination. In the end, this will allow for the integration of diverse perspectives in solving certain issues of concern in the environment.

3.4 Logical Link between ASM, Food Security, Health Status and Nutrition

Based on the consideration of conceptual frameworks, the DPSIR model is a more suitable framework for this study. This is because it conceptualizes the cause-and-effect relationship, especially with regard to ASM drivers such as economic dependence, the need for alternative livelihood, and the seasonal nature of other occupations such as agriculture. Through the integration of socioeconomic and environmental dimensions, the complex and multifaceted effects of ASM are comprehensively assessed. In other words, the DPSIR model does not only consider the linkage existing between ASM and environmental degradation but also inculcates the cascading consequences regarding nutrition and health, especially in this study.

This helps in simplifying the complex dynamics regarding ASM and food systems into manageable components. In applying DPSIR as the basis for our conceptual framework, ASM activities are known to mount a lot of pressure on arable lands (agriculture in perspective) and the environment through land degradation and deforestation as reported by Hirons (2020). The model is very relevant in making out certain areas of interventions when it comes to the plotting of causal relationships. For instance, the effective comprehension of the pressures exerted from

ASM through land degradations through mercury, tend so emphasize the dangers of health as well as that of food insecurity issue it could amount to. The flexibility of the model in this regard, gives it more advantage to be tailored towards the local context of ASM

Relating DPSIR model to this current study, it can be realized that ASM (which is our independent variable) in this study, is known to influence other factors such as food security (agriculture), health and nutrition of the inhabitants as corroborated by (Keita, 2018). It must be realized that this is an intricate cause-and-effect kind of relationship that exists as far as ASM is concerned. In this regard, ASM is the driving force that is being motivated by the economic needs of the people and communities involved in this kind of work. In this regard, the high levels of poverty, unemployment, and the valuable costs associated with these minerals tend to act as the driving force in ASM activities. Another driving force has to do with the increase in population, especially in these ASM areas. This happens due to the attractive nature of ASM, which tends to result in migration to add to the existing population. In effect, the more people participate in some of these alternative livelihoods, coping strategies, and careers, depending on the role ASM activities play in the communities, there is the likelihood of environmental degradation among other concomitant effects of ASM activities.

Ofosu *et al.* (2020) established severable linkages between the ASM industry and agriculture in delineating the linkages and complementarities between these two industries. It was realized that ASM activities' influence on agriculture could occur in many ways. For instance, farmers use the revenue gotten from ASM to support their farming as the earnings from the farming business are used to support ASM (Maconachie and Binns, 2007).

Therefore, the more the production in agriculture increases, it is expected that incomes from agricultural households also rise as such(Okoh and Hilson, 2011). By this way, the household will be assured of food security and also cater for their health needs (Galli *et al.*, 2020). This

means that the income from ASM cannot be ignored as far as the totality of the household income is concerned (Arthur-Holmes and Busia, 2020).

More so, the effect of these driving forces that forces mount a lot of pressure on the environment and the entire ecosystem. This comes in the form of soil erosion, contamination of water bodies and destruction of the environment. Moreover, pressure of ASM could also be experienced in the form of health risks. This accrues from the dangerous chemicals being used, the inimical working conditions as well as the absence of effective health facilities. Other resultant effects are in the form of respiratory illnesses, waterborne diseases, and also, work-related hazards.

The resultant effects of this ASM-induced pressure lead to a number of health issues. Moreover, the resultant state that has contaminated the arable lands has the capacity to affect food security. This could be a consequence of the unproductive nature of the land as well as water that has become less safe for both plant and human usage. Also, household food security affects the nutritional status of the household as proven by Ghattas (2014), who observed that food security is a major precondition for one to attain nutritional security. The effect on nutritional status is because of the limited access to a variety of food since food security has been affected. This is because of the degradation borne out of the ASM activities. This assertion has been supported by a number of studies (Walls *et al.*, 2019; Radhakrishna and Reddy, 2004).This suggests that household nutrition is dependent on the food security status of the household.

This effect of ASM activities results in food insecurity, malnutrition, and health issues. This impact on the communities with its inherent effects makes living conditions in the communities very difficult. For instance, these tend to affect the very few health facilities and food available. As long as ASM activities persist in these communities, the chances of exacerbation of its inimical effects is high.

This further triggers the attention of the government, international organizations as well as other groups concerned. These groups respond to some of these challenges through the implementation of policies and regulations among other enactments to control the activities of ASM. These policies are geared towards ensuring safer mining activities and safeguarding degraded lands. Some of the policies are also geared towards introducing coping strategies such as alternative livelihoods. These strategies, when adopted as responses, would minimize the dependency on ASM activities.

Some of these responses could also come in the form of sensitization and awareness programs on the implication of ASM on health and food security for instance. Moreover, some of these responses could also come in the form of community-based initiatives for training the inhabitants in the community which could be geared towards the improvement of agricultural practices.

As part of the responses, there could also be interventions in the form of making available public health care services, provision of clean water, and ensuring sufficient nutritional support. This could be made available in the form of agricultural subsidies, government partnerships, and, provision of financial support to support some of these alternative livelihoods.

In relation to gender issues, ASM activities affect women in several ways. For instance, there are several socio-economic issues that drive women into ASM activities. Similarly, this could be in the form of inadequate employment opportunities. More so, the need to support and economically, complement domestic responsibilities could be a major driving force into ASM activities. This tends to affect women in several ways.

For instance, ASM activities have the capacity to influence the roles of women in the communities. With regards to the dynamics of women's time, the decision-making abilities of women in a household will be affected especially when majority of the contribution of the are

from the women. This corroborates the earlier findings that expenditure patterns are always affected by those who receive substantial income (Saturay, 2020).

Women in ASM go through a lot of physical stress. The demanding labor characterizing ASM activities, coupled with exposure to dangerous chemical and other social pressures like sexual exploitations are some of the resulting challenges these women encounter as far as ASM is concerned (Arthur-Holmes and Abrefa Busia, 2021).

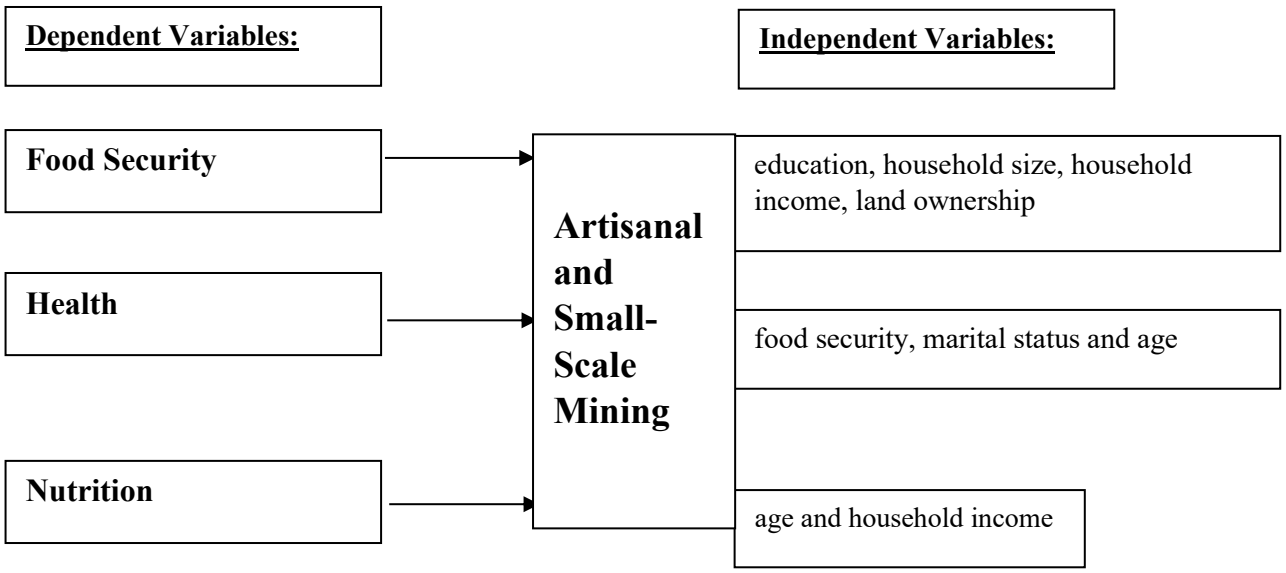
In effect, some of these challenges tend to affect the health of women. Moreover, some of these women tend to have nutritional challenges. Socially, the chances of women not being able to render all their domestic responsibilities is possible. All these challenges, when complicated has a way of perpetuating poverty cycles in communities also leading to a very high level of marginalization (Stokes-Walters *et al.*, 2021).

In a similar vein, these inimical impacts have the capacity to invite the attention of government agencies among other concerned groups. Some of these groups are likely to come up with policies that would deal with inequalities within the ASM occupations in response to any socially related challenges women in ASM go through. Other interventions could be targeted towards ensuring that women do not absolutely depend on ASM for their livelihood. To ensure this, other coping strategies and livelihood options are introduced to these women. In effect, these women could have better access to markets as well as access to financial services.

With regards to the DPSIR theory, this framework enables systematic assessment of the role gender plays as well as the challenges therein. This framework also helps in the minimization of the inherent pressures that come with it. In other words, the use of this framework helps mitigate certain impacts which are food security related, health and nutrition related. More so, the DPSIR framework provides a very comprehensive intuition as far as the factors responsible for some vulnerabilities. In this way, most of these vulnerabilities are curtailed under the kind of responses

it evokes. The logical link between ASM, food security, health status, and nutrition is shown in Fig. 3.4.

Fig. 3.4: Logical Link between ASM, Food Security, Health Status and Nutrition



Source: Authors Compilation, 2024

3.5 Empirical ASM Impact Studies

ASM has been one of the critical economic activities, particularly in most mineral-endowed places in Ghana and the world at large (Agbesinyale, 2023). In addition, its socioeconomic and environmental repercussions have drawn much attention from many stakeholders such as researchers, developmentalists, and policymakers. Among the major highlights of such concerns are intrinsic linkages to well-being outcomes as well as those related to sustainability in these mineral-rich areas regarding important areas such as the effects of ASM food security, health, and nutrition (Cossa *et al.*, 2021) (Morante-Carballo *et al.*, 2022).

Empirical studies based on these aspects have brought to bare complex and often conflicting outcomes. Even though ASM activities have an income generating capacity that supports

household food purchases and healthcare, they also cause disruption to the environment in several ways. In ASM-dominant communities where there is an interaction of issues regarding land use, labor migration and environmental degradation among other factors, ASM dynamics are mostly evident (Tsang *et al.*, 2019).

Such dynamics bring to the fore the relationship between ASM and food security, which is multifaceted, as it entails both positive and negative pathways. For instance, as the income derived from ASM tends to enhance purchasing power and diversify diets, the activities of ASM amount to the displacement of agricultural activities, minimized access to arable land, and environmental challenges which eventually, compromise food security In the same vein, health outcomes coming from ASM activities are mostly advanced through factors such as occupational hazards and inimical living conditions which tend to exacerbate vulnerabilities among marginalized groups, which involves women and children (Verbrugge and Thiers, 2021).

Importantly, a collection of studies (Smith *et al.*, 2016; Hilson *et al.*, 2018b; Owusu *et al.*, 2019; Becker *et al.*, 2021) have underscored the relevance of health and nutrition considerations into ASM impacts. Although some literature has focused on the economic benefits of ASM, a burgeoning emphasis on its broader effects and social impacts emphasizes the demand for a holistic approach regarding opportunity costs and trade-offs between development and sustainability in the ASM industry. Through empirical evidence, the understanding of the critical linkages between ASM, food security, health, and nutrition, will be deepened to make more informed policies that seek the promotion of equitable and sustainable outcomes.

3.5.1 ASM and Food Security

Although research done by Long et al, 2015, gave a comprehensive demographic and health survey of ASM communities, the study did not deeply explore how ASM activities specifically impact food security in the context of its production, accessibility and its sustainability. More so, the research recounts several wealth indicators and makes suggestions regarding levels of

economic activity. On the contrary, the research fails to link such indicators to food security, especially how mining income could influence food security. Additionally, the study does not address how mining disrupts local agricultural activities, which are very critical especially in food security.

Also, Fagariba *et al.* (2024) studied the dynamics of ASM and gave an insightful examination of how food security is affected through the lens of socio-economic and environmental factors. Conversely, the study did not delve deeply into specific food security indicators such as food availability, accessibility and utilization and how they are being impacted by ASM. Even though the study highlights environmental degradation, it fails to deliberate on how it directly influences food production and access.

The transition from agriculture to mining as a primary livelihood may offer short-term financial relief, but it has the capacity to lead to longer-term food insecurity if the local agricultural systems are undermined by mining activities and a lack of sustainable land-use practices. However, the study by Fagariba *et al*, 2024 briefly touches on the economic importance of ASM, it does not assess how sustainable this sector is with regards to long term for food security.

Debates on the proliferation of ASM in Ghana and its inimical impacts on land resources is a continuous one with various predictions on food security. This is buttressed by the fact that land conversions have the potential to affect food security according to Martanto (2021). The study emphasizes how crucial efficient land use planning is to preserve food security in the face of population expansion and rapid development, which may result in the shift of agricultural land to non-agricultural uses. This transition is a demonstration of a direct struggle for land resources, with mining and food production competing for the same location. This conflict occurs because both sectors are critical as ASM is for economic gain and employment whereas agriculture is for food security and local livelihoods. However, the paper fails to critically examine the effects of these land conversions from its' agricultural uses to other purposes as far as food security is

concerned. Critically, whenever land is converted for other purposes, it brings to the fore issues of food security. Although Martanto (2021), made it known that this proliferation of ASM has the tendency of generating a conflict of interest as far as food needs and social needs are concerned, the paper did not cover in broad perspective relating to the impact of ASM on food availability, food accessibility, food utilization and stability. More so, the paper does not consider the effects of land use conversions in various socioeconomic groups. The need to establish the effect of land conversions when it comes to ASM research and its impact on agriculture is crucial as far as these knowledge gaps and contextual gaps are concerned. This is similar to what Ofosu *et al.* (2020) emphasized; the need for specific impacts of ASM on food security. According to this paper, this advanced study is necessary for developing better strategies that draw a good balance between mining and agricultural needs.

Moreover, Martanto (2021) did not really establish how specific land use conversions such as ASM affect food security. In other words, there is no convincing argument as far as the relationship between these two entities is concerned. The outcome of this study overgeneralizes and does not take into consideration how certain cultural practices impact on food security. Therefore, supporting the need for more research into the impacts of ASM on food security becomes relevant. In other words, more in-depth analysis as pursued in this study would focus on the long-term sustainability and socioeconomic effects of ASM especially by employing the integrated approach of this current research as recommended by various researchers (Ofosu *et al.*, 2020; Hilson and Hu, 2022; Maconachie and Conteh, 2020) which bothers on socio-economic, environmental and policy aspects as it seeks to unravel their complex interaction with ASM.

Similarly, Barenblitt *et al.* (2021), in their spatial studies from 2005 to 2019, measured the annual vegetation loss attributed to artisanal gold mining in southern Ghana in terms of both geographical and temporal variability. With a cumulative footprint almost seven times greater

than that of industrial mining, the results demonstrate the disastrous effects of artisanal mining. An estimated 47,414.2 hectares were converted to mining between 2005 and 2019, with artisanal mining accounting for 89% of this total. Between 2014 and 2017, the annual rate of conversion surged in tandem with an increase in the price of gold globally. Although the study realized mining took place across 700 acres inside protected areas, endangering ecology and wildlife, and commented that the region's food security, water quality, and human health are all impacted by artisanal mining. Critically, the paper does not analyze how food security is affected. Also, it must be realized that the study only concentrates on the southern region of Ghana. This means the findings may not be directly applicable to other parts of the country or regions with different environmental and socioeconomic contexts. For that matter, this study considers using a broader database like the GLSS 7 which covers over 14,000 households across all the regions of Ghana.

Some farmers involved in ASM have already abandoned their farming activities to indulge in ASM, breaking the food supply chain in the process. Consequently, this affects the supply chain of agricultural produce in the community. This effect comes from the intricate and synergistic factor inputs shared by ASM and agriculture (Ofosu *et al.*, 2020). These factor inputs come in the form of land, labor and capital (Adator *et al.*, 2023). How does this break in the food supply chain pose threats to food security? The study also recommends a broader range of stakeholders to better understand the perspectives on mining activities in the area as recommended by Tilman *et al.* (2011) as well.

Hilson and McQuilken (2014) in their study stressed the indirect effects of ASM on agriculture-dependent livelihoods. The paper further, recounted that land degradation and resource competition are more exacerbating factors that affect vulnerable rural areas who are utterly dependent on subsistence farming. The study also shows gaps in addressing how ASM policies interact with food security frameworks, allowing the potential for more research on agricultural

productivity and food access and how best the effects of the existing relationships can be effectively managed.

This current research also seeks to deepen understanding of the impact of ASM on household food choices as it remains an unexplored area when it comes to ASM. Even though Zhang *et al.* (2020) attempted to explore how characteristics of markets serving ASM populations impact food security and households, the study cannot be taken as a typology for ASM markets due to the small sample size employed. Relatively, this assertion makes the subject of the implication of ASM on food security one of the unexplored dimensions of the ASM conversations due to the associated geographically and politically marginalized nature of such studies (Stokes-Walters *et al.*, 2021). As such, this will lead to the elimination of all unproven predictions to embolden the narratives with regard to the effect of ASM on food security from more empirical and qualitative evidence.

Although a good number of research works have utilized the large scale-mining (LSM) to determine food security (Worlanyo *et al.*, 2022; Poignant, 2023; Laing and Pinto, 2023), however, very few have been able to juxtapose and probe into its relations with ASM. This is one of the major focuses of this research.

It has also been reported that ASM communities are often constituted by local indigenes and migrant populations (Buss *et al.*, 2019). These migrant settlers have been reported to have challenges in assessing nutritious food. This was emphasized that most of the inhabitants of ASM communities are known to consume a lot of ready-to-eat foods, fatty as well as sugary foods in comparison to non-ASM communities (Arthur-Holmes and Abrefa Busia, 2021). By this means, ASM affects the quality of food consumed by such inhabitants. This affects the health of the inhabitants (Kortei *et al.*, 2020).It is due to these consequences that it has been recommended that special attention be paid to studying factors that affect food security and nutrition in ASM communities.

Beyond this, is the environmental pollution resulting from the conversion of agrarian lands for ASM purposes (Lydia *et al.*, 2022). This is the resultant effect of the various dangerous chemical pollutions on the terrestrial and aquatic habitats which ends up affecting living beings therein among others (Adu-Baffour *et al.*, 2021). Mercury, lead, and arsenic are the topmost and most hazardous pollutants as far as ASM activities are concerned according to United States Agency for Toxic Substances and Disease Registry (ATSDR) (Akoto *et al.*, 2018). Although there have been several narratives regarding the poisonous nature of these chemicals, the spate of their usage poses grave food and health concerns. This is because its continuous release into the environment poses a long-term health effect on the ecology as well as its various inhabitants through several ways such as the food and water consumed (Rice *et al.*, 2014). This assertion arouses the need for further studies into how ASM affects food security.

Issues of food have always been a prime focus of most governments. This has effects on various economic and social developments. Care must be taken not to be deluded by the Green Revolution to have the capacity to convince decision makers to solve the issue of food security (Montgomery, 2017). However, with regards to the prevailing land conversions in these ASM areas, little research attention seems to have projected the various food security impacts on such worrying trends even in the spate of this green revolution (Govindaprasad and Manikandan, 2016). This represents another knowledge and contextual gap that demands more research.

3.5.2 ASM and Nutrition

There has been a myriad of literature concerning issues of nutrition in relation to ASM. Reports of mal-nutrition on some ASM sites have been recorded (Zhang *et al.*, 2020), however, the same paper acknowledges that nutritional outcomes in such areas of mining have not been well-placed in literature. The paper examines food availability by exploring how market characteristics, such as accessibility and diversity of food items, influence the ability of artisanal miners and their families to acquire food. However, it is deficient in the aspect of nutritional quality and diversity

of diets within ASM communities, having realized that mining communities experience limited access to diverse and nutritious foods. This portrays a limited scholarship on how ASM impacts dietary diversity.

It has been established that the players within ASM consist of the indigenous people within the community and the migrant population (Damonte, 2021) These indigenous people make up the local population who are permanent settlers within the community. On the other hand, the migrant population is made up of temporary settlers who may have established provisional residents within the mining community (Mayes, 2017). These temporary settlers encounter barriers in accessing nutritious food (WHO, 2016).

Ofosu *et al*, 2020, recounted land degradation and reduction of arable land for agricultural use as some of the effects of ASM activities. However, the study does not empirically explore how this reduction in agricultural land impacts food security. Moreover, there is a paucity of research regarding how land use changes resulting from ASM activities affect food access and the broader agricultural economy. While the study delves into the socioeconomic effect of the labor shift from agriculture to mining, there is little information on how this depletion of labor affects food security in terms of food access and nutrition.

Another aspect of nutrition and ASM is the antagonistic views of purposes perpetuated between career miners and farmers impact their nutritional outcomes. The former pursues a livelihood through mineral-led strategies and social mobility objectives to be successful in their mining field without any interest in agriculture (Ofosu *et al.*, 2020). These mineral-led ambitions result in the invasion of several arable lands that could have impacted nutritional outcomes through crop cultivation. However, the career farmers have no interest in mining but are spurred on by their ambition to boost crop production and increase the nutritional outcomes of their families. Eventually, both divides will not stand the same chance of enjoying similar nutritional outcomes. While career farmers, most of whom are subsistence farmers, will be more domesticated in their

food consumption, the career miner may resort to purchasing food already made by vendors among other packages ones (Ofosu *et al.*, 2020). In a nutshell, career farmers have access to a variety of home-grown food items, while career miners have lots of cash income but limited access to a variety of food items putting their nutritional outcomes into question. It is also important to know that part of these ASM workers is made up of migrant settlers, who do not have access to homegrown foods and can only access ready-to-eat foods (Marume, 2023). These ready-to-eat foods come with many health and safety issues that may be inimical to the consumers who are predominantly miners (Crippa, 2023). This means ASM activities have effects on diet quality as well as health. As such, it is very relevant for researchers to focus on nutritional disparities when it comes to dietary outcomes regarding ASM activities.

Also, the amount of disposable income that ASM communities have access to has an impact on their nutrition. This revenue might have the ability to influence both the nutritional value and the quality of diets. According to Long *et al.* (2015), residents of ASM villages have been found to consume far more sugar and fat and less fruit and fiber than people in the surrounding areas. It is known that most of these individuals in the surrounding areas eat a variety of foods that are produced locally. Nonetheless, it is known that ASM employees eat more packaged and ready-to-eat foods (Nordhagen *et al.*, 2022). What impact does this have on the nutrition of ASM workers?

Delving into the nutritional aspect of this study is salient to the fact that the various levels of land degradation and soil pollution have an impact on the nutritional outcomes of the inhabitants therein. Fagariba *et al*, 2024 observed the nutritional outcomes of ASM inhabitants. The study realized that they are being affected by their levels of exposure to toxic chemicals used in mining activities such as Mercury. The research indicates that reduced Mercury exposure is connected to dietary items (Jinadasa *et al.*, 2021). For instance, Selenium has been known to cause some level of modification to Mercury exposure through natural accumulation and also, the promotion

of its antioxidant purpose (Zwolak, 2020). Other ones such as Omega-3 fatty acids share in similar role in performing bio-accumulative functions. The water, air, and land pollution from mining affects local agricultural productivity, yet the study does not provide comprehensive data on how these environmental factors translate to food nutritional issues.

Within the tenets of food security are food availability, food accessibility, and food utilization. There have been several narratives regarding food availability in various mining sites. However, very few have focused on food utilization which focuses much on the nutritional aspect of food security and how food is utilized within the body. It has been highly recommended that future research works place much relevance on nutritional aspects in this regard (Zhang, 2020). It has also been reported that aside from the dearth of literature about certain aspects of ASM activities, there remains an understudied population. This part of the population has issues of malnutrition as well as food security. This also gives credence to having deeper studies regarding the implications of ASM (Mishra, 2015).

More so, nutritional outcomes among communities have not received enough recognition in literature. This is because most of these studies have focused on formal mining schemes without considering the impact of artisanal small-scale mining (Long *et al.*, 2015). This stems from the fact that the impact of ASM activities as far as nutrition is concerned has not been enough investigated as compared to formal mining activities (Newlove *et al.*, 2012). This gives the subject of nutrition immense relevance as far as ASM activities are mentioned. As the subject of nutrition prevails in ASM narratives, it testifies to the fact that nutrition has not gained enough representation in the body of literature. These findings incense and bring to realization the dearth in literature as far as nutrition and ASM mining are concerned.

3.5.3 ASM and Health

Deforestation of farms due to ASM causing alteration of hydrological systems are some of the factors that destroy the ecology and consequently affect the health of people (Macháček, 2019).

According to Nabaasa, 2016, groundwater is affected by the highly poisonous chemicals used in mining such as mercury, cyanide oil, acids, and petroleum products are leached into the soil. These chemicals released into the soil bio-accumulate and leave their residues in the soils, water, plants, and animal tissues, causing harm to human life according to Pandey *et al.* (2016) Consequently, these chemicals end up poisoning water bodies that are meant to support plant and animal lives in the ecology (Okereafor *et al.*, 2020). According to Kemp and Owen (2019), farmers are unable to use such polluted water bodies for irrigation purposes, especially during the dry season due to health concerns. The World Health Organization has asserted that exposure to mercury among other chemicals poses a great risk to human health among other lifeforms (Adeola, 2020). This corroborates the fact that ASM has poses consequences on human health (Yakovleva, 2007). According to this research, artisanal mining camps are highly unsanitary, which is an additional health concern for the local environment and health, workers within the mining places are purported to face high risks of illness, injury, and stress due to the lack of basic mine safety and the physically demanding nature of the work. However, these evidence and assertions call for more empirical evidence due to the myriad health-associated effects of ASM. As such, the a need to investigate the health status of those affected by these ASM activities with the necessary empirical findings as recounted by studies such as Tsang *et al.* (2019) and Rwiza *et al.* (2023) who stressed the lack of rigorous research and evidence on the health impacts of ASM.

Ever since the proliferation of ASM especially in sub-Saharan Africa, there has been a shift of migration of labor – that there has been a shift in labor from agricultural labor to mining. These labor shifts could have consequences as far as health is concerned as some of these ASM workers tend to be involved in long hours of work which has concomitant health effects (Lu and Chou, 2017). However, the study does not discuss in detail the nuances related to labor shifts and their effects on health.

More so, this ASM phenomenon has been recorded to have resulted in a socio-economic breakdown with several rippling effects on health and nutrition. There have been several reports on the effects of ASM on the environment as well as the health of inhabitants. However, these inhabitants have prioritized the economic benefits derived from ASM over other salient factors such as its health and environmental effects (Quarm *et al.*, 2022). This is evident in the alternative sources of water such as boreholes and packaged water that have been resorted to (Botchwey and Yankey, 2023). Others have also resorted to covering mine pits to prevent the breeding of mosquitoes which could escalate to the spread of malaria (Schwartz *et al.*, 2021a). Clearly, these are instances that point to the underestimation of the inimical health impacts of ASM. What could be the cause of this downplaying of these health factors among the inhabitants of ASM communities and the players within the ASM extractive industry? This buttresses the fact that there is a need for more research into the mining-food-health-nexus as reported by Wegenast and Beck, (2020).

Additionally, the continuous shift of migration of agricultural labor to mining could lead to a socio-economic and ecological breakdown with effects on food security, health and nutrition (Baffour Kyei et al, 2021). This is because the health of the various household members involved in ASM is very relevant to the effective execution of their occupation. For instance, the sickness of a working household member has the tendency of reducing a portion of the household income which may be used to take care of certain health needs in addition to reducing the among of working hours (Arthur-Holmes, 2022). Moreover, shifts in labor from agriculture may have affected food production levels which could also have rippling effects on the health and nutrition of household members.

It has been reported that there is a dearth of holistic research on non-mercury-related issues as well as health and safety issues in the ASM industry (Smith *et al.*, 2016). Although the mining-food nexus has received broad attention from non-governmental organizations and the media, it

has not been academically studied in such a systematic comparative way with regard to effect of non-mercury-related health issues. This study further argues for a more holistic, broader approach to understanding and addressing health and safety in the ASM sector, incorporating both quantitative and qualitative data.

In addition to the incorporation of a more holistic approach, it has also been suggested by researchers that both qualitative and quantitative methodologies be employed in reference to ASM and health issues (Tsang *et al.*, 2019). This presents a methodological gap. For that matter, this study considers these two approaches in assessing the implication of ASM on health. This is being done to improve and deepen the understanding of the implications of ASM to enable these issues to gain adequate representation in the body of literature (Smith, 2016). Goerge Ofosu *et al* (2020) recommended the need for future research to concentrate on the quantitative examination of the macro and microeconomic impact of ASM externalities on the environment and local incomes to strengthen policies on livelihood enhancement initiatives.

It must also be realized that the influx of ASM activities comes with a multi-pronged effect which are both risks and opportunities for the health of the players within the gold value chain (Muthuri *et al.*, 2021). In as much as ASM may cause several environmental hazards, ASM also possesses some inherent socio-economic capacities that may have direct implications on the health of all those involved in the ASM activities, both directly and indirectly. For instance, ASM could increase the financial capacities of people involved in accessing better health care for their dependents among other health facilities, an assertion that yearns for further research.

Furthermore, the issues of ASM and health in most narratives, have focused on the effects of mercury among other ASM-mercury-laden studies (Jiménez *et al.*, 2024). Exposure to Mercury can cause cellular effects on the human body (Siti Thomas Zulaikhah, 2021). This consists of induction of oxidative stress and changes in macromolecular structure. This toxic chemical has been known to cause cardiovascular, hematological, and pulmonary alterations. It can also cause

anemia. Leukemia and Hogkin's disease have all been linked to Mercury exposure which comes from ASM activities (Taux *et al.*, 2022; Saldaña-Villanueva *et al.*, 2022). Other health effects include tremors and sleep disturbances. In other words, there are more public health and occupational safety issues that need to be accorded enough attention in this extractive industry discourse. In some instances, ASM has been regarded as a high-risk occupation that needs to be given much attention (Stemn *et al.*, 2021). It has been recommended that further research in ASM and health needs to address the issues more broadly as far as communicable diseases, the mental stability of the players within the mining value chain as well as the complete well-being of such players (Cossa *et al.*, 2021).

It is very interesting to know that ASM activities prevail in most of the poorest and most underdeveloped countries in the world (Ledwaba and Nhlengetwa, 2016). These countries are not only economically handicapped but also, they are medically underserved. As such, in their process of making living conditions better off, there is a need to assess the effects of economic activities such as ASM that underscore such economic recovery processes. This means that there is a need to pay more attention to the effects some of these economic activities like ASM may present in addition to the benefits that they bring.

3.5.4 ASM and Gender

The issue of women in ASM has been one of the major topical conversations in contemporary times. This has been a broad array of literature to this regard which in no small way has projected nuanced views on this topic (Arthur-Holmes and Busia (2022); Ofosu *et al*. (2024)). It is well-known that indigenous people and other migrant women participate in ASM operations for various justifications(Ofosu *et al.*, 2024b).

The reasons for the involvement of women in ASM operations are very diverse. Arthur-Holmes and Busia (2022) broadly categorize these underpinning reasons for women's involvement into motivations and drives. These motivations have a primary objective of taking on the ASM

operations as alternative livelihoods, a medium of economic empowerment, and a means of economic diversity. On the other hand, the drivers include poverty, the need to contribute to family necessities and gain social recognition, the unappealing character of agriculture, the lack of possibilities for effective employment, and sociocultural entrenched norms (Hilson *et al*., 2018). The attainment of improved bargaining power and the craving for financial independence are some of the reasons according to (Arthur-Holmes and Busia, 2020).

Most women have also utilized ASM source of revenue to cater for their basic survival, educational, and health needs (Ghosh, 2021). Other records have it that women engage in ASM to enjoy the liberty of personal freedom (Werthmann, 2009). According to Paschal and Kauangal (2023), the impoverished women living in rural areas are forced to work in low-skilled, less productive employment and ASM due to several factors including landlessness, underdeveloped local markets, an inability to physically access bigger markets, and a lack of financial credit. Women's adaptation in a bid to escape the poverty trap leads them to this male-dominated industry despite the several gender and social dynamics that it come with (Kumah et al., 2020). In the absence of proactive employment, ASM has always been the next alternative for women. Arthur-Holmes and Busia (2022b) asserted that there is a need to study into gender-specific impact of ASM. The necessity for developing inclusive policies makes such studies more crucial owing to the increase in women's presence in the ASM industry. For instance, it has been recorded that over 50% of the labor force engaged in ASM in Africa are mostly women (Jackline, 2022).

However, their presence is being accentuated in specific case studies that cannot be overlooked according to the global data on ASM (McQuilken and Perks, 2021). Although women play several minor roles as far as the operations of ASM are concerned. McQuilken and Perks (2021) reported that women could function as concession owners, mine operators, dealers and buying agents, and equipment owners, although these are less likely. Meaningfully, the fact that women

work in a variety of roles in numerous places cannot be over-emphasized. Although women play a variety of significant and varied roles in ASM, Buss *et al.* (2022) reported that there is still limited information on the roles played by these women and how they are being impacted as well. Research contributions are being made in this study through the discovery of more of such roles in addition to what has been described in existing literature.

Although there are more women getting engaged in ASM, the sociocultural, economic, and gendered relations in the ASM industry especially, women's participation in ASM on household dynamics, such as sexual interactions and childcare responsibilities have not been fully comprehended (Arthur-Holmes and Busia, 2021). The study focused on how women's participation in ASM and their incomes have reshaped their bargaining power, very little is known about women's empowerment and household dynamics resulting from their shift from farming to ASM (Arthur-Holmes and Busia, 2020) presenting a major gap in research. For that matter, this research explores how these additional factors may shape the women miners' experiences and struggles. Furthermore, this research focuses on the long-term impacts of the women's struggles on their health, well-being, and socioeconomic mobility in the light of ASM, and how these may differ across intersecting identities.

It must be emphasized that although access and control over resources by women have the capacity to influence household decision-making and nutrition, this relationship is complex and context-dependent (Albert and Escardíbul, 2017; Karimli *et al.*, 2021; Soh Wenda *et al.*, 2024). However, studies on ASM have recounted the underrepresentation of women's experiences in the all-encompassing-gendered sector. Weldegiorgis and Buxton (2017) reported that within the ASM industry, there is a dearth of statistics to provide a comprehensive picture of gender disparities in terms of vulnerability, access control, decision-making, and poverty. In terms of ASM, a greater portion of the people involved here are made up of women and children who make up the largest number of players in the ASM industry. Whereas the crucial roles played

by women such as participating in mineral extraction, processing, sluicing, and trading, their contribution have not been well highlighted and emphasized in literature. Karimli *et al.* (2020) underscore the importance of conducting extensive research with regards to women's lived experiences, especially on issues concerning occupational hazards, exploitation, and access to financial and technical resources among other dynamics that have been overlooked and have resulted in skewed comprehension of ASM's gendered impacts. The absence of this visibility current body of literature among other narratives forestalls the advancement of gender-sensitive policies (DELVE, 2023).

Globally within the ASM industry, women account for 50% of the labor force out of the 100 million people who engage in ASM as a source of livelihood (Jackline, 2022). Specifically, in Ghana, there are over one (1) million people, and 4.5 million others engaged in ASM (Arthur-Holmes and Busia, 2020). This demonstrates the high level of women's participation in the ASM industry and, accentuates the need to attach relevance to studies that borders on how women are impacted and gender issues in the ASM industry. Recently, the increase in women's participation in ASM which used to be a male-dominated profession, with its corresponding effects on households is one contemporary feature of the ASM industry that needs to be looked into (Labonne, 2014) as it represents a major knowledge gap. Bashwira et al. (2014) argue in favor of more research on the multiple roles of women in artisanal mining especially as women's roles in the ASM industry are being downplayed and overlooked.

Nyantakyi-Frimpong et al. (2021) reported on the fact that women have the capacity to earn extra income through ASM. However, this seems to be constrained by other factors such as gender roles both at home and mines, which in no small way affect women's empowerment. This was alluded to the variations in wages between the men and the women. The study reported increased pressure on women's time because of this situation in northern Guinea. The study postulates that the tendency for women to face challenges is irrespective of whatever amount of wages they

receive. However, how women are impacted amid this changing income from mining occupation overtime needs represents one of the relatively unexplored dimensions of this study in ASM-gender conversations.

Women are more disadvantaged when it comes to ASM (Onditi, 2022). According to this study, more women are directly and indirectly involved in ASM although they are marginalized in the mining process. These women are relegated to perform supportive roles such as transporting and processing materials, cooking and supplying food and drinks, moving tools and other equipment, and sexual services (Makaza and Chimuzinga, 2020). However, Onditi (2022) to demonstrate how these women are impacted by their involvement.

According to Ofosu et al, (2022), more research in various mining regions would be very instrumental in elucidating women's roles and labor conditions in mining. Although the study made it clear that effective policymaking requires an understanding of the nuances of ASM operations, without this understanding, any one-size-fits-all policies intended to address the issues confronting women in the sector would be ineffective. For instance, women in informal settings require regulations that address occupational health and safety, greater compensation, while those aiming to enter formalized settings might training on use of specific equipment. At this point, it is worth emphasizing that women in ASM are confronted with unique occupational health risks in their roles in addition to the insufficient protective equipment and among other facilities tailored to their needs exacerbate these risks (Ofosu *et al.*, 2022). According to DELVE (2023), there is limited scholarship on how these health impacts differ from those of their male counterparts.

Several studies (Arthur-Holmes and Busia, 2020; Arthur-Holmes *et al.*, 2023b; Serwajja and Mukwaya, 2020) have classified the role of women in ASM as direct (those involved in mining operations) and indirect (those involved in ancillary activities). However, through the lens of intersectionality, the roles of women are far as ASM is concerned, look further. It is difficult to

understand the subtleties in the dualities of ASM operations and how they affect female outcomes because of the emphasis on the unorganized and labor-intensive sectors in the literature. The comprehension of these nuances lies in approaching the study of women's participation in informal settings is through the employment intersectionality framework from social theory. The intersectionality framework is important for understanding and addressing complex social issues that cannot be fully explained by considering only single dimensions of identity or oppression (Ofosu *et al.*, 2024b).

With respect to issues of intersectionality and ASM, the kind of influence women exert is most observed by way of their gender and economic standing. More so, there is a high tendency that women coming from communities characterized by low income are liable to be confronted with aggravated forms of discrimination as well as the inability to access certain opportunities therein. It is important to note that the intersecting factors underlining gender and economic inequality account for these challenges.

The experience acquired by women in ASM varies in various forms (Makaza and Chimuzinga, 2020). This could be contingent upon their racial and ethnic backgrounds (Buss *et al.*, 2019). More so, other intersecting factors such as their race and cultural identity play a significant role in shaping these experiences. Some of these experiences could come in the form of exclusion, prejudice, and historical grievances.

Caregiving responsibilities and family/domestic dynamics are some of the roles of women that seem to have recognition from the view of intersectionality (Campero *et al.*, 2023). As far as these domestic roles are concerned, women take to ASM to make ends meet and cater for their entire family. Income from the ASM is also used to supplement other forms of household income. These economic activities are done to provide ample economic balance given their responsibilities as caregivers and also, effective domestic managers (Ibrahim *et al.*, 2022). The

spectacle of intersectionality provides an ambiance within which women can manage the demands placed on them within ASM contexts.

The inconsistencies in accessing resources as well as the advantages within ASM based on gender, geography, and class are always seen in the light of intersectionality. Profoundly, it is known that there are not many opportunities in most marginalized communities. Some of these limited accesses are related to the areas of education, training, finance, and legal issues. These factors can influence their engagement in ASM and the kind of advantages derived from ASM.

Another aspect of intersectionality is the consideration of how the health and safety of women in ASM are affected by their gender (Ofosu *et al.*, 2024b) Some of these health and safety issues occupational hazards, reproductive health issues and also, issues of environmental degradation. Additionally, these health issues have the tendency of being aggravated by factors of poverty, poor health care and gender-dominated violence (Schwartz *et al.*, 2021b).

Social identities and perspectives tend to shape the roles of women as well as their status in ASM communities (Ofosu *et al.*, 2024b).. This phenomenon is clearly seen by virtue of how intersectionality examines it. Resultantly, this could lead make women experiencing issues of discrimination, exclusion, and violence. All these have the potential to affect social identities and relationships, their roles in decision-making, and entire welfare.

It can be realized that through the theory of intersectionality, there is a framework to fully comprehend the complex and intersecting factors that tend to define women's roles and experiences in ASM (Stienstra *et al.*, 2020). By these relations as far as gender and social identities are concerned, intersectionality plays a role in ensuring inclusiveness and equitability in making sure all the disparities associated with gender and women empowerment.

In recent times, there has been much attention as far as labor issues are discussed especially among most feminist scholars. Jackline (2022) recorded that there is much involvement of

women in the ASM industry. This is being corroborated by a body of knowledge (Jenkins, 2014; Arthur-Holmes and Busia, 2020; Weldegiorgis *et al.*, 2018b) who realized that despite the large number of factual accounts on women in ASM, most of them have not made strong critiques as far as gender dynamics and power relations are concerned. This has provoked a lot of research on the presence of women in ASM of late.

3.5.4a Principles of intersectionality

Intersectionality is a theoretical framework that originated in critical race theory and feminist studies and has since been applied across various disciplines to understand how social identities and power structures intersect and interact to shape individuals' experiences of privilege, oppression, and discrimination (Carastathis, 2014). Intersectionality recognizes that individuals hold multiple social identities simultaneously, including but not limited to race, gender, class, sexuality, age, disability, nationality, and religion (Watkins Liu, 2018). These intersecting identities influence individuals' experiences, opportunities, and access to resources in complex and interconnected ways.

Intersectionality acknowledges the complexity and contextuality of social identities and power relations (Wijeyesinghe and Jones, 2014). It emphasizes that individuals' experiences of privilege and disadvantage are shaped by specific historical, cultural, and political contexts, as well as by intersecting systems of oppression and domination. Intersectionality highlights the interconnectedness of systems of power, including but not limited to racism, sexism, classism, heterosexism, ableism, and colonialism (Collins and Bilge, 2020). These systems of power intersect and interact to produce intersecting forms of oppression and privilege, affecting individuals differently based on their intersecting social identities. This means that intersectionality encourages an intersectional analysis that examines how multiple axes of identity and power intersect to shape individuals' experiences of inequality and discrimination.

It seeks to understand the complex ways in which intersecting social identities and structures of power influence individuals' lives and opportunities (Kim, 2020).

Intersectionality centers the perspectives, experiences, and voices of marginalized and oppressed groups, challenging dominant narratives and power dynamics that marginalize the experiences of those at the intersections of multiple axes of oppression (Atewologun, 2018). It emphasizes the importance of listening to and amplifying the voices of those most affected by intersecting systems of oppression. Intersectionality is closely aligned with social justice movements and advocacy efforts aimed at challenging systems of oppression and promoting equity, inclusion, and liberation for all individuals. It provides a critical framework for understanding and addressing the intersecting forms of discrimination and inequality that impact marginalized and oppressed groups.

The principles of intersectionality provide a critical lens for understanding the complexity of social identities and power relations and informing efforts to promote social justice, equity, and inclusion in diverse social contexts.

4.0 RESEARCH METHODOLOGY

4.1 Introduction

This aspect of the study dealt with the research methodology by which the objectives of this research were achieved. The chapter consists of coverage of the study, research design, data collection methods, and data analysis procedures.

4.2 Study Area

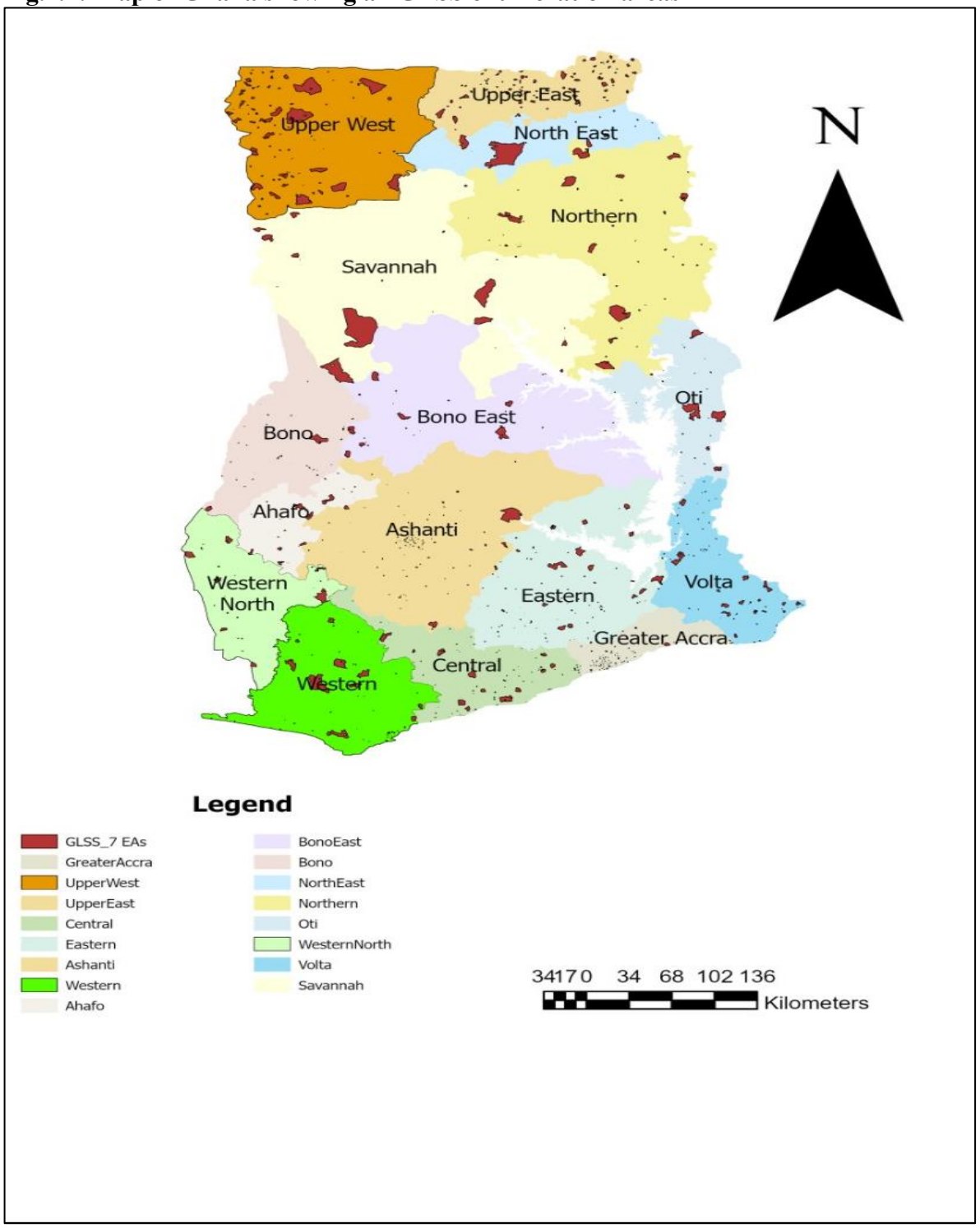
The study was centered in Ghana, a West African country that lies along the Gulf of Guinea, which is north of the equator (Briggs and Connolly, 2016). The country is located on latitude 7.946527º N and longitude -1.023194 º W in the Northern hemisphere (Appiah *et al.*, 2020). In Ghana, half of the country is less than 152m above sea level (Ibrahim *et al.*, 2020). For this study, our focus was on the households within the enumeration areas (EAs) covered by the Ghana Living Standards Survey (GLSS).

As ASM activities are prevalent across Ghana, the employment of the GLSS is very important as far as studying the implications of ASM on food security, nutrition, and health. The study area for this study entails all the areas within which GLSS data was collected. This is because the GLSS data gives comprehensive data regarding household demographics, consumption patterns, occupational data, and information on food security, all of which are important areas of concern.

Moreso, the GLSS data gives a wide coverage of the socio-economic and geographical settings across Ghana. As such, the data is able to pick up any ASM-related information within such context-specific settings. These agro-ecological and socioeconomic settings allow for the interaction between mining activities and food security. Moreover, the GLSS is mostly utilized by policymakers as well as other development organizations. As such, the use of this data means the study findings are more grounded. In addition, the GLSS is important for comparisons over time. In the process, this unraveled the socio-economic impacts of ASM in reference to food

security and livelihoods in the study area. Fig. 4.2 is a map of Ghana showing the various GLSS enumeration areas where data was gathered for this study.

Fig.4.2: Map of Ghana showing all GLSS enumeration areas



Source: (GSS, 2019a).

4.3 Justification for Use of Mixed Method

To achieve the objectives of this study, the mixed method approach, which integrates the use of quantitative and qualitative methods was employed in this study. The use of mixed methods in this study was very important for the validating and triangulating of findings (Goetz, 2022). In other words, the use of both qualitative and quantitative methods in this study helped in strengthening the validity as there was cross-verifying of the findings. As such, the quantitative patterns within the GLSS were validated by the use of qualitative narratives. This helped in achieving a more accurate representation of the impact of ASM.

The use of the GLSS data alone was not enough to efficiently capture the vulnerabilities and nuanced observation of marginalized groups like women. As such, the use of qualitative methods provided a better platform to capture these distinctions. Eventually, a more holistic and comprehensive knowledge of the impacts of ASM was attained (Buss and Rutherford, 2022).

The use of mixed methods ensured the complementarity of the various insights as far as this study is concerned. Although GLSS is known to give more robust quantitative data with respect to the socio-economic, occupations, and food security metrics, it does not contain the lived experiences, and perceptions among other nuanced social dynamics. Therefore, the use of interviews and focus group discussions by way of a qualitative approach, gave a good complement in the provision of how ASM impacts food security, nutrition, and health at the household levels (Hilson *et al.*, 2020a).

The effects of ASM on food security, nutrition and health are being affected by other factors which could be cultural, environmental and socioeconomic in nature. The use of a mixed method allowed for the combination of statistical trends regarding GLSS and qualitative data in the exploration of how such impacts were felt in various settings.

Although the GLSS data tends to show certain correlations, the use of a qualitative approach helped in uncovering the causal pathways. In the process, the various mechanisms of ASM impacts were also revealed. For instance, through the use of in-depth interviews, much understanding of how ASM led to land degradation, minimized agricultural productivity as well as changes in dietary patterns were revealed. The use of quantitative data alone was not adequate to explain such changes.

4.4 Data

To achieve objectives one and two, secondary data on the Ghana Living Standards Surveys (GLSS 7) were sourced. This is a nationally representative household survey for understanding the living conditions in Ghana. This was sourced from the Ghana Statistical Services (GSS). The GLSS 7 studies over 15,000 households in 1,000 Enumeration Areas (EAs) out of which 56.1% are rural EAs and 43.9% urban EAs with a response rate of 93.3% (GSS, 2019b).

GLSS round seven (GLSS 7) gave a comprehensive overview of the living conditions of the areas within which the data was collected. Moreover, the data provided an effective means for the monitoring of the welfare system in Ghana. This data, which is mostly a household-based survey, concentrated on the socioeconomic features as well as the well-being of various households in the country (GSS, 2019a).

In the last three decades, there have been multiple rounds of living standard surveys as this particular one being utilized in the study happens to be the seventh one. This GLSS 7 gives the findings of the data collected between October 2016 and October 2017. The GLSS is very relevant in making more informed policy reviews and planning of programs leading to national development (GSS, 2019a).

Within the GLSS 7 are several modules on which data was collected. Some of these modules entailed demographic features, education, health, migration, employment, tourism, and

housing. The other modules included household agriculture, expenditure, and income, governance, peace and security, financial services, assets, and credits. Thematically, the demographic feature covered information such as household population, size, and headship. That on education was based on all levels of educational achievement of the population aging 3 years and above, their school attendance, adult literacy rates, and apprenticeship training (GSS, 2019a). The health of the members of the household entailed their state of health in the two weeks preceding the interview. Information regarding household members using computer devices was also attained as far as information and communication technology (ICT) is concerned. The employment data entailed the various forms of employment undertaken by the household members. The migration and tourism module entailed information on the migrant population and their distribution across the country (GSS, 2019a). The housing module portrayed the types of housing arrangements of the household such as those who were renting, living in their own houses among other housing characteristics. The household agriculture module had to do with households that owned and operated farms while the non-farm enterprise module consisted of information on the various household enterprises regarding the various households. The household income and expenditure module contained data on the household income and types of expenditure of the various households. The governance, peace, and security module gave statistics regarding peace and social cohesion in the various communities within which the data was collected. The financial and insurance services module as well as that of credit and assets contained statistics on financial services obtained by the various household members, insurance services, the kind of assets they owned and credit facilities available to them (GSS, 2019a).

The GLSS 7 was targeted to provide information regarding patterns of household consumption, poverty indices, labor, financial services, governance, and ICT usage. In addition, the survey sought to gather information on updating Ghana's national accounts, migration, and tourism as

well as the provision of an effective structure for the next re-basing of the Consumer Price Index (GSS, 2019a).

In the achievement of the set objectives, detailed information was assembled. This was achieved using instruments such as household questionnaires, community questionnaires and price questionnaires for food and non-food items. The modules of the study contained various information regarding the households. For instance, the household questionnaire contained information on the demographic feature of respondents, education, health and fertility behavior, employment, migration, tourism and ICT, housing and its associated conditions as well as mortality and anthropometry (GSS, 2019a).

The GLSS 7 employed the use of a two-stage stratified sampling design. A total of 1000 enumeration areas were employed as primary sampling units (PSUs) in the survey. These were distributed across the 10 administrative regions of Ghana using a probability proportional to population size (PPS) approach. The survey used the 2010 population and housing census as the sample frame with various EAs put into their urban and rural localities. Furthermore, there was a complete listing of households within the selected PSUs to form the Secondary Sampling Units (SSUs). In the second stage, 15 households were systematically selected from each PSU, resulting in a nationwide sample size of 15,000 households (GSS, 2019a).

4.5 Identification of Enumeration Areas for ASM Study

Using the identified dataset mentioned which is the GLSS 7, there were 242 unique households involved in ASM that were identified. These 242 households came from 115EAs. This means, that in all the data, there were 115 enumeration areas (EAs) that had ASM households. Originally, each EA was supposed to contain 15 households. This resulted in a proposed 115EAs by 15 households which should result in 1,725 households. However, it is not all the EAs that contained 15 households, as some contained less households. From these 115EAs,

the corresponding households were extracted resulting in 1617 households. This represents the sample for the data. All other variables such as food security, health nutrition, and other control variables of interest were extracted for this sample of 1617 households.

4.6 Derivation of ASM indicator

Information on the ASM was sourced from the Ghana Living Standards and Measurement Survey Data. First of all, all the occupational hours for the various households were identified. This included the various occupational hours of the type of work a household member is engaged in within the GLSS 7 data collected. This aspect of the data laid much emphasis on the work of the household members during the reference period. Some of these occupations were found in industries such as mining and quarrying, fishing, manufacturing, and construction among others. As far as the ASM indicator is concerned, the occupational hours spent on mining and quarrying were proxied to represent occupational hours regarding ASM.

As such, the ASM variable was calculated as a fraction/proportion of the total occupational hours spent in a household. In other words, all the occupational hours in the household were calculated. This included the total occupational hours of both ASM and non-ASM occupational hours in each household. Then the occupational hours of ASM were calculated as a fraction of the total occupational hours. However, this was expressed in the form of percentages.

4.7 Derivation of Food Security Indicators

According to Pérez-Escamilla and Segall-Corrêa (2008), there are several ways of assessing the levels of food security. Some of the commonly used methods are the Food and Agriculture Organization (FAO) method for estimating calories available per capita at the national level, Household income and expenditure surveys, Individual's dietary intake, Anthropometry, and Experienced-based food insecurity measurement scales (Mutisya *et al.*, 2015; Lele *et al.*, 2016; Coleman-Jensen *et al.*, 2016; Russell *et al.*, 2018; Mitu *et al.*, 2022).

According to Pérez-Escamilla and Segall-Corrêa (2008), out of these five methods, four of them, namely the FAO method, household expenditure surveys, dietary intake assessment, and anthropometry are derivative measures of food insecurity. None of these methods are superior to each other as they all complement each other. The choice of the method of assessment is subject to several factors. For one to adopt any of these measures depends on assessment questions that need to be posed and the availability of funds. Although the application of several of these methods for the assessment of food security is recommended, the Food Insecurity Experience Scale FIES is the only one that gives a direct measure of the level of food insecurity (Worldwide, 2013).

The Food Insecurity Experience Scale (FIES) tool was developed by the Food and Agriculture Organization (FAO) of the United Nations (Project, 2018). The tool was set up for the measurement of the severity of food insecurity at the household or individual level (Jubayer *et al.*, 2023). The FIES tool is based on people's direct experiences of food insecurity and relies on their responses to a set of standardized questions. The FIES tool is characterized by several features with regards to its structure, versatility, comparability, and its use as an SDG indicator.

In terms of structure, the FIES is made up of yes/no questions meant to capture a range of food insecurity experiences. The administration of this questionnaire takes either a month or 12-month recall period. The FIES scale is notable for its psychometric feature which is found in the eight-item questionnaire. This scale is known to capture both physical and emotional aspects of constrained food access (Jones, 2017). This questionnaire takes into account several concerns regarding food insecurity which have to do with worries about the availability of food to severe conditions such as being without food for an entire day. The FIES was designed to make room for cross-country comparisons. More so, the tool was made for the monitoring of global food insecurity in an attempt to attain zero hunger which happens to be one of the sustainable development goals (Onori *et al.*, 2018). This FIES tool is applicable to individuals and

households depending on the context of the study (Ya *et al.*, 2023). This makes the FIES tool versatile in its use which eventually increases its cost effectiveness (Project, 2018).

The FIES tool is notable for the assessment of population prevalence regarding food insecurity (Cafiero *et al.*, 2018). Moreso, the tool is used to identify vulnerable populations. In terms of monitoring food security policies, FIES tool is very material. In addition, the FIES tool helps in the tracking of progress in terms of the attainment of international goals for the eradication of hunger.

Moreso, the FIES tool can be easily utilized at a relatively low cost. When the FIES tool is compared to other measurement methods for food security like food consumption and expenditure surveys, the FIES tool is more inexpensive. In addition, the tool is unique for its timely and reliable information on food access particularly at individual and household levels. Notably, FIES tool directly measures the food experiences of people and households as compared to the use of proxy indicators. Another advantage of the FIES tool has to do with the deeper comprehension of the food insecurity determinants and consequences when used in tandem with other indicators, especially in a large survey.

The FIES tool is also noted for its less use for specialized expertise. This is because FAO has already made software tool among other learning materials to help user of this tool. This eventually reduces the need for specialized training or the use of experts.

As far as this study is concerned, the set of questions regarding the FIES tool were extracted from the GLSS-7 questionnaire. Using the Section 9 Part C Questions 1-8 of the GLSS 7, we used the eight (8) questions on food insecurity experience scale. This is shown in Table 4.7.

Table 4.7: Table showing the FIES measurement tool

Questions within the FIES as used by the GLSS	
1	Was there a time when you or others in your household worried about not having enough food to eat because of a lack of money or other resources?
2	Still thinking about the last 12 MONTHS, was there a time when you or others in your household were unable to eat healthy and nutritious food because of a lack of money or other resources?
3	Was there a time when you or others in your household ate only a few kinds of foods because of a lack of money or other resources?
4	Was there a time when you or others in your household had to skip a meal because there was not enough money or other resources to get food?
5	Still thinking about the last 12 MONTHS, was there a time when you or others in your household ate less than you thought you should because of a lack of money or other resources?
6	Was there a time when your household ran out of food because of a lack of money or other resources?
7	Was there a time when you or others in your household were hungry but did not eat because there was not enough money or other resources for food?
8	Was there a time when you or others in your household went without eating for a whole day because of a lack of money or other resources?

Source: (GSS, 2019)

This was recorded according to the household. The summation of these eight FIES questions was taken and divided by 8 to get the average response (in other words the number of yes responses to the 8 questions divided by 8). In the analysis, the binary responses (yes/no) to these questions ranged between a minimum value of 0 and a maximum value of 1 whereby 0 is more food insecure and 1 more food secure.

4.8 Derivation of indicator for nutrition

Assessment of nutritional status could be achieved through both direct and indirect methods as demonstrated by a number of studies (Gurinović *et al.*, 2017; Gu *et al.*, 2020; Dang *et al.*, 2021; Tanweer *et al.*, 2022; Pigat *et al.*, 2023; Cafiero *et al.*, 2018). For instance, the use of anthropometric methods, biochemical and laboratory methods, clinical methods, dietary evaluation/ assessment methods, and use of energy balance are some of the direct ways by

which nutritional status can be assessed (Ferrie 2020). On the other hand, nutritional status could also be assessed indirectly. Some of the methods used are economic factors such as per capita income, population density, and social habits (Gustafson *et al.*, 2016). Ecological variables such as crop production could also be used in the assessment of nutritional status. Also, vital health statistics such as infant mortality could be used (Lee 2010).

The above studies testify to the fact that Dietary Diversity could be used as a convenient indicator of nutrition. As such, this current study employed the use of the Household Diversity Score (HDD) in determining nutritional status among respondents within the GLSS-7 data. Dietary diversity has been used as a measure of nutrition by various international agencies including the World Food Program (WFP), the Food and Agriculture Organization (FAO), and USAID (Maxwell *et al.*, 2014). This corroborates a report by Habte and Krawinkel (2016) that the Dietary Diversity Score is a better measure of nutritional status.

The use of dietary diversity as a proxy for nutrition is supported by a body of literature who have recorded high correlations between dietary diversity and nutrition. For instance, Hussien *et al.* (2021) evaluated the utilization of the Individual Dietary Diversity Score (IDDS) as a proxy indicator for identifying malnutrition with regard to patients living with HIV in Ethiopia. The research investigated the relationship between dietary diversity and nutritional status, assessing the effectiveness of IDDS in detecting malnutrition compared to conventional anthropometric and clinical assessments. The study emphasized that IDDS could be used as a consistent proxy for assessing malnutrition. This supports its use in public health programs targeted at enhancing the nutritional status of HIV-positive patients in Ethiopia. Habte and Krawinkel (2016) explored the use of the Dietary Diversity Score (DDS) as a measure of nutritional adequacy and an indicator of a healthy diet. The authors analyzed the use of DDS in addressing dietary quality and nutritional status across various contexts, especially in places with limited resources. Salifu (2021) examined how dietary diversity was used as a proxy for

nutrition in rural Africa. The study looked at the political economy of dietary consumption among resource-poor populations as it linked dietary diversity to economic welfare and food security. The study also looked at how limited access to resources affected nutritional outcomes. A low dietary diversity score could be an early warning signal for nutritional deficiencies as well as the risk of malnutrition. As such more time is allotted for effective interventions.

Dietary consumption is very important in the use of nutrition as it captures dietary quality as well as nutrient adequacy for households. This reflects the capacity of households to access a variety of nutritious foods. As far as resource intensiveness is concerned, dietary diversity requires minimal expertise and tools for its application as compared to biochemical and clinical nutritional assessments (Tilahun and Kebede, 2021). Notably, dietary diversity can be used for different populations, cultures as well as dietary patterns. More so, it can be used on a global level in the assessment of nutrition be it in low- or middle-income countries.

Dietary diversity score which is the number of food groups consumed by a particular household over a referenced period (Baye *et al.*, 2024; Gomez *et al.*, 2020), gives an intuition into the ability of households to access food as well. To achieve HDDS, the food consumption section of the GLSS-7 will be utilized. From this data, all the foods consumed by households which could be found in the food consumption and expenditure section of the GLSS-7 were grouped. There were two sources of consumption as far as the food sources are concerned. One had to do with the consumption of own produce while the other had to do with the consumption of food bought from outside. Data on own produce was in Section 8 Part H of the GLSS 7 data whereas the data on the outside purchases was located in Section 9 Part B of the GLSS 7 data. These consumptions are evaluated and put into their food corresponding food groups. This involved 12 food groups as shown in Table 4.8 (GSS, 2019).

Table 4.8: Food Groups for Dietary Diversity Score

S/N	Food Groups	Representation
1	Grains	A
2	Roots, tubers and plantain	B
3	Pulses and Legumes	C
4	Fats and oils	D
5	Meat and meat products	E
6	Fruits	F
7	Nuts and Seeds	G
8	Fish and Sea foods	H
9	Sugars and sweets	I
10	Milk and Dairy	J
11	Vegetables	K
12	Beverages	L

Source: (Usman and Haile, 2022)

In all, there were six visits that were made to the households to assess their food consumption of both their own produce and those bought from outside. From the table above, each of the food groups was designated a score of 1(if consumed) or 0 (if not consumed). The entire household score fell within the range of 0 – 12, which is equal to the total number of food groups consumed by the household.

The average Household Diversity Score for the population is calculated as

HDDS= Sum (A+B+C+D+E+F+G+H+I+J+K+L)/12 food groups

The food groups for the various visits (1-6) for both own produce and food items from outside purchases were combined. Thereafter, dietary diversity for each of the six visits was generated

and row total calculated. This row total was divided by (6 visits) to get the household dietary diversity. The household dietary diversity ranged between a minimum value of 0.014 and a maximum value of 0.972.

4.9 Derivation of Health Indicators

In the measurement of health indicators for the GLSS, the number of days of absence of household members due to illness, injury, or both per the entire household size, was used as a measure of the health status. The Ghana Living Standards Survey (GLSS) entails self-reported health data. This method was a cost-effective and accessible method for assembling information on health status, especially in large-scale surveys. Moreover, self-reported illness or injury consists of a wide range of health conditions, making it a practical proxy for assessing overall health in diverse populations.

Illness and injury refer to tangible concerns of health problems. These have the capacity to minimize quality of life as well as the ability to engage in productive ventures. These factors are essential to the overall comprehension of the well-being of individuals and households. Illness or injury have the capacity to capture a range of health risks confronting individuals (Cancelliere *et al.*, 2016). These consist of infectious diseases, accidents, and chronic conditions. Eventually the assessment of how these risks intersect with socio-economic factors like income, education, and access to healthcare, helps to inform policies regarding health outcomes.

On the contrary, this health indicator could be limited in certain ways. For instance, there are chances of underreporting or overreporting of health conditions as reported by the individuals. This could be based on whether it could be due to personal reasons, perception, or reluctance to disclose health conditions. Also, illness or injury is normally measured depending on the presence of symptoms. As such, chronic diseases and other asymptomatic ones may not be duly captured, even though they could have a significant effect on health. Illness or injury does

not distinguish between mild and severe cases. As such, a person complaining of a common cold is likely to be put in the same category as someone with a life-threatening health condition.

However, the use of illness or injury as a health indicator has been successfully applied in a number of studies. This measure of health status was used in a study regarding 'Climate change induced occupational stress and reported morbidity among cocoa farmers in South-Western Nigeria' by Oyekale (2015). The health status of the respondents was determined by using the number of times the farmer reported sickness in the assessment of impact of climate change of welfare outcomes of farmers. This particular study depended on reported sickness in the evaluation of the health status of farmers as this was able to link occupational status and exposure to stress arising from climate. However, this approach emphasized how frequency of occurring health issues could amount to indicators of broader occupational and environmental risks.

In the assessment of the 'Health and vulnerability to poverty in Ghana: evidence from the Ghana living standards survey' the occurrence of illness /injury in the GLSS-5, was employed as a proxy for health status of the respondents. According to Nonvignon et al. (2012), this measure is a better representation of household health in the GLSS 5 data collected.

To set up this indicator, the health aspect of the module was first identified. The health aspect of this module was found in Section 3 of the GLSS 7. This part of the questionnaire is divided into five parts. The first part (Part A) is administered to all the household members. Most of the questions in this part have to do with the health status of the household members in the past 2 weeks, visits to medical facilities as well as all medical expenses incurred. As far as this objective is concerned, we concentrated on the first part of the questionnaire which concentrated on the health status of the household members. The variable of interest for health was found in Question 2 (i.e. For how many days during the past 2 weeks has (NAME)

suffered from these conditions?) of Section 3 Part A of the GLSS 7 questionnaire. This health question was meant to capture all the days for which the individual has suffered illness, injury, or both. The impulse of this question was to assess the health condition of the individual in the household. All the days of absence were added up and divided by the household size so as to provide a more standardized means of assessing the data and making comparisons across households of different sizes and allow for more equitable comparisons without any bias from household size variations. This health indicator ranged between a minimum value of 0 and a maximum value of 14 days per household size as far as the GLSS 7 is concerned.

4.10 Qualitative Data

Based on the research design in this study which employed both quantitative and qualitative approaches, the latter approach was employed for the achievement of the third objective. In other words, the qualitative approach was applied regarding the third objective. Data for this section was collected from women respondents within one of the mining towns called Kyebi in the GLSS 7 enumerations areas where there is prevalence of mining. This took place from the 29th May 2023 to the 30th June 2023.

By virtue of research protocol, women respondents who participate directly and indirectly in ASM activity were purposively selected and interviewed. These women in ASM households were above the age of 18 years. This study was interested in women who have been working in the ASM industry for a year or more. As such, this there was a sampling frame from which women were randomly picked to be interviewed. That was obtained by consulting with local ASM unions and opinion/community leaders who provided me with information on the population of women involved in ASM in the area. This consultation helped me gain access to respondents and guarantee the safety of respondents and myself. Thereafter, the women were randomly selected as a subset of women from the sampling frame.

Thereafter, 25 women respondents from households where women were directly involved in ASM and 38 women who were indirectly involved in ASM were selected. These women were contacted to explain the purpose of the study to them, the interview process, and the time commitment required. They were also provided with the opportunity to ask questions and, obtain informed consent before proceeding with the interview.

Interviews were conducted using interview guides that address the nature of participation of the respondents in ASM and the impact of participation in ASM on economic well-being, health and safety, nutrition and food security, time use, domestic roles, and on the environment. Interviews were conducted in a private and comfortable setting where the interviewees felt safe and respected. These interviews were recorded by a trained assistant with the consent of the respondent. These recordings were stored on my personal computer as well as my supervisors under password protection. Considering the area, the interview was conducted using both English and Twi (local language) since respondents understand these languages better. All recordings in the local language will be translated into English before transcription.

Analysis of this data consisted of several steps. This involved transcription of the interviews, coding the data, identification of patterns and themes as well as making relevant conclusions based on the findings. The transcription of the data involved making a written record of the conversation. This was done manually and by the use of a transcription software called NVivo. This software aided in ensuring all the data was readily available for analysis by assisting in coding, querying, visualizations, creation of networks as well as text analysis.

Coding consisted of identifying and making out the various concepts, and ideas, as well as those per the preconceived themes from the study. By coding, numerical codes, alphabetical codes, and labels were assigned to responses or certain behaviors recorded during data collection. This made it easier to identify themes and patterns within the data. By querying, NVivo helped in identifying similarities, relationships, and differences in the data, and putting related codes into

various categories. Data was validated by checking for consistency with the research questions and objectives. After establishing the preconceived themes like health and safety, leadership, social impacts, time use and food security from the data, conclusions were drawn based on the data findings.

Feedback from similar research works was also used in this validation. Throughout this process, the confidentiality and anonymity of the respondents were ensured to protect their privacy. The questionnaire used to gather information contained a number of modules that sought to collect information on the demographic features of the respondents as well as detailed information regarding their direct and indirect involvement in ASM activities.

The first module of the questionnaire collects data on the personal and demographic features of the respondents with regards to their gender, household characteristics, and capacity to be interviewed alone. The second module (Module B) sought to know more about the extent of participation in ASM activities as well as the involvement of any other household members in ASM activities. The third module (Module C) focuses on how ASM impacts household members by virtue of their direct participation in terms of health and safety risks, leadership and decision-making, economic impacts, time use, and food security/nutrition. The next module (Module D) collects data regarding all those who are indirectly involved in ASM. This part of the questionnaire covers aspects related to nutrition and food security, economic impacts, environmental impacts of ASM, and additional domestic roles they may be involved in.

4.11 Analysis of Qualitative Data

Analysis of this qualitative data consisted of several steps. This involved transcription of the interviews (Stuckey, 2014), coding the data (Baralt, 2011), identification of patterns and themes as well as drawing up relevant conclusions based on the findings (Mezmir, 2020; Peterson, 2019; Salmona and Kaczynski, 2024). The transcription of the data involved making

a written record of the conversation. This was done manually and, using a transcription software called NVivo. This software aided in ensuring all the data is readily available for analysis by assisting in coding, querying, visualizations, creation of networks as well as text analysis. Coding basically consisted of identifying and making out the various concepts, and ideas, as well as those emerging from the data. By coding, numerical codes, alphabetical codes, and labels were assigned to responses or certain behaviors recorded during data collection. This made it easier to identify preconceived themes and patterns within the data. This research decided to make use of preconceived themes based on the nature of the third objective and the anticipated data being collected. As this research had some underlying gender undertones and the economic impact of ASM on women, the use of preconceived themes was preferred (Robinson, 2022).

Creswell and Poth (2016) asserts that gender-related research such as this one which focused on issues of intersectionality tends to result in specific concepts and categories. Some of these categories have to do with gender roles and inequalities, all of which form part of this research. Consequently, the use of such preconceived themes enhanced its adherence to some of these already established theories. This in effect, contributed to a more structured and focused synthesis of the research.

4.12 The Use of Preconceived Themes in Qualitative Analysis

Preconceived themes were utilized as part of the qualitative analysis. Dusi and Stevens (2022) are of the view that the use of preconceived theories ensures the applicability of how certain theories like intersectionality, which is being considered in this research, manifest in various settings. It must be realized that gender-related topics have the tendency to be complex and delicate, especially when juxtaposed with issues of identities, power dynamics, and discrimination. As such, according to Lemmons (2023), the use of preconceived themes helps in maintaining full concentration on some of these sensitive aspects so as not to derail.

Preconceived themes are ways of facilitating cross-case analysis. In other words, it ensures a variety of comparisons. This facilitates the assessment of gender impacts of various groups of people as exemplified by Spadola *et al.* (2017). More so, it must be noted that gender-related research has much to do with issues of stereotypes and empowerment. These issues are well established in a myriad of literature. In this respect, it makes sense to employ the use of preconceived themes to address such prevalent issues.

As far as policy formulation and implementation are concerned, the use of preconceived themes plays a critical role. This is because the outcome of this study for instance, could be aligned with already existing advocacies. This ensures a more action-oriented research and make the research more relevant (Morgan and Nica, 2020).

More so, the use of preconceived themes enabled the concentration on the specific aspects of how ASM influences women (Braun and Clarke, 2006). By so doing, the research aligned with the targeted research objectives and hypothesis as this research falls within the remits of the implication of ASM on food security, health, and nutrition (Fereday and Muir-Cochrane, 2006). Additionally, the use of preconceived themes allowed for a structured comparison in various localities such as urban/rural, households, and even enumeration areas (Huberman, 2014). Furthermore, consistency and efficiency are ensured in the research. For instance, this procedure will allow for the systematic coding and data categorization (Guest, 2012), to make out common patterns that will help in ensuring effective conclusions.

Another relevance of preconceived themes comes into play during the testing hypothesis based on certain economic backgrounds. This helps maintain targeted tests to ensure its alignment with policy making. In other words, the use of preconceived themes has a way of ensuring that there is no form of deviation from the targeting objectives and purposes for which they have been established, with recourse to the fact that they have been coined from strong standing,

well-researched, and theoretically grounded concepts. In a way, the use of this preconceived themes approach made the study more grounded.

After establishing themes and patterns from the data, conclusions were drawn based on the data findings. These were made depending on the inferences emerging from the data. Data was validated by checking for consistency with the research questions and objectives. Feedback from similar research works was also used in this validation. Throughout this process, the confidentiality and anonymity of the respondents were ensured to protect their privacy.

4.13 Modelling ASM, Food Security, Nutrition, Health and Other Demographic Features

Research has demonstrated several ways by which ASM relates to other factors such as food security, nutrition, and health among other variables. These relationships support the model specification and expectations of certain outcomes.

For instance, according to a study by Latifatu (2017), low food security levels were recorded in ASM-affected communities. According to this study, these ASM communities are not food sufficient as they depend on neighboring communities for food their food supplies. Considering this study, food security is expected to have a negative relationship with ASM as corroborated by Barenblitt *et al.* (2021) as well.

A high level of correlation was also recorded between food security and education (Kara and Kithu, 2020)/. Similarly, Gatobu *et al.* (2020) and Kirilova *et al.* (2020) realized that socioeconomic factors such as education, land tenure systems, and household decision-making had a strong relationship with food security.

Arthur *et al.* (2016a) recorded an inverse relationship between ASM and the health of the inhabitants within the ASM communities because of the high levels of pollution and land degradation. This relationship has been recently corroborated by Arthur-Holmes and Busia

(2022a). UNICEF (2020) reported that health conditions tend to have a strong correlation with quality and healthy diets.

By the use of cross-sectional data which was put through meta-analysis, twice frailty was recorded with unmarried men as compared to the married ones (Kojima *et al.*, 2020). Age is also expected to have an inverse relationship with increasing health (Chang *et al.*, 2020). Change et al., (2020) also reported an inverse relationship between nutrition and ASM. Hilson and Maconachie (2020) also recorded an inverse relationship between nutrition and age, while nutrition is expected to have a positive relationship with household incomes.

Table 4.13 gives an overview of the various expected outcomes regarding the relationship between ASM, food security, nutrition, health and other demographic features.

Table 4.13: Interactions between ASM, Food Security, Nutrition, Health and other demographic features

S/N	Dependent variable	Independent variables	Expected relationship	Source
1	Food security	ASM	Negative	(Latifatu, 2017)
		Education	Positive	(Iram and Butt, 2004) (De Muro and Burchi, 2007; Gatobu *et al.*, 2020)
		Marital Status	Negative	(Arthur-Holmes and Busia, 2020), (Hausermann *et al.*, 2020)
		Household size	Negative	(Zolnikov, 2020)
		Household Income	Positive	(Gatobu *et al.*, 2020)
		Land ownership	Positive	(Kirillova *et al.*, 2020; Gatobu *et al.*, 2020)
2	Health	ASM	Negative	(Arthur-Holmes and Busia, 2022a) (Cossa *et al.*, 2021)
		Marital status	Positive	(Kojima *et al.*, 2020)
		Age	Negative	(Chang *et al.*, 2020)
3	Nutrition	ASM	Negative	(Chang *et al.*, 2020)
		Age	Negative	(Hilson and Maconachie, 2020)
		Household income	Positive	(Ofosu *et al.*, 2020)

4.14 Apriori Expectations

- Food security is expected to decrease with increasing ASM activities. (–)
- Food security is expected with increasing landownership and household income (+)
- Married couples are expected to enjoy higher food security as compared to single ones (–)
- Increasing household size comes with decreasing food insecurity. (–)
- Health is expected to deteriorate with increasing food insecurity conditions (–)

- Married status is expected to a direct relationship with health (+)
- Health is expected to deteriorate with increasing age (–)
- ASM is expected to affected nutrition due to the effect of its destructive nature of arable lands (–)
- ASM is expected to increase with increasing household incomes. (–)
- ASM is expected to decrease with increasing age (–)

4.15 Model Estimation

Simple Linear Model Specification (SLM)

The model for the relationship regarding ASM, food security, health and nutrition as well as other variables was expressed using an Ordinary Least Square (OLS) approach as follows:

$Y_i = f$ (ASM, control variables)

Where $_i$ is food security, nutrition or health indicator.

The OLS approach was preferred because the dependent variables used in this study were in a continuous format. More so, the OLS is crucial and gives a simple, efficient, and interpretable method for the estimation of the relationships between dependent and independent variables. By minimizing the sum of squared residuals, OLS ensures unbiased and consistent estimates under certain assumptions. This makes it a powerful tool in understanding how changes in predictors affect outcomes. More so, its wide applicability and ability to provide clear diagnostics like R-squared and p-values make it a preferred method for drawing reliable and actionable insights from data. The dependent and independent variables used in the model are explained in Table 4.15 as follows:

Table 4.15: Table on description of variable used in model estimations

Variable	Notation	Units	Description of variables
Food security	Foodsecindex	Number	Number yes responses to 8 FAO food security questions divided by 8
Household Dietary Diversity	HDD	Number	Number of food consumed in 12 food groups divided by 12
Health	daysofabsenceIllne~h	Days	Number of days of absence from work due to illness/injury or both
Percentage of hours spent in ASM	ProportionofASMHours	%	Percentage of occupational hours spend on ASM with regard to other occupational hours in the household
Sex	Sex	Male = 1 Female = 0	Gender of household head
Area of land cultivated	Areaoflandcultivated	Hectares	Area of arable land cultivated by household
Household size	Hhsize	Number	Total number of people in the household
Marital Status	Maritalstatus	Married = 1 Unmarried = 0	Marital status of household head
Migration	Migration	Migrant = 1 Nnon-migration = 0	Migration status of household head
Primary Education	primaryEdu	Primary grade = 1; 0 otherwise	Primary educational status of household head
Secondary education or more	Secondaryplusedu	Secondary education and more = 1; 0 otherwise	Secondary educational status of household head
Wealth Index	Wealth index	Number	composite measure of a household's cumulative living standard base on important assets owned
Urban or rural location	Urbrural	Urban = 1 Rural = 0	Urban/ rural
Ownership of livestock	ownershipofLivestock	Ownership status Yes = 1; No = 0	Whether the household owns livestock

All the variables were constructed using data from GLSS 7. However, some of the variables like the dependent ones such as food security, nutrition, and health were generated from data. Variables like urban/rural, ownership of livestock, primary education, secondary education, marital status, household size, sex, and area of land were directly captured from the GLSS 7 data.

However, composite ones like the wealth index were constructed using a combination of multiple indicators related to household living standards into a single measure. These multiple indicators are in the categories of housing characteristics, access to utilities and infrastructure, household assets, and access to financial services. Some of these factors included in the wealth index were household access to water access to sewerage, access to gas, access to electricity, ownership of furniture, ownership of textiles, ownership of household appliances, ownership of mobile phones, insurance, access to financial services, and access to accommodation. These indicators were put through a principal component analysis after which the wealth index for rural and urban locations was predicted. This approach is useful for researchers to evaluate a household's relative socioeconomic status, which cannot be captured by a single variable alone.

As part of the estimations, the study also considered interacting ASM with area of land cultivated as ASM could exert different effects depending on the size of the land cultivated. For instance, on small plots, ASM activity could affect a significant proportion of arable land which could amount to a sharper decline in the productivity of the land. Relatively, the effect of ASM on larger plots will not be very pronounced as the ASM activities may only affect a section of the total land. This interaction will enable us to identify whether the effects of ASM on agriculture differ by land size. This could serve as an important policy guide for certain aimed interventions. The level of interaction will have an impact on the substitution effects undertaken in each household. For instance, households owning larger sizes of lands will have bigger opportunity costs since they could lose huge arable lands to ASM activities in comparison with those with smaller land holdings who to them, ASM is another form of viable livelihood.

Additionally, the study considered interacting ASM with the wealth index since the effect of ASM activities on households could change significantly depending on the wealth groups. With wealthier households, they may have the capacity to capitalize on economic opportunities that come with ASM activities like increased incomes and reinvest such mining profits into agriculture. On the side of poorer households, they may be confronted with the negative effects of ASM activities such as loss of agricultural productivity and environmental degradation. Such households may not have the financial resources to mitigate inimical effects.

The study also considered interacting ASM with household size as smaller household sizes may have fewer demands on resources like food and income. Therefore such households stand to benefit few livelihood options like ASM activities. On the other hand, larger households which may be characterized by higher consumption needs are confronted with balancing the resources regarding ASM and agriculture livelihoods. An interaction term helps reveal how the influence of ASM differs between wealthier and poorer households.

The model estimations were done using Stata version 18.5. All the dependent and independent variables were loaded into the Stata software. In the modeling, the requisite Stata codes (regress) was utilized to estimate the three models categorically.

4.16 Ethical Considerations

To conduct effective research work as planned, there was always need to acknowledge the ethical issues regarding the study. Before I commenced with my data collection in the field, I sought official permission and due clearance from the University Research Ethics Committee.

Ethics is one relevant aspect of the research work that was critically considered. With regards to objective (3) which involved engaging women, it demanded that all psychological and physical risks were well considered. The consent of the participants to be interviewed needed to be well sorted. All through the research process, there was a need to preserve the anonymity of the

respondents. In situations where necessary, the use of pseudonyms was employed in the reports. More so, all participants due for the interview were duly informed beforehand. The participants were conscientized of their liberty and freedom to give out any information. The assistant who took part in this research was also well trained and informed on the importance of the confidentiality of our respondents. All assistants and participants in this study were required to sign an agreement of confidentiality as far as the use of the data gathered is concerned. More importantly, all data gathered were kept on password-encrypted computers with other backups on password-encrypted storage devices. All information regarding participants was securely stored in safe locations.

Importantly, there was need to obtain informed consent from the women respondents before collecting data. This included furnishing them with information about the purpose and nature of the study, the data collection, the expected duration of the study, and any potential risks or benefits of participating. In any case, women respondents had the right to decline to participate without any consequences.

All data collected were treated as confidential. In addition, there measures were taken to protect the privacy and anonymity of the participants. These included using pseudonyms, password-protected electronic devices, and secure storage methods to contain the data collected. Ethical standards were adhered to. Participants were treated with respect and provided opportunities for them to ask questions or withdraw their consent. Details regarding the Ethical Clearance can be found in Appendix I.

5.0 RESULTS FROM EMPIRICAL ESTIMATIONS

5.1 Introduction

This chapter contains the findings and discussions of the study which have been structured in alignment with the research objectives and questions earlier specified in this study. This chapter aims to outline vivid and concise presentations of the various results and discussions from the data analysis pertaining to this study with extensive interpretations regarding the purpose of this study which sought to investigate the implications of artisanal and small-scale mining (ASM) on food security, nutrition and health. Also, the chapter explores the potential and plausible explanations behind statistical relationships, interactions, mean marginal effects, and other empirical nuances regarding these variables as they unfold within the framework of this mixed-methods approach. In addition to discussing these findings with reference to the current body of research, the chapter attempts to create a linkage with corresponding implications on research and policy. Although empirical studies on ASM are not as many as compared to qualitative studies, the findings of this study are juxtaposed with the few ones as well that other qualitative studies to attain a comprehensive discussion of the implications of ASM which is basically organized around the themes critical to the research objectives namely ASM, food security, nutrition, and health.

The results and discussion of this study are organized as follows:

- Descriptive Statistics
- ASM and food security
- ASM and nutrition
- ASM and health

Based on the above plan, the focus of each of the sections is in response to the set research objectives with reference to the data collected, significant outcomes, supported tables, figures among other descriptives where necessary.

5.2 Descriptive Statistics of The Respondents and Variables

The descriptive statistics of the various variables used in this study are shown on Table 5.2

Table 5.2: Descriptive Statistics of the Respondents and Variables

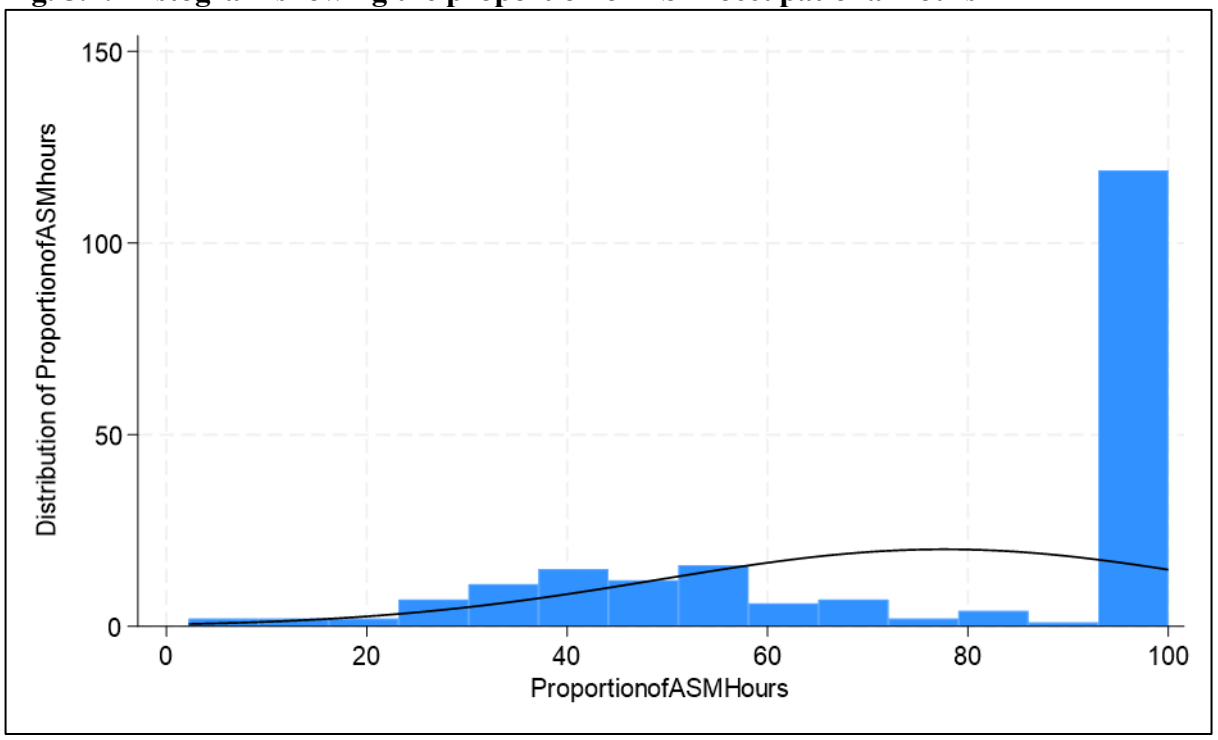
Variable	Obs/Freq	Mean	Std. Dev.	Min	Max
Sex Male Female	1617 1117 500	-	-	0	1
Marital status Married Unmarried	1617 857 760	-	-	0	1
Age	1617	44.437	15.514	16	99
Migration	1617 615 1002	-	-	0	1
Household size	1617	4.055	2.728	1	22
Area of land cultivated	1617	0.316	0.724	0	5.6
Wealth Index	1617	0.192	1.473	-2.488	4.584
Urban/rural Urban Rural	1617 636 981	-	-	0	1
Primary Education	1617	-	-	0	1
secondaryplusEdu	1617	-	-	0	1
Household Dietary Diversity	1617	0.387	0.173	0.014	0.972
Food Security	1617	0.615	0.38	0	1
Health (days of absence due to sickness/illness or both)	1617	0.917	2.00	0	14
ProprtnofASMHrs	1617	9.89	27.80	0	100

Source: Author's computation based on household data of GLSS-7 (2019)

From Table 5.2, the male-headed households form 69% of the entire households while female-headed households form 31%. This means there are more male-headed households as compared to female ones. This result is not so different from what was recorded by FAO (2016) who reported similar results regarding female-headed households in Ghana. Similarly, Baffour-Kyei *et al.* (2021) also recorded a high male-headed domination of ASM households as compared to female-headed ones, just like what was studied by Baah-Ennumh *et al.* (2020).

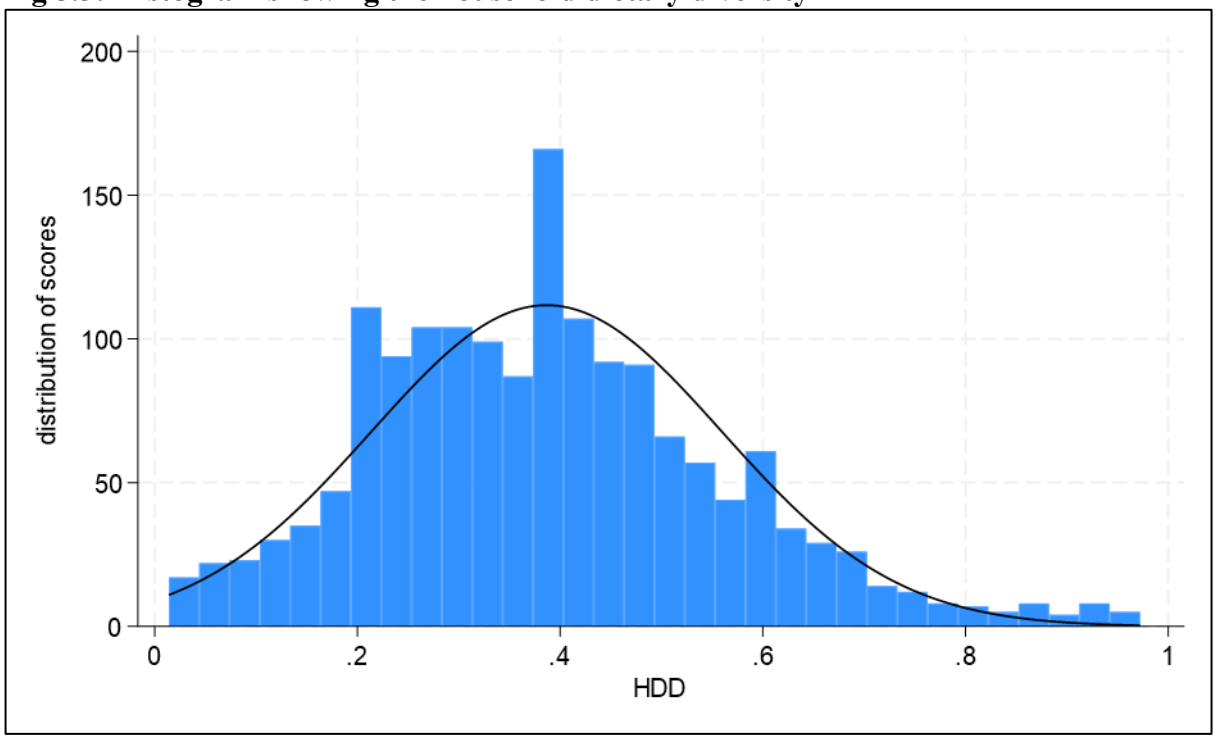
The table indicates that there are more married respondents as compared to unmarried ones. The married ones make up 53% of the entire survey as compared to the unmarried ones who make up 47%. It must be noted here that the unmarried population entails those who are single, divorced, separated, and those in consensual relationships. The ages of the respondents fall between the ranges of 16 years old to 60 years old. Overall, the mean age is approximately 44 years old with a standard deviation of 15.50. The minimum age is 16 years old while the maximum age is 99 years old. In terms of the educational background of the respondents, the categories are basically placed into primary level and secondary level or more. The primary level is made up of those basic educational categories such as kindergarten, primary, and junior high school, while the secondaryplusEdu educational category entails secondary education, tertiary education, vocational and technical education, and professional education. It must be noted that there were some respondents who had no level of formal education as these formed the base category of the dummy variable. The household size ranges from 1-22 people in the household with an average size of 4 people in the household. From the descriptive statistics, 62% of the respondents are indigenes while 38% of them can be described as immigrants. This means that there are more indigenes who are involved in ASM activities as compared to immigrants. Out of the 1617 households identified, only 206 of them mentioned ASM as an occupational activity. The range of the proportional hours of ASM ranges between 0 and 100%.

Fig. 5.2: Histogram showing the proportion of ASM occupational hours



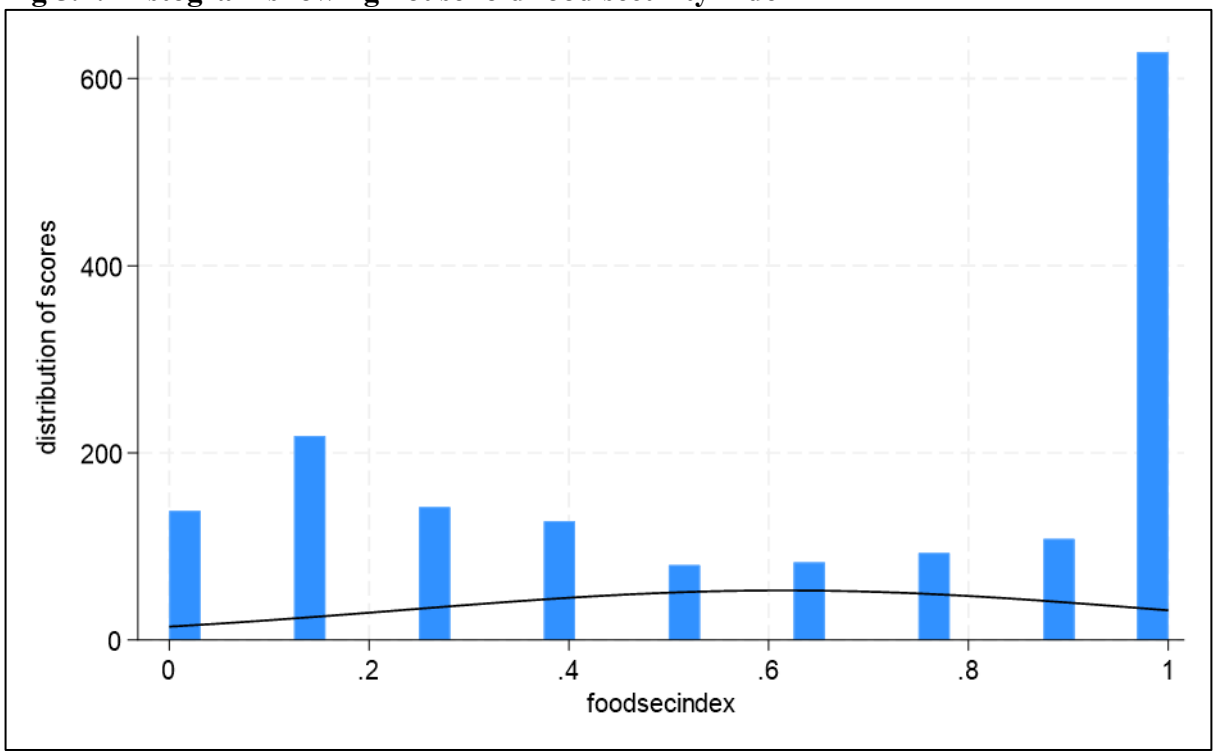
Source: (GSS, 2019)
(NB: The graph contains only households involved in ASM)

Fig 5.3: Histogram showing the household dietary diversity



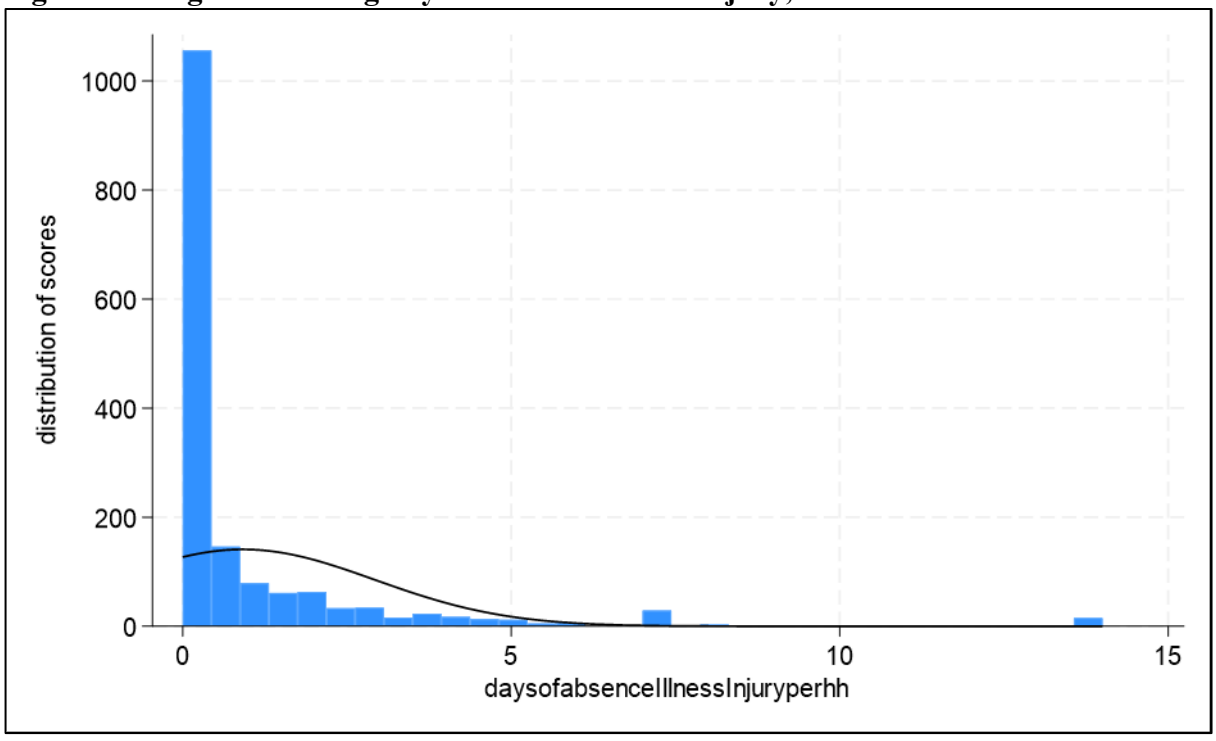
Source: (GSS, 2019)

Fig 5.4: Histogram showing household food security index



Source:(GSS, 2019)

Fig 5.5: Histogram showing days of absence due to injury, illness or both



Source: (GSS, 2019)

5.3 ASM and Food Security

The results for the regression of the food security model are as shown on Table 5.3 The table also contains results on mean marginal effects as well as relevant interactions considered.

Table 5.3: Regression results on ASM on food security estimations

Variable	Coefficient (standard error)	p-value	Marginal Effect (Standard error)	p-value
ProportionofASMHours (ASM)	-0.001* (0.00054)	0.059	-0.0009* (0.00053)	0.098
Sex	0.037 (0.034)	0.295	0.037 (0.034)	0.295
Areaoflandcultivat~e	0.052*** (0.150)	0.001	0.052*** (0.150)	0.001
Hhsize	-0.001 (0.0049)	0.829	-0.001 (0.0049)	0.829
Maritalstatus	0.0153 (0.032)	0.636	0.0153 (0.032)	0.636
primaryEdu	0.150*** (0.029)	0.000	0.150*** (0.029)	0.000
secondaryplusEdu	0.133*** (0.0464)	0.004	0.133*** (0.0464)	0.004
WealthIndex	0.0702*** (0.010)	0.000	0.0675*** (0.0971)	0.000
Age	0.00005 (0.0009)	0.947	0.00005 (0.009)	0.947
ownershipofLivestock	0.00006 (0.0264)	0.998	0.00006 (0.0264)	0998
ownershipofLand	-0.079** (0.032)	0.014	-0.079** (0.032)	0.014
Urbrural	-0.043 (0.034)	0.223	-0.043 (0.034)	0.223
c.ProprtnofASMHrs#c. WealthIndex	-0.00035 (0.00033)	0.307		
Constant	0.47*** (0.065)	0.000		
Mean dependent var	0.531		SD dependent var	0.381
R-squared	0.162		Number of obs	807
F-test	11.771		Prob > F	0.000
Akaike crit. (AIC)	618.896		Bayesian crit. (BIC)	684.603
*** p<.01, ** p<.05, * p<.1				

NB: The regression results contain interactions of interest that came out with significant co-efficients. ***, **, and * stand for values statistically significant at 0.01,0.05 and 0.1 levels respectively.

From the regression result on Table 5.3, it can be realized that the regression model significantly explains variations in the independent variables as Prob > F is less than 0.05 ($p<0.05$). The regression results indicate a significant coefficient for variables such as percentage of occupational hours in ASM, area of land cultivated, primary education, secondary and other levels of education, wealth index, and ownership of land. The constant was also found to be significant in the estimation.

As far as ASM is concerned, the results in Table 5.3 mean that a percentage change in occupational hours of ASM is associated with a decrease in food security levels by 0.001units. In other words, an additional hour spent in ASM is associated with a 0.001 decrease in food security levels, having accounted for other observed variables. The magnitude of the coefficient value (-0.001) is minimal. This significant result aligns with a priori expectations as realized from previous literature. For instance, according to contemporary studies by Nunoo *et al.* (2023), it was observed that farmers who offered their cocoa farms in exchange for ASM purposes experienced reduced household food security. However, both studies applied different methodological approaches in the achievement of these results. While this current study applied OLS regression due to the continuous nature of the dependent variable, its straight forwardness and assumption of linear relationship between the dependent and explanatory variables, Nunoo *et al.* (2023) applied endogenous switching regression model which further estimated the causal effect of ASM on food security outcomes by comparing the food security of households engaged in ASM to those not engaged. There was also difference in the sampling. This current study sampled 1617 households from GLSS data whose population was 14,009 while that of Nunoo *et al.* (2023) sampled 400 cocoa farmers within an ASM prevalent area.

Nunoo *et al.* (2023) employed a multi-dimensional approach in the measurement of food security considering both short-term and long-term impacts. In particular, the study employed a number of indicators such as dietary diversity which was responsible for measuring the variety

of food consumption, household food insecurity experience access scale (HFIAS) which gave information on the hunger levels in experienced and coping strategies which portrayed how food insecurity was handled by the respondents. However, this current study employed the use of one indicator which is the food insecurity experience scale.

Moreover, the study area used by Nunoo et al. (2023), which happens to be Amansie West District in the Ashanti Region, is a more ASM endemic area and also agrarian, where ASM is more prevalent unlike the GLSS. Such ASM-area-specific studies gave a detailed analysis of localized effects of how food security is tied to ASM activities. Such studies, unlike the GLSS, lack generalizability in regions where ASM is less prevalent, leading to results that are highly context-dependent, thereby recording a strong level of significance between ASM and food security. On the other hand, this current study made use of GLSS data which is an unbiased, multi-stage stratified sampling design, making sure that households from diverse geographical, socioeconomic, and demographic backgrounds are included (Khan *et al.*, 2016; Hasanbasri *et al.*, 2021). This ensures that the survey captures a comprehensive picture of living standards across urban and rural areas.

Bansah *et al.* (2024) used Landsat data as a different indicator for the measurement of the impact of ASM on food security. This study resulted in a negative relationship between ASM and food security, as it utilized satellite imageries from ASM endemic areas. As such, a stronger relationship and more evidence-based indicator by the use of aerial monitoring metric as compared to GLSS, which utilized a broader household survey, was recorded.

Contextually, a critical analysis of the GLSS data revealed that it is not all the ASM households that own land (GSS, 2019a). The GLSS data recorded 40% of ASM households who own arable lands, with the average land size of 0.19 ha per ASM household (GSS, 2019a). This means that these small-sized arable lands are owned by a few households. In addition, evidence from literature (Wongnaa *et al.*, 2024; Adranyi *et al.*, 2024; Byizigiro *et al.*, 2020) and qualitative

aspect of this study shows that some of these arable lands tend to be characterized by randomly dug pits, haphazard excavations among other scattered land depressions resulting from the indiscriminate use of the land for ASM activities. This reduction in arable land minimizes food production which tends to lower food security. This assertion could be compared to that of Barenblitt *et al.* (2021) who alluded the extent of vegetation and arable land lost to ASM activities. According to Barenblitt *et al.* (2021), several hectares of vegetation were converted to mining uses. In effect, this land conversion impacts local agriculture by reducing the availability of arable land, a critical factor in food production.

Although this study recognized the impact of ASM on the reduction in agricultural land which consequently affects food security in the long run, the methodological approach in the determination of this impact differs. The use of geospatial analysis leverages on satellite imagery and machine learning to quantify land use changes caused by ASM activities. Such methodological approach as demonstrated by Barenblitt *et al.* (2021) lays more emphasis on the loss of arable land and environmental degradation as indirect pathways through which ASM affects food security. Clearly, the GLSS directly measured food security indicators whereas Barenblitt *et al.* (2021), relied on environmental proxies such as land degradation and water contamination, to infer food security implications of ASM activities. Although both studies present an inverse relationship between ASM and food security, it can be observed that the interpretation of how ASM affects food security is dependent on the data used and the methodological approach. By this way, while GLSS gives a socioeconomic context that can be correlated with environmental data, while that of Barenblitt et al. (2021) provide a spatial data that elucidates the environmental mechanisms driving socioeconomic changes observed in datasets like GLSS.

In explaining the inverse relationship between ASM and food security, another assertion established by Baddianaah *et al.* (2022) and Arthur-Holmes *et al.* (2022a) observed that most of

the youth who served as a source of labor for the agricultural sector, have all drifted into mining activities. This increasing populace who takes to ASM activities is in sharp contrast with the decreasing number of farmers, especially the youth, involved in agriculture. This could be clearly seen in the greater youthful population involved in the ASM activities based on the GLSS data (GSS, 2019a), a phenomenon that consequently results in a labor deficit for farming, thereby raising food security issues. Synonymously, the qualitative aspect of this study attests to this labor shift as most women in the households attested to the fact that youth have taken to ASM activities to the detriment of other farming activities (agriculture). This connotes and gives strong support to the labor shortage with regards to agricultural activities which are potentially detrimental to food security.

Martanto (2021) observed a negative relationship between land-use conversion and food security, although the study unlike this current study, does not directly focus on ASM. However, its paradigm for land-use changes and food security applies to areas where ASM activities could be found. The methodology by Martanto (2021) utilized spatial analysis through the use of LANDSAT satellite imagery and Average Nearest Neighbor (ANN) analysis to determine the patterns of land conversion whereas in this current study, the proportion of occupational hours spent in ASM was utilized. An indirect indicator for the measurement of food security was also used as it was assessed by calculating rice production capacity against population food needs. LANDSAT satellite imagery was also utilized to distinguish patterns of land conversion from agriculture to non-agriculture purposes. Although, the use of this methodology yielded similar results with regards to the relationship between ASM and food security, a more empirical approach as advanced in this current study through the employment of GLSS data covers a broad spectrum of household socio-economic characteristics that tends to support the relationship.

Fagariba *et al.* (2024) also identified an inverse relationship between ASM and food security via several pathways as compared to this current study. One aspect of the study assessed how ASM

activities led to land degradation, water contamination, and deforestation through the views presented by the respondents via qualitative analysis. These environmental changes were shown to reduce arable land availability and soil fertility, which directly impacted agricultural productivity and food security.

However, it is worth noting that these arguments are compelling within specific contexts, especially in a situation whereby Fagariba et al. (2024) conducted the study within an ASM concentration zones. Another aspect of this ASM and food security study has to do with its ability to be measured using household surveys. In essence, the use of specific indicators for food security index as utilized in this current study and as seen in other body of literature (Saint Ville *et al.*, 2019; Allee *et al.*, 2021; Durano *et al.*, 2024) gave a more established assessment of food security as compared to the inferential views deduced from the respondents in the study by Fagariba et al. (2024). In other words, this current study gave a more robust assessment of the food security using the food security indicator.

Furthermore, it is worth noting that due to the informal and unregulated nature of ASM (Chuma *et al.*, 2024), the very households involved in ASM may not identify themselves as such, especially in household surveys like the GLSS used in this current study. This could amount to the underreporting of ASM activities and furthermore, affect its relationship with food security.

In other places of Africa, food security is a critical factor to consider in places where there is prevalence of ASM activities due to its significant effect (Zhang *et al.*, 2020). According to this current study, area of land cultivated was found to be significant as far as food security is concerned as similarly recorded by Hilson (2016b); Li *et al.* (2021b), and Wang (2022). In places where there are small average landholdings as seen in this GLSS data; each additional piece of land is able to have a substantial effect on food production as recorded in the significant positive coefficient of the area of land cultivated on Table 5.3. Likewise, the significant marginal effect of area of land cultivated is demonstrated whenever the cultivated area is expanded, this enables

the growing of diverse crops which seek to enhance food security as crop failure is minimized. The increase in cultivated land results in a greater probability of at least some crops surviving and promoting food security. In addition, households characterized by small landholdings are confronted with challenges in meeting their food needs as reported by Adator *et al.* (2023). In other words, households with the capacity to cultivate larger land sizes are more advantaged to achieve food security. As a result, marginal increases in cultivated land are significantly beneficial for improving food security. This was evidenced in the significance of the coefficient of the marginal effect on areas cultivated which could be interpreted as a unit change in area cultivated increased food security by 0.052 which happens to be consistent with the findings of Mujuru and Obi (2020). However, in typical ASM settings, this increase in land cultivated may not necessarily result in increased food security owning to issues like pollution, land degradation labor shifts among others caused by mining activities as reported by respondents from the qualitative aspect of this studies as well as other body of knowledge (Diallo and Soumah, 2023; Blanco *et al.*, 2023; Obodai *et al.*, 2024).

The study recorded a significant positive relationship between food security and education (primary and secondary or more). From the study, a unit increase in primary education increases food security by 0.150 while a unit increase in secondary or more education increases food security by 0.133. Studies such as that of Gnedeka and Wonyra (2024) made a similar observation between food security and education, whose underlining reasons could be attributed to a number of factors. For instance, education comes with enhanced economic opportunities as well as income (Ali, 2024). In this regard, this increase in economic stability allows households to procure sufficient food for their households. Education helps to ensure knowledge and awareness of balanced diets and various food requirements of their households (Rout, 2019). More so, it improves better food hygiene which tends to reduce foodborne diseases. In addition, education ensures the use of better farming practices so as to improve upon yield which promotes

food production to enhance food security (Rudolph *et al.*, 2024). Education helps in ensuring better access to weather patterns, market prices, agricultural innovations among other contemporary practices that seek to improve food security (Kirui, 2019). A marginal increase in education was also observed to have a significant positive impact on food security due to the fact that it has capacity to enhance foundational knowledge and skills regarding key dimensions of food security (Mutisya *et al.*, 2016).

The wealth index was also found to have a significant positive effect on food security. This means a rise in the wealth index causes food security to increase by 0.0702. More so, a significant marginal increase of 0.0675 was recorded. The significant positive relationship existing between the wealth index and food security shows the multifaceted ways by which wealth from ASM activities results in the ability of households to have access to food. As far as wealthier households are concerned, they are able to have improved economic stability, diversified livelihoods, and investments in agriculture (Hilson and Hu, 2022). Collectively, these advantages alleviate the challenges of food security.

As reflected from the qualitative studies, involvement in ASM activities allows them to have substantial amount of income. This enables them to access various foods items that they intend to purchase. According to the DPA's in the qualitative study, their households are able "to eat very well" on days when much income is realized from the ASM activities. This means, the wealthier they are, the more they are able to afford good food for their households.

Also, the study reported a significant negative relationship between land ownership and food security which means that an increase in land ownership will reduce food security by 0.079. Similarly, marginal increase in land ownership was also seen to have significant effect on food security. These results are consistent with that of Mulusew and Mingyong (2023), which could be due to several factors.

Factors relating to diversion of resources such as labor from agriculture to ASM could be one of such factors (Ofosu *et al.*, 2020). This is due to the labor-intensive nature of ASM which may not permit landowners to pay attention to agricultural activities as reported by Hilson and Maconachie (2020). There could also be loss of arable land because of ASM activities (Mensah-Abludo *et al.*, 2023), which may undermine food security. In addition to studies by Bansah *et al.* (2024), this assertion was also confirmed by the qualitative studies owning to the 'quick money' nature of ASM as compared to agriculture. Also, it was also confirmed from the qualitative study that the income from ASM activities is being reinvested to the detriment of other farming activities. The amount of hours committed to ASM activities shows the commitment of the households towards ASM. This could have resulted in uncultivated lands by landowners which does not contribute to food production. Even in situations of land ownership which are being characterized by small fragments of land as realized from Table 5.3, these small-sized lands may not be enough to ensure household food security, especially in such instances where ASM is more preferred to farming. In consonance with the results from the qualitative studies in addition, most of these lands from which ASM activities take place do not belong to the people involved in ASM, a notable observation comparable to that of Ofosu *et al.* (2020) and Schwartz *et al.* (2021b) In other words, the ASM activities take place on lands belonging to landowners whose sole interest lies in mining and not crop production. As such, in times when the income from ASM is unpredictable, households are faced with the challenges of food security.

5.4 ASM and Nutrition

The results for the regression of the nutrition model are as shown in Table 5.4. The table also contains results on mean marginal effects as well as relevant interactions considered.

It can be realized that Prob > F (p-value) is less than 0.05 ($p < 0.05$). This means that the model is statistically significant. From the regression analysis, ASM, primary education, migration, urban/rural, sex, wealth index, and household size were found to be significant. In addition, the

interaction between percentage of hours spent in ASM and household size were found to be significant.

Table 5.4: Regression results on ASM on nutrition estimations

Variable	Coefficient (standard error)	p-value	Marginal effect (Standard error)	p-value
ProportionofASMHours	-0.0006** (0.00024)	0.014	-0.00008** (0.00014)	0.533
primaryEdu	0.025** (0.0098)	0.009	0.025** (0.0098)	0.009
secondaryplusEdu	0.008 (0.0125)	0.52	0.008 (0.0125)	0.520
Migration	-0.029*** (0.00778)	0.000	-0.029*** (0.00778)	0.000
Urbrural	-0.019** (0.0085)	0.027	-0.019** (0.0085)	0.027
Sex	-0.039*** (0.0084)	0.000	-0.039*** (0.0084)	0.000
WealthIndex	0.05*** (0.0029)	0.000	0.05*** (0.0029)	0.000
Areaoflandcultivatedperhhsize	0.006 (0.005)	0.249	0.006 (0.005)	0.249
Hhsize	0.017*** (0.0015)	0.000	0.018*** (0.0014)	0.000
c ProportionofASMHours #c.hhsize	0.00012**	0.023		
Constant	0.345*** (0.013)	0.000		

Mean dependent var	0.387	SD dependent var	0.173
R-squared	0.261	Number of obs	1617
F- test	56.801	Prob > F	0.000
Akaike crit. (AIC)	-1555.664	Bayesian crit. (BIC)	-1496.393

*** *p<.01, ** p<.05, * p<.1*

NB: The regression results contain interactions of interest that came out with significant co-efficients.

***, **, and * stand for values statistically significant at 0.01,0.05 and 0.1 levels respectively.

These results are not different from the apriori expectations of this study. For instance, some studies through the use of other statistical approaches like logit analysis recorded a significant

relationship between dietary diversity and ASM (Wegenast and Beck, 2020; Obodai *et al.*, 2024) (Wyatt *et al.*, 2017).

From this study, the coefficient of ASM was found to be significant and has an inverse relationship with nutrition which is proxied as dietary diversity. This means that a percentage change in occupational hours of ASM is associated with a decrease in dietary diversity (nutrition) levels by 0.0006, after accounting for other observed variables. In other words, an additional hour spent in ASM is associated with a 0.0006 decrease in nutrition. Although this negative association is statistically significant, the effect size in relation to the magnitude of the coefficient is minimal. With regards to the significance of the coefficient of this variable, other studies have recorded similar results at other levels of significance.

Comparing with the study by Nordhagen *et al.* (2022), although direct nutrition indicators were not used in the assessment of dietary diversity, the food environment was assessed by the examination of factors such as market food availability, pricing, and household food acquisition behaviors. The study recorded a more nuanced and complex relationship between the two variables ASM and dietary diversity. According to Nordhagen *et al.* (2022), ASM generates cash income, however, it causes a shift from subsistence farming to the reliance of market-purchased foods which might not be diversed enough, especially in ASM areas that have limited market infrastructure, causing negative effect on dietary diversity (Zhang *et al.*, 2020).

In addition to the inferences from the study of Nordhagen *et al.* (2022), despite the cash income attained from ASM, the lack of robust and well-developed food markets in many ASM communities has the potential to result in limited access to nutritionally diverse foods. On the other hand, these same mining areas tend to attract vendors offering access to non-local food products such as fruits, vegetables, and animal products, whose availability and affordability may not be consistent due to factors suchs as transportation costs, limited production and issues regarding market control (Obodai *et al.*, 2024). This paradoxical assertion projects the nuanced

relationship exisiting between ASM and nutrition. Nonetheless, it is important to note that the dietary patterns of rural populations involved in ASM could be way different from that of the urban population considering the fact that the ASM population are from both urban and rural areas (Stokes-Walters *et al.*, 2021).These rural household where ASM is prevalent, are more used to self-production (Moyo, 2016) whereas the urban ones are used to market purchases (Obodai *et al.*, 2024). However, the GLSS does not sufficiently capture these ASM-related food acquisition methods.

More so, the studies conducted by Nordhagen *et al.* (2022) included both miners and non-miners across diverse settings in their sampling. The study was specific as to the kind of people involved in mining that were selected for the study. This enabled the study to directly determine the differences in how income from ASM activities influenced food purchasing power and dietary choices which eventually contributed to a nuanced understanding of nutrition challenges. However, this current study which employed GLSS does not really specify the level of engagement of the respondents in mining. In comparison to the household dietary diversity used in this current study, the former does not capture household-level outcomes such as dietary intake and nutritional adequacy over time. In addition, it must be realized that reliance on qualitative intuitions and a few localized market surveys as pursued by Nordhagen *et al.* (2022) does not make it sufficient enough to generalize findings across ASM communities with variable socio-economic and agricultural contexts.

Long *et al.* (2015) built another nuanced relationship between ASM and dietary diversity. According to the study, the participants interviewed did not appear to suffer any nutritional deficiency in terms of key micronutrients. However, there was lower fruit and vegetable consumption and higher sugar and fat consumption in comparison to other rural areas. This is because they have more disposable income to purchase packaged foods or foods prepared by local vendors and, thus, depend less on local agricultural products as compared to other rural

communities. This assertion resonates with the findings from the qualitative aspect of this study that recorded similar responses.

Furthermore, the commitment of occupational hours to ASM activities by the respondents as realized in the GLSS data could affect the amount of time committed into the production of diverse food crops. This could affect dietary diversity. More so, the strong significance of the wealth index variable in the estimations from the GLSS data reflects the income effects of ASM and further explains the disposable income available for them to purchase other food commodities (Piketty and Zucman, 2015). Critically, this supports the fact that the evident disadvantages of ASM are counterbalanced by the vast economic benefits accrued from ASM (Schwartz *et al.*, 2021b). Nevertheless, the seasonality of ASM activity has the capacity to lead to short-term economic survival which may not always lead to stable incomes. In the same vein, other income from ASM could be spent on non-food needs instead of improving the diversity of food consumed.

Similarly, Zhang *et al.* (2020) realized that there was deficiency in the aspect of nutritional quality and diversity of diets within ASM communities, having realized that mining communities experience constrained availability to diverse and nutritious foods. However, this study investigates the characteristics of markets that serve ASM populations that facilitate and pose barriers to getting a nutritious and sustainable diet. Despite the inverse and complex relationship between ASM and dietary diversity owing to the fact that economic benefits from ASM do not always translate into improved nutritional outcomes due to market limitations, dietary shifts, and the reduced availability of nutritious foods as established by Zhang *et al.* (2020), the use of dietary diversity indicator to establish the actual relationship between ASM and dietary diversity in this current study presented a more comparable analysis of such relationship across various socioeconomic backgrounds.

More so, in the analysis, primary education was found to have a significant positive relationship with nutrition. This means that a unit increase in primary education will increase nutrition by 0.025. This is because primary education increases awareness and requisite knowledge on nutrition and balanced diets (Rasheed, 2023). Follong *et al.* (2022) reported the significant role of primary education in the determination of dietary diversity. In addition, primary education enhances households knowledge on agricultural practices like crop rotation and pest management which promotes food security as reported (Abenwi *et al.*, 2020). In a similar vein, primary education enables households to consider other income sources beyond ASM as depicted in the other occupations in the GLSS data (GSS, 2019a). This tends to minimize the level of over-dependence on ASM and its related risks to nutrition. Similarly, marginal increases in primary education tend to have a rippling effect that tends to improve nutrition by empowering household members with knowledge for them to understand and effectively utilize resources. This marginal increase in primary education also builds their skills to make healthier choices for themselves and their families.

Migration was also found to have a significant negative relationship with nutrition. This implies that being a migrant reduces nutrition by 0.029. This negative relationship between migration and nutrition stems from several challenges related to the migrant population in ASM contexts. For instance, migrants tend to face challenges with access to land and community resources which negatively affects the nutrition of migrants (Cuvelier, 2017).

Migrants, especially rural-to-urban migrants, often leave behind agricultural livelihoods (Lahiri-Dutt, 2018a). According to Steeves *et al.* (2023), this minimizes their direct access to fresh, home-grown food due to the disruptions caused in self-dependent and subsistence farming systems (Campbell, 2018). On the other hand, evidence from the qualitative studies revealed that the income effects caused by ASM enables those involved to afford a variety of meals. In effect, such people are not much affected by the lack of fresh home-grown foods due to their capacity

to purchase some of these food items, most of which are not freshly homegrown but rather, ready to eat foods. As such, continuous consumption of such ready-to-eat foods by migrants in this case, could affect their nutritional status (Pongutta *et al.*, 2018).

Urban and rural locations were also found to have a significant negative relationship with nutrition. This meant that living in an urban area reduces nutrition by 0.019 as compared to that of a rural area. This could be due to the fact that fresh produce among other nutritious food items in urban areas are often more expensive in urban areas in comparison to rural areas (Ira *et al.*, 2020). More so, urban areas are more associated with the consumption of processed and fast foods at the expense of traditional food practices that emphasize nutritional balance like fast-foods which are calorie-dense but nutrient-poor (Cockx *et al.*, 2019). Evidence from the respondents in the qualitative study who were based in the urban area suggested that food was very expensive to buy in the area. More so, relying on farm produce was not so much considered due to the level of land degradation and deforestation that has affected agriculture in the area.

Gender represented by sex was found to have a significant negative relationship with nutrition. From Table 5.4, being male is associated with a decrease in nutrition by 0.039 as compared to female. In other words, males tend to experience lower nutrition as compared to females as reported by (Thurstans *et al.*, 2020). Similarly, Das and Singh (2020) reported that women often play a key role in food allocation in the households. In the process, they always make sure that children and other family members are fed before male members.

Some of the IPAs interviewed in the qualitative studies (especially mothers) often found themselves as primary caregivers. These people are known to take care of the children of the other women involved in ASM activities. As a result, they tend to prioritize the nutrition of their children and families, including themselves, over that of men.

The wealth index was found to have a significant positive relationship with nutrition. In other words, a unit increase in wealth index increases nutrition by 0.05. This means that households that have higher wealth index are more likely to have more diverse and balanced diets due to their capacity to afford nutritious and more balanced meals, a finding which resonates with the findings of Shirisha *et al.* (2022).

More so, wealthier households have the capacity to afford cooking and storage facilities such as cooking appliances and refrigerators which enable them to prepare and properly store healthy meals. This was confirmed by the qualitative studies who reported that the income earned from the ASM activities enables them to afford household appliances for the household.

Household size was found to have a significant positive relationship with nutrition. In other words, a unit increase in household size increases nutrition by 0.017. This means that larger households who are characterized by more household members are capable of contributing to other income-generating activities in addition to ASM. Eventually this puts them in a capacity to afford more balanced meals. Kim *et al.* (2016) and Shahraki *et al.* (2016) realized the importance of household size in the determination of nutrition. This finding is consistent with previous studies by Esquivel *et al.* (2023) Lee *et al.* (2019); Hlatshwayo *et al.* (2023)

In a situation where there are households are characterized by adults involved in ASM activities, the effect of combined income ensures better access to higher-quality foods. Similar claims were made by some IPAs who claimed that their wards involved in ASM activities were able to pool their resources together to cater for the entire household especially as some them had children who were being catered for.

The interaction between ASM and household size was found to have a significant positive relationship with nutrition. In other words, household size moderates the impact of ASM as far as nutritional outcomes are concerned. This means, within households involved in ASM, a unit

increase in household size increases nutrition by 0.017. This means the larger the household, the higher the possibility of experiencing a more positive impact of ASM on nutrition in comparison to smaller households.

More so, in larger households who are engaged in ASM, there is a better leverage as mining incomes are earned for improved nutrition resulting from labor distribution, maximization of earnings and the investment of into diverse food sources which tends to ensure positive nutrition outcomes.

5.5 ASM and Health

The results for the regression of the health model are shown on Table 5.5. The table also contains results on mean marginal effects as well as relevant interactions considered. From the table, it can be realized that Prob > F (p-value) is less than 0.05 ($p < 0.05$). This means that the model is statistically significant. From the regression analysis, ASM, household size, and urban/rural were found to be significant. In addition, the interaction between ASM and household size was found to be significant. The magnitude of the coefficient value (-0.0078) is minimal and associated with lower scores on health, which is being represented by number of days of absence due to illness/injury or both, having controlled for observed covariates. The observed relationship between ASM and health means that good health is associated with more working hours in ASM. In other words, the more hours spent in ASM activities, the less the absence due to illness/injury or both.

These results are inconsistent with aproiri expectations in that, although Schwartz *et al.* (2021a); Hilson *et al.* (2021a); Mulaba-Bafubiandi *et al.* (2023) realized a significant effect of ASM on health. The reason for the inconsistent results is contingent on several factors, one of which is the different health indicators used in the various studies.

Schwartz *et al.* (2021a) for instance, based on records on health issues relating to the exposure to dangerous chemicals used in ASM as a health indicator. The study recorded occupational

hazards like physical injuries, respiratory issues, psychological health issues as well as social and interpersonal health impacts as being resultant adverse effects of ASM on health though their qualitative studies. In comparison to this current research which based on the number of days of absence due to illness, injury or both as a health indicator as against ASM (the proportion of hours spent on ASM), the inverse relationship with this indicator means that the more they spent hours in ASM activities, the less days of absence due to illness, injury or both recorded.

Table 5.5: Regression results on ASM on health estimations

Variable	Coefficient (Standard error)	p-value	Marginal Effect (Standard Error)	p-value
ProportionofASMHours	-0.0078** (0.0032)	0.016	-0.002 (0.0018)	0.163
Migration	-0.0747 (0.1032)	0.469	-0.075 (0.1032)	0.469
Hhsize	-0.0943*** (0.20214	0.000	-0.081*** (0.0206)	0.000
Urbrural	-0.3481** (0.1115)	0.002	-0.348*** (0.1115)	0.002
Sex	-0.1687 (0.1252)	0.178	-0.169 (0.1252)	0.178
Marital stats	0.1284 (0.1222)	0.296	-0.1284 (0.1222)	0.296
primaryEdu	0.0939 (0.1299)	0.470	-0.094 (0.1300)	0.470
secondaryplusEdu	0.0793 (0.1663)	0.634	-0.079 (0.1663)	0.634
WealthIndex	-0.0067 (0.0391)	0.864	-0.007 (0.0391)	0.864
c.ProprtnofASMHrs#c.hhsize	0.001*	0.083	0.001	
Constant	1.766*** (0.1713)	0.000	1.766	
Mean dependent var	0.917	SD dependent var		2.002
R-squared	0.030	Number of obs		1617
F-test	5.003	Prob > F		0.000
Akaike crit. (AIC)	6805.413	Bayesian crit. (BIC)		6864.685
*** $p<.01$, ** $p<.05$, * $p<.1$				

NB: The regression results contain interactions of interest that came out with significant coefficients.

***, **, and * stand for values statistically significant at 0.01,0.05 and 0.1 levels respectively.

This assertion resonates with the findings from the qualitative aspect of this study which observed the respondents barely report absence to work due to illness, injury or both. This could be due to a number of factors.

According to Hilson *et al.* (2018b) people engaged in ASM earn more income which gives them improved economic stability. Hilson and Hu (2022) asserted that ASM has the capacity to serve as an avenue for wealth creation and not just a poverty alleviating measure. Arthur *et al.* (2016b) shared a similar opinion that ASM has the potential to result in higher earnings. As such, those involved can afford better health care. In addition, these workers can invest in protective equipment and medications that enable them to maintain better health. Wireko-Gyebi *et al.* (2022) mentioned that ASM workers find ways of handling health risks in several ways. Some of these could take the form of taking rest breaks which enable them to recuperate from physical strain. A similar observation was made in the qualitative study regarding physical strain as one of the physical impacts of ASM on the health of the respondents.

The study also reported that some of these workers are into self-medication which entails them employing the use of unprescribed medications and other hard drugs in the management of their pain among other related health issues (Irenge *et al.*, 2023). Although these self-medications could give some allowance of relief so as to ensure some level of productivity in the short term, it could lead to exacerbating long-term health effects as observed by Akinnawo *et al.* (2021). As realized from the qualitative aspect of this study, ASM workers perceive that certain illnesses or injuries are manageable and as such, do not amount to any ample reason to justify absence from work, hence the underreporting of such health issues which enables them to keep working without any record of absence from work.

Additionally, the income earned by these ASM workers enables them to afford various health insurance schemes in the process of mitigating the heavy health-related financial burdens, which does not make them report their health issues (Baddianaah, 2024b). In other words, they can afford better health conditions that minimize the level of their exposure to health risks like unsanitary environments, poor ventilation, and exposure to dug-outs that could serve as death traps. Additionally, opinions gathered from the qualitative study and literature show that the ASM workers perceive the benefits of ASM outweigh the risks involved (Quarm *et al.*, 2022). Aside from that, these ASM workers are able to set aside funds to cater for future health related expenses making it needless to report health issues in order to continue working.

Moreover, comparing the results of this study to that of a study by Tsang *et al.* (2019) and Schwartz *et al.* (2021b), underreporting of health concerns occurs due to lack of consistent framework for the assessment of outcomes and impacts related to ASM. This is coupled with the devoid of appropriate mechanisms and structures for the evaluation of the long-term health effects on those involved in ASM activities as well as surrounding communities (Landrigan *et al.*, 2022). Consequently, this has led to the underreporting of some of these health effects. As such, ASM workers who may unknowingly be suffering from some of these undiscovered health effects will not be in the position to report it and obtain the required medical attention.

Underreporting ASM-related health issues could also be due to underlining factors which are socio-economic, institutional, or cultural in nature. For instance, the fear of ASM workers losing their livelihood accounts for the reasons for underreporting health issues (Moyo *et al.*, 2021; Armah *et al.*, 2016). This is because ASM, being an illegal mining activity (Zvarivadza, 2018), could risk site closures among other regulatory actions should there be reports of health issues. Reporting of health issues could also generate conflicts among stakeholders in the ASM industry such as employers, community leaders, and other ASM workers since it tends to expose the unsafe working conditions on the ASM sites (Schwartz *et al.*, 2021a). In places where ASM is

one of the primary incomes, other ASM workers may be offended by whistleblowers especially when there is a perception that such actions would jeopardize the existence and continuation of their livelihoods (Otamonga and Poté, 2020).

There are also stigma and blames associated with underreporting of health concerns which could lead to absence from work (Moyo *et al.*, 2021). Inferring from the study, there are instances where health complaints could be dismissed and rather taken as personal weaknesses. It could be taken as an attempt to usurp special treatments. There are also instances in ASM dependent areas where reporting of health issues could be considered as an economic threat (Hilson *et al.*, 2021b). As such, there is pressure on affected ASM workers to remain silent to avoid drawing unwanted attention from higher authorities and external organizations. In typical ASM settings, where ASM operations are being manned by powerful figures, workers are confronted with intimidation or retaliation for raising health concerns (Arthur-Holmes and Busia, 2022b).

Underreporting of health concerns could attract legal challenges as it tends to expose the illegal nature of ASM activities (Aram *et al.*, 2024). Consequently, this could attract law enforcement actions which may eventually cause disruptions in ASM activities. As such, there are possibilities that opinion leaders could dissuade ASM workers from reporting to avoid any risk of government intervention. There are also cultural norms and gender dynamics that could lead to under-reporting of health issues on ASM sites (Danielsen and Hinton, 2022). This happens predominantly among women regarding their reproductive health as observed in the qualitative studies. In other words, reporting health issues is seen as a way of undermining traditional gender roles or norms.

In comparison to the study by Arifin *et al.* (2015) who also recorded a significant and inverse relationship between ASM and health, a different health indicator which is mercury concentration in the hair of artisanal gold miners and inhabitants around and away from the ASM sites was employed. However, this indicator did not extensively explore other contaminants apart

from mercury such as cyanide among other metals. More so, it did not capture the interaction of mercury in relation to other environmental factors like various soil types and water which could portray how mercury behaves in the ecosystem. However, the health indicator used in this study captured the effects of these other contaminants in addition to mercury, for which reason there were reports of absence from work due to illness, injury or both.

In addition to the ASM indicator, the study employed environmental samples, such as river sediments collected from mining regions, were tested for mercury contamination to the level of mining operations and associated environmental degradation. Mercury levels in fish from mining-affected rivers were also examined to estimate bioaccumulation caused by mining-related contamination. Critically, it can be observed that Arifin et al. (2015) made use of several indicators that could determine the effect of ASM on health. However, these samples were fetched from specific areas closer to ASM sites. As such, it may not fully be representative of the broader impacts of ASM. In comparison to the indicator used in this current study, it gave a broader impact of ASM because it assembles extensive and detailed information across a wide range of socio-economic and geographical dimensions. Moreover, the environmental indicators employed in the study by Arifin *et al.* (2015) does not fully integrate with socio-economic factors. This could have portrayed the effects of ASM on livelihood outcomes as being done in this current study.

In the case of Butscher *et al.* (2020), different indicators for ASM were utilized to measure the implications of ASM on health, yet still, an inverse relationship, as realized in this current study was achieved. With regards to the ASM variable, all exposures related to mining were determined by analyzing their self-reported duration and the level of intensity of work in mining activities, especially with mercury. In addition, the assessment of urine and blood samples of the respondents were used to measure mercury levels. The health-related quality of life (HRQoL) tool as well as chronic health conditions related to mercury exposure were used as health

determinants. This health variable is synonymous with what was used in this current study which happens to be the number of days of absence due to incidence of illness or injury. In other words, while the former indicator was measuring certain health conditions which are mining related, the later indicator measures the rate of absenteeism due to health issues. This means, the use of different indicators comes with differing interpretations of the health effects.

Furthermore, the use of the levels of exposure to mercury and ASM activities as an indicator for ASM as compared to the proportion of occupational hours spent in ASM as utilized in this current study could also account for the different interpretation of the significant effect of ASM. This is because the indicator used in the former was more ASM-specific while the one used in the latter was broader in its measure as it could include non-ASM-related illnesses or injuries.

More so, the ASM occupational hours which were used as the proxy for the ASM variable in this current study treated all hours spent on ASM equally. Indeed, ASM involves physically demanding tasks such as digging, carrying heavy loads, and working with various chemicals as confirmed by the DPAs in the qualitative aspect of this study as well as existing body of literature (Lydia *et al.*, 2022; Ofosu *et al.*, 2024b). This gives a measurable indicator of the level of involvement in ASM activities, as it reflects the extent of engagement and the degree to which mining activities dominate an individual's time, effort, and livelihood. Notably, ASM sites vary in terms of their mining conditions as some sites could be more hazardous as told by the DPAs in the qualitative part of this study. This same assertion has been reported by other bodies of literature (Ajith *et al.*, 2020; Cossa *et al.*, 2021; Chuma *et al.*, 2024).This exposes ASM workers to varying health risks (Kwesi *et al.*, 2024) which tends to reveal their levels of exposure to such health hazards. In view of this, characteristically, the use of the percentage of hours spent in ASM activities as an indicator serves as a proxy for mining activities regarding how deeply involved those involved in ASM and how important ASM is in terms of livelihood. This makes the indicator a more versatile one in terms of multidimensional analysis with other variables.

From Table 5.5, household size was found to have a significant negative relationship with health. This meant that a unit increase in household size results in a decreased number of days of absence due to illness, injury or both. This could be because other household members are likely to step in to ensure tasks of other ASM workers who are members of the household are completed. Consequently, this could minimize the possibility of prolonged absences from work or other activities.

Another reason is that it was realized from the qualitative aspect of the study that in larger households, responsibilities such as caregiving, domestic household chores, and income generation are often distributed among multiple members of the household. These tend to minimize the amount of physical and mental strain on individual household members. In effect, this allows them to maintain better health and attend to their occupations of which ASM is part, more consistently, which consequently reduces absenteeism.

Moreover, the existence of other women in larger households who perform caregiving duties Arthur-Holmes (2021), typically offer a built-in support system where even members in addition to the children taken care of, are provided care during illness. This often promotes faster recovery and fewer absences in such households. In households where there is reliable childcare (Makaza and Chimuzinga, 2020), it minimizes absenteeism caused by family emergencies as similarly asserted by some DPAs and IPAs from the qualitative study. In addition, emotional and practical support from family members can improve overall well-being, which seeks to promote attendance at work (Le *et al.*, 2023). Similar reasons could be attributed to the significant marginal increase in household size as realized in this study.

Furthermore, rural and urban location was found to have significant negative relationship with health. This means that being an urban resident reduces the number of days of absence due to ill, injury or both by 0.3481. This could be due to the fact that urban areas tend to have better access to healthcare facilities and medical treatments as compared to rural areas as reported in the study

of Čábelková *et al.* (2021). Consequently, this prompt access to healthcare services has the tendency to minimize the duration of absences from work due to illnesses or injuries.

Again, this finding is consistent with that of Macpherson *et al.* (2020) who reported that being an urban resident reduces the number of days of injury-related work disability compared to rural residents. Similarly, Olson-Williams *et al.* (2023) asserted that being an urban resident is associated with fewer self-reported poor mental health days compared to rural residents. Consistent with the findings from the qualitative studies of this work, which was based in an urban area, most of the DPAs hardly reported absent from work for reasons of sickness/injury or both.

The interaction between ASM and household size was found to have a significant positive relationship with health. In other words, the introduction of ASM activities introduces a host of specific challenges, which can amplify absenteeism. This implies that the negative impact of ASM on health is being moderated by a combined effect of household size and the proportion of hours allocated for ASM activities. As such, within ASM contexts, as household size increases, more days of absence due to sickness, injury, or both are recorded. This could be attributed to the cumulative exposure of household members to the toxic substances as well as issues of injuries from ASM activities which could end up in long recovery periods as observed by several studies as well as the qualitative studies (Schwartz *et al.*, 2021b; Butscher *et al.*, 2020; Landrigan *et al.*, 2022). This stress of ASM activities tends to have a disproportionate effect on vulnerable household members like women and elderly ASM workers, increasing health-related absences in the process.

5.6 Conclusion of Quantitative Analysis

In conclusion, the regression analysis underscores the significant impact of artisanal and small-scale mining (ASM) on food security, nutrition, and health, revealing a negative relationship between ASM and food security due to labor shifts and reduced agricultural productivity. This

study aligns with existing literature. However, it distinguishes itself through the use of GLSS data and a broader socio-economic perspective, offering a contrast to studies focused on ASM-prevalent areas.

The findings also highlight the complex dynamics of nutrition outcomes, with ASM negatively affecting dietary diversity due to limited market access and disrupted food acquisition patterns. However, factors like education, household size, and wealth emerge as important contributors to better nutrition and food security. Despite the challenges posed by ASM, wealthier households appear to benefit from increased economic stability, which aids food access.

Furthermore, the health outcomes linked to ASM suggest that workers may underreport health issues to maintain productivity, and larger households tend to provide better support for maintaining health. Urban residents also experience fewer health-related absences due to better healthcare access.

These results emphasize the need for targeted interventions to address the socio-economic challenges and health risks associated with ASM. The findings advocate for a comprehensive approach that considers the broader socio-economic context, including education, wealth, and household support systems, to mitigate the negative impacts of ASM and improve food security, nutrition, and health outcomes in affected communities.

6.0 RESULTS FROM QUALITATIVE STUDIES

6.1 Introduction

This section of the study presents the results and analysis of the qualitative data collected. The section begins with explanation on how the entire survey process took place to arrive at the conclusions. The organisation of this section comprises introduction, data assembling, analysis of direct participants' data, analysis of indirect participants' data and conclusion.

6.2 Qualitative Questions, Data Assembling, Responses and Interpretations

The interview guide contained a total of seventy-two (72) questions. Fifty (50) of the questions were responded to by the direct participants. The statements/questions to be responded to were grouped under seven sections (Participation Levels in ASM activities, impacts on health and safety risks, Leadership and decision-making impacts, Economic Impacts, Social Impacts, Impacts on Time Use and Impacts on Nutrition/Food Security. The indirect respondents also had twenty-two (22) questions to respond to grouped under six sections (Participation Levels in ASM activities, Impacts on Nutrition/Food security, Economic Impacts, Environmental Impacts, Impacts on Time Use, and Impact on additional domestic roles).

Procedure: The women participants were engaged directly and individually in their homes to gather data from them. Participants were tested in their participation levels, thus, either they have direct involvement in the ASM or they provide services to support those who are directly involved. Confidentiality was guaranteed to all participants and all surveys were completed.

Before analysing the data, the transcript was checked for accuracy and any mistakes in the transcription corrected against the original recording as a necessary tool advocated by (Clark *et al.*, 2017) Most of the interviews were directly recorded, transcribed, and translated from the Akan language to English. These were duly verified after the transcriptions were done. The researcher used content analysis to make sense of the data. This way of analysing qualitative data was also adopted by Kyngäs, (2020). The basic stages of the analysis are familiarization, coding

and formation of categories, interpretation of themes, confirmation of the interpretation and presentation of the results.

Familiarisation: Once the data was available, the researcher made himself conversant with it by reading the transcripts and observation notes and listening to the tapes. During this process, the researcher took note of key ideas and recurrent themes as they emerged.

Development of a thematic index: A list of codes was created based on the familiarization process mentioned above and organized into categories with the study objectives in mind. The codes enabled the researcher to organize the data into manageable formats that can be interpreted with ease in the indexing (Hanmer *et al.*, 2024). In the analysis where transcribed statements do not reflect a major statement that could be categorized into the main classifications, an additional category "other", Pass or N/A is used to place such narratives.

Indexing: According to (Cohen *et al.*, 2017) the codes in the thematic index are applied systematically to all the qualitative data. Text is annotated with all the codes that are being applied to it by highlighting the passage and noting the code.

Charting: At this time, the data were re-arranged into a series of charts that bring all the data with the same code together in one place from all the data sources. In a matrix form, each row contains a particular code, and each column a particular data source. Each cell is traceable back to the original data source.

Interpretation: The data was well read and interpreted. All the data was assembled and related to a particular category or concept together in one place (Salmona and Kaczynski, 2024), it was easy to establish the range and nature of the phenomenon of interest.

Confirmation: This was helpful to confirm the interpretation of the findings with the respondents – so-called 'respondent validation (Landrum and Garza, 2015). This was done through response validation (member checking) whereby the participants were presented with the summarised

findings to verify if they were true reflections of their perspectives. During this session, clarifications and corrections were made. This helped to verify the authenticity of the data collected and ascertain the accuracy of the information gathered. This improves trustworthiness, minimizes misinterpretations and promotes clarity (Candela, 2019).

Checking for trustworthiness: Mabuza et al., (2014) stated that qualitative research should be written up with enough clarity regarding the processes that were employed to enable the reader to evaluate the scientific rigour of the study, hence enabling acceptance or refutation of the findings. Verifications for this analysis considered the following: credibility (for internal validity), transferability (external validity), dependability (reliability), and confirmability (objectivity). All these processes above were ways of ensuring credibility which was concerned with the validity of the conclusions that were drawn from the data and how these conclusions match the reality being reported on. Also, data transferability and dependability which respectively refer to how well the study conclusions can be applied to other similar settings and the extent to which similar findings would be obtained if the study were repeated, are ensured by virtue of these processes.

6.3 Data analysis - Direct Participants

The following as shown in table 6.3 presents the bio-data and analyses of data collected from the direct participants who engage in Artisanal Small-Scale Mining.

Table 6.3: Direct Participants' Demographic characteristics

Participants' category	Code	Total Number	Sex	Household sizes	Ages	Marital Statuses	Years of participating in ASM
Direct Participants	DPA	25	F	Multiple (1-10)	18-56	Married 17, Not married 7	Minimum 1 year Maximum 21 years

Source: Field Data, (2023)

Table 6.3 presents the demographic information of the direct participants of the study. The direct participants, totalling 25 females were coded as DPA. The data provided during the fieldwork shows that one person was a single household member whilst others have 2- 5 household members. Some also had large households ranging from 6-10 members.

The age of the respondents ranged from 18 years to 56 years. The majority of the DPA respondents however were between 25 and 40 years. This represents a more youthful sample that was interviewed. Out of these numbers, 17 were married whilst the remaining 8 were single either because of the death of their husbands or never married. Despite these, 24 of them had given birth already and they either lived with their children as part of their households or their children live with other members of their families. The DPA have participated in ASM for longer periods enough to help them respond to the questionnaire as required. The least year these DPA (2) have worked in ASM was 1 year. Most of them (15) have worked in ASM for 10 years while others (8) have worked for many as 21 years in artisanal and small-scale mining. These experiences were very important to inform the data collected to support the findings of this research.

6.4 Theme development for DPA's Responses

From the qualitative interview, various preconceived themes were used to analyze the responses from direct participants. These themes were coded as shown in Table 6.4 below.

Table 6.4: Themes for direct participants

No.	Themes	Theme Code	Expectation/Measurement
1.	PLP	Participation Levels in ASM activities	a. High extent b. Low extent
2	HSR	Health and Safety Risks Impacts	a. Improved health and less risky b. Deteriorated health and highly risky
3	LDM	Leadership and Decision-making Impacts	a. Increased opportunities to lead and make decisions b. Less opportunities to lead and make decision
4	ECO	Economic Impacts	a. Improved living conditions b. Decreased or same living conditions
5	SOC	Social impacts	a. Improved social lives b. Decreased or same social lives
6	ITU	Impacts on Time Use	a. Consumes most of their time b. Consumes less of their time
7	NFS	Impacts on Nutrition/Food Security	a. Improved nutrition levels and food secure b. Decreased nutrition levels and food insecure

Source: Field Data, (2023)

6.4.1 Participation Levels in ASM Activities (PLP)

As one of the major themes understudied in ASM (Yakovleva, 2007), the extent of participation levels in ASM (PLP) of DPA was explained to be very high as participants engage in direct mining activities. High participation involves those who had ASM as their main occupation from which they feed their households. The common roles they occupied on site included carrying load, washing, fetching water, processing and amalgamation among other direct services as reported in the words of one DPA who said:

“I go to the site to search for gold. I normally go with a board. First they were not allowing the women to work so we had to plead with them to allow us wash some of the gold. Whenever the load is given to me, I make sure I go wash mine by the use of simple implements. Thereafter, we

get the gold in pieces which we end up selling to the bosses who own the site. They pay us according to how much gold we have brought to them."

Another DPA said "Sometimes I fetch water to the board when it is far, other times I do washing or carry loads with other women" while another one made comments such as "This is all I do; this job is what I use to feed my family and take care of my children. Out of this job, I have two children in the University, there is no weekday I don't go to the site unless I am sick. I can say my life depends on ASM activities. I mostly carry load and sometimes I do washing".

All these responses reflects the various levels of participation of the DPAs.

In a similar vein regarding participation levels, other responds by the DPAs were as follows;

''All the people I stay with are also involved in the ASM business. Some of them are my children, siblings and my mother',

"Three of my kids. They only serve as helping hands"

"The washing of the gold is done using simple board. Since it is a teamwork I do with my friends, we are able to wash the load (gold ore)".

Other DPAs emphasizing the benefits they stand to gain in ASM which has affected their participation also responded that "All the people I stay with are also involved in the ASM business. Some of them are my children, siblings and my mother", "When the mining goes well, I am able to take good care of the household. For me, I don't really regard any other job apart from this job. People have been able to build their own houses and acquire a lot of properties as a result of this mining",

This obviously shows DPA's are fully immersed in ASM activities and without that, their livelihood is threatened. Infact, this present study revealed that in some larger households, almost all the household members fully participate in ASM as expressed by one DPA that " 'In my house, I do this ASM work with all three children", Despite these levels of involvement, the DPAs cited the effects of certain socio-cultural belief systems and gender disparities as factors

affecting their participation in ASM. The existence of 'taboo days' as cited by the DPAs and issues of gender discrimination do not allow the women to fully participate. This was expressed by one DPA as "I only don't go to work when I am at the period of the month. The master at the place gave that instruction and we all abide by it".

Similarly, other DPAs responded to this theme in the words "I don't go to work when I am in my menses. This is a belief that is held by the authorities and management at the various work places. Sometimes, they make us all go home to be able to consecrate the place before work resumes. Apart from that I am ok", "When I am at the period of the month, I am not allowed to go to work. This is a common regulation at the workplace that everybody knows", "We are not supposed to go to the site on during our menses. Apart from that, we are free to go to work anytime there is work. All these comments reflect the participation levels of DPAs as well as factors that influence their participation levels.

6.4.2 Health and Safety Risks Impacts (HSR)

The responses gathered from 100% of the DPAs shows that ASM is risky and deteriorates the health of those who participate in it. One of the women said that

"I have been having skin rashes since I started this job. I have been admitted to the hospital twice in three months meanwhile I didn't use to experience these until I joined ASM". Another said, " Due to the dirty, muddy and cloudy water we have been washing the gold, there are times I get some body itches".

For others, though they have been falling sick regularly than when they were not engaged in ASM activities, they were able to renew their health insurance on time and go to hospital anytime they don't feel fine. As a result, they are always having the strength to go to work regularly. To them, this is better than not having anything to do. The common risks and health concerns raised relate to body pains, skin diseases, cuts, insect and snake bites, cold, fever and such like diseases.

Other workers in the ASM industry also reported of lung problems, chest pains, skin diseases, weight loss, tuberculosis, and other diseases that were contracted by virtue of their involvement in this mining occupation among other health issues.

On the other hand, some of the women indicated that their mental and physical health have improved because of their involvement in ASM activities. One of them said

“Because I know I will get money when I go to the site, I don’t worry too much, if I will worry then it is because of the difficulty involved in the work but I also know as humans we have to work, so I am fine”.

Furthermore, some of the women had not been hospitalized since they started ASM. One said,

“No! though I sometimes don’t feel too okay but I have never been hospitalized’.

The other side of the story is that respondents indicated that their mental and physical health have been impacted negatively. They acknowledge that the nature of the work makes them think too much when they are preparing to leave house. Statements such as

“I feel this work is for men, so I am always worried when I wake up in the morning knowing the stress I will go through during the day. Even if the journey to the site is far, sometimes we walk for too long, we arrive there tired or return very late. When we get “aboboyaa” (tricycle for carrying loads) too the way, we are packed with the men, which is uncomfortable and dangerous. I think about this always”

were common among DPA responses. Also, a few of the women were not sure how their mental and physical health have been affected as they expressed sentiments like

“As for me, I know I have nothing doing to survive, so I can’t say it is affecting me, I am managing”.

The nature of ASM is likely to result in injuries if workers are not extra careful. Some of the women reported having regular cuts, trips, and fractures. The few who have not reported severe injuries indicated that their cuts have been minor, but they can report that they face more danger than what the women experience. In some instances, some women have had to stop going to work as a result of an ill-health. One woman said,

“I have been falling sick that is why I don’t go to the site every day”. Another said, “I feel very weak in the morning due to a previous day’s difficult work, I rest”. Another said “I do not normally fall sick as a result of ASM. I am someone who does not often fall sick. However, I must confess that this kind of work comes with a lot of stress and tirefness. One is bound to have a lot of body pains anytime one comes from work”.

Quite a greater number of the women respondents have had to stop going to work but seldom. Very few women reported that they have never stopped going to work as a result of ill-health. Other negative risk factors are that their reproductive health have been negatively affected. Statements such as

“I stopped giving birth because I feel I was struggling to undertake my duties at work”

is a good example of how ASM has impacted the reproductive health of women in Ghana. For all of the women, they alluded that they are not allowed to go to the site when they are menstruating. This is seen as one of the cultural norms and traditions that tend to discriminate against the entirety of women's participation in ASM. It has been reported that this restriction is quite broad and even demands the conformation of any of the owners of the mining site if she is female. This is attributed to the fact that women are culturally deemed unclean whenever they are menstruating, and have been superstitiously believed to bring ‘bad luck’ to the site whenever they are in their period.

6.4.3 Leadership and Decision-making Impacts (LDM)

Most of the women interviewed were ordinary DPAs at the various sites. They do not hold leadership positions at work (site) and in their communities. They only take instructions from gang leaders who are predominantly males (although there are some females among them) and therefore the data gathered suggests a lower participation of women in leading roles in ASM activities.

One DPA expressed this as “I am just a normal gang member that goes about my duties”.

Women are not major decision-makers, and their ability to influence expands to cover fellow females and not the entire membership of a particular site where males are involved. Female miners are typically confined to manual, low-paid, and secondary roles such as fetching water, washing, and selling food items on the site. They have unequal access to ore deposits, mining groups, equipment, finance, and fair markets. Clearly, DPAs have less opportunities to lead and make decisions as expressed in the comments of one DPA as “The nature of the work will not even give me the chance to take up other positions. The work is so stressful that I don’t really get time to take up other responsibilities. There are some important meetings that I am not able to attend because of my busy and laborious work I attend every time”.

Despite the lack of opportunity to make site decisions or lead, the women indicated that their involvement in the ASM has impacted positively on their roles as women in their households. Some of the women said they are able to support their husbands in providing for the household and deciding the schools their children should attend. Some have also learned to organize and lead demonstrations due to the rowdy nature of their work environment. Interestingly, some of the women continued to explain how their involvement in ASM has improved their ability to take up certain positions within the community. A woman said

‘My participation has increased my confidence, because at site it is not good to be dull. I think I am better placed to lead than before’.

For DPAs, the ASM participation has positively changed their ability to contribute towards decision-making at work. This is because they are able to ask questions, tell the men when they cannot handle the task assigned as they are not used to remaining quiet and following any instruction as it used to be.

The women also explained that they have the capacity to access certain resources/technology/interventions by their involvement in ASM. Some indicated that they are now able to afford android phone because of the proceeds from ASM. It is also worth noting that some of the women have cultivated some form of skills as far as ASM activities are concerned. A respondent said

“Now I know how to operate the ‘Chamfyne’ (a simple mining instrument). I am very experienced in the washing and loading which newcomers struggle with, I am even able to lead and teach some of the women the process; I have done this for long”.

6.4.4 Economic Impacts (ECO)

The interview was extended to find out whether other members of the households are involved in ASM and its effects on their finances. The majority of the DPA (90%) reported that their entire household is involved in the ASM activity. Where other members are involved, the women acknowledged a positive effect on their finances.

The majority of the women explained that their involvement in ASM activities has increased their income levels. One of them mentioned,

“I have more money now than before; I am able to spend on things I want”. Other DPAs also commented that “The money is not that bad ever since I got involved. My income has really

increased. I don't know what I would have done without this job. It has given me much money which I use to cater for myself and my family as well"

Such pronouncements by the majority of the women corroborate the assertion that ASM has provided substantial income for women in comparison to other income sources (Hilson *et al.*, 2021b).

Some of the women indicated that their involvement in ASM activities has increased their savings and habit of saving in general. Majority of them also indicated that their ability to contribute towards household expenses has been heightened; this is positive. One woman said, "I hardly ask my husband for money, especially on small household items. I am happy that by my participation in ASM activities, I am able to support my husband". Another also claimed that "Although I have a lot of responsibilities, I am able to save some money from my ASM work which I use for contingencies"

The women also explained that their involvement in ASM has positively improved all other enterprises they engage in. For instance, some of them stated that they are able to buy chemicals to do farming and also pay labourers who work in their farms. Some are also able buy more items for their provision shops which is also increasing their sales and efficiency. On financial credits, majority of the women explained that their participation in ASM activities has reduced their likelihood and demands to take loans. They stated that though their tasks at work are stressful, they do not owe banks or their friends. Some stated that although they are not able to meet all their needs, what they get is able to take care of their needs if there are no emergency situations. One DPA express this as "With this kind of work, it really pays off. There are times that when the work goes on very well, I am able to make good money"

However, these assertions were not consistent with responses from other respondents. Others stated that their savings have reduced as a result of an increase in responsibilities and expenses.

The study shows that the women experienced increased household budget. With this, they mentioned that the more they earn, the more their expenses increase due to household demands. Some comments from DPAs supporting this assertion are “Hmmm, things are not as easy as they seem. If it were left to me alone, I would not worry so much. However, I am taking care of so many people so it has increased the household budget”.

Another DPA also said“The household budget has not been very easy. The household commodities are very expensive. As such, this affects the household budget every time”. One DPA also reported that “The budget has really increased. This is because food prices among other food commodities had really increased in their prices. We cannot buy some foods here. We cannot even buy plantain”.

To some few of them, other enterprises have been negatively affected because of their involvement in ASM activities. One of the women indicated

“Since I started ASM activities all my farms have spoilt. I am not able to farm like I used to’’.

In terms of financial assistance like taking loans, some of the women explained that their doing ASM activities have increased their chances of taking loans. Some said “I take loan sometimes. This is because I have a lot of people to cater for. So I take the loan to support my business”.

6.4.5 Social Impacts (SOC)

The women explained how their involvement in ASM activities has influenced their social lives in several ways. Most of the women indicated that their involvement in ASM has impacted their relationships positively. Some of the women explained that they find it easy to talk to people these days, and people also respect them because they work, and they can pay for funeral contributions and other costs in their communities. In line with this theme, one of the DPAs made comments such as “This work has really made me known in the community. It has made me popular to many of the town folks especially those involved in the ASM activities. Another DPA also said “It has made me more prominent in the community. On some days, people consult me

to seek my opinion on certain things that affect them in their homes. I must say that most of these issues people bring to me has to do with finances".

For others, due to the time-demanding nature of the work, they are not able to associate and socialise very well with neighbours who are into different occupations. For those who share similar occupations, the difficult nature of the work makes them quick-tempered, so they end up having squabbles with each other. As affirmed by Arthur-Holmes and Busia, (2022), to them, this has to some extent affected their relationships and social interactions. Also, other women explained how their involvement in ASM activities has negatively impacted their social lives, including, statements like:

"Now my skin is spoilt, I don't feel comfortable going to the public all the time, it was even better until I started bleaching to get a better skin and it ended up like this".

More so, some of the women have suffered discrimination of some form while a small section has not experienced any issues of discrimination yet. Also, the social reputation of these women is damaged by notions of sexual activities that occur in some of the mining sites as reported by (90%) of the DPAs who asserted that it was a mere rumour.

According to the majority (100%) of the DPAs, they are faced with discriminatory attitudes in the workplace during their menstruation periods. In a way, they feel marginalized and embarrassed whenever there is a need to request time off and access facilities that could help them in such situations. In that case, menstruating women are unable to work comfortably and get stigmatized as a result. One of the DPAs expressed her sentiments in the words"Sure there are some sites that women are not supposed to visit. For some superstitious beliefs, no woman is allowed to visit these sites", "Anytime they say that, it puts me into a lot of thinking. This is because there is no other job to do. So sacking us from the site will mean depriving us of our livelihood".

Another also expresses hers' as "They sometimes tease us. However, I tell them there is not work that is meant for women or men. For me, I really don't mind them as they are only teasing me. I always tell them in this world, any work that a man does, a woman can also do". These comments highlight the state of marginalization on the ASM site.

6.4.6 Impacts on Time Use (ITU)

As rigorous as it is, ASM has proven to take a lot of time to undertake. Where sites are far located, miners travel long distances within the day in order to work. This means it takes a lot of time to be part of the team. The women acknowledged that, as a result of the time-consuming nature of their work, they mostly return very late in the evening, leaving them very tired and untidy.

Responses gathered show that the majority of DPAs have increased workload as a result of their involvement in ASM activities. Most of the women indicated that their participation in ASM activities has affected the time they spend with their families. One of them said,

"I used to sit with my family in the evening to tell tales but I am not able to do this again because I return from work late and tired".

Other DPAs indicated that that their performance in domestic responsibilities has been negatively affected by their involvement in ASM activities. They explained that, but for their supportive members of their families, many things would go wrong by the time they return from the site. One of them said "I am not able to have good time with the family when work in very busy. Sometimes I go to work and spend almost twelve hours there before I come home",

Key roles that require their childcare responsibilities have decreased as a result of their involvement in ASM. Some other women said their participation and ITU have negatively affected their reliability, punctuality, and consistency. Most of them are not able to attend programs as scheduled and they also sometimes fail to attend programs like weddings,

outdooring, funerals among others. The DPAs expresses these assertions in the comments “As you can see, I try to attend some of these social gatherings although I report late sometimes” . One DPA also responded that “I plan very well. So, I make sure I do all my house chores on time. The way this job is, you need to plan very well or else you will end up not doing so many things. Sometimes, I pile up a lot of laundry in the house which I wash during day when I don’t go to work. All these statements show how the schedules and times of DPAs are being affected.

6.4.7 Impacts on Nutrition/Food Security (NFS)

The impact of women's participation in ASM activities significantly affects the food security and nutrition of their households. It was discovered that some women were able to buy food in bulk especially on market days because of the increase in their purchasing power. Most DPAs are able to eat different meals because they are able to afford them. The data showed that majority of the DPAs have not lived a whole day without food because they did not have money. One of the DPAs claimed that “Nobody goes hungry at my household. Whenever food is running out, I go out to buy food on credit and pay back with the money I am able to get from the ASM work”.

Another DPA also responded that “When I am not able to prepare food at home as a result of my involvement in Galamsey, I normally buy food from outside to feed the household. I have never slept on empty stomach but my household has suffered that before due to lack of money. I don’t farm, Galamsey is my sole work”.

Another DPA also claimed that “In my house no one goes to bed hungry. Even if there is no food in the house, I get the food items on credit and pay later”

The other element of NFS on DPAs is that though most of them are able to afford food, they do not eat it under hygienic conditions. These foods taken on site are sometimes eaten with improperly washed hands and bowls or leaves, in any case, there is short of clean water at sites. Foods are also eaten cold in most instances. Also, most of them turn to eat after 6:00 p.m. on

return which affects digestions, body shape and their health. This negative impact does not affect the DPAs alone but AIPs and other household members.

A few household members have also gone a day without food which is one of the indicators of food insecurity. The reason some of the women give was that when they fall sick or return from work very late, they are sometimes unable to prepare meals for their households. DPAs also asserted that they mostly take ready-to-eat foods or canned foods. One of the DPAs expressed her view in the words "Its not all the time that we get to eat the kinds of foods that we want", Some go to bed hungry when the work does not go well".

Another DPA expressed hers's as "Well, we are not able to consume all the foods that we want to". All these commentS highlights how food security and nutrition of DPAs are affected.

6.5 Data analysis - Indirect Participants

The following as shown in Table 6.5 presents the biodata and analyses of data collected from the indirect participants who engage in Artisanal Small-Scale Mining.

Table 6.5: Indirect Participants' Demographic characteristics

Participant's category	Code	Total Number	Sex	Household size	Age	Marital Status	Years involved in ASM activities
Indirect participants	IPA	38	F	Multiple (1-10)	18-45	Married 26 Not married 12	Minimum 6months Maximum 16 years

Source: Field Data, 2023

Table 6.5 presents the demographic information of the indirect participants of the study. The indirect participants are coded with IPA with a total of 38 females. The data provided during the field work shows that two persons were a single household member whilst others have 2, 3, 4 or 5 household members. Some had large households ranging from 6-10 members. The age of the respondents ranged from 18 years to 45 years. Majority of the IPA respondents however were between 20 and 36 years. Out of these numbers, 26 were married whilst the remaining 12 were

single either as a result of death of their husbands or never married. The IPAs have been indirectly associated in ASM for longer periods to help them respond to the questionnaire as required. The least year some of them have worked in ASM was 6 months. Most of them have worked in ASM for over 8 years. Some of them have also worked as many as 16 years in Artisanal Small-Scale Mining related activities. These experiences were very important to inform the findings of this research.

6.6 Theme development for IPA Responses

From the Qualitative interview, various themes were captured from the responses from indirect participants (IPA). In all, 6 themes evolved. These themes were coded as shown in Table 6.6

Table 6.6: Themes for indirect participants

No.	Themes	Theme Code	Expectation/Measurement
1.	PLP	Participation Levels in ASM activities	a. High extent **b.** Low extend
2	NFS	Impacts on Nutrition/Food Security	a. Improved nutrition levels and food secure b. Decreased nutrition levels and food insecure
3	ECO	Economic Impacts	a. Improved living conditions **b.** Decreased or same living conditions
4	ENV	Environmental Impact	a. Improved environment conditions **b.** Devastating environmental conditions
5	ITU	Impacts on Time Use	a. Consumes most of their time b. Consumes less of their time
6	DOS	Impact on Domestic Roles	a. Increased performance of domestic roles b. Decrease in performing domestic roles

Source: field data, 2023

6.6.1 Participation Levels in ASM Activities (PLP)

This section sought to understand the extent of IPA's participation in ASM. Most of the participants described their participation to be low whilst others had high participation. To them, they are not directly involved in ASM activities, but rather, they provide essential services to their household members who are fully involved in ASM activities. For about 86% of the respondents, their other household members are involved in ASM activities. The major activities they perform to even qualify them as IPAs as mentioned and described by them include trading of ASM materials, providing childcare responsibilities to support DPAs in their households and cooking to support their households in the absence of core household members who are trapped in the site and engaging in agricultural activities to support DPAs. For most of them, it is only the children who are not of working age who are not involved in ASM. For others, it is just the old parents who are not participating in ASM activities, which means the workforce in most households of these respondents are involved in ASM as DPAs or IPAs. This was highlighted through comments from some DPAs as

'Whenever they go to work, all they say is that Mummy please take care of my ward for me'.

'I really have lost count of the number of children I have taken care of. In one way or the other, it is a profession I have taken up to do especially with women who are into ASM activities',

'I normally sell oranges and banana in addition to the children I do take care of. Due to this, I am not able to do anything. After making sure the children have gone to school, I attend to my business as usual'.

Another IPA also said 'They bring their wards to me whenever they are going to work on the mining sites. They come along with the baby food and money as well as clothes for the child' while some other IPA also responded that 'As for me, I am a seller on the site. I sell tiger nuts on the site. I normally sell to the workers as well as the general public'

These comments highlights the various ways by which these IPAs are indirectly involved in ASM . The research continued to find out how the participation of other household members in ASM activities are affecting the household. The summary of responses indicated a positive effect on their finances and nutrition/food security and a negative on their health and safety and performance of domestic roles.

6.6.2 Impacts on Nutrition/Food Security (NFS)

The responses from IPAs showed that majority of IPAs have taken up some agricultural activity despite the involvement of their household member(s') direct participation in ASM. Some of them described that since most of their household members are directly involved in ASM, they also take the opportunity to farm so that the entire household would not have to depend on bought items, especially food. They explained that they have lands to farm, but since the ASM brings more money, most people opt for that, and the farms of the IPAs are not on a large scale but subsistence to cater to the household food needs. IPAs are engaged in farm clearing (weeding), fertilizer application, cultivation, harvesting, irrigation, and the like. They expressed a positive effect of household members participation in ASM activities on their feeding. They explain that they are able to afford different foods and even buy in bulk at certain times. The IPAs also admit that though they are involved in farming, the seasonal nature of their crops does not allow for continuous harvesting. Therefore, they also buy rice, yams and other farm produce to support what they harvest. One of the IPAs reported that "I normally eat my favorite since I have enough money. Aside doing this ASM work, I am a maize farmer. The 'galamsey' has not affected my farming activities since I plan well",

Another IPA also claimed "I cultivate plantain. Aside that, I sell alongside. I have been in this farming business for a while now. That is what I do to support myself as it does not require too much time. I can take care of the wards and do the business at the same time"

Another also claimed that “The feeding has not been so different. I always have to make sure there is enough food in the house”.

According to most IPAs, due to the participation of their household members in ASM, they are able to eat balanced meals and they almost always have something to eat. Except that they are usually not properly scheduled especially in the morning and evening. In the morning all of them rush to work and money is given to the kids to buy food when they go to school. In the evening food is usually prepared late which has its own health and nutritional implications.

6.6.3 Economic Impacts (ECO)

The Economic Impact (ECO) of ASM on indirect participants (IPA) has been described to be enormous. About 82% of the respondents indicated that their income levels have changed positively since they got indirectly involved in ASM activities. According to most of them, the other household members who are DPAs have enough money to take care of themselves, relieving them of their burden. They alluded that the DPAs sometimes even give them money when they get enough for the day. Clearly, the economic conditions of IPAs have positively changed significantly since their participation in ASM activities. The respondents also stated that though they are able to get money for their daily spending, their savings have not experienced increment.

For most of them, they do not have a savings account but rather engage in “susu” (a local contribution among women in the area). One of them stated,

“I do not get enough to save, I only contribute towards susu, every week we pay GHS25 (an equivalent of about £2).”

The majority of the women also stated that their household budget has increased since they participated in ASM activities. According to them, they spend more on food and clothing in recent times. One of them said

“Because of the nature of their work, they change clothes often and they eat at home and take some to the site, they also wash very often leading to increased cost on detergent among others”

The capacity of the women to take loans or borrow cash/in-kind from Non-Governmental Organizations (NGO), bank/financial institution, friends and relatives, group-based microfinance and informal credit/savings has increased. They explain that their capacity has increased because they equally have the means to pay. Their ability to pay also increases their affordability; meaning they are able to take higher amounts when they request compared to when they were not involved in any established economic activity. However, about 81% of the women indicated that they do not take loans from any of the mentioned sources. The only few who had ever taken loans or borrowed were during emergencies such as severe ill-health and settlement of students’ school fees some time ago. For those who have ever borrowed, explained that the decisions regarding the purpose of the money borrowed are made by them because other household members consider them adults and may not want to interfere in such affairs. This also according to them, does not mean nobody contributes to it but the final decision rests on the borrower.

6.6.4 Environmental Impact (ENV)

Most of the women respondents acknowledged devastating negative impact of ASM as well. Majority of the respondents however were categorical about the negative ways by which their environment has been affected in the ASM activities. One of the respondents said

“Our land is not good for cultivating crops and our water bodies are very dirty as a result of ASM activities”. Another said “The ASM really destroys the land and property. These ASM people have been diverting the water courses unnecessarily. I used to cook on some of the sites and sell for people. All the water bodies have been destroyed. At first people from other places used to buy maize from this town but now it is the opposite. There is now not even a single water

body we can use by way of example to show our children. ASM is not good but how far can my voice go.

In other words, ASM has had an inimical effect on their agricultural system. This impacts negatively on the cultivation of food crops on the land. In effect, these women are forced to buy most of their food from outside.

The women respondents interviewed made it clear that they are gradually getting deprived of a good source of drinking water. Some comments from majority of the IPAs in response to this theme on environment were "Our water, farms and lands have all been destroyed by ASM. Getting clean water in this community is not really easy",

"The work has really destroyed the lands, spoiled our waters and made like so expensive. At the moment, when you look around there is no river body around that one can drink safely. Gone are the days where you could go fetch some water and drink without even thinking of its effects"
"The ASM activities have really caused a lot of havoc to the environment. They have left a lot of dug-outs and a lot of stagnant waters around. These have given a bad look to the surrounding",
"There are a lot of ways ASM activities have affected the environment. It has brought a lot of mosquitoes to the environment, it has also destroyed our lands. More so, it has cause a hike in the prices of goods and services"
"ASM has destroyed all our lands. It has made water very expensive in the community".

According to them in their comments, most of the water had been polluted due to ASM activities which leaves deposits of dangerous chemicals in the water bodies. These women claimed that years ago, they used to drink from most of these water bodies anytime they were returning from their farm work. However, it was not so since ASM activities increased over the years.

6.6.5 Impacts on Time Use (ITU)

The impact of participating in ASM and the use of time is significant to understand how workload at home, child care responsibilities, time spent with family, other domestic responsibilities and reliability, punctuality, and consistency at work are affected. Most IPAs indicated that ITU is significant by their engagement in support services for ASM. For most of them, the workload at home has increased since their other household members are DPAs or are fully engaged somewhere else. The respondents also stated that their childcare responsibilities have increased because most times they need to take care of their own children and that of other women in the household who are DPAs. This was expressed in one of the comment by the DPAs as

"I don't really have so much time for myself. Sometime I have to hire people to help me sone of these chores.",

Their increased workload at home and increased childcare responsibilities also affects the time used at their farms and engagement in other economic activities. Some of the DPAs supported this assertion through comments such as

"Not until they have returned from work, the children are my responsibility "

"With the children, I like them so much. As such I make sure I wake up early to bath them, clothe them and also make sure they are well fed. The first question I always ask them after school is their homework"

For the respondents who were home-based IPAs, they explained that their time spent with their families has increased. This is because they are usually home undertaking childcare responsibilities and other domestic duties to support the DPAs in the household. For those who are site-based IPAs, their time spent with their families has reduced since they tend to return late with DPAs who go to the site as claimed by one of the respondents that

“I am not able to have enough time for myself. This is due to the nature of our work. This work can keep you for long hours. Sometimes we close in the night. When this happens, I am not able to see my children before the next day.”.

Similarly, IPAs who are home-based explained that their domestic/household responsibilities have increased. The site-based IPAs also reiterated that their domestic responsibilities have decreased over time. The last item considered under the ITU sought to find out how reliability, punctuality, and consistency have been impacted by their participation in ASM activities. The responses indicated that most IPAs are reliable, punctual, and consistent. This is because their major occupation is to provide support services to DPAs, as such they are at their beck and call though there are times when it is difficult to perform these roles.

6.6.6 Impact on Domestic Roles (DOS)

It was well articulated by the respondents that their domestic roles have been affected by their participation in ASM activities. The majority of the DPAs explained the economic improvement in their lives and their ability to financially support their spouses. For those IPAs who are home-based, their domestic roles related to cleaning, cooking, childcare responsibilities have been enhanced since they have more time to sped at home. Most of the IPAs do not resort to the support of other household members for domestic roles. For IPAs who undertake their roles at the site or outside of the home, their domestic responsibilities have been negatively affected just as the DPAs. They allude that they leave early in the morning or are not able to return home early to take up some cooking, cleaning, and washing duties.

As far as decision-making is concerned, IPAs seem to have their opinions fairly represented. This was reflected in their response which indicated that their decision-making role has not been limited by their participation in ASM activities. One of them said,

"No one has told me not to decide on certain things, but the nature of the work will not permit you all the time to make some decisions".

This stands to say that the ASM work has a lot of impact on the domestic activities of women during certain times. Statements such as

"I am not able to spend time with my family like before, I am not able to attend parties, naming ceremonies, weddings and other social gatherings"

are clear indications that the site-based IPAs have negative DOS. These were worrying developments among the women but since their involvement in ASM came with much economic gains, they could not help the situation. An interesting conversation that came up was the fact that their participation has equally impacted their sex lives. One woman added,

"Let me add this, when we get tired like that, we are not able to have good sex with our husbands… laughs".

6.7 Discussion of Findings

The high participation levels of women directly engaged in ASM activities support existing evidence that ASM is a major employment engine in rural communities (Paget *et al.*, 2017). Clearly, it can be realized from this theme that the women are consistent in their attendance to their ASM work especially as they are willing to work whenever they have the strength. In support of this, other research studies have also indicated the significant participation of women in ASM (Mugo *et al.*, 2020). According to this paper, this significant participation is being highlighted at the low level of the value chain but was unclear about their returns whereas others acknowledged 50% of those employed in ASM industry are women (Yakovleva, 2007) which goes to confirm ASM as major employer in rural economies in Africa (ACET, 2017). Comparatively in support of this fact is the ZMBQUE mine in Zimbabwe, where the entire workforce is made up of women (Makaza and Chimuzinga, 2020). This assertion pays much

credence and further on, supports the significant involvement of women within the ASM fraternity. This could be seen as an empowerment tool for women, especially in a male-dominated industry. More to that, there is an increasing presence of women within the ASM industry year by year as reported by a growing body of literature (Arthur-Holmes and Busia, 2020; Ofosu *et al.*, 2022; Paschal and Kauangal, 2023). This increasing phenomenon of women in the ASM industry is seen as a way of reducing gender inequalities in addition to empowering women as claimed by Ofosu *et al.* (2024b). It also serves as a useful lens in addressing and evening up gender-related disparities on the global scale (Arthur-Holmes *et al.*, 2023a). Hayes and Perks (2012) reported that this increase in women's participation is also motivated by several factors that underpin the attraction of several others into the ASM occupation. Some of these factors are unemployment, increasing household needs, climate change effects on agriculture, and the desire to acquire physical assets, all of which are consistent with similar reasons stated by a burgeoning literature (McQuilken and Hilson, 2016; Rutherford and Buss, 2019; Baddianaah, 2024a).

Other researchers justified the involvement of women in ASM based on three main livelihood offers which come in the form of temporary, permanent and indirect, depending on the motive of livelihood strategy adopted to earn an income from the ASM industry (Arthur-Holmes *et al.*, 2023b). Other studies gave similar reasons as far as factors affecting women's participation in ASM are concerned (Buss *et al.*, 2017; Buss *et al.*, 2022).

For DPAs aged 18-30, entry into ASM was driven largely by economic desperation, unemployment, and limited education. This confirms the findings by Lydia *et al.* (2022) and Quarm *et al.* (2022) who claimed that ASM activities among the youth were mainly driven by economic needs.

Through the lens of intersectionality, this highlights how structural inequalities converge to limit livelihood options for certain groups. In other words, increasing youth unemployment rates and economic-related challenges have landed many young people in ASM as a means of survival.

More so in this current study, unmarried women, often started ASM through social networks with invitations from sisters, aunts, or friends who were already involved in ASM, as asserted by Danielsen and Hinton (2022). Their entry was less formal, and sometimes seasonal or task specific. Additionally, most women married women with larger households, entered ASM out of household financial pressure, a finding similar to that of Stokes-Walters *et al.* (2021).

This pathway reveals the role of the intersection between gender and marital status with social capital, and how it affects their access to employment opportunities. With regards to the less formal, seasonal, or task-specific nature of their entry and participation, this emphasizes the precarious nature of their engagement in ASM.

The roles played by women in terms of their participation in ASM happen to be physically demanding tasks. These tasks are mostly underpaid and undervalued in comparison to male-dominated roles like digging or operating machinery. Irrespective of this, women still depend on these roles to feed their families. Intersectionally, their economic vulnerability intersects with gender, which tends to position them in low-status but essential roles.

Moreover, the mention of "taboo days" among other gender-based restrictions depicts how socio-cultural beliefs intersect with gender to limit women's access and consistency in participating in ASM. Also, the fact that some women indicated their involvement of their entire household in ASM, reflects the entanglement of family structure, economic needs, and gender roles. This means that women are both economic providers and primary caregivers, reinforcing the intersection pressure of being a woman, a worker and, a caregiver (Ofosu *et al.*, 2024a).

Years of involvement also played a role among women with over 10 years' experience who typically started as support workers and slowly transitioned into more stable but still gendered roles like ore washing, petty trading, or food vending. This was observed in the words of one DPA, a 39-year-old married woman who responded in the words "My husband lost his farm to the mining pit, so I had to start selling drinks at the site to support us. That's how I got involved." Similar to the observation made by Dzvimbo *et al.* (2019), these roles are more synonymous and clear extensions of traditional domestic responsibilities, compounded by the fact that they are less remunerative and less recognized compared to roles held by men. This characterizes the gendered division of labor where women are confined to peripheral activities, limiting their economic advancement.

Clearly, age, marital status, and physical strength were the factors that shaped the type of ASM across both DPA and IPA groups as observed in this current study which is also consistent with literature (Buss *et al.*, 2022). Younger, single women, especially those between 18-40 years old, among DPAs often performed physically demanding tasks such as carrying loads, sieving, or breaking stones. Among IPAs, younger women leaned toward support services, including cooking or washing for miners. Married women were more likely to engage in "compatible" roles that allowed them to balance domestic work such as food vending or trading. DPAs who had 10 years of experience elaborated those gendered expectations locked them out of high-income, decision-making roles regardless of experience. For instance, one 28-year-old DPA indicated,

"They say carrying stones is not for women, but when you need money, you do what you must even if your back breaks."

This observation reflects societal perceptions that tend to link youth and physical capability to labor-intensive roles, potentially limiting these women's access to less strenuous, higher-paying positions in the ASM industry.

As far as health and safety risks impacts are concerned, it has been reported that ASM activities are related to poor occupational health and safety (OHS). These include ergonomic pressures and traumas, joint and muscle pains, and hearing losses which are not so different from what was reported by the respondents as well as literature (De Haan *et al.*, 2020). This assertion was corroborated other researchers who reported issues of skin diseases among workers within the ASM industry (Nongrem, 2023).

These health concerns, some of which vary from long-term effects to short-term effects, have the capacity to endanger the lives of these ASM workers aside from the fact that it can terminate their occupations (Basu *et al.*, 2015) which may end up having rippling repercussions on their livelihood as well. Despite these inimical health concerns, the income accrued by these ASM workers among other gains attest to the fact that ASM can empower these DPAs to afford better health care.

Moreover, the fact that these respondents have not been hospitalized since they started ASM confirms some of the positive health outcomes that ASM activity can facilitate improved access to health care in rural areas as a mapping strategy to achieve sustainable development goal (SDG #3) specifically, and also provide a regular source of income to spend on health care (Cossa et al., 2021; De Haan et al, 2020). In the same vein, the health and safety crisis related to ASM contradicts the objective of sustainable goal (SDG #12) which focuses on responsible production and limitation of the ASM impact on the environment (Laing and Pinto, 2023).

Due to the health implications of ASM raised by the DPAs, they would consider changing job if there were options. This is because according to some of these women interviewed, they regularly take painkillers which had its negative impacts on their health. Also, some visit hospitals more often than before. It was few of them who reported that they have never reported sick because of their involvement with ASM activities. However, this assertion is not in consonance with other papers where the majority of people that reported sick on other ASM sites

(Addo *et al.*, 2023). However, even with those that did not report sick, they linked their unwellness to their menstruation periods. Such women in their periods were not allowed on the ASM sites as part of the regulations governing their work as reported by other research works (Paschal and Kauangal, 2023). More so, some needed to go to work irrespective of the state of their health to make ends meet.

Traditionally, it is pervasively believed that 'spirits' are custodians of these minerals and as such, whenever these menstruating women touch them, it 'somewhat' defiles them. Superstitiously, it is believed these 'spirits' will withdraw the minerals. It may take the performance of certain traditional customs to 'pacify' these 'spirits' in order to ensure a sustainable gold production and avert further consequences (Mengba *et al.*, 2022). These traditional beliefs in effect, could make them lose man hours which may have further repercussions on the production and livelihoods of women (Arthur-Holmes and Busia, 2022b). Broadly recorded in other countries of Africa and the world at large where ASM is prevalent, the body of research has it that superstitions and myths have always affected the general operations of ASM operations. These have always been a major dissuasion to ASM workers from looking for scientific and more pragmatic solutions to their challenges as far as their health and safety measures on the site are concerned (Matsa *et al.*, 2022). Nonetheless, most of them felt discriminated by that whilst others agreed as tradition required.

Moreover, the existing cultural norms that prohibit menstruating women from accessing ASM sites further marginalize them through the enforcement of gender-based exclusion rooted in superstitious beliefs. Irrespective of these health risks, some women rationalize their suffering since the income they earn offers a sense of empowerment, even if it comes at a cost to their well-being. This tension demonstrated by these women is a clear instance of how intersectionality exposes the multiple, interconnected barriers that shape women's participation

in ASM, which extends to their autonomy and perceived value within both the household and the mining sector.

Analysis of HSR was mainly associated with increased health risks associated with DPAs involved in ASM activities. The inference from the responses for HSR found relates adversely to ASM activities. This finding corroborates the studies that arrived at similar conclusions that ASM could affect the health of women (Arthur-Holmes and Busia, 2022; Yakovleva, 2007. Schwartz *et al.* (2021b) stated that informal ASM is characterized by poor Occupational Health and Safety (OHS) conditions, and poor practices employed in ASM pose a health threat to nearby communities. Living and working conditions in (especially 'rush') ASM communities enable HIV, TB, zoonotic, and other diseases to thrive.

For DPAs of all age groups, health risks associated with ASM activities were pronounced and linked to the physical demands of their work. Younger women below 30 years seemed to experience more acute physical injuries, including cuts, bruises, and back pain, due to their vigor and the strenuous nature of their mining tasks. In contrast, older women and those with more than 5 years of mining experience reported experiencing chronic health conditions such as muscle strain, joint pain, and respiratory problems caused by exposure to dust and hazardous mining chemicals. Married women were often more concerned about the long-term health impacts due to the added responsibility of caring for children and elderly relatives. The lack of access to proper protective equipment was frequently mentioned as contributing to these health issues as confirmed in one statement by one DPA as "I feel pain in my back and chest from working in the mine. Sometimes, I don't even sleep properly at night because of the aches." An intersectional analysis reveals that health risks in ASM disproportionately affect women due to the interplay of gender, age, marital status, and caregiving roles, as reported by Landrigan *et al.* (2022).

The mental side effect of working in harsh, unsafe mining conditions was mentioned across all age groups of direct participants. For some women, particularly those who had been in ASM for more than 5 years, the stress of job insecurity and poor working conditions such as long hours in dangerous environments, led to mental exhaustion, anxiety, and in some cases, depression. The younger generation who were between 18-30 years, reflected the psychological strain of being in an industry where safety and job stability were not guaranteed. They often voiced concerns about the future and the uncertain outcome of their work. The mental impact was also heightened by the fact that they felt trapped in this informal sector, unable to transition to other safer jobs. This was expressed as by one DPA who said "We are always worried. What if there's an accident? What will happen to my children? The stress is too much." Married women, especially those with children or elderly dependents, faced additional stressors as they balance mining work with caregiving responsibilities, leading to heightened mental health concerns. These intersecting factors accentuate the need for targeted interventions that address the compounded vulnerabilities women face in the mining sector (Cossa *et al.*, 2021).

Evidently, there are aspects of intersectionality being demonstrated through the overlapping and compounding effects of gender, health, economic necessity, and cultural beliefs according to these lived experiences of DPAs. Even though women undergo physical and mental health challenges like skin diseases, exhaustion, injuries, and stress, they are continually involved in this hazardous work because of economic vulnerability and lack of alternatives, revealing how class and gender intersect to limit their choices.

In terms of leadership and decision-making impacts (LDM), the various abilities demonstrated by the women points to the fact that they have developed several mechanisms to improve upon the economic results harnessed from their labour (Arthur-Holmes *et al.*, 2023a). The positive for LDM is concluded with the assertion by De Haan *et al.* (2020), that ASM provides opportunities for on-the-job learning and skills-based training, which are also transferrable to other economic

activities. In addition, the ASM revenues are often used to pay for education, whether by parents or by children and youth in ASM themselves. These assertions were corroborated by other researchers that ASM provides opportunities for on-the-job learning and skills-based training, which can also be effectively applied in other economic sectors (Laing and Pinto, 2023).

The adverse concerns raised by the respondents regarding LDM are that decisions regarding women involved in ASM are done by their leaders who are predominantly males and when they ask questions are tagged as “they like complaining”. Most of them are made to do what they must do. In order not to be seen as whiners which may eventually affect their schedules, they keep quiet and endure. Some of them also stated that they have negatively been impacted as they always look dirty unless they return from work; sometimes they are very tired with less time and energy to decide or take up roles at home. Since they have decreased capacity to access development/education/training or skillsets, most of the women have not also had any peculiar education or training over the time they have been working in the ASM environment. Also, the report showed that the capacity of the women to access certain resources/technology/interventions is limited in some ways. Some of them explained that anytime they buy smartphones they get lost or too dirty within a short time and not serve the purpose for which they were bought. Some expressed disinterest in acquiring expensive electronic gadgets because of the uncertainties in their possession.

These experiences are reflective of the fact that social norms and local traditions still influence the capacity of women in making decisions. Especially in situations of ASM where most of the women interviewed worked in lower tiers, their influence and dominance could be masked by the male dominance in ASM profession to some extent (Paschal and Kauangal, 2023). This feedback also affirms the findings that female miners are typically confined to manual, low-paid, and secondary roles, and, they have unequal access to ore deposits, mining groups, equipment, finance and fair markets (Thiong’o, 2023).

Intersectionality is demonstrated here through the way gender, economic status, and social norms intersect to limit women's leadership in ASM. From the respondents, women are mostly confined to low-paid, manual roles and excluded from key decisions. This highlights the gendered power imbalances. On the other hand, their participation in ASM has also led to increased confidence, skills, and household decision-making power. The fact that some have taken on informal leadership roles and access resources like mobile phones and tools emphasizes how intersecting factors can both constrain and empower women in complex ways.

DPAs who were between the ages of 18-30 years and those with less experience in ASM, reported having limited influence in decision-making processes within their ASM operations. They highlighted a strong gender divide, with male leaders dominating the management of mining groups and often relegating women to support roles. Older women, particularly those beyond age 30 with longer years of involvement, mentioned how they had started to influence decisions regarding work schedules, production, and sales, but they were still heavily marginalized. Moreover, there was a consensus among the married women that while they were involved in the day-to-day decisions, they had little authority over the strategic decisions related to finances and operations. One DPA reported, "We don't make the decisions. Men are the ones who decide what to do with the gold we mine, even though we work just as hard." These observations project the fact that married women, while involved in day-to-day decisions, often lack authority over key financial and operational choices, reflecting a persistent gender divide in leadership within ASM operations (Buss *et al.*, 2021).

The ability to advocate for better conditions or increase earnings was another area where DPAs identified barriers. Younger women (18–30) expressed their disempowerment, as they were often seen as less experienced and less entitled to negotiate better working conditions. Older women, particularly those in married or larger households, noted how their capacity to push for change was influenced by the dominant male leadership. Several women also mentioned how family

responsibilities hindered their involvement in larger decision-making, as they were often pulled back into household duties before they could assert themselves in professional contexts. One DPA said “If I complain about the conditions, they don’t listen. I just have to keep working because I have children to feed.” This means that the expectation that women bear primary responsibility for household duties often hinders their involvement in decision-making processes as reported in literature (Adam *et al.*, 2022).

In terms of economic impacts, Adranyi *et al.* (2023) had stated that ASM provides direct livelihood benefits for rural people in impoverished regions. It also gives indirect livelihood benefits for families and host communities which improves community resilience to cope with shocks, some of which are irregular income patterns and unemployment. The search for financial capital was identified as one of the major reasons for the involvement of women in this ASM industry (Thiong’o, 2023).

On the contrary, the negative aspect of the high participation of women in ASM activities is that they are not able to engage in other economic ventures like farming as realized in this qualitative study. This assertion was confirmed by other authors who claimed their farming business suffered from the competition for arable lands by the players within the ASM industry (Adator *et al.*, 2023; Wongnaa *et al.*, 2024). Also, these informal miners are vulnerable to shocks and may become stuck in an ‘ASM poverty trap’, though in most cases no better options are available. ASM is always seen by them as one of the ways to accrue financial capital to further their own education or that of their wards, access professional employment and, perhaps become entrepreneurs (Osei and Yeboah, 2023).

As an economic activity, ASM among women has over the years impacted the living conditions of most women. Despite the devastating impact on health and the environmental destructions reported by media houses and researchers, on the other hand, the women alluded that because of

their involvement in ASM activities, they are able to support their husbands and also take care of basic household needs. This conversation has been going on over the years in the world of economic research and it has been found that ASM employs people and supports their daily living (Morante-Carballo *et al.*, 2022).

With regards to women's economic needs, research has it that it is difficult for women in ASM to be granted loans, especially from formal companies (Onekpe *et al.*, 2023). This can be attributed to the fact that ASM is considered to be economically, financially and, socially risky (Hilson *et al.*, 2018a). These structural gender norms and economic responsibilities regarding women in ASM intersect to produce both empowerment as well as strain, depending on the respondent's situation. The Intergovernmental Forum on Mining, Minerals, Metals, and Sustainable Development has asserted that women tend to be confronted with various economic challenges as far as ASM activities are concerned (Weldegiorgis *et al.*, 2018a).

Nonetheless, women across both participant groups acknowledged that ASM activities offered an essential income source, especially in communities with limited employment options, a finding consistent with that of (Arthur-Holmes *et al.*, 2023b). However, among participants aged 18-30 with less than 5 years' experience, mostly reported unstable and low earnings, commonly among those working in casual or informal roles like food vending and washing ore. Married women beyond this age group with longer participation above 10 years were more likely to report improved financial autonomy, especially among direct participants who engaged in gold trading or supervised other workers. However, this income was often erratic due to fluctuations in gold prices, weather conditions, and seasonal disruptions. This was expressed in the words of one 34-year-old married IPA in the words "You can get a lot of money today and nothing for two weeks. It's not like a salary, so you can't plan."

Married women with longer ASM experience were more likely to describe greater financial independence such as making decisions about school fees, food purchases, or minor household investments. Among indirect participants, especially traders and food vendors, this autonomy was more evident as they controlled their daily income. However, younger women and those in domestic auxiliary roles noted that their incomes were often controlled by spouses or used to fill family needs first. DPAs mentioned that gendered power structures at mine sites also limited access to more lucrative roles which end up affecting women's earning potential. This was confirmed by a 42-year-old married IPA who confirmed that "I can now pay my children's school fees without waiting for their father. But I still can't enter the pit; they say it's for men"

These observations highlight the intersection of entrenched gender norms, occupational segregation, and systemic barriers that collectively restrict women's economic agency within the ASM industry. This assertion is consistent with the finding of Ofosu *et al.* (2024a) as it creates a complex landscape where women's financial autonomy is influenced by multiple, overlapping factors.

In terms of the social impact of ASM, mapping ASM with sustainable development goals also indicated that ASM provides women with prospects for social and economic empowerment (Jackline, 2022). As far as their reputation is concerned, inference from studies by Ofosu *et al.* (2024a), Munir (2022) and Johnston *et al.* (2024) recounted their involvement in illicit sexual activities as one of the reasons for their ruined social reputations. These sexual relationships could be regarded as vulnerabilities regarding working in settings that could compromise their reputation.

Intersectionality is displayed in how women's gender, occupation, physical appearance, and social expectations intersect to shape their experiences in ASM. Whereas some women gain

social respect and confidence from their financial contributions, others are confronted with isolation due to the demanding nature of their work, strained relationships, or discrimination.

With regards to impact on time use, the fact that ASM is time-consuming leaves most of the women unable to take full childcare and domestic responsibilities; this has also been acknowledged by Hayes and Perks, (2012). This was exemplified in the way nursing women in ASM are not able to spend enough time with their babies as reported in other research works (Paschal and Kauangal, 2023). Deductively, the involvement of women in ASM consumes most of their time and prevents them from undertaking other equally important activities.

The gendered role of DPAs as caregivers conflicts with the exhaustive nature of mining, This results in reduced family time, strained reliability in social and community events, and emotional fatigue. These intersecting factors of gender, labor intensity, family expectations, and social obligations tends to create a unique set of constraints that shape how women navigate ASM work and their personal lives.

Across both participant groups, respondents hinted the intense time demands of ASM-related work. DPAs aged 18-30 years described working 10-12 hours daily in physically tasking roles such as hauling, panning, and transporting ore. Indirect participants, including food vendors and traders, also worked long hours, often beginning at dawn to serve miners and staying late to sell leftovers. These extensive work hours in addition to societal expectations for women to manage household responsibilities, lead to significant time poverty.

Married women with 3 or more children spoke of frequent exhaustion, which limited their ability to attend to household responsibilities. Some of these IPA reported long hours of caregiving in some instances. The intersection of age, marital status, and caregiving responsibilities shows how these overlapping identities intensify the challenges confronted by women in ASM

(Mensah, 2024). One IPA expressed concern that “By the time I finish selling and return home, my whole body is aching. Even to cook for the children becomes a problem.”

Many women, especially those with large household sizes, opened up that ASM participation reduced the time available for family care, child supervision, and social engagement. Married DPAs over 30 years often relied on older children or extended family to manage domestic tasks. In cases where such support was unavailable, younger mothers struggled to balance mining work and childcare. The intersection of age, marital status, and caregiving responsibilities in this regard demonstrates how these overlapping identities deepen the challenges faced by women in ASM, a finding similar to that of Arthur-Holmes and Abrefa Busia (2021).

Among indirect participants, some women mentioned preparing food in bulk at night to save time, while others had to sacrifice sleep to meet work and household obligations. Some also leave their wards in the care of other IPAs who have taken caregiving as a job. This emphasizes the communal coping mechanisms within ASM communities. One DPA bemoaned that “In those times, I leave before my children wake up, and by the time I return, they’re already asleep. Sometimes I wonder if they even know me anymore.”

ASM participation has reshaped how IPAs use their time, with many facing increased childcare and domestic responsibilities due to others household members full engagement in ASM. Home-based IPAs spend more time on family duties, while site-based ones have less family time. Despite these demands, most IPAs remain reliable and consistent in their support roles. Intersectionality with regards to IPAs as far as time use impact is concerned, is demonstrated in how gender, household roles, and work type affect IPAs' time use. It can be realized that home-based women take on more childcare and domestic duties as a result of the absence of ASM workers. This is a limiting factor in their ability to earn income. More so, site-based IPAs, spent less time with family. These overlapping roles show how gender and household dynamics shape unequal burdens and experiences in ASM-affected households.

In terms of nutrition/ food security, De Haan *et al.* (2020) and Haile *et al.* (2024) explained that ASM revenues enable rural communities to increase food security and meet basic needs. These women can buy the kind of food they want anytime their ASM work goes well. They practically go in a for variety of meals whenever they realize much from their ASM activities. According to them even when they are not able to return early to prepare food, they have enough money to buy from restaurants.

For DPAs, their increased income improves food access and purchasing power. However, with regards to their their gendered role in caregiving, combined with the time-consuming nature of ASM and poor working conditions, there is a tendency to have unhygienic eating practices, poor meal timing, and challenges in preparing nutritious meals for themselves and their families. These intersecting factors lead to a paradox where women can afford food but struggle with food quality and health, highlighting how class, gender, and occupation shape uneven nutritional outcomes within households.

As far as IPAs are concerned, proceeds from farming activities are used to support household food needs. Most often, their work is often undervalued and constrained by the prioritization of ASM which is mostly regarded as economically rewarding. These IPAs combine unpaid agricultural labor, irregular food schedules, and caregiving duties in a context where time, income, and decision-making power are unequally distributed within households. The tension reflects the overlapping burdens of gendered care work and economic survival; a clear instance of how structural inequalities are seen in both the division of labor and the nutritional well-being of ASM-affected families.

With regards to IPAs, intersectionality is demonstrated in the economic impact of ASM in relation to gender, economic class, and household roles and how they shape financial outcomes. Although some IPAs tend to benefit economically from the increased income of DPAs, this gain is mostly offset by increased household expenses, especially for food, clothing among other

household expenses, which are normally managed by women. Relatively, most women do not engage with formal financial institutions, owing to barriers tied to class, education, or institutional trust. These overlapping factors related to the economic impacts of ASM show that while ASM may bring economic relief, the benefits are not evenly experienced and continue to be filtered through intersecting social and structural inequalities.

A significant number of both DPAs and IPAs, especially those in the 18-30 age group, reported irregular meal patterns due to tight work schedules. DPAs often skipped breakfast or lunch while working at the mining site, as breaks were limited and eating spaces were inadequate. IPAs, such as food vendors or petty traders, were slightly better off due to access to their own food, but still faced disruptions during busy periods. Unmarried women were more likely to skip meals entirely, especially when cash flow was poor. Participants with smaller household sizes of 1-3 tend to manage better, while those with larger families often prioritize feeding children over themselves as expressed in one unmarried DPA that “Sometimes I work from morning till evening without food. If I buy some, it means no money for home.”

From the intersectional lens, gender and occupational roles situates women in positions where they are expected to navigate both the demands of labor-intensive work and conventional expectations of women's household responsibilities contributing to overburdened schedules which limit their ability to prepare and consume regular meals. Furthermore, the economic instability inherent in ASM work exacerbates these issues, forcing women to prioritize feeding their families over themselves, often leading to skipped meals and nutritional compromises just like how Rutherford and Buss (2019) made similar observations.

Respondents across all demographics identified a limited variety in their diets, with common meals consisting of kenkey, banku, rice, and gari. Protein sources such as meat, fish, or eggs were consumed sparingly, often once or twice a week, particularly among households with low income or larger sizes of 6-10 members. Married women with many dependents reported that

any increase in income was often absorbed by school fees or rent which leaves little for diverse nutrition. IPAs, especially food sellers, sometimes benefited from leftover ingredients, but this did not significantly improve dietary balance. One IPA indicated “We eat what we can afford. It’s mostly the same every day; carbs and pepper. Meat is for special days.” From these results, it can be realized that gender roles, economic instability, and household dynamics collectively impact women's dietary diversity and nutrition as reported by Baddianaah (2023).

Several participants with children under 12 raised concerns about child malnutrition and poor feeding habits, especially in larger households or where both parents were involved in ASM activities. Some women indicated that children were left with neighbors or older siblings who gave them whatever was available, which was often sugar water, “gari soakings”, or plain rice. Only a few mentioned any external nutritional support, such as school feeding programs. According to one DPA, “My son is thin and always tired. I wish I could give him eggs every day, but sometimes even porridge is hard to find.” From the above statement, financial constraints could be exacerbated by the number of dependents, which tends to influence the quality of food available to children. Similar observations were made by Arthur-Holmes and Busia (2020) who claimed women's participation in ASM influences their household bargaining power, but can also impact family dynamics and child care responsibilities. More so, the dual burden of women has the capacity to result in neglect in child nutrition. This is because women may prioritize work over adequate feeding practices, especially when they are engaged in labor-intensive mining activities. The intersection of gender, socio-economic status, and cultural expectations contributes to this situation (Klemm *et al.*, 2020).

Across both groups, larger households of about 6-10 people and those earning an irregular income from ASM expressed concern about diet monotony. IPAs working as vendors or cooks were better able to access leftover foods after selling. Older women and those with more years of working in ASM often prioritized feeding children over themselves, which results in adult

undernutrition. This obviously emphasizes the way age and caregiving roles intersect to exacerbate nutritional vulnerabilities. Moreover, married participants stressed their reliance on starch-based meals such as cassava, yam, rice and maize due to cost and convenience. According to one 41-year-old DPA, "You fill the children's stomachs, but what they eat won't make them grow strong."

Generally, these observations reflect how economic instability and household responsibilities intersect to limit dietary diversity. More so, it also reflects how occupational positioning within the ASM sector influences food consumption patterns (Stokes-Walters *et al.*, 2021).

In terms of environmental impacts, the IPAs explained that ASM activities threaten terrestrial ecosystems, inland water, and biodiversity. It degrades and fragments habitat, and increases illegal timber and wildlife harvest, while disturbing carbon sinks and native species. This confirms the assertions from existing studies that ASM releases large volumes of pollution and hazardous waste, degrading soil, air, and water quality (Bansah, 2023). This suggests a negative implication of ASM on the environment from the literature. This stands to say that these women are not oblivious to the implications of ASM on the environment. The impact of ASM is no doubt a major threat to the environment. In addition, this tends to have a rippling effect on their income realized from the ASM activities (Sauerwein, 2023). It is widely acknowledged in different literature that forest areas, water bodies, and farmlands have been destroyed over the years through ASM (Ofosu *et al.*, 2020). From this study, women indicated that they have experienced some form of environmental issues and an increase in diseases. This is no different from what research has established in the literature that mining areas are prone to increasing malaria cases (Dao *et al.*, 2021). This development according to the women comes because of the many dug-outs emanating from ASM activities within the community. Interestingly, there were some dug-outs that were discovered in the community where the respondents lived which confirms such assertions regarding diseases/illnesses in ASM areas. Critically, some houses had

dug-outs on their compound. Most of these dug-outs held stagnant water that became breeding media for mosquitoes which ends up spreading malaria (Caldas *et al.*, 2023). More so, these dug-outs have also become death traps within the community. The women recounted a number of cases where children had drowned in some of these dug-outs and had lost their lives in the process. This is not so different from what has been reported in existing literature that several people had lost their lives through falling, drowning and the collapse of the some of these mining pits (Abdulai, 2017).

Intersectionality is displayed in women's experiences with ASM-related environmental degradation. As caregivers and community members, women tend to face overlapping risks arising from polluted water and disease to the emotional and physical toll of child fatalities caused by mining pits. Their gender roles, limited power as well as exposure to environmental harm compound their vulnerability, showing how ASM impacts them in complex, interconnected ways.

Participation in ASM affects women's domestic roles differently depending on whether they are home- or site-based. While home-based IPAs have more time for domestic tasks, site-based IPAs struggle to manage household duties due to long hours. However, their involvement in ASM has reduced time for family and social life, and some even noted a decline in intimacy with their spouses due to fatigue, reflecting the broader personal impacts of their work.

As far as domestic roles are concerned, intersectionality is demonstrated through the interplay of gender roles, location of work, and social expectations shaping IPAs' experiences in ASM. For instance, the home-based women retain and expand traditional domestic roles, while site-based IPAs face challenges balancing work and household duties, affecting cooking and their level of social participation These intersecting roles demonstrate how gender, labor type, and societal norms influence women's lived realities differently in ASM contexts.

For IPAs, particularly those engaged in agriculture and farming, environmental damage was a recurring theme. They spoke about the deforestation and soil degradation caused by ASM operations, which impacted their ability to grow food and sustain their families. Participants with larger households above six showed vulnerability as they relied on farming for subsistence. As ASM activities expanded, they lost access to fertile land, leading to decreased food production and increased dependence on market purchases. The loss of fertile land has had lasting effects on food security in mining areas, with older women especially concerned about how this environmental degradation will affect future generations. One IPA narrated that "The land is gone, and the trees are no more. We can no longer grow food like we used to, so we depend on what we can buy, which is costly." The role of women as primary caregivers and subsistence farmers, combined with limited access to resources and decision-making power, exacerbate their exposure to environmental risks (Steinfield and Holt, 2020).

Both younger and older women in indirect roles expressed concerns about pollution from illegal mining activities, particularly water contamination. The presence of chemicals such as mercury and cyanide in rivers used by local communities was highlighted as a major health risk for women engaged in household activities like cooking, washing, and fetching water. Married women, in particular, mentioned that polluted water was affecting children's health, with diarrheal diseases and other waterborne illnesses becoming more common in communities near ASM sites. It was narrated by one IPA that "We no longer get clean water from the river. It has chemicals, and we can see the effects in our children. They are always sick."

Intersectionality is demonstrated in the experiences of women affected by water contamination from ASM activities through the interplay of gender, age, marital status, and caregiving responsibilities. These intersecting factors highlight the compounded vulnerabilities women face in environments affected by ASM (Chiavaroli, 2024).

The impacts of ASM activities on domestic roles were significant for IPAs, especially older married women. As more family members became involved in ASM, particularly male partners and older children, women found themselves taking on more household tasks. They spoke about the increased burden of cooking, cleaning, and caring for children, while other family members focused on ASM. This resulted in time stress for many women, who had to juggle the demands of household work with the economic pressures of ASM-related income. One IPA alluded “My husband works in the mine, and I take care of everything at home. The children don’t get the attention they need because I’m always busy with the house.”

This demonstrates the gendered division of labor within ASM operations which relegates women to support roles, while men dominate more lucrative positions. This structural inequality restricts women's access to higher-paying opportunities and reinforces traditional gender norms that undervalue women's contributions both in the domestic sphere and within the mining sector (Ofosu *et al.*, 2024a).

Table 6.8 highlights some of the responses gathered from the respondents with regards to how ASM is associated with food security, nutrition and health in the various households within the study area.

Table 6.8: Some responses gathered from respondents on how ASM is associated with food security, health and nutrition

	PLP	ECO	ITU	NFS	HSR	LDM	SOC	ENV	DOS
	Participation Levels in ASM activities	**Economic Impacts**	**Impacts on Time Use**	**Impacts on Nutrition/Food Security**	**Health and Safety Risks Impacts**	**Leadership and Decision-making Impacts**	**Social impacts**	**Environmental Impact**	**Impact on Domestic Roles**
DPAs	*'I have always been in ASM since I don't have any job to do'*	*'It is the same money I get from the ASM that I use to take care of the household expenses'*	*Due to ASM, I don't even have time for myself and attend to other important commitments I have. I always come back tired so I use the free time I have to rest*	*'I think the ASM has caused a lot of devastation to the land that it has affected farming activities. However, always have money to buy the foods I want'*	*'We are not allowed to visit the site when are having our periods.*	*'I am a gang leader myself but I do report to other people who are mostly male supervisors'*	*'ASM has given me much money that I am so respected in the community because I am able to take part in all the community contributions/donations. '.*		
IPAs	*' I take care of six (6) children four (4) girls and two (2) boys. One is 2years old, 4 years old and 11 years while the others are also 8years old ,7 and 10 years old. Anytime they go out for their ASM activities. I am the one who cooks for the children, bath them, dress them up and mind them anytime their parents go to work. .'*	*'My children are able to support the household with the income from ASM. I also do some petty trading with their support alongside which I used to support the family'*	*'Anytime my children return from their ASM work, I have time to attend to my personal commitments'*	*'ASM activities have destroyed our water bodies and farms that we are forced to buy food from outside. Sometimes, getting clean water to drink is scarce.'*				*'The ASM has really destroyed our lands and has resulted in stagnant waters that breed mosquitoes in the community'*	*'Since all my children are into ASM, I have to do most of the housework.*

DPAs	*I m just a normal work in the gang. I am not gang leader. I am part of the gang that go to the site in search of load to wash gold. However, everything that bothers on our welfare is also my concerned.*	*Ever since I joined this work, my income has dramatically increased. I am able to earn more to cater for my family. That is the reason why I find it difficult to stop this work. On days where the work goes well, I really make a lot of money. In such time, even those in offices cannot compare themselves to me.*	*I have enough time since the job is in a shift plan, therefore I have enough time to cater for my wards.*	*I normally eat my favorite since I have enough money. Aside doing this ASM work, I am a maize farmer. The galamsey has not affected my farming activities since I plan well.*	*I do not normally fall sick as a result of ASM. I am someone who does not often fall sick. However, I must confess that this kind of work comes with a lot of stress and tirefness. One is bound to have a lot of body pains anytime one comes from work.*	*My leadership role in ASM has improved my time management and earned me community respect, as I organize and discipline workers and mediate disputes, enhancing my visibility and influence as a woman*	*This work has really made me known in the community. It has made me popular to many of the town folks especially those involved in the ASM activities.*		
IPAs	*Taking care of children is what I normally do for my daughter who is involved in this ASM work*	*I really don't do anything home that will bring me income. I solely support my daughter with her child anytime she goes to work*	*I am so committed to supporting my daughter. However, I do make time for myself when my daughter is around*	*Taking care of the child means I have to be responsible for everything that the child does. I al-ways make sure I cook enough food for myself and the child who is in basic school*				*Our water, farms and lands have all been destroyed by ASM. Getting clean water in this community is not really easy.*	*I really enjoy staying with my daughter and supporting her in her work As such, every deci-sion I make, I have to put these responsibilities into consideration.*

DPAs	*Anytime I go to work, they take the load for us. While one is working on the board, I will be on the other hand assisting. We always wait for the machine to come out before we start our work. It is very important for the machine to exit the site before we start work to avoid any accidents whatsoever.*	*This job has enabled be get money to cater for my family. To be honest, it this job should go well, it is one of the most well-paid job I have ever done.*	*Well I always go for hawking with my drinks. The ASM work is not very regular.*	*There is always food in the house. We are not selective. Even if I am not able to cook, my mum helps in preparing food for the family.*	*Working long hours in ASM causes constant standing and walking without rest, leading to persistent body and waist pain. The physically demanding nature of the job, coupled with overnight stays at the site to earn enough for my family, results in significant physical strain.*	*As a woman, this work has made me quite tough in my dealings with people. With my role in the house as a woman, it has not really changed that much.*	*People see me as someone who is well-off. I have earned a lot of respect out of that*		
IPAs	*It is not everyday that I take care of the children. Normally, I take care of them when my daugh-ter has gone to do the ASM work. Apart from Tuesday that they don't go to work, all the other days, I am the one who takes care of the children.*	*The amount of money get has not increased. This is because the number of people I have to take care of are many.*	*I normally do all the work in the home when they have come for their children.*	*Some of the children, their parents do not leave any money behind. So I have to take up that re-sponsibility of feeding the children. Sometimes, they give me money on return, other times too, they give me nothing.*				*ASM has really destroyed our farms, water and our lands. It has also led to a so many dug-out in the community.*	*It has taken most of my time but I enjoy doing it so I am not worried.*

6.8 Conclusion of Qualitative Analysis

The chapter analysed the qualitative data collected from the field exercise. The analysis is categorized into two sections: the data from Direct Participants (DPAs) of Artisanal Small-Scale Mining (ASM) and data from Indirect Participants (IPAs). Various themes were developed from the seventy-two questions responded to by the twenty-five DPAs and thirty-eight IPAs. Seven of these themes were related to the responses by DPAs and six of them related to IPAs making a total of thirteen themes.

From the analyses and synchronization of data from DPAs, it can be concluded on the Participation Levels in ASM activities (PLP) theme that the extent of participation among women in the area is very high as participants engage in direct mining activities on a regular basis including other household members. On the theme of Health and Safety Risks Impacts (HSR**),** it is concluded that ASM is risky and deteriorates the health of those who participate in it. On the theme of Leadership and Decision-making Impacts (LDM) on DPAs, the study concludes that female miners are typically confined to manual, low-paid, and secondary roles, and, they have unequal access to ore deposits, mining groups, equipment, finance, and fair markets. Key decisions and leadership roles at the site are taken by their male counterparts. On the theme of Economic Impacts (ECO) it is concluded that the income levels of participants have increased significantly enhancing their financial ability in their households and improving other enterprises they engage in. Also, on the theme of Social Impacts (SOC), the responses were varied, a good number of them were found to have the ability to pay for funeral contributions and other costs in their communities leading to increased social prestige. On the other hand, due to the time-demanding nature of their work, they are not able to associate very well with neighbours. On the Impacts on Time Use (ITU) theme, it is concluded that DPAs have increased workload and therefore affect other equally important activities. On the Impacts on Nutrition/Food Security (NFS) theme, it is concluded that ASM activities positively and

significantly affect the food security and nutrition of participants. Even though most women are able to afford foods, the kinds they want and even buy in bulk it was discovered that they do not eat it under hygienic conditions. These foods are taken at the site sometimes with improperly washed hands and bowls or leaves which may adversely affect their health.

Analysis of data from IPAs also indicates that on the theme of Participation Levels in ASM activities (PLP) the study finds high participation among the participants. Their participation however leans against that of the DPAs. On the theme of Impacts on Nutrition/Food Security (NFS), it is concluded that the majority of them have taken up some agricultural activity leading to improved nutrition levels. Also, on the theme of Economic Impact (ECO), it is concluded that their indirect participation in ASM activities has improved their living conditions. On the theme of Environmental Impact (ENV), it is concluded that their activities threaten terrestrial ecosystems, inland water, and biodiversity. It also degrades and fragments habitat, and increases illegal timber and wildlife harvest while disturbing carbon sinks and native species leading to devastating environmental conditions. The conclusion on the theme of Impacts on Time Use (ITU) is that ASM consume most of their time through increased workload at home, childcare responsibilities, time spent with family, and other domestic responsibilities, and the reliability, punctuality, and consistency at work are also affected. The last theme on the Impact of IPAs involvement in ASM activities on Domestic Roles (DOM) revealed an increase in the performance of domestic roles for IPAs who are home-based undertaking childcare responsibilities, cooking, and trading roles. For the IPAs who are site-based, it was revealed that they have decreased domestic roles.

In addressing socioeconomic disparities, there is a need to focus on economic development in rural areas. This will help improve the income levels of rural inhabitants through job creation and access to credit facilities. There is a need to target the health needs of rural populations which involves providing funding avenues for rural health care and conducting research into

rural health disparities. The intricacies of ASM are vital for creating effective policies. Without sufficient recognition of these nuances, any blanket policy aiming at tackling the issues faced by women in the industry would be futile.

In conclusion, as far as this aspect of the study is concerned, the analysis of qualitative data from both Direct Participants (DPAs) and Indirect Participants (IPAs) of Artisanal Small-Scale Mining (ASM) highlights the complex interplay of economic, social, health, and environmental factors shaping their experiences. While ASM provides economic benefits and improves food security, it also exacerbates gender disparities, health risks, environmental degradation, and time constraints, especially regarding women. These findings underscore the urgent need for targeted interventions, including economic development initiatives, improved healthcare access, and policies that address the specific challenges faced by women in ASM. A nuanced understanding of these issues is crucial to developing effective, equitable policies that promote sustainable livelihoods while mitigating the negative impacts of ASM on individuals and communities.

6.9 Comparison between Results from Qualitative and Quantitative Sections

According to the qualitative study, ASM positively impacts food security by increasing affordability and access to diverse foods. However, this assertion does not align with the findings from the quantitative studies. Notably, it must be realized that these qualitative studies examine subjective experiences and perceptions. Sometimes, these tend to emphasize short-term benefits such as increased income leading to better food affordability and variety. As such, these results are context-specific and do not represent broader patterns as portrayed in the quantitative study. Although the qualitative results portrayed improved access to diverse foods, quantitative research indicated otherwise due to small land sizes, ASM-invaded arable lands, labour shift, and the negative externalities of land-use conversions.

In comparing the results of quantitative and qualitative aspects of this study, it can be gathered from both studies that ASM has a significant effect on the health (proxied by absence due to illness, injury, or both) of the people engaged in it. This was confirmed in the quantitative study which recorded an inverse relationship between ASM and health (proxied by number of days of absence due to illness, injury, or both). The results from the quantitative study showed that spending more hours in ASM resulted in fewer absences due to illness, injury, or both. This connotes better-perceived health among ASM workers.

In addition, the qualitative study suggested that women tend to have several health issues around their reproductive health, physical, psychological, and emotional health. However, factors relating to income realized from the ASM activities, self-medication, and underreporting (to avoid absenteeism owing to issues of illegality of ASM, fear of losing their job, self-medication, and likely altercations with superior) limit their levels of absenteeism from work due to illness, injury or both as confirmed from the qualitative aspect of this study and other literature.

The qualitative study also recorded that women involved in ASM activities were generally relegated to low-remunerated, manual, and inferior roles. These women are confronted with unequal access to critical resources like ore deposits and mining equipment. The qualitative study also revealed that leadership and key decision-making roles are dominated by men. This aspect of leadership could be inferred from the male dominated household headship as depicted in the quantitative results.

The qualitative study revealed that participation in ASM has significantly increased income levels among participants, enhancing financial ability and supporting household needs and other enterprises. Also, the indirect involvement of women in ASM has improved living conditions. The significant positive effect of the wealth index regarding food security and nutrition as realized in the quantitative findings tends to support this assertion. Moreover, this aspect of the

qualitative was elucidates and throws more light on the livelihood opportunities offered by ASM. An assertion that could not be directly fetched from the quantitative study.

According to the qualitative study, ASM increases workload, leaving less time for other relevant activities. More so, time spent on domestic responsibilities and childcare affects consistency and punctuality at work. This aspect was clearly captured in the quantitative aspect regarding the amount of hours spent in ASM which proved the level of commitment and dedication to ASM activities.

According to the qualitative study, women who were indirectly involved in ASM experienced an increase in domestic roles such as childcare and cooking. It was also realized that there was a decrease in domestic responsibilities with regard to women directly involved in ASM. Although this was not clearly captured in the quantitative data, it explains some of the conditions regarding ASM that were not adequately captured in the quantitative study through the GLSS data.

6.10 Link between Results and Conceptual Framework

The DPSIR framework (Driving Forces, Pressures, State, Impacts, Responses) directly links to the results by providing a structured understanding of how artisanal and small-scale mining (ASM) influences food security, nutrition, and health. Driving Forces in this context include socio-economic factors like poverty and lack of alternative livelihoods, which drive individuals into ASM. These forces lead to Pressures, such as labor shifts from agriculture to mining, which place strain on food production systems, reducing agricultural productivity and limiting access to diverse foods, thereby worsening food security and nutrition. The State of food security, nutrition, and health is negatively affected by these pressures, as shown in the study's findings, where reduced agricultural productivity and disrupted food acquisition patterns contribute to poor nutrition and health outcomes. The Impacts refer to the negative consequences of ASM, including food insecurity, poor dietary diversity, and compromised health. Lastly, Responses are the interventions suggested by the study, including improving market access, promoting

education, and enhancing healthcare access to mitigate the socio-economic and health risks associated with ASM. The DPSIR framework helps clarify how the driving socio-economic forces, pressures from ASM, and their impacts on food security, nutrition, and health require comprehensive responses to address these complex challenges.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This concluding chapter entails a revisit of the major findings of this study as well as insights acquired from the research. More so, this chapter seeks to highlight their significance within the larger scope of research. In addition, the chapter synthesizes the key points discussed, bringing together the various themes and contributions to the field. Reflecting on the research objectives, discussions on the extent to which these objectives have been achieved are made as well as any limitations encountered during this research. Finally, this chapter gives recommendations for future research and practical implications based on the findings, targeted at opening new avenues for more studies.

7.2 Conclusions

The principal aim of this study is to understand the impacts of ASM on food security, health and nutrition at the household level in Ghana as well as its effects on women participating directly or indirectly in ASM activities to contribute towards improved policy making. To achieve these objectives, the study employed a mixed method approach by utilizing GLSS 7 data as well as the use of in-depth interviews with women members in one of the GLSS survey areas. The quantitative analyses utilized OLS estimation methods on household-level data derived from the GLSS 7 database. The qualitative methods included in-depth interviews with women members participating directly and indirectly in ASM activities selected within the sampled households utilized for the quantitative part of the study.

Results revealed a significant ($p<0.10$) association between ASM and food security levels, controlling observed covariates; a finding that is consistent with existing literature. This current study also suggests a statistically significant ($p<0.05$) negative association between ASM and nutrition as reflected by dietary diversity scores, a finding consistent with the existing literature. Finally, this study suggested significantly ($p<0.05$) that ASM is negatively associated with health

outcomes, which was proxied by the number of days of absence due to illness, injury, or both, (having controlled for observed covariates), a finding consistent with literature. Therefore, the apriori expectation that ASM is associated with lower food security and nutrition scores, as confirmed by the econometric analyses is consistent with the literature. On the other hand, the findings suggest that ASM is inversely associated with health (the number of days of absence due to illness) outcomes, implying good health.

Apart from the key variable ASM, other socio-economic factors also exerted varied influences on food security, health, and nutrition. The findings suggest food security is significantly and positively associated with area cultivated, primary education, secondary education, and wealth index but negatively related to ownership of land. Nutrition level is significantly and positively associated with primary education, wealth index, and family size. Lower scores of nutrition outcomes are significantly associated with migrants, male members, and households located in urban areas. Health status, measured by the number of days of absence due to illness, injury, and both, is significantly and negatively associated with family size and households located in urban areas. In other words, households with larger family sizes and those located in urban areas are associated with relatively better health than small family sizes and rural residents.

The use of a mixed method in this study highlighted the need to consider other important factors such as gender which is more seen through the lens of intersectionality. Reflecting on both quantitative and qualitative results and discussion, it can be confirmed that the factors associated with the inverse association between food security and ASM are not only confined to social, economic and environmental factors.

The qualitative aspect of this study sought to explore various subjective experiences, perceptions, and patterns realized from the quantitative study. The qualitative study revealed that ASM and subsistent agriculture are severely relied on by both the migrant and indigenous people within the communities. As a result, these people become vulnerable whenever the land is used for

ASM activities by way of alternative livelihood. Moreso, this study revealed that both poor and wealthier households all face the challenges posed by ASM activities. However, wealthier households stand a better chance of mitigating these inimical effects as compared to poor households. This results in variable and unequal outcomes with regard to food security. A notable finding is with regard to the inverse relationship between ASM and poor health proxied by the number of days of absence due to illness. This relationship suggested that more working hours in ASM correlate with fewer days of absence due to illness or injury. This outcome differs from prior studies, which often report adverse health effects from ASM activities. The divergence in the findings was attributed to the different health indicators employed. While earlier studies pointed out direct health impacts that came from chemical exposures, this current study employed absenteeism due to illness or injury as a proxy for health. However, this absenteeism which tends to be underreported as realized in qualitative and quantitative aspects of this study, despite underlying health risks, could be attributed to factors such as improved economic stability from ASM earnings, access to better healthcare, use of protective equipment, self-medication practices, and coping mechanisms to manage physical strain. Other reasons were cultural, fear of losing the job as well as the illegal status of ASM operations. Also, the variability in ASM site conditions and the broader measure of occupational hours applied in this study give a nuanced perspective on ASM's health impacts.

Comparative analysis with regard to other prior studies revealed differences in methodology and scope regarding indicators used for the measurement of ASM and health. In other words, this current study employed a broader multidimensional approach that sought to integrate socioeconomic and environmental factors with regard to the metrics of measurement for ASM. On the other hand, other studies focused on the influence of specific contaminants. This comprehensive perspective gives room for an inclusive understanding of ASM's impact on health and livelihoods.

7.3 Recommendations of the Study

It is recommended that intricate, social, economic, and environmental impacts resulting from ASM activities be resolved through the use of tailored policies. For instance, in terms of food security, policymakers, agricultural agencies, NGOs, and community organizations need to promote the cultivation of more sustainable agricultural lands by urging landowners to allocate some land for food production. This could be ensured by implementing agricultural policies that support and incentivize sustainable farming practices and ensure land and soil preservation. More so, government agencies must intensify education and sensitization on over-reliance on ASM. This could be achieved by promoting alternative livelihoods, especially for young people to balance mining with agriculture. Land management authorities, local governments, and environmental agencies need to address land ownership issues by implementing policies that protect agricultural land and discourage its conversion into mining zones. This could be achieved through the enforcement of regulations to promote land use that supports both agriculture and mining in a balanced manner. The government needs to improve access to education, especially primary and secondary education to improve agricultural knowledge as well as economic opportunities.

It is important to strengthen the food market structure to ensure better nutrition. This involves improving the availability and affordability of diverse and nutritious foods in ASM communities. It is recommended that government agencies in charge of education, local schools, NGOs, and community health workers reinforce nutrition education to increase awareness of balanced diets, food safety, and the benefits of dietary diversity. This education should focus especially on ASM workers and their families. Reduction of the nutritional disparities between wealthier and poorer households through the provision of targeted nutrition interventions such as is also recommended. Also, increasing economic opportunities to ensure equitable access to healthy foods, regardless of income. This could be achieved through the introduction of financial support

programs such as subsidized food markets, meal programs, mobile markets, farm-to-school and farm-to-table initiatives, and nutrition counseling for lower-income groups food vouchers, support for small businesses that sell diverse foods by government agencies, financial institutions, and NGOs involved in poverty alleviation programs. It is recommended that research institutions as well as governments establish systems for monitoring the impact of interventions on dietary diversity in places where there is ASM. This will assist in ensuring that such efforts are having the desired impact and allow for adjustments if needed.

With regard to health (proxied by absence due to illness, injury, or both), it is recommended that clear reporting mechanisms are established by employers. This could be achieved through the creation of confidential reporting channels, such as mobile health apps, telemedicine and third-party health service providers, to enable workers to report health issues anonymously. There is a need for sensitization on the importance of reporting health problems to prevent long-term damage, including information about risks from unsafe working conditions.

It is also important to promote awareness and education on health risks. This could be achieved through the conduction of regular workshops, health campaigns, and informational sessions focusing on the health risks associated with ASM activities (e.g., exposure to mercury, physical strain) by health organizations. Offering information on affordable healthcare options available to ASM workers by employers and other stakeholders is also recommended.

Building a supportive environment, through the provision of peer support groups within the community, where workers can seek help and support, reducing the fear of stigmatization or losing their livelihood due to reporting their poor health status. The provision of resources by community organizations and women's groups for counseling and psychological support for workers who might feel vulnerable or intimidated is also advised.

Improving health and safety standards on mining sites through the implementation of stronger safety protocols by employers is also recommended. This could be achieved through the provision of personal protective equipment (PPEs) like helmets and gloves by employers.

To monitor long-term health effects and create standardized health indicators it is important to develop consistent frameworks for assessing and tracking the health effects of ASM activities over time to ensure that health problems are detected early by employers and health institutions. This could be achieved by creating a database for monitoring health outcomes related to ASM, using standardized health indicators (e.g., days of absence, incidence of specific diseases, and injuries). Additionally, government health agencies and employers need to collect and analyze health data from workers regularly to identify emerging trends and areas for intervention.

Reducing the stigma and socio-economic pressures that discourage workers from reporting health issues must also be enhanced. This could be done by engaging in public awareness campaigns that challenge harmful cultural norms, especially those that discourage women from reporting health issues related to reproductive health or general well-being. Moreover, policymakers need to create financial safety nets for workers, such as paid sick leave, health insurance, or emergency medical funds, to reduce the fear of financial ruin if they take time off due to illness.

It is recommended that policymakers improve access to healthcare services in ASM communities, especially for those who live in rural areas. Establishing partnerships with local healthcare facilities to provide affordable, on-site health checks and treatment for ASM workers is also recommended. More so, subsidizing the cost of healthcare and medication for ASM workers, particularly for those with chronic conditions exacerbated by mining is also recommended.

Community mining initiatives should focus on overcoming the unique challenges women face, including limited involvement in decision-making and heightened exposure to risks associated with ASM activities. To support this, it is crucial to provide alternative livelihood options, fair access to resources, and training programs that address gender-specific needs. Also, Childcare and education programs should also be well-considered, ensuring that mining activities do not disrupt women's caregiving responsibilities or children's access to education. Such measures can help break intergenerational cycles of poverty and promote sustainable community development.

There is also the need for mining policies to invest in gathering ASM-specific and localized data. This will help in the formulation of evidence-based decision-making. Such data could include health data, environmental impact assessments, and community-level socioeconomic trends. The use of tools like geospatial analysis could provide deeper insights into the effects of ASM on specific communities, improving intervention precision.

7.4 Limitations of the Study

Although the use of GLSS 7 data was very useful in the determination of ASM households, the focus of the survey paid less attention to very ASM-related questions. The ASM indicator used is limited in its measure as it does not capture any form of spatial information regarding ASM. The lack of granularity in the ASM variable also affected the ASM variable which only captures the proportion of ASM occupational hours used. Some other key factors related to ASM such as specific ASM working conditions and what types of ASM activities were captured in the ASM hours were not clearly defined in the working hours attributed to ASM. This affected the strength of the significance of the ASM indicator. Also, the ASM indicator derived from the GLSS data lacks other salient factors like income levels and the intensity of mining activities. This puts a limitation on the capacity of the indicator to capture nuanced dynamics and localized impacts. Since the GLSS data gives a generalized perspective, the specific impacts of the ASM across

regions are underestimated. The use of ASM-specific data could have unraveled more nuanced analyses, which could potentially uncover subtle relationships and variations, in effect affecting the strength of the significance.

The use of GLSS in this study does not allow substantial coverage of factors such as access to markets, dietary acquisition methods, and mining-related health costs. In effect, this reduces the depth of analysis. In addition, the GLSS does not cover gender-related challenges regarding ASM. Moreover, the study depended on household surveys where food insecurity indicators are self-reported. Disadvantageously, there is a possibility of such information being underreported or overreported due to recall bias. There are possibilities that metrics regarding injury rates, health impacts related to mining activities, and environmental degradation caused by ASM are either underreported or missing entirely. The use of cross-sectional data such as GLSS data is devoid of long-term trends as well as seasonal variations in ASM activities and their supposed impacts.

More so, the GLSS data did not focus on details of questions regarding the direct economic benefits from ASM activities, food environments as well as precise health-related costs regarding ASM (GSS, 2019a). This gap can amount to the specific effect of ASM on dietary diversity and dilute the strength of the observed relationship.

The health indicator employed in this study may come with various effects and varying working hours. As such, the lack of differentiation could result in challenges in linking the assessment of certain ASM activities that are related to specific outcomes.

7.5 Areas for Future Research

Future research should consider inculcating granular, localized data with broader socio-economic surveys. There is a need for the integration of more localized and ASM-specific data

collection methods. This will be used as a supplement to GLSS findings and provide more details of ASM's socioeconomic and environmental impacts that are duly captured. Moreover, the inclusion of ASM modules in the GLSS could be very useful as far as ASM-related studies are concerned.

This will help reflect and portray the multifaceted as well as other related impacts of ASM. Ideally, much comprehension would be gained in knowing how ASM affects food security especially at both macro and micro levels. More so, this study recommends the use of satellite imageries of ASM among other sentinel imageries in the determination of the variable for ASM. This will reinforce the representativeness of the cardinal variable used in this study.

REFERENCES

Abdulai, A.-G. (2017). The galamsey menace in Ghana: A political problem requiring political solutions. *Policy Brief,* **5**.

Abenwi, S. J., Atemnkeng, J. T. & Sama, M. C. (2020). Can Education Contribute To Household Food Security? The Cameroon Experience. *European Journal of Education Studies*.

ACET (2017). African Transformation Report 2017: Agriculture Powering Africa's Economic Transformation. ACET Accra, Ghana.

Acheampong, T. (2022). The Energy Transition and Critical Minerals in Ghana: Diversification Opportunities and Governance Challenges, Ghana Extractive Industries Transparency Initiative (GHEITI).

Adam, J. N., Adams, T., Gerber, J.-D. & Amacker, M. (2022). The dilemma of women empowerment in informal artisanal and small-scale gold ore mining in Ghana. *Cogent Social Sciences,* **8,** 2108231.

Adator, S. W., Wu, Q., Lambongang, M., Otoo, S. L., Bosah, C. P. & Nimako, K. O. (2023). Farmers' perception of the impact of gold mining on shrinking agricultural land and their livelihood in the Asutifi-North District. *Resources Policy,* **81,** 103379.

Addo, A. M., Nyantakyi, E. K., Appiah-Adjei, E., Ackerson, N. O. B., Yeboah, S. I. I. K., Borkloe, J. K., Domfeh, M. K., Siabi, E. K., Wezenamo, C. A. & Owusu, M. (2023). Environmental and health impacts of mining: a case study in Kenyasi-Ahafo Region, Ghana. *Arabian Journal of Geosciences,* **16,** 334.

Adeola, F. O. (2020). Global impact of chemicals and toxic substances on human health and the environment. *Handbook of Global Health***,** 1-30.

Adomako-Kwakye, C. & Mensah, R. O. (2022). Too much, too little: the dilemma of Ghana's legal regime for investment in the mining sector. *Int. J. Law Soc,* **5,** 123.

Adranyi, E., Stringer, L. C. & Altink, H. (2023). The impacts of artisanal and small-scale gold mining on rural livelihood trajectories: Insights from Ghana. *The Extractive Industries and Society,* **14,** 101273.

Adranyi, E., Stringer, L. C. & Altink, H. (2024). Joined-up governance for more complementary interactions between expanding artisanal small-scale gold mining and agriculture: Insights from Ghana. *Plos one,* **19,** e0298392.

Adu-Baffour, F., Daum, T. & Birner, R. (2021). Governance challenges of small-scale gold mining in Ghana: Insights from a process net-map study. *Land Use Policy,* **102,** 105271.

Afferi, T. P. (2024). The Persistent Involvement of Chinese Migrants in Small-Scale Mining in Rural Ghana: Role of the "Men" and the "Boys". Carleton University.

Agbesinyale, E. J. (2023). An institutional weakness?–The participation of Chinese miners in Ghana's artisanal and small-scale gold mining (ASGM) sector.

Aizawa, Y. (2016). Artisanal and small-scale mining as an informal safety net: evidence from Tanzania. *Journal of International Development,* **28,** 1029-1049.

Ajith, M. M., Ghosh, A. K. & Jansz, J. (2020). Risk factors for the number of sustained injuries in artisanal and small-scale mining operation. *Safety and health at work,* **11,** 50-60.

Ajith, M. M., Ghosh, A. K. & Jansz, J. (2021). A mixed-method investigations of work, government and social factors associated with severe injuries in artisanal and small-scale mining (ASM) operations. *Safety Science,* **138,** 105244.

Akinnawo, E. O., Onisile, D. F., Alakija, O. A. & Akpunne, B. C. (2021). Self-Medication with Over-the-Counter and Prescription Drugs and Illness Behavior in Nigerian Artisans. *International Journal of High Risk Behaviors and Addiction,* **10**.

Akoto, O., Bortey-Sam, N., Nakayama, S. M., Ikenaka, Y., Baidoo, E., Apau, J., Marfo, J. T. & Ishizuka, M. (2018). Characterization, spatial variation and risk assessment of heavy metals and a metalloid in surface soils in Obuasi, Ghana. *Journal of Health and Pollution,* **8,** 180902.

Albert, C. & Escardíbul, J. O. (2017). Education and the empowerment of women in household decision-making in S pain. *International Journal of consumer studies,* **41,** 158-166.

Ali, M. (2024). Unlocking Opportunities: The Socioeconomic Impact of Quality Education.

Allan-Blitz, L.-T., Goldfine, C. & Erickson, T. B. (2022). Environmental and health risks posed to children by artisanal gold mining: A systematic review. *SAGE Open Medicine,* **10,** 20503121221076934.

Allee, A., Lynd, L. R. & Vaze, V. (2021). Cross-national analysis of food security drivers: comparing results based on the Food Insecurity Experience Scale and Global Food Security Index. *Food Security,* **13,** 1245-1261.
Ankamah, U. (2022). To Help or Hurt: Stories about gold mining in a community in rural Ghana.
Annan, S. T. (2024). The Ban on Illegal Mining in Ghana: Environmental and Socio-Economic Effect on Local Communities. *Journal of Geoscience and Environment Protection,* **12,** 153-162.
Antonescu, R.-M. (2018). Applying DPSIR Model to sustainable territorial development, in South-Muntenia Region. *Journal of Urban and Landscape Planning***,** 114-126.
Appiah, F., Seidu, A.-A., Ahinkorah, B. O., Baatiema, L. & Ameyaw, E. K. (2020). Trends and determinants of contraceptive use among female adolescents in Ghana: Analysis of 2003–2014 Demographic and Health Surveys. *SSM-population health,* **10,** 100554.
Aram, S. A., Saalidong, B. M., Yankyera, A., Akoto, A. B. & Amoah, S. K. (2024). 'New mining scheme, same old problems?'; risk factors and health challenges in underground community mining in Ghana. *Environmental Research: Health,* **2,** 045006.
Arifin, Y. I., Sakakibara, M. & Sera, K. (2015). Impacts of artisanal and small-scale gold mining (ASGM) on environment and human health of Gorontalo Utara Regency, Gorontalo Province, Indonesia. *Geosciences,* **5,** 160-176.
Armah, F. A., Boamah, S. A., Quansah, R., Obiri, S. & Luginaah, I. (2016). Unsafe occupational health behaviors: understanding mercury-related environmental health risks to artisanal gold miners in Ghana. *Frontiers in Environmental Science,* **4,** 29.
Arora, M. (2020). GENDER ISSUES IN THE ARTISANAL AND SMALL-SCALE MINING SECTOR. URL: https://www.land-links.org/wp-content/uploads/2020/05/USAID-ASM-and-Gender-Brief-1-June-20-Final.pdf.
Arthur-Holmes, F. (2021). Gendered division of labour and "sympathy" in artisanal and small-scale gold mining in Prestea-Huni Valley Municipality, Ghana. *Journal of Rural Studies,* **81,** 358-362.
Arthur-Holmes, F. & Abrefa Busia, K. (2021). Occupying the fringes: The struggles of women in artisanal and small-scale gold mining in rural Ghana—Evidence from the Prestea–Huni Valley Municipality. *Gender Issues,* **38,** 156-179.
Arthur-Holmes, F. & Busia, K. A. (2020). Household dynamics and the bargaining power of women in artisanal and small-scale mining in sub-Saharan Africa: A Ghanaian case study. *Resources Policy,* **69,** 101884.
Arthur-Holmes, F. & Busia, K. A. (2022a). Safety concerns and occupational health hazards of women in artisanal and small-scale mining in Ghana. *The Extractive Industries and Society***,** 101079.
Arthur-Holmes, F. & Busia, K. A. (2022b). Safety concerns and occupational health hazards of women in artisanal and small-scale mining in Ghana. *The Extractive Industries and Society,* **10,** 101079.
Arthur-Holmes, F. & Busia, K. A. (2022c). Women, North-South migration and artisanal and small-scale mining in Ghana: Motivations, drivers and socio-economic implications. *The Extractive Industries and Society,* **10,** 101076.
Arthur-Holmes, F., Busia, K. A. & Katz-Lavigne, S. (2023a). 'We don't joke with our money': Gender-based occupational segregation and women's remuneration negotiations in artisanal and small-scale mining. *Resources Policy,* **80,** 103188.
Arthur-Holmes, F., Busia, K. A., Vazquez-Brust, D. A. & Yakovleva, N. (2022a). Graduate unemployment, artisanal and small-scale mining, and rural transformation in Ghana: what does the 'educated'youth involvement offer? *Journal of Rural Studies,* **95,** 125-139.
Arthur-Holmes, F., Busia, K. A., Yakovleva, N. & Vazquez-Brust, D. A. (2022b). Artisanal and small-scale mining methods and the Sustainable Development Goal 6: Perceived implications for clean water supply. *Environmental Science & Policy,* **137,** 205-215.
Arthur-Holmes, F., Yeboah, T. & Busia, K. A. (2023b). Dimensions of women's mobility, livelihoods and vulnerability in artisanal and small-scale mining-induced local economy. *Journal of Rural Studies,* **101,** 103061.
Arthur, F., Agyemang-Duah, W., Gyasi, R. M., Yeboah, J. Y. & Otieku, E. (2016a). Nexus between artisanal and small-scale gold mining and livelihood in prestea mining region, Ghana. *Geography Journal,* **2016**.

Arthur, F., Agyemang-Duah, W., Gyasi, R. M., Yeboah, J. Y. & Otieku, E. (2016b). Nexus between Artisanal and Small-Scale Gold Mining and Livelihood in Prestea Mining Region, Ghana. *Geography Journal,* **2016,** 1605427.

Asaki, F. A., Oteng-Abayie, E. F. & Baajike, F. B. (2024). Effects of water, energy, and food security on household well-being. *Plos one,* **19,** e0307017.

Asare, D., Ansong, M., Asante, W. A. & Kyereh, B. (2024). Impact of different illegal artisanal small-scale mining techniques on soil properties in a major mining landscape in Ghana. *Environmental Challenges,* **17,** 101008.

Asori, M., Mpobi, R. K. J., Morgan, A. K., Apoanaba, T. A., Katey, D., Ampofo, S. T., Julius, O. & Appiah, D. O. (2023). Is illegal mining socio-politically entrenched? An opinion piece of the interaction between formal politics and chief dominance in mineral governance, and its influence on fighting Galamsey in Ghana. *GeoJournal,* **88,** 1953-1963.

Atampugre, G., Tilahun, S. A., Oke, A., Mabhaudhi, T., Cofie, O., Igbadun, H. E. & Olaleye, A. (2024). Social-ecological landscape sustainability in West Africa: applying the driver pressure state impact response framework in Ghana and Nigeria. *Discover Sustainability,* **5,** 413.

Atewologun, D. (2018). Intersectionality theory and practice. Oxford University Press Oxford.

Atienza, M., Scholvin, S., Irarrazaval, F. & Arias-Loyola, M. (2023). Formalization beyond legalization: ENAMI and the promotion of small-scale mining in Chile. *Journal of Rural Studies,* **98,** 123-133.

Awoyemi, A. E., Issahaku, G. & Awuni, J. A. (2023). Drivers of household food security: evidence from the Ghana living standards survey. *Journal of Agriculture and Food Research,* **13,** 100636.

Ayinpoya Akafari, A., Kifle Abebe, G., Martiniello, G., Chaaban, J. & Chalak, A. (2021). Land appropriation, customary tenure and rural livelihoods: gold mining in Ghana. *Third World Quarterly,* **42,** 2572-2592.

Baah-Boateng, W., Twum, E. K. & Akyeampong, E. K. (2022). Gender differences in extractive activities: evidence from Ghana. *International Journal of Social Economics,* **49,** 961-975.

Baah-Ennumh, T. Y., Forson, J. A. & Mmbali, O. S. (2020). Sustainable livelihoods in artisanal small-scale mining communities: a case study of Tarkwa-Nsuaem municipality of Ghana. *Global Social Welfare,* **7,** 81-95.

Baddianaah, I. (2023). Navigating access to golden lands: Gender roles and constraints of women in artisanal and small-scale mining operations in north-western Ghana. *Geo: Geography and Environment,* **10,** e130.

Baddianaah, I. (2024a). "If you don't go to site, they call you a lazy person": Drivers of women's participation in artisanal and small-scale mining: The case of rural northern Ghana. *Resources Policy,* **98,** 105327.

Baddianaah, I. (2024b). Reflecting on the impact of an artisanal and small-scale mining ban on impoverished agrarian communities in northern Ghana. *The Extractive Industries and Society,* **19,** 101502.

Baddianaah, I., Baatuuwie, B. N. & Adongo, R. (2022). Socio-demographic factors affecting artisanal and small-scale mining (galamsey) operations in Ghana. *Heliyon,* **8**.

Baffour-Kyei, V., Mensah, A., Owusu, V. & Horlu, G. S. (2021). Artisanal small-scale mining and livelihood assets in rural southern Ghana. *Resources Policy,* **71,** 101988.

Bakr, A. (2018). Smart artisanal gold mining from a Sudanese perspective. *Biomedical Journal of Scientific & Technical Research,* **8,** 8-14.

Bank, W. (2020). Accelerating and Innovating Climate Action: A Retrospective of the World Bank's Experience with Select Climate and Carbon Trust Funds. World Bank.

Bansah, K. J. (2023). Artisanal and small-scale mining formalization in Ghana: The government's approach and its implications for cleaner and safer production. *Journal of cleaner production,* **399,** 136648.

Bansah, K. J., Acquah, P. J. & Boafo, A. (2024). Land, water, and forest degradation in artisanal and small-scale mining: Implications for environmental sustainability and community wellbeing. *Resources Policy,* **90,** 104795.

Bansah, K. J., Arthur-Holmes, F. & Assan, E. (2023). Climate induced transformation of agriculture to artisanal mining economy in dry regions. *Journal of Rural Studies,* **99,** 11-19.

Bansal, V., Wallach, J., Brandão, J. L., Lord, S., Taha, N., Akoglu, T., Kiss, L. & Zimmerman, C. (2023). An intervention-focused review of modern slave labor in Brazil's mining sector. *World Development,* **171,** 106362.

Baralt, M. (2011). Coding qualitative data. *Research methods in second language acquisition: A practical guide***,** 222-244.

Barenblitt, A., Payton, A., Lagomasino, D., Fatoyinbo, L., Asare, K., Aidoo, K., Pigott, H., Som, C. K., Smeets, L. & Seidu, O. (2021). The large footprint of small-scale artisanal gold mining in Ghana. *Science of the Total Environment,* **781,** 146644.

Bashwira, M.-R. & van der Haar, G. (2022). Necessity or choice: women's migration to artisanal mining regions in eastern DRC. *The (In) Visibility of Women and Mining.* Routledge.

Basu, N., Clarke, E., Green, A., Calys-Tagoe, B., Chan, L., Dzodzomenyo, M., Fobil, J., Long, R. N., Neitzel, R. L. & Obiri, S. (2015). Integrated assessment of artisanal and small-scale gold mining in Ghana—Part 1: Human health review. *International journal of environmental research and public health,* **12,** 5143-5176.

Baye, K., Laillou, A. & Chitekwe, S. (2024). Empowering women can improve child dietary diversity in Ethiopia. *Maternal & Child Nutrition,* **20,** e13285.

Becker, J., Furu, P., Singo, J., Shoko, D., Elbel, J., Bose-O'Reilly, S. & Steckling-Muschack, N. (2021). Determinants of health and health needs assessment of artisanal and small-scale gold miners in Kadoma, Zimbabwe: A mixed method approach. *Environmental Research,* **197,** 111081.

Bikubanya, D.-L. & Geenen, S. (2023). From adverse incorporation to decent work? Evidence from artisanal and small scale gold mining in DR Congo.

Blanco, G. D., Fernández-Llamazares, Á., Blanco, G. D., Baker, J., Tagliari, M. S. M., Hayata, M. A., Campos, M. L. & Hanazaki, N. (2023). The impacts of mining on the food sovereignty and security of Indigenous Peoples and local communities: A global review. *Science of the Total Environment,* **855,** 158803.

Boadi, S., Nsor, C. A., Antobre, O. O. & Acquah, E. (2016). An analysis of illegal mining on the Offin shelterbelt forest reserve, Ghana: Implications on community livelihood. *Journal of Sustainable Mining,* **15,** 115-119.

Boamah, F. (2014). How and why chiefs formalise land use in recent times: the politics of land dispossession through biofuels investments in Ghana. *Review of African Political Economy,* **41,** 406-423.

Botchwey, G. & Yankey, O. (2023). Small-Scale Mining, Environment and Livelihoods: Perspectives from Mining Communities in Ghana. *African Journal of Social Sciences Education,* **2**.

Brain, K. A. (2017). The impacts of mining on livelihoods in the Andes: A critical overview. *The Extractive Industries and Society,* **4,** 410-418.

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology,* **3,** 77-101.

Briggs, P. & Connolly, S. (2016). Ghana, Bradt travel guides.

Bryceson, D. F., Gough, K. V., Jønsson, J. B., Kinabo, C., Shand, M. C., Rodrigues, C. U. & Yankson, P. W. (2022). Mineralized urbanization in Africa in the twenty-first century: becoming urban through mining extraction. *International Journal of Urban and Regional Research,* **46,** 342-369.

Buss, D., Katz-Lavigne, S., Aluoka, O. & Alma, E. (2022). "Remember the women of Osiri": women and gender in artisanal and small-scale mining in Migori County, Kenya. *The (In) Visibility of Women and Mining.* Routledge.

Buss, D. & Rutherford, B. (2022). Gendering women's livelihoods in artisanal and small-scale mining: an introduction. *The (In) Visibility of Women and Mining.* Routledge.

Buss, D., Rutherford, B., Sebina-Zziwa, A., Kibombo, R. & Kisekka, F. (2017). Gender and artisanal and small-scale mining in central and east Africa: Barriers and benefits.

Buss, D., Rutherford, B., Stewart, J., Côté, G. E., Sebina-Zziwa, A., Kibombo, R., Hinton, J. & Lebert, J. (2019). Gender and artisanal and small-scale mining: implications for formalization. *The Extractive Industries and Society,* **6,** 1101-1112.

Buss, D., Rutherford, B., Stewart, J., Côté, G. E., Sebina-Zziwa, A., Kibombo, R., Hinton, J. & Lebert, J. (2021). A Mine of One's Own?: Gender norms and empowerment in artisanal and small-scale mining. *Women's economic empowerment.* Routledge.

Butscher, F.-M., Rakete, S., Tobollik, M., Mambrey, V., Moyo, D., Shoko, D., Muteti-Fana, S., Steckling-Muschack, N. & Bose-O'Reilly, S. (2020). Health-related quality of life (EQ-5D+ C) among people living in artisanal and small-scale gold mining areas in Zimbabwe: a cross-sectional study. *Health and quality of life outcomes,* **18,** 1-13.

Byizigiro, R., Biryabarema, M. & Rwanyiziri, G. (2020). Alleviating some Environmental Impacts resulting from Artisanal and Small-scaleMining Sector: A Critical Review. *Rwanda Journal of Engineering, Science, Technology and Environment,* **3**.

Čábelková, I., Gardanova, Z., Neimatov, E. & Esaulov, V. (Year). Spatial accessibility assessment to healthcare facilities: urban and rural areas. *In:* E3S Web of Conferences, 2021. EDP Sciences, 02004.

Cafiero, C., Viviani, S. & Nord, M. (2018). Food security measurement in a global context: The food insecurity experience scale. *Measurement,* **116,** 146-152.

Caldas, R. J. C., Nogueira, L. M. V., Rodrigues, I. L. A., Andrade, E. G. R. d., Costa, C. M. L. & Trindade, L. d. N. M. (2023). Incidence of malaria among indigenous people associated with the presence of artisanal mining. *Revista Gaúcha de Enfermagem,* **44,** e20220098.

Campbell, B. (2018). Moral ecologies of subsistence and labour in a migration-affected community of Nepal. *Journal of the Royal Anthropological Institute,* **24,** 151-165.

Campero, C., Harris, L. M., Rodriguez, A. & Kunz, N. C. (2023). Women's participation in the mining industry: Tracing the business case across APEC countries. *The Extractive Industries and Society,* **16,** 101348.

Cancelliere, C., Donovan, J., Stochkendahl, M. J., Biscardi, M., Ammendolia, C., Myburgh, C. & Cassidy, J. D. (2016). Factors affecting return to work after injury or illness: best evidence synthesis of systematic reviews. *Chiropractic & manual therapies,* **24,** 1-23.

Candela, A. G. (2019). Exploring the function of member checking. *The qualitative report,* **24,** 619-628.

Carastathis, A. (2014). The concept of intersectionality in feminist theory. *Philosophy compass,* **9,** 304-314.

Carnohan, S. A., Trier, X., Liu, S., Clausen, L. P., Clifford-Holmes, J. K., Hansen, S. F., Benini, L. & McKnight, U. S. (2023). Next generation application of DPSIR for sustainable policy implementation. *Current Research in Environmental Sustainability,* **5,** 100201.

Chang, E.-S., Kannoth, S., Levy, S., Wang, S.-Y., Lee, J. E. & Levy, B. R. (2020). Global reach of ageism on older persons' health: A systematic review. *PloS one,* **15,** e0220857.

Chiavaroli, C. (2024). Gendering Toxic Contamination: Toxic Risks, Bodies, and Pregnancies in Gold Mining and Coca Farming Communities in the Bajo Cauca Region. *Antipode,* **56,** 1560-1580.

Chuma, M., Field, T.-L. & Mutemeri, N. (2024). A conceptual framework for reframing artisanal and small-scale mining: understanding characterization of artisanal and small-scale mining in South Africa. *Journal of the Southern African Institute of Mining and Metallurgy,* **124,** 311-318.

Clark, L., Birkhead, A. S., Fernandez, C. & Egger, M. J. (2017). A transcription and translation protocol for sensitive cross-cultural team research. *Qualitative health research,* **27,** 1751-1764.

Clifford, M. J. (2022). Artisanal and small-scale mining and the sustainable development goals: why nobody cares. *Environmental Science & Policy,* **137,** 164-173.

Cockx, L., Colen, L., De Weerdt, J. & Paloma, G. Y. (2019). Urbanization as a driver of changing food demand in Africa: evidence from rural-urban migration in Tanzania.

Coderre-Proulx, M., Campbell, B. & Mandé, I. (2016). International migrant workers in the mining sector, ILO Geneva.

Cohen, L., Manion, L. & Morrison, K. (2017). Coding and content analysis. *Research methods in education.* Routledge.

Coleman-Jensen, A., Rabbitt, M. P., Gregory, C. A. & Singh, A. (2016). Household food security in the United States in 2015.

Collins, N. & Lawson, L. (2018). Strategies for working with artisanal and small-scale miners in sub-Saharan Africa. *Africa's Mineral Fortune.* Routledge.

Collins, P. H. & Bilge, S. (2020). Intersectionality, John Wiley & Sons.

Cossa, H., Scheidegger, R., Leuenberger, A., Ammann, P., Munguambe, K., Utzinger, J., Macete, E. & Winkler, M. S. (2021). Health studies in the context of artisanal and small-scale mining: a scoping review. *International Journal of Environmental Research and Public Health,* **18,** 1555.

Cossa, H. F. H. (2023). Assessing the effects of mining projects on maternal, new-born and child health in sub-saharan Africa. University_of_Basel_Associated_Institution.
Creswell, J. W. & Poth, C. N. (2016). Qualitative inquiry and research design: Choosing among five approaches, Sage publications.
Crippa, C. (2023). Artisanal food productions of animal origin: exploring food safety in the age of Whole Genome Sequencing.
Cuvelier, J. (2017). Money, migration and masculinity among artisanal miners in Katanga (DR Congo). *Review of African Political Economy,* **44,** 204-219.
Damonte, G. (2021). Limited state governance and institutional hybridization in alluvial ASM in Peru. *Resources Policy,* **72,** 102118.
Dang, J., Lin, M. E., Huang, S., Hulsebos, I. F., Yenikomshian, H. A. & Gillenwater, J. (2021). 536 Use of Bioelectrical Impedance Analysis for Assessment of Nutritional Status: A Systematic Review. *Journal of Burn Care & Research,* **42**.
Danielsen, K. & Hinton, J. (2022). A social relations of gender analysis of artisanal and small-scale mining in Africa's Great Lakes Region. *The (In) Visibility of Women and Mining.* Routledge.
Dankwah, D. B., Enu-Kwesi, F., Koomson, F., Ntiri, R. O. & Asmah, E. E. (2024). Interface between artisanal and small-scale mining and cocoa farming in the Wassa Amenfi East and West Districts of Ghana. *The Extractive Industries and Society,* **17,** 101418.
Dao, F., Djonor, S. K., Ayin, C. T.-M., Adu, G. A., Sarfo, B., Nortey, P., Akuffo, K. O. & Danso-Appiah, A. (2021). Burden of malaria in children under five and caregivers' health-seeking behaviour for malaria-related symptoms in artisanal mining communities in Ghana. *Parasites & vectors,* **14,** 418.
Darko, H. F., Karikari, A. Y., Duah, A. A., Akurugu, B. A., Mante, V. & Teye, F. O. (2023). Effect of small-scale illegal mining on surface water and sediment quality in Ghana. *International Journal of River Basin Management,* **21,** 375-386.
Das, J. & Singh, A. (2020). Women Empowerment and Its Impact on Livelihood and Food Security of Households: A Review. *Current Journal of Applied Science and Technology,* **39,** 19-28.
De Haan, J., Dales, K. & McQuilken, J. (2020). Mapping artisanal and small-scale mining to the Sustainable Development Goals. *Newark DE: University of Delaware (Minerals, Materials and Society program in partnership with PACT)*.
De Muro, P. & Burchi, F. (2007). Education for rural people and food security. *A Cross Country Analysis. Food and Agricultural Organization of the United Nations, Rome*.
Deb, M., Tiwari, G. & Lahiri-Dutt, K. (2008). Artisanal and small scale mining in India: selected studies and an overview of the issues. *International Journal of Mining, Reclamation and Environment,* **22,** 194-209.
DELVE. (2023). Q&A: Understanding women's roles and barriers to participation in artisanal and small-scale mining

February 27, 2024. URL: https://www.delvedatabase.org/resources/2023-state-of-the-artisanal-and-small-scale-mining-sector?_gl=1*1jgvfsp*_ga*NjU4NDY4NDAxLjE3MzMzNzM0OTY.*_ga_03THTD2TV9*MTczMzM3NDg4My4xLjAuMTczMzM3NDg4My4wLjAuMA..
Diallo, B. S. & Soumah, M. S. (2023). From agricultural practices to mining activities: The consequences of this paradigm shift for the food security in Guinea. *Przegląd Prawa Rolnego***,** 171-190.
Dossou Etui, I. M., Stylo, M., Davis, K., Evers, D. C., Slaveykova, V. I., Wood, C. & Burton, M. E. (2024). Artisanal and small-scale gold mining and biodiversity: a global literature review. *Ecotoxicology,* **33,** 484-504.
Durano, F. L., Sarmiento, J. M., Romo, G. D. A., Wahing, G. D., Traje, A. M. & Baker, D. (2024). Food security of agri-food system actors during the COVID-19 pandemic in the Philippines: Post-pandemic implications to sustainable development. *Journal of Agriculture and Food Research,* **18,** 101284.
Dusi, D. & Stevens, P. A. (2022). Thematic analysis: an analytical method in its own right. *Qualitative Data Analysis: Key Approaches***,** 293-316.

Dzvimbo, M. A., Ncube, C. & Monga, M. (2019). Scratching the Surface: Exploring Women's Roles in Artisanal and Small Scale Mining in Zimbabwe. *Budapest International Research and Critics Institute-Journal (BIRCI-Journal),* **2,** 125-133.

Elliott, M. & O'Higgins, T. G. (2020). From DPSIR the DAPSI (W) R (M) Emerges… a Butterfly–'protecting the natural stuff and delivering the human stuff'. *Ecosystem-based management, ecosystem services and aquatic biodiversity: Theory, tools and applications***,** 61-86.

Eludoyin, A. O., Ojo, A. T., Ojo, T. O. & Awotoye, O. O. (2017). Effects of artisanal gold mining activities on soil properties in a part of southwestern Nigeria. *Cogent Environmental Science,* **3,** 1305650.

Eniowo, O. D. (2024). Exploring the risk factors to formal financing for artisanal and small-scale mining operations. *Societal Impacts,* **3,** 100043.

Esquivel, M., Shelton, C., Paresa, K., Higa, A., Okihiro, M. & Cuevas, A. (2023). Household Size, Food Insecurity and Fruit and Vegetable Intake of Keiki Produce Prescription (Kprx) Program Participants. *Journal of Nutrition Education and Behavior,* **55,** 53.

Fagariba, C. J., Sumani, J. B. B. & Mohammed, A. S. (2024). Artisanal and Small-Scale Gold Mining Impact on Soil and Agriculture: Evidence from Upper Denkyira East Municipality, Ghana. *European Journal of Environment and Earth Sciences,* **5,** 12-20.

FAO (2016). The state of food and agriculture. *Climate change, agri*.

Fereday, J. & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International journal of qualitative methods,* **5,** 80-92.

Finn, B. M., Simon, A. & Newell, J. (2024). Decarbonization and social justice: The case for artisanal and small-scale mining. *Energy Research & Social Science,* **117,** 103733.

Follong, B. M., Verdonschot, A., Prieto-Rodriguez, E., Miller, A., Collins, C. E. & Bucher, T. (2022). Nutrition across the curriculum: a scoping review exploring the integration of nutrition education within primary schools. *Nutrition research reviews,* **35,** 181-196.

Fritz, M., McQuilken, J., Collins, N. & Weldegiorgis, F. (2022). Global Trends in Artisanal and Small-Scale Mining (ASM): A review of key numbers and issues, International Institute for Sustainable Development (IISD).

Galli, F., Grando, S., Adamsone-Fiskovica, A., Bjørkhaug, H., Czekaj, M., Duckett, D. G., Almaas, H., Karanikolas, P., Moreno-Pérez, O. M. & Ortiz-Miranda, D. (2020). How do small farms contribute to food and nutrition security? Linking European small farms, strategies and outcomes in territorial food systems. *Global Food Security,* **26,** 100427.

Gandy, M., Michaelis, R., Acraman, J., Donald, K. A., Fitzpatrick, M., LaFrance Jr, W. C., Margolis, S. A., Modi, A. C., Reuber, M. & Tang, V. (2023). Integrated psychological care services within seizure settings: key components and implementation factors among example services in four ILAE regions: a report by the ILAE Psychiatry Commission. *Epilepsia,* **64,** 1766-1784.

Gasparinnetti, P., Bakker, L. B., Queiroz, J. M. & Vilela, T. (2024). Economic valuation of artisanal small-scale gold mining impacts: A framework for value transfer application. *Resources Policy,* **88,** 104259.

Gatì, I. A., D'alessandro, M., Giacobbe, S. & Esposito, V. (2024). DPSIR (Driving Forces-Pressures-State-Impact-Response) model applied to two Sicilian transitional areas to a better management. *Biologia Marina Mediterranea,* **28,** 152-155.

Gatobu, C. K., Omboto, P. & Mining, P. (2020). Socio-Economic Factors that Influence Household Food Security in West Pokot County, Kenya.

Geenen, S., Kabilambali, G., Bashizi, F. M. & Vanlerberghe, E. (2022). Women who "age too fast": female work, bodies and health in the gold mines of Eastern Democratic Republic of Congo. *The Extractive Industries and Society,* **12,** 101138.

Geyer, H. (2023). The self-regulation of informal land uses and tenure through customary land management systems. *International Development Planning Review,* **45,** 321-343.

Ghattas, H. (2014). Food Security and Nutrition in the context of the Global Nutrition Transition. *Food and Agriculture Organization: Rome, Italy*.

Ghosh, J. (2021). Informal women workers in the Global South: Policies and practices for the formalisation of women's employment in developing economies, routledge.

Gilbert, D. (2022). The Effects of Illegal Small-scale Gold Mining in Ghana: A Threat to Food Security.
Gilbert, D. & Albert, O.-B. (2016). Illegal small-scale gold mining in Ghana: A threat to food security. *Journal of Food Security,* **4,** 112-119.
Gnedeka, K. T. & Wonyra, K. O. (2024). The effect of formal education on food security in Togo. *Environment, Development and Sustainability***,** 1-21.
Goetz, J. M. (2022). The Impact of Informal and Rural Labour Markets on Poverty Reduction: A Mixed Methods Study of Artisanal and Small-Scale Gold Mining (ASGM) in Northwest Tanzania. SOAS University of London.
Gomez, G., Fisberg, R. M., Previdelli, A. N., Kovalskys, I., Fisberg, M., Herrera-Cuenca, M., Sanabria, L. Y. C., Yepez, M. C., Pareja, R. G. & Rigotti, A. (2020). Dietary diversity in eight Latin American countries: Results from ELANS Study. *Proceedings of the Nutrition Society,* **79,** E703.
Govindaprasad, P. & Manikandan, K. (2016). Farm land conversion and food security: empirical evidences from three villages of Tamil Nadu. *Indian Journal of Agricultural Economics,* **71,** 493-503.
Greenfield, P. M. (2018). Studying social change, culture, and human development: A theoretical framework and methodological guidelines. *Developmental Review,* **50,** 16-30.
GSS. (2019a). Ghana Living Standards Survey 7 Main Report. URL: https://statsghana.gov.gh/gssmain/fileUpload/pressrelease/GLSS7%20MAIN%20REPORT_FINAL.pdf [26.12.2024].
GSS. (2019b). Ghana Living Standards Survey (GLSS 7): Main Report. . URL: https://microdata.statsghana.gov.gh
Gu, Y., Xia, Y., Zhang, S., Bao, X., Wu, H., Bian, S., Huang, L., Meng, G. & Niu, K. (2020). Method of dietary nutritional status assessment and its application in cohort study of nutritional epidemiology. *Zhonghua liu Xing Bing xue za zhi= Zhonghua Liuxingbingxue Zazhi,* **41,** 1145-1150.
Guenther, M. (2018). Local effects of artisanal mining: Empirical evidence from Ghana. Presentation at the international conference'environmental economics: a focus on natural ressources', orléans.
Guest, G. (2012). Applied Thematic Analysis, Sage Publications.
Güiza-Suárez, L. & Kaufmann, C. J. (2024). Successfully negotiating artisanal-industrial mining coexistence: A case study from Colombia. *The Extractive Industries and Society,* **17,** 101450.
Gurinović, M., Zeković, M., Milešević, J., Nikolić, M. & Glibetić, M. (2017). Nutritional assessment.
Gustafson, D., Gutman, A., Leet, W., Drewnowski, A., Fanzo, J. & Ingram, J. (2016). Seven food system metrics of sustainable nutrition security. *Sustainability,* **8,** 196.
Habte, T.-Y. & Krawinkel, M. (2016). Dietary diversity score: a measure of nutritional adequacy or an indicator of healthy diet?
Haile, N. Z., Huluka, A. T. & Beyene, A. B. (2024). Impacts of mining projects on food security of households in Ethiopia: empirical evidence from Benishangul-Gumuz Region. *Frontiers in Sustainable Food Systems,* **8,** 1481827.
Hanmer, S. B., Tsai, M. H., Sherrer, D. M. & Pandit, J. J. (2024). Modelling the economic constraints and consequences of anaesthesia associate expansion in the UK National Health Service: a narrative review. *British Journal of Anaesthesia*.
Hasanbasri, A., Kilic, T., Koolwal, G. & Moylan, H. (2021). LSMS+ program in Sub-Saharan Africa: Findings from individual-level data collection on labor and asset ownership, World Bank Washington, DC.
Hausermann, H., Adomako, J. & Robles, M. (2020). Fried eggs and all-women gangs: the geopolitics of Chinese gold mining in Ghana, bodily vulnerability, and resistance. *Human Geography,* **13,** 60-73.
Hayes, K. & Perks, R. (2012). Women in the artisanal and small-scale mining sector of the Democratic Republic of the Congo. *High-value natural resources and peacebuilding***,** 529-544.
Helenius, W. (2024). Conflict and extended minerals: balancing responsibility, risks, and regulatory compliance.
Hilson, G. (2016a). Artisanal and small-scale mining and agriculture: Exploring their links in rural sub-Saharan Africa, International Institute for Environment and Development.

Hilson, G. (2016b). Farming, small-scale mining and rural livelihoods in Sub-Saharan Africa: A critical overview. *The Extractive Industries and Society,* **3,** 547-563.
Hilson, G., Hilson, A. & Maconachie, R. (2018a). Opportunity or necessity? Conceptualizing entrepreneurship at African small-scale mines. *Technological forecasting and social change,* **131,** 286-302.
Hilson, G., Hilson, A., Siwale, A. & Maconachie, R. (2018b). Female faces in informal 'spaces': Women and artisanal and small-scale mining in sub-Saharan Africa. *Africa Journal of Management,* **4,** 306-346.
Hilson, G. & Hu, Y. (2022). Changing priorities, shifting narratives: remapping rural livelihoods in Africa's artisanal and small-scale mining sector. *Journal of rural Studies,* **92,** 93-108.
Hilson, G., Hu, Y. & Kumah, C. (2020a). Locating female 'voices' in the minamata convention on mercury in sub-saharan Africa: the case of Ghana. *Environmental Science & Policy,* **107,** 123-136.
Hilson, G., Laing, T., Hilson, A., Arnall, A. & Mondlane, S. (2025). How does small-scale mining stabilize rural livelihoods in Sub-Saharan Africa? the case of Mozambique. *World Development,* **185,** 106761.
Hilson, G. & Maconachie, R. (2020). Artisanal and small-scale mining and the Sustainable Development Goals: Opportunities and new directions for sub-Saharan Africa. *Geoforum,* **111,** 125-141.
Hilson, G. & McQuilken, J. (2014). Four decades of support for artisanal and small-scale mining in sub-Saharan Africa: a critical review. *The Extractive Industries and Society,* **1,** 104-118.
Hilson, G., Mondlane, S., Hilson, A., Arnall, A. & Laing, T. (2021a). Formalizing artisanal and small-scale mining in Mozambique: Concerns, priorities and challenges. *Resources Policy,* **71,** 102001.
Hilson, G., Sauerwein, T. & Owen, J. (2020b). Large and artisanal scale mine development: The case for autonomous co-existence. *World Development,* **130,** 104919.
Hilson, G., Van Bockstael, S., Sauerwein, T., Hilson, A. & McQuilken, J. (2021b). Artisanal and small-scale mining, and COVID-19 in sub-Saharan Africa: A preliminary analysis. *World Development,* **139,** 105315.
Hirons, M. (2011). Managing artisanal and small-scale mining in forest areas: perspectives from a poststructural political ecology. *The Geographical Journal,* **177,** 347-356.
Hirons, M. (2020). How the Sustainable Development Goals risk undermining efforts to address environmental and social issues in the small-scale mining sector. *Environmental Science & Policy,* **114,** 321-328.
Hlatshwayo, S. I., Ojo, T. O. & Ngidi, M. S. C. (2023). Effect of market participation on the food and nutrition security status of the rural smallholder farmers: the case of Limpopo and Mpumalanga provinces, South Africa. *Frontiers in Sustainable Food Systems,* **7,** 1097465.
Hruschka, F. (2015). Comparative analysis of ASM strategies in four countries of Africa, Asia and Latin America. Pact, Estelle Levin Ltd et IPIS.
Huberman, A. (2014). Qualitative data analysis a methods sourcebook.
Huntington, H. & Marple-Cantrell, K. (2021). Customary governance of artisanal and small-scale mining in Guinea: Social and environmental practices and outcomes⋆. *Land use policy,* **102,** 105229.
Huntington, H. & Marple-Cantrell, K. (2022). The importance of artisanal and small-scale mining for rural economies: livelihood diversification, dependence, and heterogeneity in rural Guinea. *Journal of Rural Studies,* **94,** 177-191.
Hussien, F. M., Mebratu, W., Ahmed, A. Y., Mekonnen, T. C., Hassen, A. M., Asfaw, Z. A., Hassen, H. Y. & Abate, K. H. (2021). Performance of individual dietary diversity score to identify malnutrition among patients living with HIV in Ethiopia. *Scientific reports,* **11,** 18681.
Ibrahim, A. F., Rutherford, B. & Buss, D. (2022). Gendered "choices" in Sierra Leone: women in artisanal mining in Tonkolili District. *The (In) Visibility of Women and Mining.* Routledge.
Ibrahim, F., Adu-Bredu, S., Addo-Danso, S. D., Duah-Gyamfi, A., Manu, E. A. & Malhi, Y. (2020). Patterns and controls on fine-root dynamics along a rainfall gradient in Ghana. *Trees,* **34,** 917-929.

Ira, A., Farrokhfal, M. & Mali, Z. (2020). The nutritious price index and food security of urban and rural households in Iran. *Statistical Journal of the IAOS,* **36,** 963-968.
Iram, U. & Butt, M. S. (2004). Determinants of household food security: An empirical analysis for Pakistan. *International journal of social economics*.
Irenge, C. A., Bushenyula, P. K., Irenge, E. B. & Coppieters, Y. (2023). Participative epidemiology and prevention pathway of health risks associated with artisanal mines in Luhihi area, DR Congo. *BMC public health,* **23,** 121.
Isung, C. B. (2021). The socio-economic implications of artisanal and small-scale mining on mining communities in northern Ghana. *Open Access Library Journal,* **8,** 1.
Jackline, A. (2022). Women in artisanal and small scale mining Uganda: regulation, barriers and benefits. *KAS African Law Study Library,* **9,** 4-21.
Jenkins, K. (2014). Women, mining and development: An emerging research agenda. *The Extractive Industries and Society,* **1,** 329-339.
Jerie, S. (2013). Ergonomic Hazards Associated with Small Scale Mining in Southern Africa. *International Journal of Pure & Applied Sciences & Technology,* **15**.
Jiménez, A. D., Smith, N. M. & Holley, E. A. (2022). Capitals in artisanal and small-scale mining in Marmato, Colombia: Using the sustainable livelihoods framework to inform formalization. *The Extractive Industries and Society,* **12,** 101157.
Jiménez, A. D., Smith, N. M. & Holley, E. A. (2024). Towards sustainable ASM-based livelihoods: The role of institutional arrangements in the formalization of artisanal and small-scale mining. *Resources Policy,* **94,** 105129.
Jinadasa, B., Jayasinghe, G., Pohl, P. & Fowler, S. W. (2021). Mitigating the impact of mercury contaminants in fish and other seafood—A review. *Marine Pollution Bulletin,* **171,** 112710.
Johnston, L., Mulenga, M., Davison, C., Liu, J., Corbett, K. & Janes, C. (2024). Challenging the myth of women's empowerment: Mining development and commercial sex in a Zambian town. *Wellbeing, Space and Society,* **6,** 100186.
Jones, A. D. (2017). Food insecurity and mental health status: a global analysis of 149 countries. *American journal of preventive medicine,* **53,** 264-273.
Jubayer, A., Islam, S., Nowar, A., Nayan, M. M. & Islam, M. H. (2023). Validity of Food insecurity experience scale (FIES) for use in rural Bangladesh and prevalence and determinants of household food insecurity: An analysis of data from Bangladesh integrated household survey (BIHS) 2018-2019. *Heliyon,* **9**.
Kahupi, I., Yakovleva, N. & Chen, S. (2023). The significance of SDG16 "Strong institutions" toward the adoption of circular economy approaches for artisanal and small-scale mining sector in sub-Saharan Africa. *The Social Dimensions of the Circular Economy.* Springer.
Kanianska, R. (2016). Agriculture and its impact on land-use, environment, and ecosystem services. *Landscape ecology-The influences of land use and anthropogenic impacts of landscape creation***,** 1-26.
Kansake, B. A., Sakyi-Addo, G. B. & Dumakor-Dupey, N. K. (2021). Creating a gender-inclusive mining industry: Uncovering the challenges of female mining stakeholders. *Resources Policy,* **70,** 101962.
Kara, A. M. & Kithu, L. M. (2020). Education attainment of head of household and household food security: a case for Yatta Sub-County, Kenya. *American journal of educational research,* **8,** 558-566.
Karimli, L., Lecoutere, E., Wells, C. R. & Ismayilova, L. (2021). More assets, more decision-making power? Mediation model in a cluster-randomized controlled trial evaluating the effect of the graduation program on women's empowerment in Burkina Faso. *World development,* **137,** 105159.
Karimli, L., Shephard, D. D., McKay, M. M., Batista, T. & Allmang, S. (2020). Effect of Non-formal Experiential Education on Personal Agency of Adolescent Girls in Tajikistan: Findings from a Randomized Experimental Study. *Global Social Welfare,* **7,** 141-154.
Keita, M. M. (2018). Environmental and socio-economic impacts of artisanal gold mining on agricultural production in Sikasso region, Mali. Egerton University.
Kemp, D. & Owen, J. R. (2019). Characterising the interface between large and small-scale mining. *The Extractive Industries and Society,* **6,** 1091-1100.

Khan, L., Shabbir, J. & Gupta, S. (2016). Unbiased ratio estimators of the mean in stratified ranked set sampling. *Hacettepe Journal of Mathematics and Statistics,* **46,** 1151-1158.
Kim, M. (2020). Intersectionality and gendered racism in the United States: A new theoretical framework. SAGE Publications Sage CA: Los Angeles, CA.
Kim, S.-W., Bae, K.-H., Seo, J.-B., Jeon, J.-H., Lee, W.-K., Lee, I.-K., Kim, J.-G. & Park, K.-G. (2016). Association between household size, residential area, and osteoporosis: analysis of 2008 to 2011 Korea National Health and Nutrition Examination Survey. *The Korean Journal of Internal Medicine,* **31,** 712.
Kirillova, O. V., Amirova, E. F., Kuznetsov, M. G., Valeeva, G. A. & Zakharova, G. P. (Year). Innovative directions of agricultural development aimed at ensuring food security in Russia. *In:* BIO Web of Conferences, 2020. EDP Sciences, 00068.
Kirilova, E. G., Vaklieva-Bancheva, N. G., Vladova, R. K. & Petrova, T. S. (2020). Optimal Products Portfolio Design of a Sustainable Supply Chain Using Different Recipes for Dairy Products Production. *CET Journal-Chemical Engineering Transactions,* **81**.
Kirui, O. (2019). The complementarity of education and use of productive inputs among smallholder farmers in Africa. *ZEF-Discussion Papers on Development Policy*.
Klemm, R., Nordhagen, S. & Winch, P. (2020). Young-Child Feeding in Challenging Settings: A Case Study in Artisanal Mining Families in the Republic of Guinea. *Current Developments in Nutrition,* **4,** nzaa051_011.
Kojima, G., Walters, K., Iliffe, S., Taniguchi, Y. & Tamiya, N. (2020). Marital status and risk of physical frailty: a systematic review and meta-analysis. *Journal of the American Medical Directors Association,* **21,** 322-330.
Kortei, N. K., Heymann, M. E., Essuman, E. K., Kpodo, F. M., Akonor, P. T., Lokpo, S. Y., Boadi, N. O., Ayim-Akonor, M. & Tettey, C. (2020). Health risk assessment and levels of toxic metals in fishes (Oreochromis noliticus and Clarias anguillaris) from Ankobrah and Pra basins: Impact of illegal mining activities on food safety. *Toxicology Reports,* **7,** 360-369.
Kotsadam, A. & Tolonen, A. (2016). African mining, gender, and local employment. *World Development,* **83,** 325-339.
Kumah, C., Hilson, G. & Quaicoe, I. (2020). Poverty, adaptation and vulnerability: An assessment of women's work in Ghana's artisanal gold mining sector. *Area,* **52,** 617-625.
Kumi-Boateng, B. & Stemn, E. (2020). Spatial analysis of artisanal and small-scale mining in the Tarkwa-Nsuaem Municipality of Ghana. *Ghana Mining Journal,* **20,** 66-74.
Kwesi, S. S., Dartey, E., Kuffour, R. A., Dekugmen, D. Y., Osei-Bonsu, R., Mintah, D. K., Serwaa, B. A. & Beniako, A. A. (2024). Occupational Health and Safety Practices among Small-Scale Mining Workers in Ghana. *European Journal of Science, Innovation and Technology,* **4,** 26-39.
Kyere-Boateng, R. & Marek, M. V. (2021). Analysis of the social-ecological causes of deforestation and forest degradation in Ghana: Application of the DPSIR framework. *Forests,* **12,** 409.
Labianca, C., De Gisi, S., Todaro, F. & Notarnicola, M. (2020). DPSIR model applied to the remediation of contaminated sites. A case study: Mar Piccolo of Taranto. *Applied Sciences,* **10,** 5080.
Lahiri-Dutt, K. (2018a). Extractive peasants: reframing informal artisanal and small-scale mining debates. *Third World Quarterly,* **39,** 1561-1582.
Lahiri-Dutt, K. (2018b). Reframing the debate on informal mining. *Between the plough and the pick: Informal, artisanal and small-scale mining in the contemporary world***,** 1-28.
Laing, T. & Pinto, A. N. (2023). Artisanal and small-scale mining and the low-carbon transition: Challenges and opportunities. *Environmental Science & Policy,* **149,** 103563.
Landrigan, P., Bose-O'Reilly, S., Elbel, J., Nordberg, G., Lucchini, R., Bartrem, C., Grandjean, P., Mergler, D., Moyo, D. & Nemery, B. (2022). Reducing disease and death from Artisanal and Small-Scale Mining (ASM)-the urgent need for responsible mining in the context of growing global demand for minerals and metals for climate change mitigation. *Environmental health,* **21,** 78.
Landrum, B. & Garza, G. (2015). Mending fences: Defining the domains and approaches of quantitative and qualitative research. *Qualitative psychology,* **2,** 199.
Latifatu, I. (2017). Effects of artisanal and small-scale mining on food security in Dakurupe and Kui communities of Bole District.

Le, H., Gopalan, N., Lee, J., Kirige, I., Haque, A., Yadav, V. & Lambropoulos, V. (2023). Impact of Work and Non-Work Support on Employee Well-Being: The Moderating Role of Perceived Organizational Support. *Sustainability,* **15,** 15808.
Leal Filho, W., Azul, A. M., Brandli, L., Özuyar, P. G. & Wall, T. (2020). Zero hunger, Springer.
Ledwaba, P. & Nhlengetwa, K. (2016). When policy is not enough: prospects and challenges of artisanal and small-scale mining in South Africa. *Journal of Sustainable Development Law and Policy (The),* **7,** 25-42.
Lee, J.-Y., Choi, S.-K. & Seo, J.-S. (2019). Evaluation of the nutrition status and metabolic syndrome prevalence of the members according to the number of household members based on the Korea National Health and Nutrition Examination Survey (2013–2014). *Korean Journal of Community Nutrition,* **24,** 232-244.
Lele, U., Masters, W. A., Kinabo, J., Meenakshi, J., Ramaswami, B., Tagwireyi, J. & Goswami, S. (2016). Measuring food and nutrition security: An independent technical assessment and user's guide for existing indicators. *Rome: Food Security Information Network, Measuring Food and Nutrition Security Technical Working Group,* **177**.
Lemmons, K. (2023). Study Abroad Academic Pre-Departure Course: Increasing Student's Intercultural Competence Pre-Sojourns. *Frontiers: The Interdisciplinary Journal of Study Abroad,* **35,** 128-150.
Lewison, R. L., Rudd, M. A., Al-Hayek, W., Baldwin, C., Beger, M., Lieske, S. N., Jones, C., Satumanatpan, S., Junchompoo, C. & Hines, E. (2016). How the DPSIR framework can be used for structuring problems and facilitating empirical research in coastal systems. *Environmental Science & Policy,* **56,** 110-119.
Li, T., Cui, L., Singh, R. K., Fava, F., Xu, Z., Kumar, S., Song, X., Tang, L., Wang, Y. & Hao, Y. (2021a). Unveiling the Past, Current and Future of Global Sustainable Livelihoods Research by Visual and Quantitative Analysis.
Li, Y., Zhao, B., Huang, A., Xiong, B. & Song, C. (2021b). Characteristics and driving forces of non-grain production of cultivated land from the perspective of food security. *Sustainability,* **13,** 14047.
Lilford, E. & Guj, P. (2020). Corporate Income Tax Provisions and Fiscal Incentives Specific to Mining. *Mining Taxation: Reconciling the Interests of Government and Industry.* Springer.
Liu, X., Shi, X. & Chen, K. (2022). Inequality of opportunity in children's nutritional outcomes in China. *Global Food Security,* **33,** 100635.
Long, R. N., Renne, E. P. & Basu, N. (2015). Understanding the social context of the ASGM sector in Ghana: A qualitative description of the demographic, health, and nutritional characteristics of a small-scale gold mining community in Ghana. *International journal of environmental research and public health,* **12,** 12679-12696.
Longfield, A. (2024). Young Lives, Big Ambitions: Transforming Life Chances for Vulnerable Children and Teens, Jessica Kingsley Publishers.
Lu, L. & Chou, C.-Y. (2017). Long working hours and presenteeism in Asia: A cultural psychological analysis. *The Routledge companion to wellbeing at work.* Routledge.
Lutz-Ley, A. N. & Buechler, S. J. (2020). Minería y mujeres en el noroeste de México: Un acercamiento desde la ecología política feminista a los impactos sobre medios de vida rurales. *Human Geography (United Kingdom),* **13,** 74-84.
Lydia, O., Godwin, A. & Isaac, L. (2022). "We have done nothing wrong": Youth miners' perceptions of the environmental consequences of artisanal and small-scale mining (ASM) in Ghana. *The Extractive Industries and Society,* **12,** 101179.
Mabe, F. N., Owusu-Sekyere, E. & Adeosun, O. T. (2021). Livelihood coping strategies among displaced small scale miners in Ghana. *Resources Policy,* **74,** 102291.
Macháček, J. (2019). Typology of environmental impacts of artisanal and small-scale mining in African Great Lakes Region. *Sustainability,* **11,** 3027.
Maconachie, R. & Binns, T. (2007). 'Farming miners' or 'mining farmers'?: Diamond mining and rural development in post-conflict Sierra Leone. *Journal of Rural studies,* **23,** 367-380.
Maconachie, R. & Conteh, F. M. (2020). Artisanal mining and the rationalisation of informality: critical reflections from Liberia. *Canadian Journal of Development Studies/Revue canadienne d'études du développement,* **41,** 432-449.

Macpherson, R. A., Amick III, B. C., Collie, A., Hogg-Johnson, S., Koehoorn, M., Smith, P. M. & McLeod, C. B. (2020). Urban-rural differences in the duration of injury-related work disability in six Canadian provinces. *Journal of Occupational and Environmental Medicine,* **62,** e200-e207.

Makaza, D. & Chimuzinga, P. (2020). Barriers to Women's full participation in Artisanal and Small-scale Mining Sector. *PDF Available at: https://www. planetgold. org/sites/default/files/ZELA,* **202020**.

Mallo, S. J. (2012). Mitigating the activities of artisanal and small-scale miners in Africa: challenges for engineering and technological institutions. *Int J Mod Eng Res,* **2,** 4714-25.

Malone, A., Figueroa, L., Wang, W., Smith, N. M., Ranville, J. F., Vuono, D. C., Zapata, F. D. A., Paredes, L. M., Sharp, J. O. & Bellona, C. (2023). Transitional dynamics from mercury to cyanide-based processing in artisanal and small-scale gold mining: Social, economic, geochemical, and environmental considerations. *Science of the Total Environment,* **898,** 165492.

Malone, A., Smith, N. M. & Zeballos, E. Z. (2021). Coexistence and conflict between artisanal mining, fishing, and farming in a Peruvian boomtown. *Geoforum,* **120,** 142-154.

Manzila, A. N. (2022). A study of alternative techniques to mercury amalgamation for gold extraction in artisanal and small-scale gold mining.

Markham, K. & Sangermano, F. (2018). Evaluating wildlife vulnerability to mercury pollution from artisanal and small-scale gold mining in Madre de Dios, Peru. *Tropical Conservation Science,* **11,** 1940082918794320.

Martanto, R. (2021). Land use conversion pattern and food security for sustainable food land direction in Karanganyar Regency, Indonesia. *AgBioForum,* **23,** 143-152.

Marume, W. (2023). The implications of artisanal small-scale mining on food security in Zimbabwe. *Akdeniz Havzası ve Afrika Medeniyetleri Dergisi,* **5,** 65-80.

Matsa, M. M., Mazire, F., Musasa, T. & Defe, R. (2022). Health and safety issues within artisanal and small-scale gold mining: a case for Penhalonga, Ward 21 Mutasa District, Zimbabwe. *African Geographical Review,* **41,** 93-107.

Maxwell, D., Vaitla, B. & Coates, J. (2014). How do indicators of household food insecurity measure up? An empirical comparison from Ethiopia. *Food policy,* **47,** 107-116.

Mayes, R. (2017). 'We're sending you back': Temporary skilled labour migration, social networks and local community. *Migration, Mobility and Displacement,* **3,** 71-84.

McQuilken, J. & Hilson, G. (2016). Artisanal and small-scale gold mining in Ghana. *Evidence to inform an 'action dialogue'. IIED, London*.

Mengba, J. D., Atanga, R. A. & Akurugu, C. A. (2022). Small-scale gold mining and gender roles: Critical reflections on socio-cultural dynamics in north-eastern Ghana. *SN Social Sciences,* **3,** 4.

Mensah-Abludo, E., Peprah, K. & Baddianaah, I. (2023). Application of triple bottom line concept to artisanal and small-scale mining activities in Wa East District, Ghana. *Journal of Degraded & Mining Lands Management,* **10**.

Mensah, J., Amoah, J. O. & Nketsiah-Essoun, A. (Year). Effects of artisanal gold mining and routes towards sustainable development for a low-profile mining community in Ghana. *In:* Natural Resources Forum, 2024. Wiley Online Library.

Mensah, L. (2021). Legal pluralism in practice: critical reflections on the formalisation of artisanal and small-scale mining (ASM) and customary land tenure in Ghana. *The Extractive Industries and Society,* **8,** 100973.

Mensah, L. (2024). Battling on multiple frontiers: an African feminist examination of women's struggles in artisanal and small-scale mining (ASM). *Cogent Social Sciences,* **10,** 2399935.

Meutia, A. A., Lumowa, R. & Sakakibara, M. (2022). Indonesian artisanal and small-scale gold mining—a narrative literature review. *International Journal of Environmental Research and Public Health,* **19,** 3955.

Mezmir, E. A. (2020). Qualitative data analysis: An overview of data reduction, data display, and interpretation. *Research on humanities and social sciences,* **10,** 15-27.

Mi, J., Hou, H., Raval, S., Yang, Y., Zhang, S., Hua, Y., Wang, C. & Chen, F. (2020). Effect of crop cultivation on the soil carbon stock in mine dumps of the Loess Plateau, China. *Science of The Total Environment,* **741,** 139809.

Mimba, M. E., Mbafor, P. U. T., Fils, S. C. N. & Nforba, M. T. (2023). Environmental Impact of Artisanal and Small-scale Gold Mining in East Cameroon, Sub-Saharan Africa: An Overview. *Ore and Energy Resource Geology***,** 100031.
Mishra, N. (2015). Research Study on Coal Mining, Displacement and Rural Livelihoods: A Study in Mahanadi Coalfield Odisha.
Mitu, M. M. P., Islam, K., Sarwar, S., Ali, M. & Amin, M. R. (2022). Spatial differences in diet quality and economic vulnerability to food insecurity in Bangladesh: results from the 2016 household income and expenditure survey. *Sustainability,* **14,** 5643.
Mkubukeli, Z. & Tengeh, R. K. (2016). Prospects and challenges for small-scale mining entrepreneurs in South Africa.
Moktadir, M. A. & Ren, J. (2023). Promoting sustainable management of hazardous waste-to-wealth practices: An innovative integrated DPSIR and decision-making framework. *Journal of Environmental Management,* **344,** 118470.
Montgomery, D. R. (2017). Growing a revolution: bringing our soil back to life, WW Norton & Company.
Moomen, A.-W., Bertolotto, M., Lacroix, P. & Jensen, D. (Year). Exploring spatial symbiosis of agriculture and mining for sustainable development in northwest Ghana. *In:* 2019 8th International Conference on Agro-Geoinformatics (Agro-Geoinformatics), 2019. IEEE, 1-6.
Moomen, A.-W., Lacroix, P., Bertolotto, M. & Jensen, D. (2020). The drive towards consensual perspectives for enhancing sustainable mining. *Resources,* **9,** 147.
Morante-Carballo, F., Montalván-Burbano, N., Aguilar-Aguilar, M. & Carrión-Mero, P. (2022). A bibliometric analysis of the scientific research on artisanal and small-scale mining. *International Journal of Environmental Research and Public Health,* **19,** 8156.
Morgan, D. L. & Nica, A. (2020). Iterative thematic inquiry: A new method for analyzing qualitative data. *International Journal of Qualitative Methods,* **19,** 1609406920955118.
Moyo, D., Zishiri, C., Ncube, R., Madziva, G., Sandy, C., Mhene, R., Siziba, N., Kavenga, F., Moyo, F. & Muzvidziwa, O. (2021). Tuberculosis and silicosis burden in artisanal and small-scale gold miners in a large occupational health outreach programme in Zimbabwe. *International Journal of Environmental Research and Public Health,* **18,** 11031.
Moyo, F., Ncube, M. & Ndlovu, T. (2022). The competing nature-based livelihood-strategies: Artisanal small-scale mining (ASM) perspectives in agricultural-communities in Umzingwane District, Zimbabwe.
Moyo, S. (2016). Family farming in sub-Saharan Africa: its contribution to agriculture, food security and rural development.
Mugo, D., Ondieki-Mwaura, F. & Omolo, M. (2020). The social-cultural context of women participation in artisanal and small-scale mining: Case of Taita Taveta region of Kenya. *African Journal of Emerging Issues,* **2,** 21-30.
Mujere, N. & Isidro, M. (2016). Impacts of artisanal and small-scale gold mining on water quality in Mozambique and Zimbabwe. *Impact of Water Pollution on Human Health and Environmental Sustainability.* IGI Global.
Mujuru, N. M. & Obi, A. (2020). Effects of cultivated area on smallholder farm profits and food security in rural communities of the Eastern Cape Province of South Africa. *Sustainability,* **12,** 3272.
Mulaba-Bafubiandi, A. F., Ukponu, M. U., Odo, A. U., Singh, N. & Chauke, B. B. (2023). Contemporary Issues in the Governance and Regulation of Artisanal and Small-Scale Mining (ASM) in Africa. *Mining Law and Governance in Africa.* Routledge.
Mulenga, M., Ouma, K. O., Monde, C. & Syampungani, S. (2024). Aquatic mercury pollution from artisanal and small-scale gold mining in sub-Saharan Africa: Status, Impacts, and Interventions. *Water,* **16,** 756.
Mulusew, A. & Mingyong, H. (2023). An empirical investigation of the dynamic linkages of land access and food security: Evidence from Ethiopia using system GMM approach. *Journal of Agriculture and Food Research,* **11,** 100494.
Munir, L. (2022). Do cooperatives improve female miners' outcomes? A case study of Rwanda. *The Journal of Development Studies,* **58,** 2349-2365.

Muthuri, J. N., Jain, A., Ndegwa, A. A., Mwagandi, S. M. & Tagoe, N. D. (2021). The impact of Covid-19 on gold and gemstone artisanal and small-scale mining in sub-Saharan Africa: The case of Ghana and Kenya. *Africa Journal of Management,* **7,** 121-147.

Mutisya, M., Kandala, N.-b., Ngware, M. W. & Kabiru, C. W. (2015). Household food (in) security and nutritional status of urban poor children aged 6 to 23 months in Kenya. *BMC public health,* **15,** 1-10.

Mutisya, M., Ngware, M. W., Kabiru, C. W. & Kandala, N.-b. (2016). The effect of education on household food security in two informal urban settlements in Kenya: a longitudinal analysis. *Food Security,* **8,** 743-756.

Mwakaje, A. G. (2012). Environmental degradation under artisanal and small-scale mining in Tanzania: can innovations in institutional framework help?

Newlove, A. A., Owusu, W. & Charles, A. (2012). The relationship between lifestyle variables, blood pressure and dietary habits of male adult miners in Ghana.

Nongrem, W. I. E. (2023). Health and livelihood conditions of coal Workers: a case study of jaintia hills of Meghalaya. Mizoram University.

Nordhagen, S., Fofana, M. L., Diallo, S., Songbono, J. L., Stokes-Walters, R., Zhang, L. X., Klemm, R. & Winch, P. J. (2022). Between the city and the farm: food environments in artisanal mining communities in Upper Guinea. *Public health nutrition,* **25,** 368-380.

Nunoo, I., Boansi, D. & Owusu, V. (2023). Does the use of cocoa farmlands for artisanal small-scale gold mining really increase household food insecurity? Evidence from Ghana. *Resources Policy,* **87,** 104329.

Nyantakyi-Frimpong, H., Christian, A. K., Ganle, J. & Aryeetey, R. (2023). "Now we've all turned to eating processed foods": a photovoice study of the food and nutrition security implications of 'galamsey'in Ghana. *African Journal of Food, Agriculture, Nutrition and Development,* **23,** 22200-22220.

Nyantakyi-Frimpong, H., Mambulu, F. N., Kerr, R. B., Luginaah, I. & Lupafya, E. (2016). Agroecology and sustainable food systems: Participatory research to improve food security among HIV-affected households in northern Malawi. *Social Science & Medicine,* **164,** 89-99.

O'Faircheallaigh, C. & Regan, A. (2017). Artisanal and small scale mining in Bougainville: Risk, reward and regulation.

Obodai, J. (2022). The impacts of small-scale gold mining on food security in Ghana, Open University (United Kingdom).

Obodai, J., Bhagwat, S. & Mohan, G. (2024). The interface of environment and human wellbeing: Exploring the impacts of gold mining on food security in Ghana. *Resources Policy,* **91,** 104863.

Obodai, J., Mohan, G. & Bhagwat, S. (2023). Beyond legislation: Unpacking land access capability in small-scale mining and its intersections with the agriculture sector in sub-Saharan Africa. *The Extractive Industries and Society,* **16,** 101357.

Ofosu-Mensah, E. A. (2017). Historical and modern artisanal small-scale mining in Akyem Abuakwa, Ghana. *Africa Today,* **64,** 69-91.

Ofosu-Mensah, E. A. (2021). Mining (ASM) in Ghana: From Pre-Colonial. *J. Afr. Pol. Stud.,* **27**.

Ofosu, G., Dittmann, A., Sarpong, D. & Botchie, D. (2020). Socio-economic and environmental implications of Artisanal and Small-scale Mining (ASM) on agriculture and livelihoods. *Environmental Science & Policy,* **106,** 210-220.

Ofosu, G. & Sarpong, D. (2022). Mineral exhaustion, livelihoods and persistence of vulnerabilities in ASM settings. *Journal of Rural Studies,* **92,** 154-163.

Ofosu, G., Sarpong, D., Torbor, M. & Asante, S. (2024a). 'Mining women'and livelihoods: Examining the dominant and emerging issues in the ASM gendered economic space. *Economic and Industrial Democracy,* **45,** 1213-1241.

Ofosu, G., Sarpong, D., Torbor, M. & Asante, S. (2024b). 'Mining women'and livelihoods: Examining the dominant and emerging issues in the ASM gendered economic space. *Economic and Industrial Democracy***,** 0143831X231212562.

Ofosu, G., Siaw, D., Sarpong, D. & Danquah, S. (2024c). Ban mining, ban dining? Re (examining) the policy and practice of 'militarised conservationism'on ASM operations. *The Extractive Industries and Society,* **17,** 101432.

Ofosu, G., Torbor, M. & Sarpong, D. (2022). Gender and artisanal and small-scale mining: Exploring women's livelihood and occupational roles in formalised settings. *Journal of Rural Studies,* **96,** 121-128.
Ofosu, G. O. (2022a). Examining the 'Golden'Practices of Small-Scale Mining: Small-Scale Mining, Livelihoods, and the Benefits of Formalisation, Springer.
Ofosu, G. O. (2022b). The Land Reclamation Processes and the Mutually Beneficial Consequences to Local Mining Communities. *Examining the 'Golden'Practices of Small-Scale Mining: Small-Scale Mining, Livelihoods, and the Benefits of Formalisation.* Springer.
Okereafor, U., Makhatha, M., Mekuto, L., Uche-Okereafor, N., Sebola, T. & Mavumengwana, V. (2020). Toxic metal implications on agricultural soils, plants, animals, aquatic life and human health. *International journal of environmental research and public health,* **17,** 2204.
Okoh, G. & Hilson, G. (2011). Poverty and livelihood diversification: Exploring the linkages between smallholder farming and artisanal mining in rural Ghana. *Journal of International Development,* **23,** 1100-1114.
Olson-Williams, H., Grey, S. & Cochran, A. (2023). Ecological study of urbanicity and self-reported poor mental health days across US counties. *Community Mental Health Journal,* **59,** 986-998.
Ondayo, M. A., Watts, M. J., Mitchell, C. J., King, D. C. & Osano, O. (2024). Artisanal Gold Mining in Africa—Environmental Pollution and Human Health Implications. *Exposure and Health,* **16,** 1067-1095.
Onditi, F. (2022). Gender equality, mining, and society. *Gender inequalities in Africa's mining policies: A study of inequalities, resource conflict and sustainability.* Springer.
Onekpe, S. A., Nwachukwu, C. C. & Iyi, E. A. (2023). Evaluation of Artisanal and Small-Scale Mining Operators' Access to Finance in Nasarawa State. *European Journal of Engineering and Environmental Sciences| EJEES,* **7,** 21-31.
Onifade, M., Zvarivadza, T., Adebisi, J. A., Said, K. O., Dayo-Olupona, O., Lawal, A. I. & Khandelwal, M. (2024). Advancing toward sustainability: The emergence of green mining technologies and practices. *Green and Smart Mining Engineering,* **1,** 157-174.
Onori, F., Viviani, S. & Brutti, P. (2018). Towards global monitoring: equating the Food Insecurity Experience Scale (FIES) and food insecurity scales in Latin America. *Convegno della Società Italiana di Statistica.* Springer.
Orleans-Boham, H., Sakyi-Addo, G. B., Tahiru, A. & Amankwah, R. (2020). Women in artisanal mining: Reflections on the impacts of a ban on operations in Ghana. *The Extractive Industries and Society,* **7,** 583-586.
Osei, L., Yeboah, T., Kumi, E. & Antoh, E. F. (2021). Government's ban on Artisanal and Small-Scale Mining, youth livelihoods and imagined futures in Ghana. *Resources Policy,* **71,** 102008.
Osei, S. (2023). Religion and the fight against illegal small-scale mining in Ghana a case of Abuakwa North District. University of Education, Winneba.
Osumanu, I. K. (2020). Small-scale mining and livelihood dynamics in North-Eastern Ghana: Sustaining rural livelihoods in a changing environment. *Progress in Development Studies,* **20,** 208-222.
Otamonga, J.-P. & Poté, J. W. (2020). Abandoned mines and artisanal and small-scale mining in Democratic Republic of the Congo (DRC): Survey and agenda for future research. *Journal of Geochemical Exploration,* **208,** 106394.
Otoijamun, I., Kigozi, M., Abdulraman, S. O., Adetunji, A. R. & Onwualu, A. P. (2021). Fostering the sustainability of artisanal and small-scale mining (ASM) of Barite in Nasarawa State, Nigeria. *Sustainability,* **13,** 5917.
Owusu, O., Bansah, K. J. & Mensah, A. K. (2019). "Small in size, but big in impact": socio-environmental reforms for sustainable artisanal and small-scale mining. *Journal of Sustainable Mining,* **18,** 38-44.
Oyekale, A. S. (2015). Climate change induced occupational stress and reported morbidity among cocoa farmers in South-Western Nigeria.
Paget, D., Garrett, N. & Crawford, A. (2017). IGF Guidance for Governments: Managing artisanal and small-scale mining.

Pandey, R., Dwivedi, M. K., Singh, P., Patel, B., Pandey, S., Patel, B., Patel, A. & Singh, B. (2016). Effluences of heavy metals, way of exposure and bio-toxic impacts: An update. *J. Chem. Chem. Sci,* **66,** 2319-7625.

Pantoja Timarán, F. H. & Pantoja Barrios, S. D. (2016). Artisanal and Small-Scale Gold Mining in Colombia. Problems and Challenges. *Revista Facultad de Ciencias Económicas: Investigación y Reflexión,* **24,** 147-160.

Park, J. N., Rouhani, S., Beletsky, L., Vincent, L., Saloner, B. & Sherman, S. G. (2020). Situating the continuum of overdose risk in the social determinants of health: a new conceptual framework. *The Milbank Quarterly,* **98,** 700-746.

Paschal, M. & Kauangal, J. (2023). Women position in artisanal and small-scale mining in Sub-Saharan Africa: A systematic literature review. *Resources policy,* **81,** 103314.

Paschal, M., Kauangal, J. & Nuhu, S. (2024). The existing financial sources for artisanal and small-scale mining in mineral-rich countries in Sub-Saharan Africa: a review. *Mineral Economics,* **37,** 45-53.

Payton, A., Lagomasino, D., Barenblitt, A., Fatoyinbo, T., Asare, K., Aidoo, K., Pigott, H., Som, C. K., Smeets, L. & Seidu, O. (2021). The large footprint of small-scale artisanal gold mining in Ghana.

Perks, R. (2011). 'Can I go?'—exiting the artisanal mining sector in the democratic republic of Congo. *Journal of International Development,* **23,** 1115-1127.

Peterson, J. S. (2019). Presenting a qualitative study: A reviewer's perspective. *Gifted Child Quarterly,* **63,** 147-158.

Pigat, S., Soshina, M., Berezhnaya, Y. & Kryzhanovskaya, E. (2023). Web-Based 24-Hour Dietary Recall Tool for Russian Adults and School-Aged Children: Validation Study. *JMIR Formative Research,* **7,** e41774.

Pijpers, R. (2014). Crops and carats: Exploring the interconnectedness of mining and agriculture in Sub-Saharan Africa. *Futures,* **62,** 32-39.

Pijpers, R. J. (2024). Mining and Development in Sierra Leone: Negotiating Change and Navigating Uncertainty, Taylor & Francis.

Piketty, T. & Zucman, G. (2015). Wealth and inheritance in the long run. *Handbook of income distribution.* Elsevier.

Poignant, A. (2023). Small-scale mining and agriculture: Evidence from northwestern Tanzania. *Resources Policy,* **83,** 103694.

Pokorny, B., von Lübke, C., Dayamba, S. D. & Dickow, H. (2019). All the gold for nothing? Impacts of mining on rural livelihoods in Northern Burkina Faso. *World Development,* **119,** 23-39.

Pongutta, S., Chongwatpol, P., Tantayapirak, P. & Vandevijvere, S. (2018). Declaration of nutrition information on and nutritional quality of Thai ready-to-eat packaged food products. *Public health nutrition,* **21,** 1409-1417.

Project, I. (2018). Data4Diets: building blocks for diet-related food security analysis. Tufts University Boston, MA, USA.

Purnomo, M., Utomo, M. R., Pertiwi, V. i. A., Laili, F., Pariasa, I. I., Riyanto, S., Andriatmoko, N. D. & Handono, S. Y. (2021). Resistance to mining and adaptation of Indonesia farmer's household to economic vulnerability of small scale sand mining activities. *Local Environment,* **26,** 1498-1511.

Quarm, J. A., Anning, A. K., Fei-Baffoe, B., Siaw, V. F. & Amuah, E. E. Y. (2022). Perception of the environmental, socio-economic and health impacts of artisanal gold mining in the Amansie West District, Ghana. *Environmental Challenges,* **9,** 100653.

Radhakrishna, R. & Reddy, K. V. (2004). Food security and nutrition: Vision 2020, Citeseer.

Rai, P. K., Lee, S. S., Zhang, M., Tsang, Y. F. & Kim, K.-H. (2019). Heavy metals in food crops: Health risks, fate, mechanisms, and management. *Environment international,* **125,** 365-385.

Rai, P. K., Sonne, C. & Kim, K.-H. (2023). Heavy metals and arsenic stress in food crops: Elucidating antioxidative defense mechanisms in hyperaccumulators for food security, agricultural sustainability, and human health. *Science of The Total Environment,* **874,** 162327.

Rasheed, M. (2023). Promoting nutritional education in primary school children. *British Journal of Nursing,* **32,** S14-S18.

Rice, K. M., Walker Jr, E. M., Wu, M., Gillette, C. & Blough, E. R. (2014). Environmental mercury and its toxic effects. *Journal of preventive medicine and public health,* **47,** 74.
Robinson, O. C. (2022). Conducting thematic analysis on brief texts: The structured tabular approach. *Qualitative Psychology,* **9,** 194.
Ros–Tonen, M. A., Aggrey, J. J., Somuah, D. P. & Derkyi, M. (2021). Human insecurities in gold mining: a systematic review of evidence from Ghana. *The Extractive Industries and Society,* **8,** 100951.
Rout, N. R. (2019). A Case Study of Level and Variation in the Knowledge about Healthy Diet among Homemakers.
Rubbers, B. (2020). Mining boom, labour market segmentation and social inequality in the Congolese Copperbelt. *Development and Change,* **51,** 1555-1578.
Rubbers, B. (2023). Mining and the scalar transformations of the state in the Democratic Republic of Congo. *The Journal of Modern African Studies,* **61,** 73-90.
Rudolph, M., Muchesa, E. & Sibanda, C. (2024). The Influence of Education on Women and Food Security. *South African Journal of Agricultural Extension,* **52,** 91-106.
Russell, J., Lechner, A., Hanich, Q., Delisle, A., Campbell, B. & Charlton, K. (2018). Assessing food security using household consumption expenditure surveys (HCES): a scoping literature review. *Public Health Nutrition,* **21,** 2200-2210.
Rutherford, B. & Buss, D. (2019). Gendered governance and socio-economic differentiation among women artisanal and small-scale miners in Central and East Africa. *Third World Thematics: A TWQ Journal,* **4,** 63-79.
Rwiza, M. J., Bayuo, J., Kimaro, J. M., Kleinke, M., Lyasenga, T. J., Mosses, J. T. & Marwa, J. (2023). Artisanal and small-scale mining in Tanzania and health implications: A policy perspective. *Heliyon,* **9**.
Saim, A. K. (2021). Mercury (Hg) use and pollution assessment of ASGM in Ghana: challenges and strategies towards Hg reduction. *Environmental Science and Pollution Research***,** 1-10.
Saint Ville, A., Po, J. Y. T., Sen, A., Bui, A. & Melgar-Quiñonez, H. (2019). Food security and the Food Insecurity Experience Scale (FIES): ensuring progress by 2030. Springer.
Saldaña-Villanueva, K., Pérez-Vázquez, F. J., Ávila-García, I. P., Méndez-Rodríguez, K. B., Carrizalez-Yáñez, L., Gavilán-García, A., Vargas-Morales, J. M., Van-Brussel, E. & Diaz-Barriga, F. (2022). A preliminary study on health impacts of Mexican mercury mining workers in a context of precarious employment. *Journal of Trace Elements in Medicine and Biology,* **71,** 126925.
Salifu, G. A.-N. (2021). The Proof of Economic Welfare is in the Eating of Nutritious diets by resource-poor; A Political Economy Analysis of the International Evidence of Dietary Consumption in Rural Africa. *International Journal of Business Administration,* **12,** 10-34.
Salmona, M. & Kaczynski, D. (2024). Qualitative data analysis strategies. *How to conduct qualitative research in finance.* Edward Elgar Publishing.
Salo, M., Hiedanpää, J., Karlsson, T., Ávila, L. C., Kotilainen, J., Jounela, P. & García, R. R. (2016). Local perspectives on the formalization of artisanal and small-scale mining in the Madre de Dios gold fields, Peru. *The Extractive Industries and Society,* **3,** 1058-1066.
Sánchez-Vázquez, L., Espinosa-Quezada, M. G. & Eguiguren-Riofrio, M. B. (2016). "Golden reality" or the "reality of gold": Artisanal mining and socio-environmental conflict in Chinapintza, Ecuador. *The Extractive Industries and Society,* **3,** 124-128.
Saturay, E. (2020). Money Is Easy in Paracale: Small-scale Miners' Perceptions, Strategies, and Modes of Spending and Consumption in Relation to Variable Income.
Sauerwein, T. (2023). Should mining companies partner with artisanal miners? Why only time will tell. *Journal of Rural Studies,* **100,** 103006.
Schneider, P., Oswald, K.-D., Riedel, W., Le Hung, A., Meyer, A., Nolivos, I. & Dominguez-Granda, L. (2020). Best Practice for Responsible Small Scale Aggregates Mining in Developing Countries. *International Business, Trade and Institutional Sustainability***,** 529-553.
Schwartz, F. W., Lee, S. & Darrah, T. H. (2021a). A review of health issues related to child labor and violence within artisanal and small-scale mining. Wiley Online Library.
Schwartz, F. W., Lee, S. & Darrah, T. H. (2021b). A review of the scope of artisanal and small-scale mining worldwide, poverty, and the associated health impacts. *GeoHealth,* **5,** e2020GH000325.

Serwajja, E. & Mukwaya, P. I. (2020). Condemned to the periphery: The lived experiences of women in artisanal gold mining activities in Karamoja sub-region, Uganda. *The Extractive Industries and Society,* **7,** 1511-1524.

Shahraki, S. H., Amirkhizi, F., Amirkhizi, B. & Hamedi, S. (2016). Household food insecurity is associated with nutritional status among Iranian children. *Ecology of food and nutrition,* **55,** 473-490.

Shangase, M. (2022). Youth and Women Participation in Extractive Industries: A Cooperatives Approach to Artisanal and Small-scale Mining (ASM). *The Strategic Review for Southern Africa,* **44**.

Shirisha, P., Muraleedharan, V. & Vaidyanathan, G. (2022). Wealth related inequality in women and children malnutrition in the state of Chhattisgarh and Tamil Nadu. *BMC nutrition,* **8,** 86.

Siaciti, N. & Masinja, J. (2022). Assessing the Implementation of the Key Tenets of the African Mining Vision with Zambia's Key Mining Policy on Artisanal and Small Scale Mining. *International Journal of Natural Sciences,* **3,** 28-40.

Singo, J., Isunju, J. B., Moyo, D., Bose-O'Reilly, S., Steckling-Muschack, N. & Mamuse, A. (2022). Accidents, injuries, and safety among artisanal and small-scale gold miners in Zimbabwe. *International journal of environmental research and public health,* **19,** 8663.

Siti Thomas Zulaikhah, S. T. Z. (2021). Mercury and its effect on human health: a review of the literature. *International Journal of Public Health Science (IJPHS)*.

Siwale, A. & Siwale, T. (2017). Has the promise of formalizing artisanal and small-scale mining (ASM) failed? The case of Zambia. *The Extractive Industries and Society,* **4,** 191-201.

Smith, N. M., Ali, S., Bofinger, C. & Collins, N. (2016). Human health and safety in artisanal and small-scale mining: an integrated approach to risk mitigation. *Journal of cleaner production,* **129,** 43-52.

Smith, N. M., Smith, J. M., John, Z. Q. & Teschner, B. A. (2017). Promises and perceptions in the Guianas: The making of an artisanal and small-scale mining reserve. *Resources Policy,* **51,** 49-56.

Soh Wenda, B. D., Fon, D. E., Molua, E. L. & Longang, S. G. (2024). Women, income use and nutrition quality: effects of women's decision-making in rural households in Cameroon. *Agriculture & Food Security,* **13,** 29.

Spadola, C. E., Rottapel, R., Khandpur, N., Kontos, E., Bertisch, S. M., Johnson, D. A., Quante, M., Khalsa, S. B. S., Saper, R. B. & Redline, S. (2017). Enhancing yoga participation: A qualitative investigation of barriers and facilitators to yoga among predominantly racial/ethnic minority, low-income adults. *Complementary therapies in clinical practice,* **29,** 97-104.

Steeves, B. A., Hollis-Hansen, K., McElrone, M., Nur, H. & Landry, M. J. (2023). Supporting Food and Nutrition Security Among Migrant, Immigrant, and Refugee Populations. *Journal of Nutrition Education and Behavior,* **55,** 83-84.

Steinfield, L. & Holt, D. (2020). Structures, systems and differences that matter: Casting an ecological-intersectionality perspective on female subsistence farmers' experiences of the climate crisis. *Journal of Macromarketing,* **40,** 563-582.

Stemn, E., Amoh, P. O. & Joe-Asare, T. (2021). Analysis of artisanal and small-scale gold mining accidents and fatalities in Ghana. *Resources Policy,* **74,** 102295.

Stienstra, D., Manning, S. & Levac, L. (2020). More promise than practice: GBA+, intersectionality and impact assessment. *Live Work Well Research Centre*.

Stokes-Walters, R., Fofana, M. L., Songbono, J. L., Barry, A. O., Diallo, S., Nordhagen, S., Zhang, L. X., Klemm, R. D. & Winch, P. J. (2021). "If you don't find anything, you can't eat"–Mining livelihoods and income, gender roles, and food choices in northern Guinea. *Resources Policy,* **70,** 101939.

Stuckey, H. L. (2014). The first step in data analysis: Transcribing and managing qualitative research data. *Journal of Social Health and Diabetes,* **2,** 006-008.

Tampushi, L. L., Onyari, J. M. & Muthama, N. J. (2022). Assessing Social and Environmental Impacts of Artisanal and Small-Scale Gold Mining Practices in Lolgorian, Kenya. *European Journal of Sustainable Development Research,* **6,** em0192.

Tanweer, A., Niaz, M., Imran, S., Humayun, A. & Hussain, Z.-U.-N. (2022). Establishing the Needs Assessment for Improving Dietary Assessment for Pakistani Population Evidence from Qualitative Study Findings. *Pakistan Journal of Medical & Health Sciences,* **16,** 1123-1123.
Taux, K., Kraus, T. & Kaifie, A. (2022). Mercury exposure and its health effects in workers in the Artisanal and Small-Scale Gold Mining (ASGM) sector—A systematic review. *International journal of environmental research and public health,* **19,** 2081.
Terry, S. (2019). International Monetary Fund Structural Adjustment Policy and Loan Conditionality in Ghana: Economic, Cultural, and Political Impacts.
Thiong'o, D. M. (2023). Women Participation in Artisanal and Small-Scale Mining in Taita Taveta County, Kenya. JKUAT-COHRED.
Thurstans, S., Opondo, C., Seal, A., Wells, J., Khara, T., Dolan, C., Briend, A., Myatt, M., Garenne, M. & Sear, R. (2020). Boys are more likely to be undernourished than girls: a systematic review and meta-analysis of sex differences in undernutrition. *BMJ global health,* **5,** e004030.
Tilahun, A. G. & Kebede, A. M. (2021). Maternal minimum dietary diversity and associated factors among pregnant women, Southwest Ethiopia, 2021. *BMC nutrition,* **7,** 1-10.
Tilman, D., Balzer, C., Hill, J. & Befort, B. L. (2011). Global food demand and the sustainable intensification of agriculture. *Proceedings of the national academy of sciences,* **108,** 20260-20264.
Tobalagba, A. & Vijeyarasa, R. (2020). Engendering regulation of artisanal and small-scale mining: participation, protection and access to justice. *Third World Quarterly,* **41,** 1635-1652.
Tolonen, A. (2015). Mining booms in Africa and local welfare effects: Labor markets, women's empowerment and criminality.
Tsang, V. W., Lockhart, K., Spiegel, S. J. & Yassi, A. (2019). Occupational health programs for artisanal and small-scale gold mining: A systematic review for the WHO global plan of action for workers' health. *Annals of global health,* **85**.
Tuffour, J. (2023). Accounting for the effects of institutional changes on Ghana's small-scale gold mining sector, pre-colonial to the post-structural adjustment programme eras. Anglia Ruskin Research Online (ARRO).
UNICEF (2020). The state of food security and nutrition in the world 2020.
Usman, M. A. & Haile, M. G. (2022). Market access, household dietary diversity and food security: Evidence from Eastern Africa. *Food Policy,* **113,** 102374.
Vallejos, P. Q., Veit, P., Tipula, P. & Reytar, K. (2020). Undermining rights: Indigenous lands and mining in the Amazon.
Veiga, M. M. & Marshall, B. G. (2019). The Colombian artisanal mining sector: Formalization is a heavy burden. *The Extractive Industries and Society,* **6,** 223-228.
Verbrugge, B. & Geenen, S. (2019). The gold commodity frontier: A fresh perspective on change and diversity in the global gold mining economy. *The Extractive Industries and Society,* **6,** 413-423.
Verbrugge, B. & Thiers, R. (2021). Artisanal and small-scale mining. *Handbook of Critical Agrarian Studies.* Edward Elgar Publishing.
Walls, H., Baker, P., Chirwa, E. & Hawkins, B. (2019). Food security, food safety & healthy nutrition: are they compatible? *Global Food Security,* **21,** 69-71.
Wang, J., Lin, W. & Huang, Y.-H. (2010). A performance-oriented risk management framework for innovative R&D projects. *Technovation,* **30,** 601-611.
Wang, X. (2022). Managing land carrying capacity: Key to achieving sustainable production systems for food security. *Land,* **11,** 484.
Watkins Liu, C. (2018). The anti-oppressive value of critical race theory and intersectionality in social movement study. *Sociology of Race and Ethnicity,* **4,** 306-321.
Wegenast, T. & Beck, J. (2020). Mining, rural livelihoods and food security: A disaggregated analysis of sub-Saharan Africa. *World Development,* **130,** 104921.
Weldegiorgis, F., Lawson, L. & Verbrugge, H. (2018a). Women in Artisanal and Small-Scale Mining: Challenges and opportunities for greater participation.
Weldegiorgis, F., Lawson, L. & Verbrugge, H. (2018b). Women in Artisanal and Small-Scale Mining: Challenges and opportunities for greater participation, International Institute for Sustainable Development Winnipeg.

Weng, L. & Margules, C. (2022). Challenges with formalizing artisanal and small-scale mining in Cameroon: Understanding the role of Chinese actors. *The Extractive Industries and Society,* **9,** 101046.
WHO (2016). Environmental and occupational health hazards associated with artisanal and small-scale gold mining.
Wijeyesinghe, C. L. & Jones, S. R. (2014). Intersectionality, identity, and systems of power and inequality. *Intersectionality and higher education: Theory, research, and praxis***,** 9-19.
Wilson, L.-A. (2018). Unshackling South African artisanal miners: Considering Burkina Faso's legislative provisions as a guideline for legalisation and regulation.
Wireko-Gyebi, R. S., Arhin, A. A., Braimah, I., King, R. S. & Lykke, A. M. (2022). Working in a risky environment: Coping and risk handling strategies among small-scale miners in Ghana. *Safety and health at work,* **13,** 163-169.
Wongnaa, C. A., Nti, E. K., Acheampong, P. P., Bannor, R. K., Prah, S. & Babu, S. (2024). Towards sustainable food crop production: drivers of shift from crop production to mining activities in Ghana's Arable Lands. *Environmental Challenges,* **14,** 100835.
Worlanyo, A. S., Alhassan, S. I. & Jiangfeng, L. (2022). The impacts of gold mining on the welfare of local farmers in Asutifi-North District in Ghana: A quantitative and multi-dimensional approach. *Resources Policy,* **75,** 102458.
Worldwide, M. H. (2013). The Food Insecurity Experience Scale.
Wyatt, L., Ortiz, E. J., Feingold, B., Berky, A., Diringer, S., Morales, A. M., Jurado, E. R., Hsu-Kim, H. & Pan, W. (2017). Spatial, temporal, and dietary variables associated with elevated mercury exposure in Peruvian riverine communities upstream and downstream of artisanal and small-scale gold mining. *International Journal of Environmental Research and Public Health,* **14,** 1582.
Ya, R. M., Nor, N. M., Jaafar, N. H., Sidek, S., Ab Rahman, J., Sulaiman, N. & Abu, W. A. M. (2023). Validation of the Malay version of Food Insecurity Experience Scale (M-FIES) using Rasch analysis. *Malaysian Journal of Nutrition,* **29,** 529-537.
Yakovleva, N. (2007). Perspectives on female participation in artisanal and small-scale mining: A case study of Birim North District of Ghana. *Resources Policy,* **32,** 29-41.
Yang, W., Xue, M., Wang, Y., Long, T., Deng, S., Deng, B. & Fang, N. (2023). Evaluation of Enterprise Green Mine Construction Based on DPSIR Model. *International Journal of Environmental Research and Public Health,* **20,** 4932.
Yankson, P. W. & Gough, K. V. (2019). Gold in Ghana: The effects of changes in large-scale mining on artisanal and small-scale mining (ASM). *The Extractive Industries and Society,* **6,** 120-128.
Yoshimura, A., Suemasu, K. & Veiga, M. M. (2021). Estimation of mercury losses and gold production by artisanal and small-scale gold mining (ASGM). *Journal of Sustainable Metallurgy,* **7,** 1045-1059.
Yussif, K., Dompreh, E. B. & Gasparatos, A. (2023). Sustainability of urban expansion in Africa: a systematic literature review using the Drivers–Pressures–State–Impact–Responses (DPSIR) framework. *Sustainability Science,* **18,** 1459-1479.
Zhang, L. X., Koroma, F., Fofana, M. L., Barry, A. O., Diallo, S., Lamilé Songbono, J., Stokes-Walters, R., Klemm, R. D., Nordhagen, S. & Winch, P. J. (2020). Food security in artisanal mining communities: An exploration of rural markets in northern Guinea. *Foods,* **9,** 479.
Zhang, Y., Ullah, M. & Merdan, A. (2024). Perspective on Artisinal and Small-scale gold Mining: Ecological and Socio-economic Inovation. *The Extractive Industries and Society,* **18,** 101444.
Zhao, Y., Zhao, X., Fan, D. & Qiu, Y. (2023). A comprehensive method for refining essential SDGs variables for land degradation monitoring based on the DPSIR framework. *International Journal of Digital Earth,* **16,** 741-761.
Zolnikov, T. R. (2020). Effects of the government's ban in Ghana on women in artisanal and small-scale gold mining. *Resources Policy,* **65,** 101561.
Zvarivadza, T. (2018). Artisanal and Small-Scale Mining as a challenge and possible contributor to Sustainable Development. *Resources Policy,* **56,** 49-58.
Zvarivadza, T., Onifade, M., Dayo-Olupona, O., Said, K. O., Githiria, J. M., Genc, B. & Celik, T. (2024). On the impact of Industrial Internet of Things (IIoT)-mining sector perspectives. *International Journal of Mining, Reclamation and Environment***,** 1-39.

Zwolak, I. (2020). The role of selenium in arsenic and cadmium toxicity: an updated review of scientific literature. *Biological trace element research,* **193,** 44-63.

APPENDIX I ETHICAL CLEARANCE

School of Agriculture, Policy and Development

ETHICAL CLEARANCE GRANTED

Form 2. MSc PhD Staff Ethical Clearance Submission Form

PLEASE allow a minimum of 3 weeks for this process.
You must not begin your research until you have obtained consent as evidenced by this form returned from the APD student Office signed and dated. Ethical Clearance cannot be granted retrospectively.

This form can only be used if the application:

- Does not involve participants who are patients or clients of the health or social services
- Does not involve participants whose capacity to give free and informed consent may be impaired within the meaning of the Mental Capacity Act 2005
- Does not involve patients who are 'vulnerable'
- Does not involve any element of risk to the researchers or participants
- Does not involve any participants who have a special relationship to the researchers/investigators

If any of the above apply, please refer to the APD Ethics Chair to decide whether an application can be made through the APD review process or whether the application needs to be referred to the full University Committee.

It is the applicant's responsibility to check for any particular requirements of a funder regarding ethical review. Some funders may require that the application is reviewed by full University Committee and not the devolved School committee.

Full details of the University Research Ethics procedures are available at http://www.reading.ac.uk/internal/res/ResearchEthics/reas-REethicshomepage.aspx and you are encouraged to access these pages for a fuller understanding. Some helpful advice is available on this link http://www.reading.ac.uk/internal/res/ResearchEthics/reas-REwhatdoIneedtodo.aspx and the FAQs are particularly relevant.

ALL QUESTIONS MUST BE COMPLETED.

APD Ethical Clearance Application Reference Number : 002157

1. APPLICANT DETAILS:

Main applicant name: Kwadwo Adusei Peasah
Name of academic supervisor/project investigator: Prof. C.S. Srinivasan and Prof. Rahman Sanzidur
Email Address (decision will be emailed here): k.aduseipeasah@pgr.reading.ac.uk
MSc Student ☐

PhD Student	☒
Staff Member	☐
Other (please specify)	Click here to enter text.

2. PROJECT DETAILS:

Title of project: Artisanal Small-Scale Mining (ASM) and its implications on food security, health and nutrition.

Please provide a lay summary of the project, including what is being investigated and why: The project seeks to investigate how women are impacted by virtue of their direct and indirect participation in ASM activities. As such, a comprehensively developed interview guide is being used to solicit information on how women within these mining households in the mining community are impacted by virtue of their direct and indirect involvement in Artisanal Small Scale Mining activities.

Procedure. Please outline the project's research protocol (what procedures, research methods and analysis methods are being used) : Women respondents who participate directly and indirectly in ASM activity will be purposively selected and interviewed. These women in ASM households must be above the age of 18 years. This study is interested in women who have been working in the ASM industry for a year or more. As such, this will be the sampling frame from which women will be randomly picked to be interviewed. This will be obtained by consulting with local ASM unions and opinion/community leaders who can provide me with information on the population of women involved in ASM in the area. (This consultation will help me gain access to respondent and also, guarantee safety of respondents and myself) Thereafter, women will be randomly selected as a subset of women from the sampling frame.

Thereafter, 20 (10 each) women respondents from the households where women are directly and indirectly involved in ASM will be selected. These women will be contacted so as to explain the purpose of the study to them, the interview process, and the time commitment required. They will also be provided with opportunity to ask questions and also, obtain informed consent before proceeding with the interview.

Interviews will be conducted using interview guides that addresses the nature of participation of the respondents in ASM and the impact of participation in ASM on economic well-being, health and safety, nutrition and food security, time use, domestic roles and on the environment. Interviews will be conducted in a private and comfortable setting where the interviewees feel safe and respected. These interviews will be recorded by a trained assistant with the consent of the respondent. These recordings will be stored on my personal computer as well as that my supervisors under password protection. Considering the area, the interview will be conducted using both English and Twi (local language) since respondents understand these languages better. All recordings in the local language will be translated into English before transcription.

Analysis of this data consist several steps. These involve transcription of the interviews, coding the data, identification of patterns and themes as well as making relevant conclusions based on the findings. The transcription of the data involve making a written record of the conversation.

This would be done manually and also, by the use of a transcription software called Nvivo. This software will aid in ensuring all the data is readily available for analysis by assisting in coding, querying, visualisations, creation of networks as well as text analysis.

Coding basically consist of identifying and making out the various concepts, ideas, as well as those emerging from the data. By coding, numerical codes, alphabetical codes and labels will be assigned to responses or certain behaviours recorded during data collection. This will make it easier to identify themes and patterns within the data. By querying, Nvivo will help in identifying similarities, relationships and differences in the data, and putting related codes into various categories. Within the Nvivo are tools such as simple search, advanced search and matrix coding which will all be employed in the analysis of the data. The software will also aid in creating and visualising network of relationships. After establishing theme and patterns from the data, conclusions will be drawn based o the data findings. This would be made depending on the inferences emerging from the data. Data will be validated by checking for its consistency with the research questions and objectives. Feedbacks from similar research works will also be used in this validation. Throughout this process, the confidentiality and anonymity of the respondents will be ensured so as to protect their privacy.

Period over which the data collection is to be undertaken (note: data collection CANNOT commence until ethical approval has been granted as evidenced by this form signed and returned).

Proposed Start Date: 29/05/2023
Proposed End Date: 30/06/2023

3. THE RESEARCH:

a) **Nature and number of participants** who are expected to take part in your survey/focus group. Please estimate if uncertain. As ethical clearance involving minors is more complex because of safeguarding and consent issues, please consider carefully whether you need to involve minors under the age of 16 in your research.

Participants	**Number participating**
Minors under 16 years of age	Click here to enter text.
Students	Click here to enter text.
Other members of the University	Click here to enter text.
Members of the general public	20
Businesses	Click here to enter text.
Government officials	Click here to enter text.
Other *If other please specify:*	Click here to enter text.

Funding. Is the research supported by funding from a research council or other external sources for example a charity or business?

Yes ☒ If yes, please specify funder : Ghana Scholarship Secretariat No ☐

If yes, it is the responsibility of the applicant to check for any particular requirements of the funder regarding ethical review. Some funders may require that the application is reviewed by full University Committee and not the devolved School committee.

Recruitment. Please describe recruitment procedures. How have participants been selected? Are there any inclusion/exclusion criteria? Participants must be told on the Participant Information Sheet how and why they have been selected. You should attach ay recruitment materials to this application. I have selected participants based on the households involved in Artisanal Small Scale Mining. (This is done in consultation with ASM unions and community/opinion leaders so as to gain access to respondent and guarantee safety) Within these households, there must be women who are both directly or indirectly being impacted by ASM.

Exceptions. Does the research involve minors, medical patients, individuals with learning difficulties, vulnerable adults, participants recruited through social service departments, or anyone in a special relationship with yourself/data collectors? E.g. Supervisor; lecturer to a group of students; or person in a position of responsibility for participants.

Yes ☐

No ☒

If yes, this may result in referral to the University Research Ethics Committee (please note their deadlines). Please provide extra detail here: Click here to enter text.

Where is the data collection to be undertaken? Specify country(ies) and specific location(s) A small-scale mining town within the East Akim District of Eastern Region of Ghana

What forms of data collection does the research involve?

Group discussion/ workshop ☐

Personal interviews ☒

Telephone interviews ☐

Questionnaire/paper survey ☐

Postal survey ☐

Email/ online survey ☐

Which software tool will be used, if any? Click here to enter text.

Other *(specify)*: Click here to enter text.

Who will undertake the collection and/or analysis of data?

Myself ☒

Other MSc students ☐

Other Higher degree students ☐ Other contract research and/or academic staff ☐
Individuals outside University☐

External organisations ☐

If individuals outside the University and/or external organisations are involved in the collection or analysis of data, give brief details below. Indicate how the ethical procedures and standards of the University will be satisfied: Click here to enter text.

Does the research require participants to consume any food products?

No ☒

Yes ☐

If yes, please provide full details and indicate measures in place to ensure excellent food hygiene standards and ensure participant safety. Click here to enter text.

Do you consider there are any potential ethical issues in this project? Does the research require collection of information that might be considered sensitive in terms of confidentiality, potential to cause personal upset, etc.?

No ☒

Yes ☐

If yes, please provide full details and indicate how these issues will be addressed, how researchers will manage participant reaction. Support and de-brief sheets should be attached if relevant. Click here to enter text.

Will the research involve any element of intentional deception at any stage? (i.e. providing false or misleading information about the study, or omitting information)?

No ☒

Yes ☐

If yes, this must be justified here. You should also consider including debriefing materials for participants which outline the nature and justification of the deception used. Click here to enter text.

Are participants offered a guarantee of anonymity and/or that the information they supply will remain confidential?

Yes ☒

No ☐

If yes, give brief details of the procedures to be used to ensure this and particularly if the data has 'linked' or 'keyed' anonymity (eg. where published results are anonymous but participant details are recorded and held separately to the responses but keyed with reference number) : Information regarding participants will be recorded and held separately from the response. However, the data will be keyed with reference numbers

Will participants be required to complete a separate consent form? Many APD applications do not require participants to complete a separate consent form. Please see the templates provided.

Yes. Names, addresses and copies of completed forms will be given to APD student office

☒ No. The data collection is anonymous and a combined information/consent sheet supplied

Neither of the above, or the research involves participants under the age of 16

If 'neither of the above' selected, or the research involves participants under the age of 16, please outline the specific circumstances. Click here to enter text.

Will participants be offered any form of incentive for undertaking the research?

No ☒

Yes ☐

If yes, give brief details, including what will happen to the incentive should the participant later withdraw their input or decide not to proceed : Click here to enter text.

DATA PROTECTION

Data Storage, data protection and confidentiality. Please make sure you are familiar with the University of Reading's guidelines for data protection and information security. http://www.reading.ac.uk/internal/imps/

Please outline plans for the handling of data to ensure data protection and confidentiality. Covering the following issues: Will any personal information be stored? How and where will the data be stored? Who will have access to the data? When will it be deleted?

Participants will be identified by ID number. Any personal details related to the ID (names of repondents) will be stored separately with a link to the ID number. As such, the contribution of each participant will be referred to by use of the ID number. More so, it must be noted that audio files and text files will be stored on my PC under password protection and will not be shared with third parties. The aggregated data will be retained for preparation of any publications. Original recordings, transcripts and any kind of identifying information will be destroyed at the end of my PhD course.

Applicants: Please now scroll to Section 7 to input your :

Information Sheet(s) for Participants (mandatory)

Data Collection Tools, for example: recruitment materials, interview/focus group protocols (how you are conducting the process), interview/focus group questions, questionnaires, online survey questions, debriefing and fact sheets

- Consent Forms (optional, may not be necessary if consent assumed in Information Sheet)

If the text boxes do not allow input in the desired format, please append documents separately to the email when sending this form.

Please then email your completed form (and any separate supporting documents) to your supervisor/project investigator. Project investigators or independent academics may return form directly to sapdethics@reading.ac.uk

A decision on whether ethical clearance has been granted will be emailed to you via the APD Student Office along with your authorised form.

You may NOT proceed with your data collection until ethical approval has been granted as evidenced by return of this approved form.

Note: The process of obtaining ethical approval does not include an assessment of the scientific merit of the questionnaire. That is the separate responsibility of your supervisor/project investigator in discussion with yourself.

Supervisor/project investigator review. Section to be completed by supervisor/PI where relevant.

Participant information sheet(s), data collection tools and any other supporting information may be pasted in section 7 below. Alternatively they may be attached to this email. Please review these documents and then complete the checklist below.

Checklist. Does this application and supporting documents adequately address the following ?

☒ The safety of the researcher(s) and those collecting data, the safety of the participant(s)

☒ Is the language /grammar/content appropriate (i.e. University standards and reputation upheld)

☒ There are no questions that might reasonably be considered impertinent or likely to cause distress to the participants

☒ The researcher has provided the participant information sheet (mandatory)

☒ The researcher has provided the questionnaire or survey/ workshop, focus group or interview questions (mandatory)

☒ The Participant Information Sheet gives sufficient information for the participants to give their INFORMED consent

☐ A separate consent form has been included (optional)

☒ Data will be handled, stored and deleted appropriately according to University guidelines, and the participants have been adequately informed about this in the Participant Information Sheet

☒ The Participant Information Sheet contains all relevant sections

☒ **I am satisfied that this application meets the minimum standards for APD Ethical Clearance to be granted**

Supervisor/Project Investigator, please forward this form as a WORD document and any separate supporting documents to sapdethics@reading.ac.uk. The form will be logged by the student office and allocated to an APD ethics committee reviewer. The APD ethics reviewer will review the application and complete section 6.

APD ethics committee review. Section to be completed by APD Ethics Committee member.

Decision

Clearance refused ☐
Resubmission required ☐

Clearance granted as presented ☒
Clearance granted subject to revisions suggested ☐
No need to resubmit once amended Referred to APD Research Ethics Chair☐
May require further information

Ethics Committee Member please enter comments, reasons for rejection, summary of revisions required before proceeding (if applicable):

Click here to enter text.

Committee Member Name: Giacomo Zanello **Date Reviewed :** 24/05/2023

APD Ethics Committee member electronic signature (For signature, save document as pdf, then open pdf and use 'sign' option. Alternatively check here if no electronic signature used ☐)

APD Ethics Committee Member : Now please email this completed form (as signed pdf) to sapdethics@reading.ac.uk together with any separate supporting documents . The student office will record the outcome and return the completed form to the applicant with the decision.

Supporting Documents.

Please cut and paste the following documents into the text boxes below.

- Participant Information Sheet(s),
- Protocols (the procedures, how you will conduct and administer the data collection, interviews, surveys)
- Data Collection Instruments (interview questions and survey questions)
- Consent Forms (if Participant Information Sheet does not assume consent)
- Recruitment Materials (if relevant)

It is preferable that all information connected to this application is contained in one document. However, if you find that the text boxes below are not adequate, you may attach and email these supporting documents separately.

Supporting Documents for this application are pasted below. The text boxes cannot accept some types of formatting when pasting in documents. If this is the case, append them separately to the email with this form.

Participant Information Sheet

Project name: Artisanal Small-Scale Mining (ASM) and its implications on food security,

health and nutrition Thank you for your interest in this study.

Before you decide to participate, it is important you understand why the research is being completed, and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

I am a PhD student at the University of Reading. As part of my thesis, I am conducting research into Artisanal Small-Scale Mining (ASM) and its implications on food security, health and nutrition.

This research project aims to find out how women in Artisanal Small Scale Mining communities are impacted by their direct and indirect participation in the Artisanal Small Scale Mining activity. Artisanal Small-Scale Mining is an important livelihood activity in your community. As far as my research is concerned, I want to understand what impact participating in ASM has had on your livelihood as far as health, food security and nutrition are concerned. Other dimensions of interests in this interview as far as your participation in ASM is concerned are its impact on your environment, time use, economic impacts, leadership and social impacts.

To undertake this research, we are currently contacting women in ASM households. We would like to invite you to participate in this in-depth interview taking place in your community which is Kyebi, in the East Akim District of the Eastern Region of Ghana. This interview will take approximately 1 hour of your time. You are going to be interviewed on how your direct and indirect involvement in ASM has impacted on you. With the assistance of the ASM union in the community and community opinion leader (This was done so as to gain access to respondents and guarantee safety of respondents), you have been purposively selected as part of 20 women participants, ten
(10) each of you who are directly impacted by Artisanal Small Scale Mining while the other are not directly involved but are impacted by virtue of the participation by other household

members in the mining activity. We are interested in how the Artisanal Small Scale Mining activity has directly and indirectly impacted on you. Notably, the interview questions put down are basically regarding areas of health and safety, leadership, economic impacts, social impacts, time use, nutrition/ food security, environmental impacts and other domestic roles. So, these are the broad topics that I will be talking about. You are encouraged to freely express your opinions and please be assured that your views are valued and that, there are no right or wrong answers to the questions asked.

We will not collect any personal details as part of the interview. Your identity will not be revealed to anyone other than the researcher conducting this survey. Each participant will be identified by means of a random number allocated at the beginning of the study. This information will be put on a spreadsheet and will be passwordprotected and the password known only to me and my supervisor, and will not be shared with any third parties. The spreadsheet will be kept on my password protected PC and will be destroyed at the end of my PhD studies. Your personal details will not be published as part of my research. As all data is presented in aggregate format, it will not be possible to identify any individuals from their responses.

Participation is entirely voluntary and you are free to withdraw from the interview at any time you feel uncomfortable or unwilling to participate, and you do not have to specify a reason. You will not be incentivised in anyway. This interview will not have any health implications whatsoever, on the respondents.Any in-part or total contribution can be withdrawn up until the point at which the data is aggregated before 31/12/2023. After 31/12/2023 it will not be possible to withdraw your contribution from the results of the research. If you wish to withdraw, please contact Kwadwo Adusei Peasah on +44(0)7393739730, quoting the reference at the top of this page. The reference will only be used to identify your interview transcript and will not reveal any other information about you.

The discussion will be audio recorded if you agree, and the anonymised transcripts of the audio recordings will be used by the student researcher working on the project. Once transcribed the original recording will be deleted.
Your anonymity will not be compromised as only the reference number above will be used to identify the transcript.

If at any stage you wish to receive further information about this research project, please do not not hesitate to contact me by my email details below before 31/01/2025. The findings will be written up into my PhD thesis and published in academic journals. This will not affect your anonymity.

All data I collect will be stored securely electronically on a password-protected computer. The original recording, transcripts and any kind of identifying information will be deleted at the end of the research project upon completion of my PhD studies. However, the aggregated data will be retained without any identifying information.

By participating in this interview, you are acknowledging that you understand the terms and conditions of participation in this study and that you consent to these terms.

This research project has been reviewed according to the procedures specified by the University Research Ethics Committee, and has been given a favourable ethical opinion for conduct.
Thank you very much for taking time to take part in this survey.

Kwadwo Adusei Peasah
School of Agriculture, Policy and Development Agriculture Building
Earley Gate,
Whiteknights Road
PO Box 237
Reading
RG6 6AR
United
Kingdom
Phone: + 44 (0) 07393739730
E-Mail: k.aduseipeasah@pgr.reading.ac.uk

Alternatively, you may contact my supervisor on Supervisor Contact Details
Name: Prof. C.S. Srinivasan Phone:
+44 (0) 118 378 8966
E-Mail: c.s.srinivasan@reading.ac.uk

PROTOCOLS

Informed Consent: Importantly, there is need to obtain informed consent from the women respondents before collecting data. This includes furnishing them with information about the purpose and nature of the study, the data collection, the expected duration of the study, and any potential risks or benefits of participating. In any case, women respondents have the right to decline to participate without any consequences.

Confidentiality: All data collected will be treated as confidential. In addition, there are measures taken to protect the privacy and anonymity of the participants. These include using pseudonyms, password-protected electronic devices, and secure storage methods to contain the data collected.

Ethical Considerations: Ethical standards will be adhered to. Participants will be treated with with respect and provided opportunities for them to ask questions or withdraw their consent.

Data Collection Methods: interview guides will be used in collecting information from respondents. The guide contain open ended questions that seek to solicit deep-seated views of respondents.

Women respondents who participate directly and indirectly in ASM activity will be purposively selected and interviewed.These women in ASM households must be above the age

of 18 years. This study is interested women who have been working in the ASM industry for a year or more. As such, this will be the sampling frame from which woman will be randomly picked to be interviewed. This will be obtained by consulting with local mining unions and community/opinion leaders who can provide me with information on the population of women miners in the area. There after, women will be randomly selected as a subset of women from the sampling frame, using systematic sampling method.

Thereafter, the selected women will be contacted to explain the purpose of the study, the interview process, and the time commitment required. They will also be provided with an opportunity to ask questions and obtain informed consent before proceeding with the interview.Interviews will be conducted using interview guide that addresses the research questions. Interviews will be conducted in a private and comfortable setting where the interviewees feel safe and respected.

For the purposes of keeping and maintaining a true representation of the respondents' view, the interview will be recorded with the consent of the respondents. Thereafter, the interview data will be transcribed and analyzed. The confidentiality and anonymity of the respondent will be ensured throughout the process so as to protect their privacy.

DATA COLLECTION INSTRUMENTS

INTERVIEW GUIDE FOR ASSESSMENT OF WOMEN EMPOWERMENT IN ASM HOUSEHOLDS

The interview will be a semi-structured interview where the respondent women will be asked about their nature of involvement in ASM, the impact of involvement in ASM activities on their health and safety, economic well- being, nutrition and food security, time use, domestic roles and also about environment impacts. The questions under each of these sections in the interview guide below are only indicative of the issues that the respondents will be encouraged to discuss in the course of the interview and are not intended as sequential questions to be put to each respondent.

Module A: Individual Identification

1. Household Identification: .....
2. Name of respondent currently being interviewed

Surname……...Other Name……...

3. Sex of Respondent M/F
4. Type of household

□ male and female adult □ female adult only

5. Household size □1 □2 □3 □4 □5 □6 and more
6. Ability to be interviewed alone

□Alone □With adult females present □With adult males present □With adults mixed sex present □With children present □With adults mixed sex and children present

7. Outcome of interview

□Completed □household member too ill to respond/cognitively impaired □respondent not at home/temporarily

□unavailable □respondent not at home/extended absence □refused □could not locate Module

B: Participation Levels in ASM activities

(This section seeks to know more about the extent of participation in ASM activities)

1. How do you describe your participation in ASM activities?
2. Are there any members of your household involved in ASM?
3. What are some of the things you do/levels of participation as far as your participation in ASM is concerned?
4. How many members of your household are involved in ASM?
5. In what ways does their engagement in ASM affect the household?

Module C: Direct participation Impacts on health and safety risks

1. In what ways has your health been impacted by your participation in ASM
2. How has your mental and physical health been impacted as a result of your participation in ASM?
3. How frequently have you been reporting sick ever since your participation in ASM?
4. How often have you reported injuries relating to participation in ASM activities?
5. How often have you had to stop going to work due to poor health condition as a result of participation in ASM?
6. Have you had any other occupational health effects as a result of your participation in ASM?
7. How has participation in ASM affected your reproductive health?
8. Have you been hospitalised as a result of your participation in ASM?
9. How long was the hospitalisation as a result of your participation in ASM?
10. How much did you spend on medications and hospital bill on such medical expenses relating to your participation in ASM?
11. Are there any other ways your health has been impacted as a result of your participation in ASM? Leadership and decision-making impacts

1. How has your participation in ASM impacted your role as a woman in the household?
2. How has your participation in ASM affected your ability to take up certain positions?
3. How has you participation in ASM changed your ability to contribute towards decision making at work?
4. How has your participation in ASM affected your capacity to access certain resources/technology/interventions?
5. How has your participation in ASM impacted your capacity to access development/education/training or particular skillsets?
6. Are there any skills that you have cultivated as a result of participating in ASM?
7. How has your involvement in ASM impacted your decision making in the household?
8. In what other ways has your participation in ASM changed/impacted your decision making? Economic Impacts

1. How has your income changed by your direct participation in ASM activities?
2. How has your savings changed by your direct participation in ASM activities?
3. How has the household budget been affected ever since you got involved in ASM?
4. How has your participation in ASM affected your ability to contribute towards

household expenses?

5. How has your participation in ASM changed any other enterprise you are engaged in?
6. How has your participation in ASM affected your decision to take a loan or borrow cash/in-kind from Non- Governmental Organisations (NGO), bank/financial institution, friends and relatives, group-based microfinance and informal credit/savings?
7. How has your participation in ASM affected your ability to cater for your home?
8. In what other ways have you been economically affected by your participation in ASM? Social Impacts

1. How has your direct participation in ASM affected your social status and relationships with their families and communities?

2. Have you been involved in ASM experienced any form of discrimination/social stigma as a result of your participation in ASM?
3. Have you suffered any form of physical, psychological, emotional or mental abuse as a result of your involvement in ASM?
4. Have you experienced any form of violence/assault ever since your participation in ASM?
5. How did this affect the rest of the household as a result of your participation in ASM?
6. Socially, are there any other ways you have been affected by your participation in ASM? Impacts on Time Use

1. How has your participation in ASM affected your work load at home?
2. How has your participation in ASM activities affected your child care responsibilities?
3. In what other ways has participation in ASM affected your time spent with family?
4. How has your participation in ASM affected the performance in your domestic/household responsibilities.?
5. How has your participation in ASM affected your reliability, punctuality and consistency at work? Impacts on Nutrition/Food Security

1. Was there a time when you or others in your household experienced any food scarcity as a result of your involvement in ASM?
2. Was there a time when you or others in your household were unable to eat healthy and nutritious food because of a lack of money or other resources as a result of your participation in ASM activities?
3. How has your participation in ASM affected the kinds of foods purchased and the monetary budget for food?
4. Have you or your household ran out of food because of a lack of money or other resources as a result of your involvement in ASM?
5. Have you or your household gone an entire day without eating for due to lack of money or other resources ever since your participation in ASM?
6. In what other ways has your nutrition changed due to your participation in ASM?
7. In what other ways has your participation in ASM affected your agricultural responsibilities?

Module D: Indirect participation Impacts

on Nutrition/food security

1. Have you taken up any agricultural activities due to the involvement of any household member in ASM?
2. What were some of these agricultural activities/how has this changed your roles in this regard?
3. How has your feeding been affected by involvement of any household member in ASM?
4. How has purchase of food items been affected by the involvement of any household member in ASM?
5. In what other ways has the involvement of a member of the household affected your nutrition/food security? Economic Impacts

1. How has your income been changed by your indirect participation in ASM activities?
2. How has your savings been impacted by your indirect participation in ASM activities?
3. How has the household budget been affected ever since a member of the household got involved in ASM?
4. How has your indirect participation in ASM affected your capacity to take a loan or borrow cash/in-kind from Non-Governmental Organisations (NGO), bank/financial institution, friends and relatives, group-based microfinance and informal credit/savings?
5. As a result of indirect participation in ASM, who makes the decisions regarding the purpose of the money borrowed and why?

Environmental Impacts

1. Are there any environmental relation issues you are have been confronted with as a result of your indirect participation in ASM?
2. In what ways were you affected by these environmental issue as a result of this indirect participation?
3. In what ways has your environment been affected as a result of indirect participation in ASM?
4. In what other ways has your indirect participation impacted the environment? Impacts on Time Use

1. How has your indirect participation in ASM affected your work load at home?
2. How has your participation in ASM activities affected your child care responsibilities?
3. In what other ways has participation in ASM affected your time spent with family?
4. How has your participation in ASM affected the performance in your domestic/household responsibilities.?
5. How has your participation in ASM affected your reliability, punctuality and consistency at work?

Impact on additional domestic roles

1. What roles did you have to play as a result of the participation of a household member in ASM, that has not been mentioned?
2. How have your roles in decision making been affected as a result of participation of a household member in ASM?
3. In what other ways are you affected due to indirect participation in ASM?

APPENDIX II: INTERVIEW GUIDE FOR ASSESSMENT OF WOMEN EMPOWERMENT IN ASM HOUSEHOLDS

Module A: Individual Identification

1. Household Identification: .....

2. Name of respondent currently being interviewed

Surname……...Other Name……...

3. Sex of Respondent M/F

4. Type of household

□ male and female adult □ female adult only

5. Household size □1 □2 □3 □4 □5 □6 and more

6. Ability to be interviewed alone

□Alone □With adult females present □With adult males present □With adults mixed sex present □With children present □With adults mixed sex and children present

7. Outcome of interview

□Completed □household member too ill to respond/cognitively impaired □respondent not at home/temporarily □unavailable □respondent not at home/extended absence □refused □could not locate

Module B: Participation Levels in ASM activities

(This section seeks to know more about the extent of participation in ASM activities)

1. How do you describe your participation in ASM activities?

2. Are there any members of your household involved in ASM?

3. What are some of the things you do/levels of participation as far as your participation in ASM is concerned?

4. How many members of your household are involved in ASM?

5. In what ways does their engagement in ASM affect the household?

Module C: Direct participation

Impacts on health and safety risks

1. In what ways has your health been impacted by your participation in ASM

2. How has your mental and physical health been impacted as a result of your participation in ASM?

3. How frequently have you been reporting sick ever since your participation in ASM?

4. How often have you reported injuries relating to participation in ASM activities?

5. How often have you had to stop going to work due to poor health condition as a result of participation in ASM?

6. Have you had any other occupational health effects as a result of your participation in ASM?

7. How has participation in ASM affected your reproductive health?

8. Have you been hospitalised as a result of your participation in ASM?

9. How long was the hospitalisation as a result of your participation in ASM?

10. How much did you spend on medications and hospital bill on such medical expenses relating to your participation in ASM?

11. Are there any other ways your health has been impacted as a result of your participation in ASM?

Leadership and decision-making impacts

1. How has your participation in ASM impacted your role as a woman in the household?

2. How has your participation in ASM affected your ability to take up certain positions?

3. How has you participation in ASM changed your ability to contribute towards decision making at work?

4. How has your participation in ASM affected your capacity to access certain resources/technology/interventions?

5. How has your participation in ASM impacted your capacity to access development/education/training or particular skillsets?

6. Are there any skills that you have cultivated as a result of participating in ASM?

7. How has your involvement in ASM impacted your decision making in the household?

8. In what other ways has your participation in ASM changed/impacted your decision making?

Economic Impacts

1. How has your income changed by your direct participation in ASM activities?

2. How has your savings changed by your direct participation in ASM activities?

3. How has the household budget been affected ever since you got involved in ASM?

4. How has your participation in ASM affected your ability to contribute towards household expenses?

5. How has your participation in ASM changed any other enterprise you are engaged in?

6. How has your participation in ASM affected your decision to take a loan or borrow cash/in-kind from Non-Governmental Organisations (NGO), bank/financial institution, friends and relatives, group-based microfinance and informal credit/savings?

7. How has your participation in ASM affected your ability to cater for your home?

8. In what other ways have you been economically affected by your participation in ASM?

Social Impacts

1. How has your direct participation in ASM affected your social status and relationships with their families and communities?

2. Have you been involved in ASM experienced any form of discrimination/social stigma as a result of your participation in ASM?

3. Have you suffered any form of physical, psychological, emotional or mental abuse as a result of your involvement in ASM?

4. Have you experienced any form of violence/assault ever since your participation in ASM?

5. How did this affect the rest of the household as a result of your participation in ASM?

6. Socially, are there any other ways you have been affected by your participation in ASM?

Impacts on Time Use

1. How has your participation in ASM affected your work load at home?

2. How has your participation in ASM activities affected your child care responsibilities?

3. In what other ways has participation in ASM affected your time spent with family?

4. How has your participation in ASM affected the performance in your domestic/household responsibilities.?

5. How has your participation in ASM affected your reliability, punctuality and consistency at work?

Impacts on Nutrition/Food Security

1. Was there a time when you or others in your household experienced any food scarcity as a result of your involvement in ASM?

2. Was there a time when you or others in your household were unable to eat healthy and nutritious food because of a lack of money or other resources as a result of your participation in ASM activities?

3. How has your participation in ASM affected the kinds of foods purchased and the monetary budget for food?

4. Have you or your household ran out of food because of a lack of money or other resources as a result of your involvement in ASM?

5. Have you or your household gone an entire day without eating for due to lack of money or other resources ever since your participation in ASM?

6. In what other ways has your nutrition changed due to your participation in ASM?

7. In what other ways has your participation in ASM affected your agricultural responsibilities?

Module D: Indirect participation

Impacts on Nutrition/food security

1. Have you taken up any agricultural activities due to the involvement of any household member in ASM?

2. What were some of these agricultural activities/how has this changed your roles in this regard?

3. How has your feeding been affected by involvement of any household member in ASM?

4. How has purchase of food items been affected by the involvement of any household member in ASM?

5. In what other ways has the involvement of a member of the household affected your nutrition/food security?

Economic Impacts

1. How has your income been changed by your indirect participation in ASM activities?

2. How has your savings been impacted by your indirect participation in ASM activities?

3. How has the household budget been affected ever since a member of the household got involved in ASM?

4. How has your indirect participation in ASM affected your capacity to take a loan or borrow cash/in-kind from Non-Governmental Organisations (NGO), bank/financial institution, friends and relatives, group-based microfinance and informal credit/savings?

5. As a result of indirect participation in ASM, who makes the decisions regarding the purpose of the money borrowed and why?

Environmental Impacts

1. Are there any environmental relation issues you are have been confronted with as a result of your indirect participation in ASM?

2. In what ways were you affected by these environmental issue as a result of this indirect participation?

3. In what ways has your environment been affected as a result of indirect participation in ASM?

4. In what other ways has your indirect participation impacted the environment?

Impacts on Time Use

1. How has your indirect participation in ASM affected your work load at home?

2. How has your participation in ASM activities affected your child care responsibilities?

3. In what other ways has participation in ASM affected your time spent with family?

4. How has your participation in ASM affected the performance in your domestic/household responsibilities.?

5. How has your participation in ASM affected your reliability, punctuality and consistency at work?

Impact on additional domestic roles

1. What roles did you have to play as a result of the participation of a household member in ASM, that has not been mentioned?

2. How have your roles in decision making been affected as a result of participation of a household member in ASM?

3. In what other ways are you affected due to indirect participation in ASM?

APPENDIX III: QUESTIONS ON HOUSEHOLD FOOD INSECURITY

	During **the last 12 MONTHS:**	**Code** "Yes" = 1" No"= 2 "Don't 'know" = 8 "Refused" = 9
1	Was there a time when you or others in your household worried about not having enough food to eat because of a lack of money or other resources?	
2	Still thinking about the last 12 MONTHS, was there a time when you or others in your household were unable to eat healthy and nutritious food because of a lack of money or other resources?	
3	Was there a time when you or others in your household ate only a few kinds of foods because of a lack of money or other resources?	
4	Was there a time when you or others in your household had to skip a meal because there was not enough money or other resources to get food?	
5	Still thinking about the last 12 MONTHS, was there a time when you or others in your household ate less than you thought you should because of a lack of money or other resources?	
6	Was there a time when your household ran out of food because of a lack of money or other resources?	
7	Was there a time when you or others in your household were hungry but did not eat because there was not enough money or other resources for food?	
8	Was there a time when you or others in your household went without eating for a whole day because of a lack of money or other resources?	

APPENDIX IV: SAMPLE OF TRANSCRIPTIONS FROM INDEPTH INTERVIEWS (DIRECTLY IMPACTED RESPONDENT)

My name is Adwoa Hannah (pseudonym). I belong to a household with seven (7) people including myself. There are four (4) females and two (2) males. I feed them all. The females are in secondary school while the other two males are doing their own work as artisans. I have used ASM (galamsey) work cater for my four females in Senior High School. I am the only one in the family involved in galamsey. At the galamsey site, I am the head of females at the site, I share the roles among the females at the site, I have time to cater for my children despite my involvement in Galamsey. I have had no injury at the galamsey site, I do not normally fall sick as a result of galamsey. Sometimes when I have headaches, I don't go to the galamsey site. We don't sit in water while washing the sand at the site. I also don't go to the ASM site when in my menses as there are traditional customs that prohibit that. I have never been hospitalized as result of galamsey.

At the site, I organize the ladies, I discipline them too. I settle disputes and punish culprits. Galamsey has helped me to cater for my kids but I have not been able to buy any electronic gadgets such Mobile phone. I have not obtained any skill at the galamsey. Infact the galamsey has improve my financial standings. I am able to give my friends loans but I have no account for savings. I also do not loan from the bank. At the galamsey site, there is no discrimination. I normally fight at the galamsey site, we fight verbally. I Have enough time since the job is in a shift plan, therefore I have enough time to cater for my wards.

There is no way the galamsey job has affected my household chores and domestic duties.

I am able to eat what I want as a result of galamsey. I normally eat my favorite since I have enough money. Nobody goes hungry at my household. Whenever food is running out, I go out to buy food on credit and pay back with the money I am able to get from the ASM work. Aside doing this ASM work, I am a maize farmer. The galamsey has not affected me.

APPENDIX V: SAMPLE OF TRANSCRIPTIONS FROM INDEPTH INTERVIEWS: (INDIRECTLY IMPACTED RESPONDENT)

I take care of six (6) children four (4) girls and thee (2) boys. One is 2years old, 4 years old and 11 years while the others are also 8years old ,7 and 10 years old. Anytime they go out for their ASM activities. I am the one who cooks for the children, bath them, dress them up and mind them anytime their parents go to work.

I have always been engaged in agricultural activities for a long time. I cultivate plantain, yam cassava, cocoa and maize. I am 55 yeas of age. Despite my age, I am still engaged in agricultural activities in addition to taking care of my grandchildren

Due to this extra responsibility, I have stopped some aspects of farming like the cassava farming which I used to. For the cocoa, I have leased it out to a farm hand. I have done all these because I don't get time to work on the farm. My husband that used to help me now is no more.

More so I purchase a lot of food from outside. Some of the foodstuff like cassava that I would have farmed for, I have to go and buy them because I don't have time to cultivate them. I buy cassava and rice and other stuff. I am not able to buy and prepare the food that I want. Apart from agriculture, I prepare kenkey for sale. I am not able to do enough savings due to all these responsibilities. I can only save less that 300 pounds a month. I go and borrow money from friends and other creditors. I don't go to the bank for any credit due to police. I prepare the kenkey and send it to the retailers so they can sell it for me.

ASM is both good and bad for us. It has destroyed our waters, lands and led to the breeding of mosquitoes in our environment. It has also led to malaria among other diseases. When it happens like that, we can only resort to herbal medicine since we cannot afford hospital bills. Just recently, one of my grandsons got admitted and was discharged. Since I have to take care of her due to her parents involvement in ASM, I was not able to do my kenkey as usual. I really have

time for myself. Although I want to admit that I have lots of responsibilities, I still make time to take care of the six children.

With domestic duties too, I get enough time to do it. For social programs among other things, I am not able to attend most of them because I always want to give my grandchildren uttermost care since their parents are involved in ASM. It's not all the time that they go for ASM especially as it is raining. I have been taking care of the kids to an extent that the children no longer go to their parents even when they are aground. As they always like my company.

APPENDIX VI: ON-FIELD PHOTOGRAPHS OF ASM OPERATIONS AS WELL AS THE INTERVIEW SESSIONS

Plate 1: One DPA who is also a nursing mother being interviewed

Plate 2: One DPA being interviewed on one of the taboo days when she could not go to work

Plate 3: One elderly IPA being interviewed at her homestead

Plate 4: An elderly IPA being interviewed in the comfort of her home

Plate 5: One IPA being interviewed after taking the child she takes care of to school

Plate 6: A full set up of a 'champhyne' (ASM machine for processing the gold ore)

Plate 7: The aftermath effect of ASM operations resulting in a dug-out. A typical example of a stagnant water that could have adverse effects on human health and soil as well