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Dietary intake, nutritional status and mental wellbeing of homeless adults in Reading, UK[1-4]

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Running Head: Nutrition in homeless compared to housed adults

Keywords: homelessness, mental health, nutrient intake, dietary methodology, nutrition intervention

Abbreviations: CVD, cardiovascular disease; DRV, dietary reference value; EPIC, European Prospective Investigation into Cancer and Nutrition; FETA, FFQ EPIC tool for analysis; NSP, non-starch polysaccharides; PHQ-SADS, patient health questionnaire: somatic anxiety depressive symptoms; RNI, recommended nutrient intake; %E, percentage of total energy intake.

Abstract

Malnutrition has been reported in the homeless, yet the specific nutritional issues faced by each homeless community are unclear. This is in part due to nutrient intake often being compared to dietary reference values as opposed to a comparative housed population. Additionally, the complex interplay between nutrient intake, reward mediated behaviour and mental illness has frequently been overlooked. This observational study aimed to compare the dietary intake, nutritional status and mental wellbeing of homeless and housed adults. Homeless (*n*=75) and matched housed (*n*=75) adults were recruited from the Reading region (UK). Nutrient intake was determined using the EPIC Norfolk Food Frequency Questionnaire. The Patient Health Questionnaire: Somatic Anxiety Depressive Symptoms (PHQ-SADS) assessed for signs indicative of mental illness. Demographic, behavioural and physiological information was collected using closed-ended questions and anthropometric measurements. Overall, dietary intake was poorer in homeless adults who reported higher intakes of salt (8.0g vs. 6.4g, *P*=0.017), SFA (14.6% vs. 13.0%, *P*=0.002) and alcohol (5.3% vs. 1.9%, *P*<0.001) and lower intakes of fibre (13.4g vs. 16.3g, *P*<0.001), vitamin C (79mg vs. 109mg, *P*<0.001) and fruit (96g vs. 260g, *P*<0.001) than housed adults. Smoking, substance misuse and PHQ-SADS scores were also higher in the homeless group (*P*<0.001). Within the homeless population, street homeless (n=24) had lower SFA (13.7% vs.15.0%, *P*=0.010), calcium (858mg vs. 1032mg, *P*=0.027) and milk intakes (295g vs. 449g, *P*=0.001) than hostel residents (n=51), which may reflect the issues with food storage in street homeless individuals. This study highlights the disparity between nutritional status in homeless and housed populations and the need for dietary intervention in the homeless community.

Introduction

Homelessness is a global issue. In England, over 68,500 households in 2015 were classified as homeless [1] and a further 3,569 were considered rough sleepers [2]. The lack of stable accommodation, in conjunction with a low or absent income, raises challenges for the homeless, one of which is access to food, although this is likely to differ between rough sleepers and those in temporary accommodation. However despite the widespread prevalence of homelessness, relatively few studies have sought to determine the nutritional status of these individuals, a situation that may partly reflect the difficulty in collecting data from this transient population.

Despite this, several themes have emerged from studies to date, including a high SFA, low fruit and vegetable diet [3-6], elevated serum cholesterol [7] and low levels of vitamin B-6, calcium and iron[7; 8], although findings have not been consistent between countries. For example, lower skin-fold thickness and muscle mass measurements have demonstrated 'wasting' in homeless communities in Germany and the US (1989-2001) [4; 7; 8], whereas others have found a proportion of homeless that, according to their BMI, are overweight or obese in the US (2012-2013) [9; 10].

In the presence of physiological stresses arising from exposure to harsh environmental conditions, the absence of a nutritionally balanced diet is likely to have a detrimental impact on the health of a homeless individual. Elevated levels of acute and chronic disease [11; 12], increased visits to emergency departments [13] and an average age of death of 47 years in the UK [14] highlight the additional challenges faced by the homeless community. Cardiovascular disease (CVD), for which diet is a key modifiable factor, is reported as the leading cause of mortality in homeless adults between 45-65 years, [15; 16].

A higher prevalence of mental illness (e.g. depression, anxiety) in the homeless compared to the general population has also been reported [12; 17]. Reward mediated behaviors such as problematic alcohol use, smoking and substance misuse are also frequently described [4; 12]. The reported substitution of food with alcohol by alcoholic homeless individuals [4] and the use of money for illicit substances as opposed to food in homeless drug addicts [12] demonstrates the potential nutritional consequences arising from reward mediated behavior. Addictive substances may also impact upon the absorption, metabolism and/or requirements for nutrients [18; 19].

Habitual diets and culture limit the extent to which nutrient intake of the homeless is comparable between countries or regions [20]. Furthermore, studies have often failed to account for the impact of physical and mental wellbeing on dietary intake; do not use a control group and have widespread reliance on dietary reference values (DRV), which is potentially misleading. Comparing homeless and housed individuals within the same region would overcome this issue, providing a more accurate assessment of homeless intake in the specific location. However such studies are currently lacking.

The aim of the present research was to compare nutritional status, dietary intake and mental wellbeing in a group of homeless with age and gender-matched housed individuals (control group) in Reading, UK. A secondary aim was to establish the marginal impact of homeless status (e.g. street homeless vs. hostel residents) on these parameters.

Methods

Participants and study design

In this cross-sectional observation study homeless (n=75) and housed (n=75) men and women were recruited. During recruitment, the two groups were broadly matched on the basis of age range (18-29, 30-39, 40-49, >50yrs), gender and ethnicity. In order to capture homeless individuals at the more extreme stages of homelessness this study only included individuals ‘living rough’ on the street and those in the initial stages of housing (supported living). Street homeless were recruited from a church drop-in centre that provides hot meals. Two hostels (charity and council led) were used to recruit individuals residing in ‘stage 1’ accommodation. In addition to accommodation for adults previously living on the street, the charity-led hostel also provides ‘in house’ meals. Recruitment posters were displayed in each venue by staff, and residents/clients recruited on a first-come basis. Housed volunteers were recruited at random through a volunteer database at the Hugh Sinclair Unit of Human Nutrition, Reading, and via posters displayed at Reading central library and around the Reading University campus. The University of Reading School of Chemistry, Food and Pharmacy Research Ethics Committee (Approval number: 20/14) and The Salvation Army Ethics Committee granted ethical approval for the study. All participants gave informed written consent prior to participation.

Data Collection

Each participant completed three questionnaires during a single research session. A room was provided at each venue for the purpose of the study and one of four trained researchers and a volunteer from the specific venue were present during each session. Each volunteer was provided with the option of either completing the questionnaires themselves or being asked the questions by the researcher. For those opting to self-complete the questionnaires, responses were checked and verified prior to departure. Questionnaires took between 60-90 minutes to complete. Volunteers were reimbursed for their participation in the study via a £10 shopping voucher.

Questionnaires

To assess nutrient intake, the European Prospective Investigation into Cancer and Nutrition (EPIC)-Norfolk FFQ was used. The FFQ is a validated semi-quantitative questionnaire consisting of 130 food and drink items [21; 22]. For each item the participant is required to choose one out of 9 possible frequency options ranging from 'never/less than once a month' to '6+ per day'. FFQs are typically completed with reference to the preceding 6 months to 1 year. However to ensure reported nutrient intake related to the time an individual was homeless, participants were asked to complete the FFQ with reference to the last month only, as some had been homeless for one to two months. FFQ EPIC tool for analysis (FETA) software was used to determine daily nutrient levels from the FFQ responses, which is based upon McCance and Widdowson's The Composition of Foods (5^{th} edition) and its supplements [23]. Energy, macronutrients (including sub-classes of fats and carbohydrates), key vitamins and minerals (associated with public health concerns), and 14 food groups (alcoholic beverages, cereal and cereal products, egg and egg dishes, fats and oils, fish and fish products, fruit, meat and meat products, milk and milk products, non-alcoholic beverages, nuts and seeds, potatoes, soups and sauces, sugars; preserves and snacks, and vegetables) were reported in the present analysis.

The validated Patient Health Questionnaire: Somatic Anxiety and Depressive Symptoms (PHQ-SADS) was used to determine the presence of symptoms related to a mental health condition [24]. It combines three questionnaires to screen for the presence of depression (PHQ-9), anxiety (GAD-7) and somatization (PHQ-15) disorders. Each part of the questionnaire resulted in a score from

which individuals are categorized as 'none', 'mild', 'moderate' or 'severe' with relation to the presence of depressive, anxiety and/or somatic symptoms.

A 'Health and Lifestyle' questionnaire formulated specifically for the present study was used to record demographic data as well as information about smoking, alcohol and substance abuse. The questionnaire consisted predominantly of quantitative questions requiring a yes/no answer. Individuals were also asked about their appetite, meal frequency and the amount of money spent on food using questions, as per previous studies on nutritional status and homelessness [7].

Physiological measurements

A stadiometer (Seca 213, Seca medical measuring systems) and calibrated electrical scales (Seca 877, Seca medical measuring systems) were used to measure height and weight respectively using standard operating procedures. BMI was calculated as weight (kg)/ height (m^2) and classified in accordance with the WHO guidelines [25]. The mean of three handgrip strength measurements of the participant's dominant hand using a hand-held dynamometer (Takei 5001, Takei Scientific Instruments Co.) provided a non-invasive measure of general muscle strength [26]. Blood pressure measurements were taken in triplicate using an automated blood pressure monitor (M10-IT, Omron healthcare Ltd.). In order to assess CVD risk, the online 'QRISK 2-2015 Web Calculator' was used to estimate the 10-year risk of developing CVD [27].

Statistical analysis

The study was powered using previous comparison of energy intake (kJ) in homeless and domiciled male youths in Toronto [28]. Using G*Power [29], it was estimated that 68 participants would be required in each group for a 2385kJ energy difference with s SD of 6408kJ (α level P=0.05, 1-β power 0.85). Estimated samples sizes based on differences in total fat (g), protein (g), vitamin B6 (mg) and calcium (mg) were lower (range n=12-32 per group). To allow for a 10% dropout or incomplete data collection a total of 75 participants were recruited per group.

Means and standard deviations were used to describe parametric distributed data, and medians and 95% Confidence Intervals (CI) for non-parametric distributed data. Counts and percentages were used for categorical variables. Homeless and housed groups were broadly matched for their gender, age range and ethnic category during the data collection stage. Data were checked for normality of distribution, and where possible skewed variables were transformed using $\log_{10}$.

Parametric data were analysed using general linear models (GLM) and non-parametric using Independent samples Mann-Whitney U tests for the comparison of continuous variables. For categorical variables chi-squared tests were used to assess for differences between the two groups. $P<0.05$ was classified as significant. Data were analysed using SPSS Statistics 21.0 (IBM, UK).

Results

Participant characteristics

Demographic information of the homeless (n=75) and housed (n=75) groups is shown in **Table 1**. The mean age was 38 (SD 11) years (range 19-59 years) for the homeless and 38 (SD 11) years for the housed participants (range 20-59 years). Ethnicity and gender distributions were matched between groups. With regards to education, there was a significant difference in attainment between groups (P<0.001); whilst the majority of homeless individuals had achieved secondary education or lower education (O-Level's/GCSE's and primary education), the majority of the housed group had attained above secondary level with 25% (*n*=19) reporting higher degrees compared to 4% (*n*=3) in the homeless group. Homeless individuals consisted of those sleeping rough on the street (*n*=24) or residing in Hamble Court (*n*=22) or Salvation Army (*n*=29) hostels. All housed individuals lived in private sector accommodation consisting of rented, mortgaged or owned property.

Responses of both groups to questions regarding reward mediated behaviour, meal consumption and cooking facilities are shown in **Table 2**. Significantly more homeless compared to housed individuals reported that they smoked ($P<0.001$) and/or had taken illicit substances within the preceding month ($P<0.001$). There was no significant difference between the number of individuals who reported consuming alcohol, although significantly more of the homeless (35%, *n*=18) compared to housed (8%, *n*=5) individuals who consumed alcohol reported intakes above the recommended weekly intake of 14 units (UK) for men and women respectively ($P<0.001$, data not shown). The majority of homeless individuals reported consuming 1 or 2 meals per day in contrast to the housed that predominantly reported 3 meals daily ($P<0.001$). In addition, significantly less homeless participants reported having enough to eat, a good appetite and

cooking facilities (all comparisons, *P*<0.001). For the homeless individuals reporting cooking facilities, the majority only had access to a microwave in a communal living space whereas all housed participants reported a full kitchen in their accommodation. A greater proportion of homeless individuals reported receiving less than £150 ($200) and spending less than £50 ($67) on food per week compared to housed individuals (all comparisons, *P*<0.001).

Physiological and psychological characteristics

There was no significant difference in BMI between the two groups as shown in **Table 3**. However, a greater number of homeless (66.6%) had a BMI<24.9kg/m^2, with 5.3% classified as underweight (BMI <18.5m^2), whereas half (50.6%) of the housed group were classified as overweight and obese (BMI>25kg/m^2) and none as underweight. Despite this 4% more homeless adults (21.3% vs. 17.3% for housed) were also classified as obese (BMI>30kg/m^2). The homeless had a significantly higher mean diastolic blood pressure (DBP) (*P*=0.008) and mean QRISK-2 score (*P*=0.009) compared to the housed, with no significant difference in systolic BP (SBP) or handgrip strength.

Homeless individuals scored significantly higher than the housed group for the presence of somatic (PHQ-15), anxiety (GAD-7) and depressive (PHQ-9) symptoms (all comparisons, *P*<0.001) with a mean classification of 'mild' (score range 5-9) for each condition (**Table 3**). In total, 24% (n=18) of homeless adults reported mental illness diagnoses (depression, n=11; schizophrenia, n=1, multiple diagnoses, n=5; undisclosed diagnosis, n=1) and 4% (n=3) of housed adults (all depression).

When comparing street homeless (n=24) with first-stage living hostel residents (n=51), no significant differences were observed for weight, BMI, SBP, DBP or PHQ-SADS scores (**Table 6**). There was a trend for higher handgrip strength in street homeless participants compared to first-stage living hostel residents (*P*=0.058), although the difference failed to reach significance. Mean duration of street homelessness was 5.4 (SD 6.8) months and hostel residency 9 months (SD 9.3).

Nutritional intake

Homeless individuals reported a significantly higher mean daily intake of total fat (*P*=0.049), SFA (*P*=0.002), MUFA (*P*=0.026) and alcohol (*P*<0.001), as a percentage of energy intakes, compared to the housed group (**Table 4**). In contrast, carbohydrate (*P*<0.001) and protein

194 (*P*=0.011) accounted for a significantly lower percentage of energy in the homeless group. Mean
195 daily intake of non-starch polysaccharides (NSP) was significantly lower in homeless compared to
196 homed individuals (*P*<0.001). Further comparison of daily NSP intake with the UK recommended
197 level of 18g [(30)] highlighted that the majority of homeless (*n*=58, 77%) and homed (*n*=46, 61%)
198 individuals had an intake below 18g (data not shown). Removal of over-reporters (n=2, homeless
199 adults) did not alter the statistical findings (data not shown). Whilst total energy intake did not differ
200 between street homeless and hostel residents, mean SFA intake (%TE) was significantly higher for
201 hostel residents (*P*=0.010).
202 Micronutrient data (**Table 4**) demonstrated a significantly higher mean daily intake of salt in the
203 homeless compared to housed group (*P*=0.014). In contrast, vitamin C intake was significantly
204 lower in the homeless compared to housed (*P*=<0.001). Daily intake for the majority of individuals
205 in both the homeless and homed groups was found to meet or exceed the RNI (32) for most of the
206 micronutrients measured including vitamin C. In contrast, 58 (77%) homeless and 54 (72%) homed
207 individuals had below the LRNI for selenium (**Figure 1)**. Approximately half of the homeless (*n*=39,
208 52%) and homed (*n*=38, 51%) groups failed to meet the zinc LRNI. Although the majority of
209 homeless (*n*=40, 53%) and homed (*n*=41, 55%) individuals met the iron LRNI, these were
210 predominantly men. Consequently for women, 13 out of 15 homeless and all of the 15 women in
211 the homed group failed to reach the iron LRNI of 14.8mg (data not shown). In contrast to iron, the
212 majority of homeless (*n*=61, 81%) and homed individuals (*n*=67, 89%) reported a sodium intake
213 above the LRNI of 1600mg. Of these individuals 45 (60%) homeless and 42 (56%) homed
214 consumed above the recommended maximum salt level of 6g.
215 Division of FFQ data into food groups is shown in **Table 5**. The mean daily homeless diet
216 consisted of significantly higher amounts of alcoholic beverages (*P*<0.001), fats/oils (*P*=0.023),
217 meat and meat products (*P*=0.037) and potatoes (*P*=0.035). In contrast, the homeless compared to
218 homed diet was composed of a significantly lower amount of fruit and nuts and seeds (*P's*<0.001),
219 and vegetables (*P*=0.022). Removal of individuals reporting mental health diagnoses (n=21)
220 resulted in a loss of significant difference in intake of fats/oils (P=0.18) between the groups; no
221 other findings were altered.

Calcium, iodine and riboflavin intakes were all significantly lower in street homeless compared with first-stage living hostel residents ($P<0.05$) (**Table 6**). Despite this, hostel residents were found to consume significantly greater quantities of milk ($P=0.001$) and potato ($P=0.012$), and less soups and sauces ($P=0.047$). There was also a trend for greater sugary snack consumption in hostel residents ($P=0.052$).

As a sensitivity analysis, data analysis was repeated in males only (n=120) and in participants reporting 'white' ethnicity (n=122). The identified significance differences were similar following removal of females, although just a tendency for a lower vitamin B6 intake in the homeless was observed ($P=0.078$). Analysis in only white participants led to an additional significant difference for PUFA (5.51% ± 1.41 homeless, 5.91% ± 1.36 housed, $P=0.031$).

Discussion

The present study compared dietary intake, nutritional status and mental wellbeing of homeless and housed adults in Reading. Our findings suggest that homeless adults have a higher risk of cardiovascular disease and incidence of anxiety and depressive symptoms, and poorer dietary and nutrient intake than housed adults. Homeless diets were characterised by high consumption of meat and meat product, fats and oils and alcoholic beverages, and significantly lower intakes of fruits, vegetables, nuts and seed than housed comparators. Street homeless were at particular risk of calcium and iodine deficiency, and had a significantly lower intake of milk and milk products than hostel residents.

Whilst no significant difference in energy intake was observed between homeless and housed adults, 27% of homeless reported not having 'enough to eat' and 38% reporting having ≤ one meals per day. There was also a trend ($P=0.080$) for a lower BMI in the homeless group. In the present study, both homeless and housed intakes of total fat and SFA exceeded the UK recommended intakes (total fat, 34% total energy; SFA, 10% total energy)[30]. However, homeless adults reported significantly a higher intake of these fats, as observed previously in the homeless community[7; 32]. This may be attributed to their greater intakes of meat and meat products (e.g. sausages, minced beef and processed sliced meat) and fats and oils (e.g. butter). SFA intake was

250 also significantly higher in hostel residents than street homeless, which supports previous data that
251 charitable meal provision is weighted towards sugar and fat energy [33]. Homeless adults reported a
252 significantly lower intake of carbohydrate and protein derived energy.

253 Englyst NSP intake was below the recommended daily intake of 18g/day [30] in both housed
254 and homeless groups. However, significantly lower intakes of NSP were reported in the homeless
255 group (no difference between street homeless and first-stage living hostel residents), which may be
256 due to their lower fruit and vegetable intake. A diet low in fruit, vegetables and fibre has been
257 reported previously in the homeless community [3-5]. In the present study, a greater disparity in fruit
258 intake between homeless and housed participants than vegetables was observed (170% vs.19%
259 higher in housed respectively); this may reflect the type of meals (hot meals including vegetables
260 [36]) available to the homeless population and lack of fresh fruit provided. In line with a low fruit
261 intake, a significantly lower intake of vitamin C was observed in the homeless, supporting previous
262 studies [6; 31]. However the majority of homeless individuals still met or exceeded the daily vitamin C
263 RNI of 40mg.

264 Intakes of calcium, iodine and riboflavin were significantly lower in street homeless compared
265 with hostel residents, who consumed significantly more milk and milk products and potato. This
266 may be due to hostel residents having access to cold food storage facilities and regular cooked
267 meals, which has been associated with nutritional advantages in the US [35]. Inadequate calcium
268 intakes have been observed previously in UK single homeless adults[36].

269 Alcohol was a significant source of energy in the homeless group, as reported previously [6].
270 Furthermore, a greater percentage of homeless had B vitamin intakes below the LRNI and, given
271 that chronic alcohol use is associated with malabsorption and reduced utilization of B vitamins [38],
272 this is likely to be underestimated. Early clinical thiamin (vitamin B1) deficiency, which causes the
273 alcohol–linked neurological disorder Wernicke–Korsakoff syndrome, has been observed previously
274 in homeless men [39] and prophylactic oral thiamine is advised for harmful or dependent drinkers at
275 risk of malnutrition [40].

276 The significantly higher salt intake in the present homeless population represents an
277 established risk factor for the development of hypertension [41] although, despite a significantly
278 higher diastolic level in the homeless group, mean blood pressure measurements were within the

normal range [42]. However, the significantly higher QRISK-2 score in the homeless group indicates that the homeless group are at a greater risk of developing CVD within the next 10 years. Hand grip strength, a low value of which has been associated with increased mortality in adults > 50 years [26; 43], was significantly greater in street-homeless compared to hostel residents; although this is likely to be most reflective of increased physical activity. Significantly more homeless compared to housed reported smoking and substance misuse in the present study, as documented previously [4; 12]. Furthermore, a significantly greater number of homeless that consumed alcohol reported an intake above recommended levels, which is consistent with previous data [6].

Homeless adults had significantly higher scores for each PHQ-SADS component compared to housed group, which corresponds with the high levels of mental illness reported in the homeless community versus the general population [12]. Within the homeless community, street sleepers are more likely to experience depression [44], as observed in the present study whereby street homeless had higher scores for the depressive component (PHQ-9) of the PHQ-SADS compared with hostel residents. It is currently unclear as to whether mental illness precedes homelessness or homelessness induces/ exacerbates the occurrence of mental illness and the role, if any, nutrition has to play in these conditions. The higher numbers of homeless compared to housed reporting a poor appetite, in the presence of the increased levels of mental illness, may reflect the depressive influence of mental conditions on appetite [45], which warrants further investigation.

The current study has a number of limitations. The high male to female ratio is consistent with other studies and reflects the preponderance of males in the homeless population [12]. However, male dominance and potential selection bias due to reliance on services accessed by the homeless to attain participants limit the generalizability of the results [48]. In addition, comparison with the most recent (2011) Census in Reading (74.8% white)[49], suggests that white individuals may have been over-represented in this sample (81% white). The significant difference between the educational status of the homeless and housed groups may represent an uncontrolled confounding factor given that higher educational status has been associated with a ‘healthier’ diet [50]. The EPIC FFQ has been validated for the assessment of nutrient intake in different populations [22; 51], is less burdensome that weighed intake dairies and was consequently considered appropriate for the current research. However, due to the transient nature of the homeless

population, participants were asked to report dietary intake over the previous month (i.e. shorter-term intake), which may have been challenging individuals with fluid dietary patterns. Memory recall may be further confounded in the homeless community whereby greater incidences of reward mediated behaviour, mental illness and alcohol related brain damage are reported. Objective assessment of energy expenditure, food intake and nutritional status, using biomarkers, would help to confirm the observed differences. Finally, the grouping of hostels may be confounding due to differences in storage facilities and the provision of food. For example, whilst breakfast and dinner were provided by the charity-led hostel, residents in the council-led hostel were self-catered. Further analysis regarding the impact of meal provision on nutritional status in first-stage living hostels is therefore warranted.

The often limited and infrequent access to food by homeless individuals means that the provision of nutritionally sufficient meals is of utmost importance. However, determining which nutritional issues are specific to a homeless community is required in order to determine suitable intervention strategies. Previous studies have aimed to address poor dietary intake in homeless populations through recipe modification at food aid organisations [33] and implementation of educational programs [21; 32; 46]. Decreasing the total and SFA content of meals and increasing fruit availability in the hostels surveyed would help to address some of the issues identified in Reading. Milk supplementation in street-homeless adults could also help to address calcium, iodine and riboflavin insufficiencies. Whilst beyond the scope of this study, exploration of Food Bank usage, which has increased in the UK [47], may also assist in the identification of suitable interventions for the local area.

The findings of this study highlight the vulnerability of homeless adults in Reading, who have reduced mental wellbeing, a higher risk of CVD and a poorer dietary intake compared with the housed population. Further objective data is warranted, but the results clearly highlight the need for intervention aimed at improving mental wellbeing and nutritional status in this group.

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Conflict of Interest

None

Authorship

JAL and RF designed the research protocol; RF, JS, CM and LA collected homeless data; JS collected homed data; JS and RF analysed data and drafted the manuscript. All authors have read and approved the final manuscript. This research received no specific grant from any funding agency, commercial or not-for-profit sectors. The authors have no conflicts of interest to declare.

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Table 1: Demographic characteristics of homeless (n=75) and housed (n=75) adults

Characteristics	Homeless		Housed	
	n	%	*n*	%
Gender				
Males	60	80	60	80
Females	15	20	15	20
Ethnicity				
White	61	81	61	81
Mixed	7	9	7	9
Indian/Pakistani/Bangladeshi	2	3	2	3
Black/African/Caribbean	5	7	5	7
Education				
Secondary education or below	64	85	12	16
Above secondary education	11	15	63	84
Housing status				
Living on the street	24	32	0	0
Living in a hostel	51	68	0	0
Living in private sector accommodation	0	0	75	100

Table 2: Responses by homeless (n=75) and housed (n=75) groups to behavioural questions[1]

Behavioural questions	Subjects responding 'yes'				*P* value
	Homeless		Housed		
	n	%	*n*	%	
Do you smoke?[2]	71	95	2	3	<0.001
Do you drink alcohol?	52	69	61	81	0.070
Do you take illicit drugs?[2]	46	61	1	1	<0.001
Do you have enough to eat?	55	73	75	100	<0.001
Do you have a good appetite?	51	68	71	95	<0.001
Are there any cooking facilities available for use?	31	41	75	100	<0.001
How many meals do you have per day?[2]					<0.001
0	2	2	0	0	
1	27	36	0	0	
2	35	47	21	28	
3	11	15	54	72	
How much money do you receive per week?[2]					<0.001
<£50	23	31	0	0	
£50-£149	45	60	12	16	
>£150	7	9	63	84	
How much money do you use to buy food per week?[2]					<0.001
<£20	53	70	4	5	
£20-49	20	27	37	49	
>£50	2	3	34	46	

[1]Data were analysed using chi-square tests comparing homeless and housed responses on each characteristic

[2]Analysed using Fisher's Exact test with Freeman-Halton extension for contingency tables greater than 2x2

Table 3: Physiological characteristics, PHQ-9 SADS and QRISK-2 scores for homeless (n=75) and housed (n=75) adults[1]

Characteristics	Homeless		Housed		*P* value
	Mean	SD	Mean	SD	
Weight, kg	73.3	15.4	77.5	14.6	0.19
Height, m	1.74	9.0	1.73	8.8	0.63
BMI, kg/m^2	24.5	5.7	25.8	4.2	0.08
Underweight (<18.49kg/m^2, %)	5.3		0.0		-
Healthy (18.5-24.9kg/m^2, %)	61.3		48.0		-
Overweight (25-29.9kg/m^2, %)	12.0		33.3		-
Obese (>30kg/m^2, %)	21.3		17.3		-
Systolic blood pressure, mm Hg	125.7	17.9	124.2	12.1	0.70
Diastolic blood pressure, mm Hg	78.2	12.0	73.6	8.2	0.008
Hand grip strength, kg	36.4	8.4	37.5	9.2	0.60
QRISK-2 Score (%)[2]	5.1	6.2	2.7	4.0	0.009
GAD-7[3]	6.0	5.9, 9.1	2.5	1,7, 3.3	<0.001
PHQ-9[3]	7.0	7.3, 10.9	2.0	1.9, 3.3	<0.001
PHQ-15[3]	6.0	5.5, 7.7	3.0	2.7, 3.9	<0.001

[1]Data were analysed using independent t-tests. PHQ-15, patient health questionnaire-15 for somatic symptoms; GAD-7, general anxiety disorders-7 for anxiety symptoms; PHQ-9, patient health questionnaire-9 for depressive symptoms.
[2]Estimated risk of developing CVD over the next 10 years.
[3]Values are medians (95% CI), data analysed using Independent samples Mann-Whitney U Test.

Table 4: FFQ derived daily energy and nutrient intake for homeless (n=75) and housed adults (n=75)[1]

Nutrient	Homeless		Housed		*P* value
	Mean	SD	Mean	SD	
Energy, kcal	2140	1121	1848	471	0.38
Energy, kJ	8988	4700	7741	2016	0.39
Total fat, % TE	37.2	6.3	34.9	5.3	0.049
SFA, % TE	14.6	3.1	13.0	3.3	0.002
MUFA, % TE	13.9	2.6	13.0	2.2	0.026
PUFA, % TE	5.5	1.4	5.9	1.4	0.08
Cholesterol, mg	357	204	274	114	0.020
Total protein, % TE	16.7	4.0	18.2	3.5	0.011
Total carbohydrate, % TE	43.4	9.3	48.1	6.9	<0.001
Total Sugars, %TE	5.4	2.6	4.4	1.2	0.009
Englyst Fibre (NSP), g	13.4	7.9	16.3	6.4	<0.001
Alcohol, g	17.5	30.7	5.0	8.1	<0.001
Alcohol, % TE	5.3	7.7	1.9	2.6	<0.001
Calcium, mg	977	537	942	323	0.77
Iron, mg	11.0	6.1	10.9	3.0	0.18
Total folate, mcg	288	173	281	92	0.25
Iodine, mcg	148	78	146	44	0.35
Sodium, mg	3186	1974	2573	764	0.17
Salt, g	8.0	4.9	6.4	1.9	0.014
Niacin, mg	22.8	11.9	22.5	6.0	0.21
Selenium, mcg	60.7	42.0	61.2	19.2	0.083
Vitamin A, mcg	1491	2107	1122	1252	0.85
Thiamin, mg	1.5	0.8	1.5	0.4	0.24
Riboflavin, mg	2.2	1.4	2.0	0.7	0.90
Vitamin B6, mg	2.1	1.0	2.2	0.6	0.032
Vitamin B12, mcg	8.4	9.1	6.4	4.5	0.58
Vitamin C, mg	78.8	58.9	109.4	62.5	<0.001
Vitamin D, mcg	3.5	3.6	3.0	1.7	0.74
Vitamin E, mg	12.1	7.0	11.8	4.2	0.34
Zinc, mg	9.7	4.9	9.3	2.4	0.53

[1]Values are means ± SDs, homeless (*n*=75) and housed (*n* =75). Data were analysed using independent t-tests. NSP, non-starch polysaccharide; %TE, percentage of total energy intake.

Table 5: Daily intake of the 14 food groups derived from FFQ analysis for homeless (n=75) and housed (n=75) adults[1]

Food group	Homeless		Housed		*P* value
	Mean	SD	Mean	SD	
Alcoholic beverages, g	363	593	93.5	185	<0.001
Cereals and cereal products, g	235	178	240	109	0.076
Eggs and egg dishes, g	20.6	21.2	19.0	17.9	0.61
Fats and oils, g	23.6	20.5	16.0	11.2	0.023
Fish and fish products, g	41.2	63.7	40.3	27.8	0.052
Fruit, g	96	107	260	224	<0.001
Meat and meat products, g	157	109	111	54	0.037
Milk and milk products, g	400	241	385	198	0.80
Non-alcoholic beverages, g	790	710	710	438	0.83
Nuts and seeds, g	3.4	7.4	9.9	15.0	<0.001
Potatoes, g	94.0	67.0	66.3	50.3	0.035
Soups and sauces, g	61.4	61.1	56.1	55.3	0.76
Sugars; preserves and snacks, g	43.3	46.4	39.6	32.0	0.96
Vegetables, g	205	156	244	149	0.022

[1]Data analysed using GLM.

Table 6: Subject characteristics and nutritional intake for street homeless (n=24) and first-stage living hostel residents (n=51)[1]

Characteristic	Street homeless		Hostel residents		P-value
	Mean	SD	Mean	SD	
Gender (m/f)	21/3	-	39/12	-	-
Age, years	38	11	38	11	0.99
Weight, kg	74.7	16.0	73.9	16.7	0.78
BMI, kg/m^{-2}	23.9	4.6	25.1	6.3	0.42
SBP	130.1	17.1	123.9	17.7	0.15
DBP	81.4	9.5	76.9	12.6	0.096
Hand-grip	39.7	8.2	35.3	8.3	0.058
GAD-7[2]	6.0	5.1, 12.6	6.0	5.3, 8.4	0.84
PHQ-9[2]	8.0	7.2, 15.2	7.0	6.2, 10.1	0.27
PHQ-15[2]	6.0	4.8, 9.9	6.0	5.2, 7.4	0.83
Energy, kcal	2008	1388	2202	979	0.13
Energy, kJ	8428	5814	9251	4114	0.13
Fat, %TE	36.6	7.0	37.5	6.0	0.55
SFA, %TE	13.7	3.1	15.0	3.1	0.010
MUFA, %TE	14.0	2.9	13.8	2.5	0.86
PUFA, %TE	5.7	1.6	5.4	1.3	0.56
Protein, %TE	17.1	5.0	16.6	3.5	0.89
CHO, %TE	41.5	11.2	44.5	8.2	0.19
Sugars, g	94.1	60.8	121.8	70.3	0.15
NSP, g	13.2	9.5	13.5	7.2	0.39
Alcohol, g	23.9	40.2	14.5	25.0	0.39
Calcium, mg	858	707	1032	433	0.027
Iron, mg	10.8	7.8	11.0	5.3	0.41
Total folate, mcg	226	167	304	174	0.10
Iodine, mcg	128	91	157	73	0.033
Sodium, mg	3198	2531	3180	1680	0.42
Salt, g	8.0	6.3	7.9	4.2	0.41
Niacin, mg	22.3	13.8	23.0	11.0	0.43
Selenium, mcg	62.3	49.8	59.9	38.2	0.63
Vitamin A, mcg	1252	1647	1604	1647	0.18
Thiamin, mg	1.34	0.86	1.55	0.84	0.10
Riboflavin, mg	1.79	1.22	2.42	1.45	0.012
Vitamin B6, mg	1.89	1.13	2.20	0.99	0.10
Vitamin B12, mcg	7.3	7.5	9.0	9.8	0.13
Vitamin C, mg	74.6	65.3	80.8	56.2	0.23
Vitamin D, mcg	3.2	2.6	3.7	4.0	0.22
Vitamin E, mg	11.4	7.8	12.4	6.6	0.25
Zinc, mg	9.6	6.4	9.8	4.2	0.35
Cereal and cereal products (g/day)	229	225	238	154	0.22
Egg and egg dishes (g/day)	17.4	16.4	22.1	23.1	0.36

Fats and oils (g/day)	22.1	23.8	24.4	19.0	0.16
Fish and fish products (g/day)	30.4	30.3	46.4	74.1	0.16
Fruit (g/day)	97	131	95	96	0.87
Meat and meat products (g/day)	164	137	153	95	0.40
Milk and milk products (g/day)	295	226	449	234	0.001
Nuts & seeds (g/day)	5.2	9.3	2.5	6.2	0.08
Potato (g/day)	66.6	43.5	107.4	72.1	0.012
Soups and sauces (g/day)	90.4	78.7	47.7	45.6	0.047
Sugars; preserves and snacks (g/day)	30.8	26.2	49.2	52.5	0.052
Vegetables (g/day)	205	162	205	155	0.71

[1]Values are means ± SDs, street homeless (*n*=24) and hostel residents (*n* =51). Data were analysed using GLM. NSP, non-starch polysaccharide; %TE, percentage of total energy intake.

[2]Data are medians (95% CI), analysed using Independent Samples Mann-Whitney U Tests.

Figure 1: Homeless and housed individuals with daily intake below LRNI for each micronutrient. Values are percentages (%) of individuals who did not meet the daily RNI for each micronutrient, homeless (*n*=75) and housed (*n*=75)