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Article

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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.

1 **Abstract**

2 Malnutrition has been reported in the homeless, yet the specific nutritional issues faced by each

3 homeless community are unclear. This is in part due to nutrient intake often being compared to

4 dietary reference values as opposed to a comparative housed population. Additionally, the

5 complex interplay between nutrient intake, reward mediated behaviour and mental illness has

6 frequently been overlooked. This observational study aimed to compare the dietary intake,

7 nutritional status and mental wellbeing of homeless and housed adults. Homeless (n=75) and

8 matched housed (n=75) adults were recruited from the Reading region (UK). Nutrient intake was

9 determined using the EPIC Norfolk Food Frequency Questionnaire. The Patient Health

10 Questionnaire: Somatic Anxiety Depressive Symptoms (PHQ-SADS) assessed for signs indicative

11 of mental illness. Demographic, behavioural and physiological information was collected using

12 closed-ended questions and anthropometric measurements. Overall, dietary intake was poorer in

13 homeless adults who reported higher intakes of salt (8.0g vs. 6.4g, P=0.017), SFA (14.6% vs.

14 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,

15 P<0.001), vitamin C (79mg vs. 109mg, P<0.001) and fruit (96g vs. 260g, P<0.001) than housed

16 adults. Smoking, substance misuse and PHQ-SADS scores were also higher in the homeless

17 group (P<0.001). Within the homeless population, street homeless (n=24) had lower SFA (13.7%

18 vs.15.0%, P=0.010), calcium (858mg vs. 1032mg, P=0.027) and milk intakes (295g vs. 449g,

19 P=0.001) than hostel residents (n=51), which may reflect the issues with food storage in street

20 homeless individuals. This study highlights the disparity between nutritional status in homeless and

21 housed populations and the need for dietary intervention in the homeless community.

Introduction

22

23   Homelessness is a global issue. In England, over 68,500 households in 2015 were classified as

24   homeless [1] and a further 3,569 were considered rough sleepers [2]. The lack of stable

25   accommodation, in conjunction with a low or absent income, raises challenges for the homeless,

26   one of which is access to food, although this is likely to differ between rough sleepers and those in

27   temporary accommodation. However despite the widespread prevalence of homelessness,

28   relatively few studies have sought to determine the nutritional status of these individuals, a

29   situation that may partly reflect the difficulty in collecting data from this transient population.

30   Despite this, several themes have emerged from studies to date, including a high SFA, low fruit

31   and vegetable diet [3-6], elevated serum cholesterol [7] and low levels of vitamin B-6, calcium and

32   iron[7; 8], although findings have not been consistent between countries. For example, lower skin-

33   fold thickness and muscle mass measurements have demonstrated 'wasting' in homeless

34   communities in Germany and the US (1989-2001) [4; 7; 8], whereas others have found a proportion

35   of homeless that, according to their BMI, are overweight or obese in the US (2012-2013) [9; 10].

36   In the presence of physiological stresses arising from exposure to harsh environmental

37   conditions, the absence of a nutritionally balanced diet is likely to have a detrimental impact on the

38   health of a homeless individual. Elevated levels of acute and chronic disease [11; 12], increased

39   visits to emergency departments [13] and an average age of death of 47 years in the UK [14]

40   highlight the additional challenges faced by the homeless community. Cardiovascular disease

41   (CVD), for which diet is a key modifiable factor, is reported as the leading cause of mortality in

42   homeless adults between 45-65 years, [15; 16].

43   A higher prevalence of mental illness (e.g. depression, anxiety) in the homeless compared to the

44   general population has also been reported [12; 17]. Reward mediated behaviors such as problematic

45   alcohol use, smoking and substance misuse are also frequently described [4; 12]. The reported

46   substitution of food with alcohol by alcoholic homeless individuals [4] and the use of money for illicit

47   substances as opposed to food in homeless drug addicts [12] demonstrates the potential nutritional

48   consequences arising from reward mediated behavior. Addictive substances may also impact upon

49   the absorption, metabolism and/or requirements for nutrients [18; 19].

50   Habitual diets and culture limit the extent to which nutrient intake of the homeless is comparable

51   between countries or regions [20]. Furthermore, studies have often failed to account for the impact

52   of physical and mental wellbeing on dietary intake; do not use a control group and have

53   widespread reliance on dietary reference values (DRV), which is potentially misleading. Comparing

54   homeless and housed individuals within the same region would overcome this issue, providing a

55   more accurate assessment of homeless intake in the specific location. However such studies are

56   currently lacking.

57   The aim of the present research was to compare nutritional status, dietary intake and mental

58   wellbeing in a group of homeless with age and gender-matched housed individuals (control group)

59   in Reading, UK. A secondary aim was to establish the marginal impact of homeless status (e.g.

60   street homeless vs. hostel residents) on these parameters.

61

62   **Methods**

63   *Participants and study design*

64   In this cross-sectional observation study homeless (n=75) and housed (n=75) men and women

65   were recruited. During recruitment, the two groups were broadly matched on the basis of age

66   range (18-29, 30-39, 40-49, >50yrs), gender and ethnicity. In order to capture homeless individuals

67   at the more extreme stages of homelessness this study only included individuals 'living rough' on

68   the street and those in the initial stages of housing (supported living). Street homeless were

69   recruited from a church drop-in centre that provides hot meals. Two hostels (charity and council

70   led) were used to recruit individuals residing in 'stage 1' accommodation. In addition to

71   accommodation for adults previously living on the street, the charity-led hostel also provides 'in

72   house' meals. Recruitment posters were displayed in each venue by staff, and residents/clients

73   recruited on a first-come basis. Housed volunteers were recruited at random through a volunteer

74   database at the Hugh Sinclair Unit of Human Nutrition, Reading, and via posters displayed at

75   Reading central library and around the Reading University campus. The University of Reading

76   School of Chemistry, Food and Pharmacy Research Ethics Committee (Approval number: 20/14)

77   and The Salvation Army Ethics Committee granted ethical approval for the study. All participants

78   gave informed written consent prior to participation.

79   *Data Collection*

80   Each participant completed three questionnaires during a single research session. A room was

81   provided at each venue for the purpose of the study and one of four trained researchers and a

82   volunteer from the specific venue were present during each session. Each volunteer was provided

83   with the option of either completing the questionnaires themselves or being asked the questions by

84   the researcher. For those opting to self-complete the questionnaires, responses were checked and

85   verified prior to departure. Questionnaires took between 60-90 minutes to complete. Volunteers

86   were reimbursed for their participation in the study via a £10 shopping voucher.

87   *Questionnaires*

88   To assess nutrient intake, the European Prospective Investigation into Cancer and Nutrition

89   (EPIC)-Norfolk FFQ was used. The FFQ is a validated semi-quantitative questionnaire consisting

90   of 130 food and drink items [21; 22]. For each item the participant is required to choose one out of 9

91   possible frequency options ranging from 'never/less than once a month' to '6+ per day'. FFQs are

92   typically completed with reference to the preceding 6 months to 1 year. However to ensure

93   reported nutrient intake related to the time an individual was homeless, participants were asked to

94   complete the FFQ with reference to the last month only, as some had been homeless for one to

95   two months. FFQ EPIC tool for analysis (FETA) software was used to determine daily nutrient

96   levels from the FFQ responses, which is based upon McCance and Widdowson's The Composition

97   of Foods (5th edition) and its supplements [23]. Energy, macronutrients (including sub-classes of fats

98   and carbohydrates), key vitamins and minerals (associated with public health concerns), and 14

99   food groups (alcoholic beverages, cereal and cereal products, egg and egg dishes, fats and oils,

100   fish and fish products, fruit, meat and meat products, milk and milk products, non-alcoholic

101   beverages, nuts and seeds, potatoes, soups and sauces, sugars; preserves and snacks, and

102   vegetables) were reported in the present analysis.

103   The validated Patient Health Questionnaire: Somatic Anxiety and Depressive Symptoms (PHQ-

104   SADS) was used to determine the presence of symptoms related to a mental health condition [24]. It

105   combines three questionnaires to screen for the presence of depression (PHQ-9), anxiety (GAD-7)

106   and somatization (PHQ-15) disorders. Each part of the questionnaire resulted in a score from

107   which individuals are categorized as 'none', 'mild', 'moderate' or 'severe' with relation to the

108   presence of depressive, anxiety and/or somatic symptoms.

109   A 'Health and Lifestyle' questionnaire formulated specifically for the present study was used to

110   record demographic data as well as information about smoking, alcohol and substance abuse. The

111   questionnaire consisted predominantly of quantitative questions requiring a yes/no answer.

112   Individuals were also asked about their appetite, meal frequency and the amount of money spent

113   on food using questions, as per previous studies on nutritional status and homelessness [7].

114   *Physiological measurements*

115   A stadiometer (Seca 213, Seca medical measuring systems) and calibrated electrical scales

116   (Seca 877, Seca medical measuring systems) were used to measure height and weight

117   respectively using standard operating procedures. BMI was calculated as weight (kg)/ height (m^2)

118   and classified in accordance with the WHO guidelines [25]. The mean of three handgrip strength

119   measurements of the participant's dominant hand using a hand-held dynamometer (Takei 5001,

120   Takei Scientific Instruments Co.) provided a non-invasive measure of general muscle strength [26].

121   Blood pressure measurements were taken in triplicate using an automated blood pressure monitor

122   (M10-IT, Omron healthcare Ltd.). In order to assess CVD risk, the online 'QRISK 2-2015 Web

123   Calculator' was used to estimate the 10-year risk of developing CVD [27].

124   *Statistical analysis*

125   The study was powered using previous comparison of energy intake (kJ) in homeless and

126   domiciled male youths in Toronto [28]. Using G*Power [29], it was estimated that 68 participants

127   would be required in each group for a 2385kJ energy difference with s SD of 6408kJ (α level

128   P=0.05, 1-β power 0.85). Estimated samples sizes based on differences in total fat (g), protein (g),

129   vitamin B6 (mg) and calcium (mg) were lower (range n=12-32 per group). To allow for a 10%

130   dropout or incomplete data collection a total of 75 participants were recruited per group.

131   Means and standard deviations were used to describe parametric distributed data, and medians

132   and 95% Confidence Intervals (CI) for non-parametric distributed data. Counts and percentages

133   were used for categorical variables. Homeless and housed groups were broadly matched for their

134   gender, age range and ethnic category during the data collection stage. Data were checked for

135   normality of distribution, and where possible skewed variables were transformed using $\log_{10}$.

136   Parametric data were analysed using general linear models (GLM) and non-parametric using

137   Independent samples Mann-Whitney U tests for the comparison of continuous variables. For

138   categorical variables chi-squared tests were used to assess for differences between the two

139   groups. $P<0.05$ was classified as significant. Data were analysed using SPSS Statistics 21.0 (IBM,

140   UK).

141

142   **Results**

143   *Participant characteristics*

144   Demographic information of the homeless (n=75) and housed (n=75) groups is shown in **Table**

145   **1**. The mean age was 38 (SD 11) years (range 19-59 years) for the homeless and 38 (SD 11)

146   years for the housed participants (range 20-59 years). Ethnicity and gender distributions were

147   matched between groups. With regards to education, there was a significant difference in

148   attainment between groups (P<0.001); whilst the majority of homeless individuals had achieved

149   secondary education or lower education (O-Level's/GCSE's and primary education), the majority of

150   the housed group had attained above secondary level with 25% (*n*=19) reporting higher degrees

151   compared to 4% (*n*=3) in the homeless group. Homeless individuals consisted of those sleeping

152   rough on the street (*n*=24) or residing in Hamble Court (*n*=22) or Salvation Army (*n*=29) hostels. All

153   housed individuals lived in private sector accommodation consisting of rented, mortgaged or

154   owned property.

155   Responses of both groups to questions regarding reward mediated behaviour, meal

156   consumption and cooking facilities are shown in **Table 2**. Significantly more homeless compared to

157   housed individuals reported that they smoked (*P*<0.001) and/or had taken illicit substances within

158   the preceding month (*P*<0.001). There was no significant difference between the number of

159   individuals who reported consuming alcohol, although significantly more of the homeless (35%,

160   *n*=18) compared to housed (8%, *n*=5) individuals who consumed alcohol reported intakes above

161   the recommended weekly intake of 14 units (UK) for men and women respectively (*P*<0.001, data

162   not shown). The majority of homeless individuals reported consuming 1 or 2 meals per day in

163   contrast to the housed that predominantly reported 3 meals daily (*P*<0.001). In addition,

164   significantly less homeless participants reported having enough to eat, a good appetite and

165 cooking facilities (all comparisons, *P*<0.001). For the homeless individuals reporting cooking

166 facilities, the majority only had access to a microwave in a communal living space whereas all

167 housed participants reported a full kitchen in their accommodation. A greater proportion of

168 homeless individuals reported receiving less than £150 ($200) and spending less than £50 ($67)

169 on food per week compared to housed individuals (all comparisons, *P*<0.001).

170 *Physiological and psychological characteristics*

171 There was no significant difference in BMI between the two groups as shown in **Table 3**.

172 However, a greater number of homeless (66.6%) had a BMI<24.9kg/m^2, with 5.3% classified as

173 underweight (BMI <18.5m^2), whereas half (50.6%) of the housed group were classified as

174 overweight and obese (BMI>25kg/m^2) and none as underweight. Despite this 4% more homeless

175 adults (21.3% vs. 17.3% for housed) were also classified as obese (BMI>30kg/m^2). The homeless

176 had a significantly higher mean diastolic blood pressure (DBP) (*P*=0.008) and mean QRISK-2

177 score (*P*=0.009) compared to the housed, with no significant difference in systolic BP (SBP) or

178 handgrip strength.

179 Homeless individuals scored significantly higher than the housed group for the presence of

180 somatic (PHQ-15), anxiety (GAD-7) and depressive (PHQ-9) symptoms (all comparisons,

181 *P*<0.001) with a mean classification of 'mild' (score range 5-9) for each condition (**Table 3**). In total,

182 24% (n=18) of homeless adults reported mental illness diagnoses (depression, n=11;

183 schizophrenia, n=1, multiple diagnoses, n=5; undisclosed diagnosis, n=1) and 4% (n=3) of housed

184 adults (all depression).

185 When comparing street homeless (n=24) with first-stage living hostel residents (n=51), no

186 significant differences were observed for weight, BMI, SBP, DBP or PHQ-SADS scores (**Table 6**).

187 There was a trend for higher handgrip strength in street homeless participants compared to first-

188 stage living hostel residents (*P*=0.058), although the difference failed to reach significance. Mean

189 duration of street homelessness was 5.4 (SD 6.8) months and hostel residency 9 months (SD 9.3).

190 *Nutritional intake*

191 Homeless individuals reported a significantly higher mean daily intake of total fat (*P*=0.049),

192 SFA (*P*=0.002), MUFA (*P*=0.026) and alcohol (*P*<0.001), as a percentage of energy intakes,

193 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.

222   Calcium, iodine and riboflavin intakes were all significantly lower in street homeless compared

223   with first-stage living hostel residents ($P<0.05$) (**Table 6**). Despite this, hostel residents were found

224   to consume significantly greater quantities of milk ($P=0.001$) and potato ($P=0.012$), and less soups

225   and sauces ($P=0.047$). There was also a trend for greater sugary snack consumption in hostel

226   residents ($P=0.052$).

227   As a sensitivity analysis, data analysis was repeated in males only (n=120) and in

228   participants reporting 'white' ethnicity (n=122). The identified significance differences were similar

229   following removal of females, although just a tendency for a lower vitamin B6 intake in the

230   homeless was observed ($P=0.078$). Analysis in only white participants led to an additional

231   significant difference for PUFA (5.51% ± 1.41 homeless, 5.91% ± 1.36 housed, $P=0.031$).

232

233   **Discussion**

234   The present study compared dietary intake, nutritional status and mental wellbeing of homeless

235   and housed adults in Reading. Our findings suggest that homeless adults have a higher risk of

236   cardiovascular disease and incidence of anxiety and depressive symptoms, and poorer dietary and

237   nutrient intake than housed adults. Homeless diets were characterised by high consumption of

238   meat and meat product, fats and oils and alcoholic beverages, and significantly lower intakes of

239   fruits, vegetables, nuts and seed than housed comparators. Street homeless were at particular

240   risk of calcium and iodine deficiency, and had a significantly lower intake of milk and milk products

241   than hostel residents.

242   Whilst no significant difference in energy intake was observed between homeless and housed

243   adults, 27% of homeless reported not having 'enough to eat' and 38% reporting having ≤ one

244   meals per day. There was also a trend ($P=0.080$) for a lower BMI in the homeless group. In the

245   present study, both homeless and housed intakes of total fat and SFA exceeded the UK

246   recommended intakes (total fat, 34% total energy; SFA, 10% total energy)[30]. However, homeless

247   adults reported significantly a higher intake of these fats, as observed previously in the homeless

248   community[7; 32]. This may be attributed to their greater intakes of meat and meat products (e.g.

249   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

279 normal range [42]. However, the significantly higher QRISK-2 score in the homeless group indicates

280 that the homeless group are at a greater risk of developing CVD within the next 10 years. Hand

281 grip strength, a low value of which has been associated with increased mortality in adults > 50

282 years [26; 43], was significantly greater in street-homeless compared to hostel residents; although

283 this is likely to be most reflective of increased physical activity. Significantly more homeless

284 compared to housed reported smoking and substance misuse in the present study, as documented

285 previously [4; 12]. Furthermore, a significantly greater number of homeless that consumed alcohol

286 reported an intake above recommended levels, which is consistent with previous data [6].

287 Homeless adults had significantly higher scores for each PHQ-SADS component compared to

288 housed group, which corresponds with the high levels of mental illness reported in the homeless

289 community versus the general population [12]. Within the homeless community, street sleepers are

290 more likely to experience depression [44], as observed in the present study whereby street

291 homeless had higher scores for the depressive component (PHQ-9) of the PHQ-SADS compared

292 with hostel residents. It is currently unclear as to whether mental illness precedes homelessness or

293 homelessness induces/ exacerbates the occurrence of mental illness and the role, if any, nutrition

294 has to play in these conditions. The higher numbers of homeless compared to housed reporting a

295 poor appetite, in the presence of the increased levels of mental illness, may reflect the depressive

296 influence of mental conditions on appetite [45], which warrants further investigation.

297 The current study has a number of limitations. The high male to female ratio is consistent

298 with other studies and reflects the preponderance of males in the homeless population [12].

299 However, male dominance and potential selection bias due to reliance on services accessed by

300 the homeless to attain participants limit the generalizability of the results [48]. In addition,

301 comparison with the most recent (2011) Census in Reading (74.8% white)[49], suggests that white

302 individuals may have been over-represented in this sample (81% white). The significant difference

303 between the educational status of the homeless and housed groups may represent an uncontrolled

304 confounding factor given that higher educational status has been associated with a 'healthier' diet

305 [50]. The EPIC FFQ has been validated for the assessment of nutrient intake in different populations

306 [22; 51], is less burdensome that weighed intake dairies and was consequently considered

307 appropriate for the current research. However, due to the transient nature of the homeless

308　population, participants were asked to report dietary intake over the previous month (i.e. shorter-

309　term intake), which may have been challenging individuals with fluid dietary patterns. Memory

310　recall may be further confounded in the homeless community whereby greater incidences of

311　reward mediated behaviour, mental illness and alcohol related brain damage are reported.

312　Objective assessment of energy expenditure, food intake and nutritional status, using biomarkers,

313　would help to confirm the observed differences. Finally, the grouping of hostels may be

314　confounding due to differences in storage facilities and the provision of food. For example, whilst

315　breakfast and dinner were provided by the charity-led hostel, residents in the council-led hostel

316　were self-catered. Further analysis regarding the impact of meal provision on nutritional status in

317　first-stage living hostels is therefore warranted.

318　　　The often limited and infrequent access to food by homeless individuals means that the

319　provision of nutritionally sufficient meals is of utmost importance. However, determining which

320　nutritional issues are specific to a homeless community is required in order to determine suitable

321　intervention strategies. Previous studies have aimed to address poor dietary intake in homeless

322　populations through recipe modification at food aid organisations [33] and implementation of

323　educational programs [21; 32; 46]. Decreasing the total and SFA content of meals and increasing fruit

324　availability in the hostels surveyed would help to address some of the issues identified in Reading.

325　Milk supplementation in street-homeless adults could also help to address calcium, iodine and

326　riboflavin insufficiencies. Whilst beyond the scope of this study, exploration of Food Bank usage,

327　which has increased in the UK [47], may also assist in the identification of suitable interventions for

328　the local area.

329　　The findings of this study highlight the vulnerability of homeless adults in Reading, who have

330　reduced mental wellbeing, a higher risk of CVD and a poorer dietary intake compared with the

331　housed population. Further objective data is warranted, but the results clearly highlight the need for

332　intervention aimed at improving mental wellbeing and nutritional status in this group.

333

337 recruitment of homeless participants and Sarah Hargreaves (Hugh Sinclair Unit of Human

338 Nutrition) for assisting in the recruitment of housed participants.

339

344 **Conflict of Interest**

345 None

346

347 **Authorship**

348 JAL and RF designed the research protocol; RF, JS, CM and LA collected homeless data; JS

349 collected homed data; JS and RF analysed data and drafted the manuscript. All authors have read

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REFERENCES

1. Department for Communities and Local Government (2016) Statutory homelessness: October to December Quarter 2015 England. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/509763/Statutory_Homelessness_Statistical_Release_October_to_December_2015.pdf (accessed June 2016)

2. Department for Communities and Local Government (2016) Rough Sleeping Statistics: Autumn 2015 England. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/503015/Rough_Sleeping_Autumn_2015_statistical_release.pdf (accessed June 2016)

3. Rushton CM, Wheeler E (1993) The dietary intake of homeless males sleeping rough in Central London. *J Hum Nutr Diet* **6**, 443-456.

4. Langnäse K, Müller MJ (2001) Nutrition and health in an adult urban homeless population in Germany. *Public Health Nutr* **4**, 805-811.

5. Hickey C, Downey D (2003) *Hungry for Change: Social Exclusion, Food Poverty and Homelessness in Dublin; a Pilot Research Study*: Focus Ireland.

6. Darmon N, Coupel J, Deheeger M *et al.* (2001) Dietary inadequacies observed in homeless men visiting an emergency night shelter in Paris. *Public Health Nutr* **4**, 155-161.

7. Luder E, Boey E, Buchalter B *et al.* (1989) Assessment of the nutritional status of urban homeless adults. *Public Health Rep* **104**, 451.

8. Wolgemuth JC, Myers-Williams C, Johnson P *et al.* (1992) Wasting malnutrition and inadequate nutrient intakes identified in a multiethnic homeless population. *J Am Diet Assoc* **92**, 834-839.

9. Koh KA, Hoy JS, O'Connell JJ *et al.* (2012) The hunger–obesity paradox: obesity in the homeless. *J Urban Health* **89**, 952-964.

10. Tsai J, Rosenheck RA (2013) Obesity among chronically homeless adults: is it a problem? *Public Health Rep* **128**, 29.

11. Hwang SW (2001) Homelessness and Health. *Can Med Assoc J* **164**.

12. Homeless Link (2015) *The unhealthy state of homelessness: health audit results 2014*.

13. Kushel MB, Vittinghoff E, Haas JS (2001) Factors associated with the health care utilization of homeless persons. *JAMA* **285**, 200-206.

14. CRISIS (2011) Homelessness: A silent killer http://www.crisis.org.uk/data/files/publications/Homelessness a silent killer.pdf. (accessed June 2016)

15. Hibbs JR, Benner L, Klugman L *et al.* (1994) Mortality in a cohort of homeless adults in Philadelphia. *N Engl J Med* **331**, 304-309.

16. Hwang SW, Orav EJ, O'Connell JJ *et al.* (1997) Causes of death in homeless adults in Boston. *Ann Intern Med* **126**, 625-628.

17. Krausz RM, Clarkson AF, Strehlau V *et al.* (2013) Mental disorder, service use, and barriers to care among 500 homeless people in 3 different urban settings. *Soc Psychiatry Psychiatr Epidemiol* **48**, 1235-1243.

18. Lykkesfeldt J, Christen S, Wallock LM *et al.* (2000) Ascorbate is depleted by smoking and repleted by moderate supplementation: a study in male smokers and nonsmokers with matched dietary antioxidant intakes. *Am J Clin Nutr* **71**, 530-536.

19. German Nutrition Society (DGE) (2015) New Reference Values for Vitamin C Intake. *Ann Nutr Metab* **67**, 13-20.

20. Kubisová D, Adámková V, Lánská V *et al.* (2007) Higher prevalence of smoking and lower BMI, waist circumference, cholesterol and triacylglyceride levels in Prague's homeless compared to a majority of the Czech population. *BMC Public Health* **7**, 1.

21. Sprake EF, Russell JM, Barker ME (2014) Food choice and nutrient intake amongst homeless people. *J Hum Nutr Diet* **27**, 242-250.

22. Bingham SA, Welch AA, McTaggart A *et al.* (2001) Nutritional methods in the European prospective investigation of cancer in Norfolk. *Public Health Nutr* **4**, 847-858.

23. Mulligan AA, Luben RN, Bhaniani A *et al.* (2014) A new tool for converting food frequency questionnaire data into nutrient and food group values: FETA research methods and availability. *BMJ open* **4**, e004503.

24. Kroenke K, Spitzer RL, Williams JB *et al.* (2010) The patient health questionnaire somatic, anxiety, and depressive symptom scales: a systematic review. *Gen Hosp Psychiatry* **32**, 345-359.

25. World Health Organisation (WHO) expert committee (1995) *Physical status: the use and interpretation of anthropometry*. Geneva: World Health Organization.

26. Lauretani F, Russo CR, Bandinelli S *et al.* (2003) Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. *J Appl Physiol* **95**, 1851-1860.

27. Hippisley-Cox J, Coupland C, Vinogradova Y *et al.* (2008) Predicting cardiovascular risk in England and Wales: prospective derivation and validation of QRISK2. *BMJ* **336**, 1475-1482.

28. Tarasuk V, Dachner N, Li J (2005) Homeless youth in Toronto are nutritionally vulnerable. *J Nutr* **135**, 1926-1933.

29. Faul F, Erdfelder E, Lang A-G *et al.* (2007) G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods* **39**, 175-191.

30. The Committee on Medical Aspects of Food and Nutrition Policy (COMA) (1991) Dietary reference values for food energy and nutrients: report of the panel on dietary reference values of the committee on medical aspects of food policy: HMSO, London.

31. Malmauret L, Leblanc J, Cuvelier I *et al.* (2002) Dietary intakes and vitamin status of a sample of homeless people in Paris. *Eur J Clin Nutr* **56**, 313.

32. Food Standards Agency (2006) Research into food poverty and homelessness in Northern Ireland - final report.

33. Pelham-Burn SE, Frost CJ, Russell JM *et al.* (2014) Improving the nutritional quality of charitable meals for homeless and vulnerable adults. A case study of food provision by a food aid organisation in the UK. *Appetite* **82**, 131-137.

34. Public Health England (2014) National diet and nutrition survey: results from years 1-4 (combined) of the rolling programme (2008/2009-2011/12): executive summary. London: PHE Publications.

35. Wiecha JL, Dywer JT, Jacques PF *et al.* (1993) Nutritional and economic advantages for homeless families in shelters providing kitchen facilities and food. *J Am Diet Assoc* **93**, 777-783.

36. Evans NS, Dowler EA (1999) Food, health and eating among single homeless and marginalized people in London. *J Hum Nutr Diet* **12**, 179-199.

37. Drake MA (1992) The nutritional status and dietary adequacy of single homeless women and their children in shelters. *Public Health Rep* **107**, 312.

38. Hoyumpa A (1980) Mechanisms of thiamin deficiency in chronic alcoholism. *Am J Clin Nutr* **33**, 2750-2761.

39. Darnton-Hill I, Truswell A (1990) Thiamin status of a sample of homeless clinic attenders in Sydney. *Med J Aus* **152**, 5-9.

40. National Institute of Clinical Excellence (2010) Alcohol-use disorders: diagnosis and management of physical complications [CG100]. London: NICE publications.

41. Cook NR, Cutler JA, Obarzanek E *et al.* (2007) Long term effects of dietary sodium reduction on cardiovascular disease outcomes: observational follow-up of the trials of hypertension prevention (TOHP). *BMJ* **334**, 885.

42. National Institute of Clinical Excellence (NICE) (2011) Hypertension: clinical management of primary hypertension in adults. NICE guidelines, CG127. London: NICE publications.

43. Stenholm S, Mehta NK, Elo IT *et al.* (2014) Obesity and muscle strength as long-term determinants of all-cause mortality—a 33-year follow-up of the Mini-Finland Health Examination Survey. *Int J Obes* **38**, 1126-1132.

44. La Gory M, Ritchey FJ, Mullis J (1990) Depression among the homeless. *J Health Soc Behav*, 87-102.

45. Konttinen H, Männistö S, Sarlio-Lähteenkorva S *et al.* (2010) Emotional eating, depressive symptoms and self-reported food consumption. A population-based study. *Appetite* **54**, 473-479.

46. Johnson LJ, Myung E, McCool AC *et al.* (2009) Nutrition Education for Homeless Women—Challenges and Opportunities: A Pilot Study. *J Foodservice Bus Res* **12**, 155-169.

47. Loopstra R, Reeves A, Taylor-Robinson D *et al.* (2015) Austerity, sanctions, and the rise of food banks in the UK. *BMJ* **350**, h1775.

48. Faugier J, Sargeant M (1997) Sampling hard to reach populations. *J Adv Nurs* **26**, 790-797.

49. Office for National Statistics (2012) *2011 Census: Key Statistics for Wales, March 2011 - Ethnic Group and Identity.* https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populatione stimates/bulletins/2011censuskeystatisticsforwales/2012-12-11#ethnic-group-and-identity (accessed June 2017)

50. Friel S, Kelleher C, Nolan G *et al.* (2003) Social diversity of Irish adults nutritional intake. *Eur J Clin Nutr* **57**, 865-875.

51. McKeown NM, Day NE, Welch AA *et al.* (2001) Use of biological markers to validate self-reported dietary intake in a random sample of the European Prospective Investigation into Cancer United Kingdom Norfolk cohort. *Am J Clin Nutr* **74**, 188-196.

52. Cade J, Burley V, Warm D *et al.* (2004) Food-frequency questionnaires: a review of their design, validation and utilisation. *Nut Res Rev* **17**, 5-22.

53. Scientific Advisory Committee on Nutrition (SACN) (2015) Carbohydrates and health. London: The Stationary Office.

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)