

# Low nutrient intake and frailty among overweight and obese migrant women from ethnically diverse backgrounds aged 60+ years: a mixed-methods study

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1 **‘Low Nutrient Intake And Frailty Among Overweight And Obese Migrant**  
2 **Women From Ethnically Diverse Backgrounds Aged 60+ Years: A Mixed-**  
3 **Methods Study’**

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6

7 **INTRODUCTION**

8

9

10 Frailty has become the focus of extensive research due to the ever-increasing aging of  
11 the global population. Frailty is characterized as a disorder of multiple physiological  
12 systems in which homeostatic mechanisms start failing, increasing the risk of declines  
13 in cognitive and physical function.<sup>1-3</sup> Furthermore, longitudinal studies have  
14 demonstrated a greater prevalence of cardiovascular disease and diabetes among frail  
15 older people,<sup>4</sup> and a greater frailty burden for women in comparison to men.<sup>5,6</sup>  
16 Therefore, identifying and treating individuals at risk of frailty may help delay its  
17 negative consequences and reduce the financial, social, and personal burdens these  
18 consequences place upon individuals, families and societies.<sup>7,8</sup>

19

20 One of the most widely used definitions of frailty is the frailty phenotype proposed  
21 and validated by Fried and colleagues.<sup>2</sup> This battery of tests identifies people as frail  
22 when they meet three or more of five criteria: relatively weak grip strength,  
23 unintentional weight loss, self-reported exhaustion, slow walking speed and low  
24 levels of physical activity (PA). The inclusion of unintentional weight loss is used as a  
25 proxy measure of dietary inadequacy, which is congruent with the conceptualization  
26 of frailty as a wasting disorder.<sup>2-3</sup> However, obesity can also be linked with frailty, as

27 indicated by the greater risk of physical function decline and pro-inflammatory state  
28 commonly found among older adults who are obese.<sup>9</sup>

29

30 In older adults, the use of unintentional weight loss in the definition of frailty is  
31 problematic as this measure may not be sensitive enough to reflect reduced energy  
32 and nutrient intakes.<sup>8</sup> Weight loss will not occur if energy intake matches energy  
33 expenditure, however a diet that is adequate in energy can still be deficient in certain  
34 nutrients, increasing a person's risk for frailty. Therefore, we hypothesize that a low  
35 intake of energy and selected nutrients is a stronger predictor of frailty in  
36 overweight/obese older women from diverse ethnic backgrounds than unintentional  
37 weight loss. There is limited evidence examining the association between frailty as a  
38 syndrome and nutrient intakes, and this has been conducted in predominantly White  
39 older adults.<sup>8</sup> Thus, very little is known about these associations in older adults from  
40 diverse ethnic backgrounds. In addition, to develop interventions that can effectively  
41 delay or prevent frailty in older women from diverse ethnic backgrounds, more  
42 information is needed to explore if there are links between perceptions of body  
43 weight, dietary intake and physical function in a population with disproportionately  
44 higher rates of overweight and obesity.

45

46 Therefore, the aims of this study were to: 1) examine the associations between  
47 dietary/nutrient intake and frailty in a sample of older women ( $\geq 60$  years) from  
48 diverse ethnic backgrounds living in the UK; 2) to gain a greater understanding of the  
49 potential links between women's perceptions of body weight, dietary intake and  
50 physical function.

51

52

## METHODS

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54

### 55 **Study Design**

56

57 A cross-sectional, mixed-methods design was employed, using 24-hr dietary recall  
58 interviews that were enhanced with the addition of a qualitative semi-structured  
59 interview. These methods allowed for the quantitative estimate of energy/nutrient  
60 intake and its association with frailty, as well as providing insights into women's  
61 perceptions of their body weight, dietary intake and physical function.

62

### 63 **Recruitment and Participants**

64

65 A convenience sample of first generation migrant women from Ireland, Jamaica,  
66 Montserrat, St Kitts and Nevis, India, Pakistan, Bangladesh, Yemen, Sierra Leone,  
67 Somalia, and Eritrea were recruited to participate in the study. Inclusion criteria  
68 included being at least 60 years of age, with no medical conditions affecting memory  
69 (e.g., dementia), and the ability to walk 15ft with no or minimal assistance (i.e., use of  
70 a walking stick). Community-dwelling women living on their own or with family  
71 members were recruited using maximum variation sampling<sup>10</sup> to achieve our goal of  
72 recruiting a sample across the ranges of age, migration backgrounds, socio-economic  
73 status, and main ethnic groups living in the geographic region. This was achieved by  
74 using the most recent Birmingham census data to identify the most representative  
75 migrant groups.<sup>11</sup> Community centres serving specific migrant and older adult groups

76 were contacted and informed about the study. Those in leadership roles at these  
77 centers facilitated access to potential participants so they could be approached and  
78 informed of the purpose of the study. Participants were recruited via word-of-mouth  
79 and snowballing.<sup>12</sup> Ethics approval was granted by The University of Birmingham  
80 Ethics Committee (reference No. ERN\_13-0557). All participants provided written  
81 informed consent.

82

### 83 **Data Collection**

84

85 Data were collected at the participants' time and location of choice (e.g., homes or  
86 community centers). For participants not fluent in English, trained interpreters fluent  
87 in Punjabi, Bengali, Arabic and Somali provided simultaneous translation during  
88 recruitment and data collection. Socio-demographic information was gathered via a  
89 researcher-administrated questionnaire.

### 90 ***Dietary Intake.***

91 A multiple-pass 24-hr dietary recall interview was conducted to gather data on the  
92 types and amounts of foods consumed on the previous day via a standard protocol.<sup>13</sup>  
93 Information was also obtained on nutrient supplement use. A photographic food atlas  
94 assisted with the estimation of portion sizes.<sup>14</sup> The first author (DCG), a dietitian,  
95 trained in dietary assessment conducted all 24-hr dietary recalls. Data coding and  
96 processing was conducted by DCG, with oversight from JLT who has extensive  
97 expertise in dietary assessment. These procedures enabled a standardized data entry  
98 and analysis process. The dietary recall interview was audio-recorded to ensure  
99 accuracy of quantitative data entry and to facilitate the collection of additional

100 qualitative information. When participants stated that the previous day did not reflect  
101 their habitual diet (e.g., they had engaged in fasting practices), the 24-hr dietary recall  
102 was repeated later in the same week on a day that was identified by participants as  
103 being representative of their habitual intake. This occurred in 5 participants. Data  
104 were not gathered during periods of major religious observances (e.g., Ramadan,  
105 Diwali). All recalls were conducted during weekdays, excluding Monday. Nutrient  
106 analysis was completed using DietPlan 6.0 software (Forestfield software Ltd 2006,  
107 Horsham, UK), which included standard and supplemental food composition  
108 databases that covered the range and ethnic diversity of foods consumed in the UK.  
109  
110 Similarly to methods reported by Bartali and colleagues,<sup>8</sup> low intake was defined as  
111 the lowest quintile of the distribution of energy (<13 kcal/kg) and specific nutrients:  
112 protein <30 g, vitamin D <0.5 µg, vitamin E <2.5 mg, retinol <101 µg, vitamin C <32  
113 mg, folate <127 µg, iron <5.6 mg, calcium <349 mg, and zinc <3.6 mg. A nutritional  
114 score was obtained by summing the number of nutrients categorized as low intake.  
115 This nutritional score was subsequently categorized into a low intake of 0, 1-3, or >3  
116 nutrients. A low intake of >3 nutrients was classified as poor nutritional status.

117

### 118 *Anthropometric measures and assessment of frailty.*

119 Anthropometric measures included height measured to the nearest mm (SECA 213  
120 portable stadiometer), weight to the nearest 0.1 kg (SECA 899 digital scale), and hip  
121 and waist circumference (WC) measured to the nearest cm using an extractable tape  
122 measure. All anthropometric measurements were taken with the participant wearing  
123 light clothing and no shoes. Body mass index (BMI) was calculated as weight divided

124 by height squared ( $\text{kg}/\text{m}^2$ ), and waist-to hip-ratio (WHR) as waist circumference  
125 divided by hip circumference (cm).

126 Frailty status was assessed using a modified version of the original frailty definition  
127 developed by Fried and colleagues.<sup>2</sup> This included: 1) Exhaustion, defined using self-  
128 reported fatigue from two questions from the Center for Epidemiological Studies-  
129 Depression (CES-D) depression scale (“I felt that everything I did was an effort,” and  
130 “I could not get going.”) Participants who reported having these feelings for  $\geq 3$  days  
131 over the previous week to either or both questions received positive scores for  
132 exhaustion; 2) Slow walking speed, with the highest quintile of the time needed to  
133 walk a distance of 15 feet, adjusted by height ( $>14.5$  seconds for height  $\leq 157.7$  cm  
134 and  $>9.7$  seconds for height  $> 157.7$  cm); 3) Weak grip strength was defined as the  
135 lowest quintile for adjusted grip strength using a JAMAR hand-held dynamometer  
136 (Sammons Preston Rolyan, Bolingbrook, Illinois, USA), adjusted by BMI.

137 Participants met the criteria for weak grip strength if their BMI and grip strength were  
138  $\leq 25.8 \text{ kg}/\text{m}^2$  and  $\leq 12 \text{ kg}$ ;  $>25.9- 29.6 \text{ kg}/\text{m}^2$  and  $\leq 11 \text{ kg}$ ;  $>29.7- 31.6 \text{ kg}/\text{m}^2$  and  $\leq 12$   
139  $\text{kg}$ ; and  $\geq 31.7 \text{ kg}/\text{m}^2$  and  $\leq 14 \text{ kg}$ . A low level of PA was defined as the lowest quintile  
140 of caloric expenditure ( $< 60 \text{ kcal}/\text{week}$ ) using the International Physical Activity  
141 Questionnaire short-form modified for the elderly (IPAQ-E).<sup>15</sup> This version of the  
142 IPAQ provides examples of activities that are more common among older adults and  
143 has shown a moderate correlation ( $r=0.347$ ,  $p<0.01$ ), and moderate agreement  $\kappa$   
144 ( $95\% \text{CI}$ )=  $0.448$  ( $0.18-0.72$ ,  $p < 0.001$ ) with accelerometry.<sup>16</sup>

145

146 Since the purpose of this study was to examine the association between dietary intake  
147 and frailty, similar to Bartali’s study, unintentional weight loss ( $>10$  pounds in the last  
148 year) was excluded from the original frailty definition.<sup>8</sup> Therefore, participants with

149 >2 positive criteria were categorized as frail, while those with  $\leq 1$  positive criteria  
150 were categorized as not frail.

151

### 152 *Semi-structured interviews.*

153 A purposive sub-sample (n=46) across the range of age, ethnic groups and socio-  
154 economic status was invited to participate in an interview that was guided by a list of  
155 topics related to migration histories, dietary intake and eating behaviors, and  
156 engagement in PA (migration histories and PA data not reported here). For the  
157 purpose of this study, dietary topics centered on participants' perceptions of their diets  
158 in relation to their body weight and frailty status (referred to as physical function  
159 during the interviews). The interview guide was pilot-tested prior to the study and was  
160 further revised via an iterative process throughout the data collection period. All  
161 interviews were audio-taped and transcribed verbatim, with the interviews conducted  
162 with participants who were not fluent in English being translated from their native  
163 language into English by a trained interpreter during the interview process (n=16).

164

### 165 **Data Analysis**

166

#### 167 *Quantitative data analysis.*

168 Descriptive characteristics (means, SDs, and percentages) were calculated for socio-  
169 demographic variables. To identify potential confounding factors, independent t-tests  
170 or Mann-Whitney U tests (for non-parametric data) were conducted to examine any  
171 significant differences in continuous variables between those classified as frail or not  
172 frail, with Chi-squared or Fisher's exact tests conducted for categorical variables.



173 Point-biserial correlations ( $r_{pb}$ ) were used to determine the association between frailty  
174 status (dichotomous variable), weight loss, and indices of overweight/obesity (e.g.,  
175 BMI, WC and WHR). Multiple logistic regressions were used to evaluate the  
176 association between frailty status and each of its components with low energy intake  
177 and poor nutritional status. Separate models were conducted to test the association  
178 between nutrient intakes with frailty adjusting for confounding factors and energy  
179 intake. All statistical analyses were performed using SPSS version 21.0 (SPSS INC.,  
180 Chicago, IL); alpha was set at  $p < 0.05$ .

181

### 182 *Qualitative data analysis.*

183 An inductive thematic analysis of the interview transcripts was conducted, allowing  
184 for the identification of themes being driven by participants' perspectives of their  
185 diets in the context of their body weight and physical function/frailty status rather  
186 than fitting the data into a pre-existing theoretical framework.<sup>17</sup> Initially, a subset of  
187 transcripts were read several times by the first author and two independent researchers  
188 to identify predominant topics across the data. An initial coding frame using  
189 qualitative analysis software (QSR NVivo, version 10) was developed which formed  
190 the basis of broad coding and analysis. All of the transcripts were then coded by the  
191 first author. The coding frame was discussed and refined by all authors until  
192 consensus was reached. Data saturation was considered to have been achieved when  
193 no new or relevant information emerged from each of the various ethnic groups  
194 included in the study.<sup>18</sup>

195

## RESULTS

196

197

198

199 Table 1 includes the demographic characteristics of participants. On average,  
200 participants (mean age=  $70.5 \pm 7.6$  years) reported having  $2.3 \pm 1.5$  diseases  
201 previously diagnosed by a doctor, with hypertension, arthritis and type 2 diabetes the  
202 most common. Over 88% of the sample was classified as overweight or obese. BMI  
203 cut-points for overweight and obesity among the Arab, Indian, Pakistani and  
204 Bangladeshi participants were those recommended by the World Health Organization  
205 for Asian populations.<sup>19</sup> Although participants came from all socioeconomic levels,  
206 79% were categorized as being in the two most socio-economically deprived quintiles  
207 based on the English indices of deprivation.<sup>20</sup> Seventeen participants (22.4%) were  
208 classified as frail, while 23 (30.3%) and 36 (47.4%) were classified as pre-frail and  
209 non-frail, respectively. Frail participants were older and had a higher number of  
210 diagnosed diseases; these were the only demographic variables that were statistically  
211 different between frail and non-frail participants.

### 212 **Frailty and low nutrient intake**

213

214 Among frail participants, 82.3% had a low nutrient intake of at least one selected  
215 nutrient (Table 2). The percentage of women with frailty increased with the greater  
216 number of nutrients classified as low intake. Logistic regression analyses indicated  
217 that low energy intake was independently associated with frailty (odds ratio [OR]:  
218 11.71, 95% confidence interval [CI]: 2.36-57.97). After adjusting for energy, age and  
219 number of diseases, poor nutritional status (>3 low nutrient intakes) was significantly  
220 associated with frailty (OR: 6.58, 95% CI: 1.01-43.08) in comparison to those women

221 who did not have a low intake of any nutrients. After adjusting for energy and other  
222 confounding variables, only slow walking speed was significantly associated with  
223 poor nutritional status (OR: 1.86, 95% CI: 1.31-3.07).

224

225 In addition, a low intake of retinol (OR: 10.33, 95% CI: 1.55- 68.94) and zinc (OR:  
226 8.47, 95% CI: 1.04-68.80) were significantly associated with frailty after adjustment  
227 for energy intake and other confounding variables (Table 3). Self-reported weight loss  
228 ( $p=0.3$  for Fisher's exact test), BMI ( $r_{bp}= 0.09$ ,  $p=0.4$ ), waist circumference ( $r_{bp}= 0.2$ ,  
229  $p=0.1$ ), and WHR ( $r_{bp}= 0.03$ ,  $p=0.8$ ) were not associated with frailty.

230

### 231 **Qualitative Interview Results**

232

233 Two main themes which linked women's perceptions of body weight, dietary intake  
234 and physical function were identified. They were: 1) concerns about weight and body  
235 image; and 2) perceptions about negative effects of unhealthy foods on physical  
236 function and health. Specific quotes from participants have been used to demonstrate  
237 the themes outlined above.

238

#### 239 ***Weight and body image concerns.***

240 Weight and body image emerged as two issues that were particularly important to  
241 participants. Data suggest that these women have become more aware of their weight  
242 as they have aged. Furthermore, some participants emphasized that their weight status  
243 worried them more than getting older or other health problems as the excerpts below  
244 indicate:

245

246 *'I am very careful that I don't eat too much, though I am very hungry but I will leave*  
247 *[the food uneaten]...I never say I want to eat more, no! ... I do not want to put on*  
248 *weight, that is in the back of my mind, I never think of the heart [problem], I think of*  
249 *my weight'* (Indian, 73y).

250

251 *'It doesn't bother me [the age], but when somebody says you are fat, then it hurts me!'*  
252 *(Indian, 62y).*

253

254 Participants' narratives also highlighted a difficult relationship between their diets and  
255 body weight, leading to feelings of frustration and shame:

256

257 *'My thinking was always eating healthy, but...I don't know how I put on so much*  
258 *weight so quickly and I've been trying [to lose weight] for many years now, it's not*  
259 *going down. I don't know what happened... I have gained so much I can't even get rid*  
260 *of it... since I've put on weight and I am out of size as well, I think 'Oh God people,*  
261 *don't see me!'* ...*That stops me from going out, dressing up as well, meeting people or*  
262 *going into places'* (Pakistani, 62y)

263

264 Given pervasive concerns about weight gain, many participants described modifying  
265 their diets in an effort to lose weight. However, adopting more restrictive diets have  
266 led some women to link these changes with a negative impact on their strength:

267

268 *'When you are getting older is hard to lose weight ...well, I used to cut down my food*  
269 *and then I think I was falling apart, I was getting weak... so I just said, "I'll just*  
270 *continue [as normal]'"* (African-Caribbean, 79y)

271 Other participants who have also tried to reduce their food intake mentioned that they  
272 occasionally complement their '*light diets*' with certain food items in order to meet  
273 their perceived dietary requirements:

274

275 '*When I feel I haven't had enough protein... and need to rebuild some of the cells,*  
276 *dying cells, ...then I would consciously have fish or chicken and try to eat a large*  
277 *portion to try to convince myself that I'm eating enough protein...but no, I do a lot of*  
278 *light days [of decreased consumption of fat and animal products]'* (African-  
279 *Caribbean, 68y).*

280

281 ***Perceptions about negative effects of unhealthy foods on physical function and***  
282 ***health.***

283 Participants' perceptions about the link between diet, physical function and general  
284 health were mainly driven by their beliefs about the negative effects unhealthy foods  
285 have on their mobility. For instance, some participants mentioned that eating  
286 '*fattening food*' decreases their ability to be more active:

287

288 '*If I had fried food and I walk, I feel breathless yeah, so I keep in line what I am*  
289 *eating*' (Indian, 71y)

290

291 '*Like...when you eat chips [French fries] you feel so heavy and you don't feel like*  
292 *moving, you don't feel like running you know*' (Indian, 74y)

293

294 Overall, women felt that the quality of the food they eat is associated with their  
295 general health, and that a healthy diet is an important component of healthy aging:

296 *'Health is related to what you put in your body, you are what you eat and if you put*  
297 *healthy food in your body, you can expect to be healthy at this age' (African-*  
298 *Caribbean, 69y)*

299

300

## DISCUSSION

301

302

303 The present study examined the association between dietary intake and frailty in a  
304 group of free-living first generation migrant older women using a mixed-methods  
305 approach. Findings from this study indicated that having a low energy intake was  
306 associated with frailty, and a poor nutritional status was significantly associated with  
307 frailty after adjusting for energy and other confounding factors. Poor nutritional status  
308 was also associated with slow walking speed, one of the criteria of the frailty  
309 syndrome. The findings also provided rich insight into participants' perceptions about  
310 the links between their body weight, dietary intake, and physical function.

311 Our findings support existing evidence associating frailty and its components to  
312 nutrition at the nutrient level.<sup>8</sup> Poor nutritional status and low serum levels of several  
313 nutrient biomarkers (serum carotenoids,  $\alpha$ -tocopherol, 25-hydroxyvitamin D, and  
314 vitamin B6) have been found to be related to an increased risk of frailty among  
315 predominantly White older adults.<sup>21-23</sup> These data, in addition to the findings from the  
316 present study, suggest that an inadequate diet plays a crucial role in the physical  
317 function of older adults. This is of particular importance due to the body composition  
318 changes associated with old age leading to loss of muscle mass (sarcopenia) that can  
319 contribute to morbidity and decreased quality of life.<sup>3</sup>

320 There are multiple pathways in which micronutrient deficiencies can increase the risk  
321 of frailty in older adults by promoting conditions commonly associated with older age  
322 such as oxidative stress, impaired immunity, muscle and bone metabolism, and  
323 inflammation.<sup>24</sup> In our study, only retinol and zinc were independently associated with  
324 frailty, suggesting that these two nutrients may be of particular concern in this sample.  
325 Retinol is suggested to protect cell membranes from oxidative damage related to  
326 aging,<sup>25</sup> while both retinol and zinc play an important role in maintaining the integrity  
327 of the immune system.<sup>26</sup> Although malnourishment is typically associated with  
328 underweight, this study confirms that overweight/obese individuals can also be  
329 malnourished due to consuming a poor quality diet.<sup>27</sup> Thus, an individual can be frail  
330 and not necessarily experience weight loss.

331 Among this sample, body weight concerns emerged as a key factor influencing energy  
332 and nutrient intake. Therefore, the majority of participants were more conscious about  
333 eating in moderation in order to lose weight, and did not identify being concerned  
334 with how their dietary intake would affect nutrient adequacy. Although it is well  
335 known that body dissatisfaction is highly associated with dietary intake in younger  
336 adults, it is only recently that this has been reported in older adults, especially in  
337 women.<sup>28</sup> Among women from minority ethnic groups, body weight perceptions have  
338 been reported to be more positive and accepting of larger figures and a body weight  
339 consistent with medically defined overweight or obesity.<sup>29</sup> However, our findings  
340 indicate that the women in this ethnically diverse sample are concerned about their  
341 body weight and the negative consequences associated with overweight/obesity.  
342 These concerns may potentially lead them to adopt restrictive eating practices that  
343 may cause more harm than good. Although body dissatisfaction has been previously  
344 reported in younger migrant women,<sup>30</sup> to our knowledge, this is the first time that this

345 has been found in a sample of older migrant women with high rates of  
346 overweight/obesity.

347 Regarding the negative effects of unhealthy foods on physical function and health, a  
348 few studies have found that an unhealthy diet (i.e., poor consumption of fruits and  
349 vegetables, low adherence to a Mediterranean-type diet) is associated with mobility  
350 limitations and disability in older adults, particularly in women.<sup>31-33</sup> Although this  
351 association has been found to be stronger in non-obese individuals,<sup>32</sup> in our study  
352 women felt that unhealthy foods, particularly fatty foods, were negatively related to  
353 their mobility. Thus, in overweight/obese older women, healthier diets may be  
354 perceived as a means of ameliorating mobility loss and further physical decline.

355 Given pervasive concerns about weight gain, findings from this study suggest that  
356 older women from ethnically diverse backgrounds with a high prevalence of  
357 overweight/obesity need dietary advice that promotes both the maintenance of a  
358 healthy body weight and nutrient adequacy. Particularly, because both excess weight  
359 and nutritionally inadequate diets are important determinants of morbidity and  
360 premature mortality.<sup>34</sup>

361 The major strength of the present study is the inclusion of a population commonly  
362 under-represented in research,<sup>35</sup> and little is known about dietary intake, eating  
363 behaviors, and frailty in older migrant women. The mixed-methods methodology is  
364 also a strength, as it allowed for the examination of dietary intake and its association  
365 with frailty as well as providing important insights into women's perceptions of their  
366 dietary intake and its link with body weight and physical function. In addition, the  
367 interview sample size was relatively large for a mixed-methods study, and data  
368 saturation was reached in all participants across the range of age and ethnic groups.



369 Finally, some limitations of the study need to be considered. Due to the cross-  
370 sectional study design and a relatively small sample size for the quantitative data,  
371 causal inferences cannot be made and findings may not be generalizable to the wider  
372 population of first generation older migrant women living in the UK. In addition,  
373 almost 90% of the sample was overweight or obese. Although this could be  
374 considered a strength as the sample reflects the higher prevalence of  
375 overweight/obesity in ethnic groups in the UK,<sup>36</sup> the findings do not include data from  
376 participants who were underweight. This could have limited the potential of finding  
377 an association between frailty, protein and other micronutrients consistently found in  
378 previous studies.<sup>8,23,37</sup> In addition, BMI was used as a measure of weight status. This is  
379 problematic as BMI does not distinguish between lean tissue and fat mass, and cannot  
380 take into account the height loss that occurs with older age.<sup>34</sup> Studies including a  
381 larger sample of older women from ethnically diverse backgrounds using an accurate  
382 measure of body composition and nutritional biomarkers are needed to confirm our  
383 findings. A larger sample will also allow for the examination of significant  
384 differences between ethnic groups.

385 Another important limitation was the use of a single 24-hr dietary recall, a limitation  
386 shared with other studies conducted with older adults and ‘hard to reach’  
387 populations.<sup>38</sup> This method was considered the most appropriate as it minimized  
388 participant burden and allowed participants with limited English literacy to fully  
389 participate in both the quantitative and qualitative aspects of the study. Limitations in  
390 willingness of participants to participate in a second 24-hr dietary recall interview, in  
391 addition to budgetary constraints, prevented the use of repeated 24-hr dietary recalls.  
392 In the present study, energy intake was relatively low and as such, under-reporting  
393 cannot be ruled out. Under-reporting has been found to be associated with female

394 gender, higher age, lower socio-economic status, and overweight/obesity.<sup>39</sup> Because  
395 of the day-to-day variability in dietary intake, the single 24-dietary recall provided  
396 data for the sample rather than an estimate of an individual's dietary intake. The  
397 interviews were conducted by a trained nutritionist, and when necessary with the aid  
398 of interpreters with the same ethno-cultural background who were familiar with the  
399 participants' dietary habits. In addition, we enhanced the 24-hr dietary recall with an  
400 in-depth probing interview that allowed for a rich exploration of habitual dietary  
401 behaviors not possible with a standard 24-hr dietary recall. Low dietary and nutrient  
402 intakes in older adults are not uncommon given important changes in body  
403 composition, intestinal absorption and decreased levels of PA.<sup>40</sup> In our study, women  
404 were highly sedentary, which could have also influenced their energy intake.  
405 Nevertheless, misreporting may have occurred and as such, our results should be  
406 interpreted in light of this limitation.

407

## 408 **IMPLICATIONS FOR RESEARCH AND PRACTICE**

409

410

411 Findings from this study indicate that among a group of mainly overweight/obese  
412 migrant women from ethnically diverse backgrounds, poor nutritional status is an  
413 independent predictor of frailty. Given that weight loss may not necessarily be present  
414 in community-dwelling older women, low energy and nutrient intakes make important  
415 contributions to the development of frailty. Therefore, assessing dietary intake may  
416 assist with screening for, and treating, frailty. Moreover, the mismatch found between  
417 body weight and dietary inadequacy may potentially cause older women to engage in  
418 self-imposed dietary restrictions that could cause further health problems. Future

419 strategies to prevent and detect frailty in this sub-group of the population should focus  
420 on maintenance of a healthy body weight as well as in the overall nutritional quality  
421 of the diet.

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573 **Table 1. Participant Demographic Characteristics**

<b>Variable</b>	<b>Mean <math>\pm</math> SD or %</b>	<b>Mean <math>\pm</math> SD or %</b>	<b>Mean <math>\pm</math> SD or %</b>	<b>p values</b>
	<b>Total n=76</b>	<b>Non-frail n=59</b>	<b>Frail n=17</b>	
Age (y)	70.5 $\pm$ 7.6	69.9 $\pm$ 6.5	74.1 $\pm$ 9.3	0.04
Residency in the UK (y)	38.73 $\pm$ 17.1	37.2 $\pm$ 17.8	44.1 $\pm$ 13.5	0.10
No. of diseases	2.3 $\pm$ 1.5	2.1 $\pm$ 1.5	3.3 $\pm$ 1.2	<0.001
Ethnicity, %				0.06
African-Caribbean	21 (27.6)	14 (23.7)	7 (41.2)	
African	10 (13.2)	10 (10.6)	0 (0)	
Arab	8 (10.5)	5 (8.5)	3 (17.6)	
Indian	20 (26.3)	17 (28.8)	3 (17.6)	
Pakistani	7 (9.2)	6 (10.2)	1 (5.9)	
Bangladeshi	5 (6.6)	2 (3.4)	3 (17.6)	
Irish	5 (6.6)	5 (8.5)	0 (0)	
IMD quintile, %				0.20
1 (most deprived)	49 (64.5)	34 (57.6)	15 (88.2)	
2	11 (14.5)	10 (16.9)	1 (5.9)	
3	7 (9.2)	7 (11.9)	0 (0)	
4-5 (less deprived)	9 (11.8)	8 (13.6)	1 (5.9)	
Education, %				0.07
No qualifications	26 (34.2)	16 (27.1)	10 (58.8)	
Primary school	8 (10.5)	6 (10.2)	2 (11.8)	
Secondary school	18 (23.7)	15 (37.3)	3 (17.6)	
Tertiary	24 (31.6)	22 (37.3)	2 (11.8)	
Marital status, %				0.60
Married	34 (44.7)	31 (52.5)	3 (17.6)	

Widowed	30 (39.5)	21 (35.6)	9 (52.9)	
Single/ separated/divorced	12 (15.8)	7 (11.9)	5 (29.4)	
Living alone, %	26 (34.2)	20 (33.9)	6 (35.3)	0.60
BMI (kg/m <sup>2</sup> )	29.3 ± 4.9	29.1 ± 4.8	30.2 ± 5.3	0.43
Normal, %	9 (11.8)	9 (15.3)	0 (0)	
Overweight, %	23 (30.3)	16 (27.1)	7 (41.2)	
Obese, %	44 (57.9)	34 (57.6)	10 (58.8)	
WC (cm) <sup>a</sup>	98.8 ± 10.8	97.8 ± 11.1	102.0 ± 9.3	0.15
WHR <sup>a</sup>	0.92 ± 0.8	0.92 ± 0.1	0.92 ± 0.6	0.70
Unintentional weight loss, %	9 (11.8)	6 (10.2)	6 (10.2)	0.41
Supplement use, %	30 (39.5)	24 (40.7)	6 (35.3)	0.46
Energy intake (Kcals)	1243.5 ± 524.4	1379.9 ± 507.9	819.7 ± 262.5	<0.01
Frailty score (No. of frailty components, %)				NA
0	36 (47.4)	36 (61)	0 (0)	
1	23 (30.3)	23 (39)	0 (0)	
≥2	17 (22.4)	0 (0)	17 (100)	

574 <sup>a</sup> n=68, BMI= Body Mass Index, IMD= Index of Multiple Deprivation, WC= waist  
575 circumference, WHR= waist-to-hip ratio, NA=not applicable.  
576  
577

578 **Table 2. Association Between Frailty Syndrome and its Components According**  
579 **to the Number of Nutrients with Low Intake (n=76)**

Number of nutrients with low intake				Adjusted Odds Ratios <sup>a</sup>	
Variables	0	1-3	>3	Low intake of 1-3 nutrients compared to 0	Low intake of >3 nutrients compared to 0
	%	%	%	OR (95% CI)	OR (95% CI)
Frailty	17.6	29.4	52.9	3.11 (0.56-17.35)	6.58 (1.01-43.08) <sup>b</sup>

syndrome						
Frailty components:						
Exhaustion	24.2	26.9	35.3	0.92 (0.26-3.17)	1.12 (0.17-7.20)	
Low PA	9.1	19.2	47.1	2.30 (0.46-11.33)	5.26 (0.72- 38.10)	
Weak grip	18.2	26.9	17.6	0.57 (0.15- 2.16)	1.23 (0.14-10.26)	
strength						
Slow	6.1	15.4	47.1	0.85 (0.11-6.79)	1.86 (1.13-3.07) <sup>b</sup>	
walking						
speed						

580 <sup>a</sup> Adjusted for low energy intake, age and number of diseases; <sup>b</sup> p< 0.05

581

582

583 **Table 3. Frailty Syndrome Associated with Low Intake of Specific Nutrients**

584 **(n=76)**

<b>Frailty <sup>b</sup></b>	
<b>Nutrient intake <sup>a</sup></b>	<b>OR (95% CI)</b>
Protein (g/day)	0.76 (0.09-5.99)
Retinol (µg/day)	10.33 (1.55- 68.94) <sup>c</sup>
Vitamin D (µg/day)	0.96 (0.18-5.19)
Vitamin E (mg/day)	0.98 (0.17-5.68)
Vitamin C (mg/day)	3.82 (0.67-21.64)
Folate (µg/day)	0.78 (0.12- 5.06)
Calcium (mg/day)	3.87 (0.65-22.85)
Iron (mg/day)	0.94 (0.17- 5.19)
Zinc (mg/day)	8.47 (1.04-68.8) <sup>c</sup>

585 <sup>a</sup> Defined as the lowest quintile of each selected nutrient, <sup>b</sup> Adjusted for low energy

586 intake, age and number of diagnosed diseases, <sup>c</sup>  $p < 0.05$

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