



Castaneda-Gameros, D., Redwood, S., & Thompson, J. (2017). Low Nutrient Intake and Frailty Among Overweight and Obese Migrant Women From Ethnically Diverse Backgrounds Ages 60 Years and Older: A Mixed-Methods Study. *Journal of Nutrition Education and Behavior*, 49(1), 3-10.e1. <https://doi.org/10.1016/j.jneb.2016.08.006>

Peer reviewed version

Link to published version (if available):  
[10.1016/j.jneb.2016.08.006](https://doi.org/10.1016/j.jneb.2016.08.006)

[Link to publication record in Explore Bristol Research](#)  
PDF-document

This is the accepted author manuscript (AAM). The final published version (version of record) is available online via Elsevier at <http://dx.doi.org/10.1016/j.jneb.2016.08.006>. Please refer to any applicable terms of use of the publisher.

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

Research Article

Diana Castaneda-Gameros, MSc<sup>1</sup>; Sabi Redwood, EdD MA RGN/RSCN<sup>2,3</sup>; Janice L. Thompson, PhD, FACSM<sup>1</sup>.

<sup>1</sup>School of Sport, Exercise & Rehabilitation Sciences, University of Birmingham B15 2TT, UK

<sup>2</sup>School of Social & Community Medicine, University of Bristol BS8 1TH, UK.

<sup>3</sup> NIHR CLAHRC West, 9th Floor, Whitefriars BS1 2NT, UK

## **Address for correspondence:**

Diana Castaneda-Gameros, MSc.,

School of Sport, Exercise & Rehabilitation Sciences, University of Birmingham  
B15 2TT, UK.

Phone: +44 (0)121 414 8745

Email: [dxc242@student.bham.ac.uk](mailto:dxc242@student.bham.ac.uk)

## **Acknowledgements:**

The authors thank the study participants who participated in this study and the organizations that helped with recruitment. This study and DCG were partially supported by The National Council on Science and Technology (Mexico) and by seed-corn funding from the Institute for Research into Superdiversity (University of Birmingham). SR's time is supported by the National Institute for Health Research (NIHR) Collaboration for Leadership in Applied Health Research and Care West (CLAHRC West) at University Hospitals Bristol NHS Foundation Trust.

## ABSTRACT

**Objective:** To examine associations between energy/nutrient intakes and frailty in older migrant women, and to explore perceptions of body weight, dietary intake and physical function.

**Design:** Cross-sectional mixed-methods study.

**Setting:** Birmingham, UK.

**Participants:** Seventy-six first generation migrant women  $\geq 60$  years.

**Main Outcome Measures:** Energy/nutrient intakes (assessed by 24-hr dietary recall), frailty (using the frailty phenotype), and links between perceptions of body weight, dietary intake, and physical function (via semi-structured interviews).

**Analysis:** Bivariate and logistic regression analyses examined associations between frailty and low energy/nutrient intakes. Interviews were analyzed using thematic analysis.

**Results:** Seventy-six women completed a 24-hr dietary recall; 46 participated in a semi-structured interview. Low energy intake was associated with frailty (OR: 11.71, 95% CI: 2.36-57.97). After adjusting for energy and other confounders, a low intake of  $>3$  nutrients was associated with frailty (OR: 6.58, 95% CI: 1.01-43.08).

Qualitative data suggest that dietary intake was influenced by concerns about body weight and perceptions that unhealthy foods reduce mobility.

**Conclusions and Implications:** Among older migrant women with high prevalence of overweight/obesity, an inadequate dietary intake may be a stronger predictor of frailty than weight loss. Dietary interventions should focus on healthy weight maintenance and optimization of nutritional adequacy and physical function.

**Key words:** Frailty; nutrient inadequacy; overweight/obesity; older women;  
ethnically diverse

## INTRODUCTION

1

2

3

4 Frailty has become the focus of extensive research due to the ever-increasing aging of  
5 the global population. Frailty is characterized as a disorder of multiple physiological  
6 systems in which homeostatic mechanisms start failing, increasing the risk of declines  
7 in cognitive and physical function.<sup>1-3</sup> Furthermore, longitudinal studies have  
8 demonstrated a greater prevalence of cardiovascular disease and diabetes among frail  
9 older people,<sup>4</sup> and a greater frailty burden for women in comparison to men.<sup>5,6</sup>

10 Therefore, identifying and treating individuals at risk of frailty may help delay its  
11 negative consequences and reduce the financial, social, and personal burdens these  
12 consequences place upon individuals, families and societies.<sup>7,8</sup>

13

14 One of the most widely used definitions of frailty is the frailty phenotype proposed  
15 and validated by Fried and colleagues.<sup>2</sup> This battery of tests identifies people as frail  
16 when they meet three or more of five criteria: relatively weak grip strength,  
17 unintentional weight loss, self-reported exhaustion, slow walking speed and low  
18 levels of physical activity (PA). The inclusion of unintentional weight loss is used as a  
19 proxy measure of dietary inadequacy, which is congruent with the conceptualization  
20 of frailty as a wasting disorder.<sup>2-3</sup> However, obesity can also be linked with frailty, as  
21 indicated by the greater risk of physical function decline and pro-inflammatory state  
22 commonly found among older adults who are obese.<sup>9</sup>

23

24 In older adults, the use of unintentional weight loss in the definition of frailty is  
25 problematic as this measure may not be sensitive enough to reflect reduced energy

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

39

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

45

46

47

## METHODS

48

49

### 50 **Study Design**

51

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

57

### 58 **Recruitment and Participants**

59

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

72 centers facilitated access to potential participants so they could be approached and  
73 informed of the purpose of the study. Participants were recruited via word-of-mouth  
74 and snowballing.<sup>12</sup> Ethics approval was granted by The University of Birmingham  
75 Ethics Committee (reference No. ERN\_13-0557). All participants provided written  
76 informed consent.

77

## 78 **Data Collection**

79

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

## 85 ***Dietary Intake.***

86 A multiple-pass 24-hr dietary recall interview was conducted with all participants to  
87 gather data on the types and amounts of foods consumed on the previous day via a  
88 standard protocol.<sup>13</sup> Information was also obtained on nutrient supplement use. A  
89 photographic food atlas assisted with the estimation of portion sizes.<sup>14</sup> The first author  
90 (DCG), a dietitian, trained in dietary assessment conducted all 24-hr dietary recalls.  
91 Data coding and processing was conducted by DCG, with oversight from JLT who  
92 has extensive expertise in dietary assessment. These procedures enabled a  
93 standardized data entry and analysis process. The dietary recall interview was audio-  
94 recorded to ensure accuracy of quantitative data entry and to facilitate the collection  
95 of additional qualitative information. When participants stated that the previous day  
96 did not reflect their habitual diet (e.g., they had engaged in fasting practices), the 24-



97 hr dietary recall was repeated later in the same week on a day that was identified by  
98 participants as being representative of their habitual intake. This occurred in 5  
99 participants. Data were not gathered during periods of major religious observances  
100 (e.g., Ramadan, Diwali). All recalls were conducted during weekdays, excluding  
101 Monday. Nutrient analysis was completed using DietPlan 6.0 software (Forestfield  
102 software Ltd 2006, Horsham, UK), which included standard and supplemental food  
103 composition databases that covered the range and ethnic diversity of foods consumed  
104 in the UK.

105

106 Similarly to methods reported by Bartali and colleagues,<sup>8</sup> low intake was defined as  
107 the lowest quintile of the distribution of energy (<13 kcal/kg) and specific nutrients:  
108 protein <30 g, vitamin D <0.5 µg, vitamin E <2.5 mg, retinol <101 µg, vitamin C <32  
109 mg, folate <127 µg, iron <5.6 mg, calcium <349 mg, and zinc <3.6 mg. A nutritional  
110 score was obtained by summing the number of nutrients categorized as low intake.  
111 This nutritional score was subsequently categorized into a low intake of 0, 1-3, or >3  
112 nutrients. A low intake of >3 nutrients was classified as poor nutritional status.

113

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

115 Anthropometric measures included height measured to the nearest mm (SECA 213  
116 portable stadiometer), weight to the nearest 0.1 kg (SECA 899 digital scale), and hip  
117 and waist circumference (WC) measured to the nearest cm using an extractable tape  
118 measure. All anthropometric measurements were taken with the participant wearing  
119 light clothing and no shoes. Body mass index (BMI) was calculated as weight divided  
120 by height squared ( $\text{kg}/\text{m}^2$ ), and waist-to hip-ratio (WHR) as waist circumference  
121 divided by hip circumference (cm).

122 Frailty status was assessed using a modified version of the original frailty definition  
123 developed by Fried and colleagues.<sup>2</sup> This included: 1) Exhaustion, defined using self-  
124 reported fatigue from two questions from the Center for Epidemiological Studies-  
125 Depression (CES-D) depression scale (“I felt that everything I did was an effort,” and  
126 “I could not get going.”) Participants who reported having these feelings for  $\geq 3$  days  
127 over the previous week to either or both questions received positive scores for  
128 exhaustion; 2) Slow walking speed, with the highest quintile of the time needed to  
129 walk a distance of 15 feet, adjusted by height ( $>14.5$  seconds for height  $\leq 157.7$  cm  
130 and  $>9.7$  seconds for height  $> 157.7$  cm); 3) Weak grip strength was defined as the  
131 lowest quintile for adjusted grip strength using a JAMAR hand-held dynamometer  
132 (Sammons Preston Rolyan, Bolingbrook, Illinois, USA), adjusted by BMI.  
133 Participants met the criteria for weak grip strength if their BMI and grip strength were  
134  $\leq 25.8$  kg/m<sup>2</sup> and  $\leq 12$  kg;  $>25.9$ -  $29.6$  kg/m<sup>2</sup> and  $\leq 11$  kg;  $>29.7$ -  $31.6$  kg/m<sup>2</sup> and  $\leq 12$   
135 kg; and  $\geq 31.7$  kg/m<sup>2</sup> and  $\leq 14$  kg. A low level of PA was defined as the lowest quintile  
136 of caloric expenditure ( $< 60$  kcal/week) using the International Physical Activity  
137 Questionnaire short-form modified for the elderly (IPAQ-E).<sup>15</sup> This version of the  
138 IPAQ provides examples of activities that are more common among older adults and  
139 has shown a moderate correlation ( $r=0.347$ ,  $p<0.01$ ), and moderate agreement  $\kappa$   
140 ( $95\%CI= 0.448$  ( $0.18$ - $0.72$ ,  $p < 0.001$ ) with accelerometry.<sup>16</sup>  
141  
142 Since the purpose of this study was to examine the association between dietary intake  
143 and frailty, similar to Bartali’s study, unintentional weight loss ( $>10$  pounds in the last  
144 year) was excluded from the original frailty definition.<sup>8</sup> Therefore, participants with  
145  $>2$  positive criteria were categorized as frail, while those with  $\leq 1$  positive criteria  
146 were categorized as not frail.

147

148 ***Semi-structured interviews.***

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

160

161 **Data Analysis**

162

163 ***Quantitative data analysis.***

164 Descriptive characteristics (means, SDs, and percentages) were calculated for socio-  
165 demographic variables. To identify potential confounding factors, independent t-tests  
166 or Mann-Whitney U tests (for non-parametric data) were conducted to examine any  
167 significant differences in continuous variables between those classified as frail or not  
168 frail, with Chi-squared or Fisher's exact tests conducted for categorical variables.  
169 Point-biserial correlations ( $r_{pb}$ ) were used to determine the association between frailty  
170 status (dichotomous variable), weight loss, and indices of overweight/obesity (e.g.,

171 BMI, WC and WHR). Multiple logistic regressions were used to evaluate the  
172 association between frailty status and each of its components with low energy intake  
173 and poor nutritional status. Separate models were conducted to test the association  
174 between nutrient intakes with frailty adjusting for confounding factors and energy  
175 intake. All statistical analyses were performed using SPSS version 21.0 (SPSS INC.,  
176 Chicago, IL); alpha was set at  $p < 0.05$ .

177

### 178 *Qualitative data analysis.*

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

191

192

## RESULTS

193

194

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

### 208 **Frailty and low nutrient intake**

209

210 Among frail participants, 82.3% had a low nutrient intake of at least one selected  
211 nutrient (Table 2). The percentage of women with frailty increased with the greater  
212 number of nutrients classified as low intake. Logistic regression analyses indicated  
213 that low energy intake was independently associated with frailty (odds ratio [OR]:  
214 11.71, 95% confidence interval [CI]: 2.36-57.97). After adjusting for energy, age and  
215 number of diseases, poor nutritional status (>3 low nutrient intakes) was significantly  
216 associated with frailty (OR: 6.58, 95% CI: 1.01-43.08) in comparison to those women  
217 who did not have a low intake of any nutrients. After adjusting for energy and other  
218 confounding variables, only slow walking speed was significantly associated with  
219 poor nutritional status (OR: 1.86, 95% CI: 1.31-3.07).

220

221 In addition, a low intake of retinol (OR: 10.33, 95% CI: 1.55- 68.94) and zinc (OR:  
222 8.47, 95% CI: 1.04-68.80) were significantly associated with frailty after adjustment  
223 for energy intake and other confounding variables (Table 3). Self-reported weight loss  
224 ( $p=0.3$  for Fisher's exact test), BMI ( $r_{bp}= 0.09$ ,  $p=0.4$ ), waist circumference ( $r_{bp}= 0.2$ ,  
225  $p=0.1$ ), and WHR ( $r_{bp}= 0.03$ ,  $p=0.8$ ) were not associated with frailty.

226

### 227 **Qualitative Interview Results**

228

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

234

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

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

241

242 *'I am very careful that I don't eat too much, though I am very hungry but I will leave*  
243 *[the food uneaten] ... I never say I want to eat more, no! ... I do not want to put on*

244 *weight, that is in the back of my mind, I never think of the heart [problem], I think of*  
245 *my weight’ (Indian, 73y).*

246

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

249

250 Participants’ narratives also highlighted a difficult relationship between their diets and  
251 body weight, leading to feelings of frustration and shame:

252

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

259

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

263

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

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

270

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

276

277 ***Perceptions about negative effects of unhealthy foods on physical function and***  
278 ***health.***

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

283

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

286

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

289

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



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

295

296

## DISCUSSION

297

298

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

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

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

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

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

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

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

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

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

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

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

403

#### 404 **IMPLICATIONS FOR RESEARCH AND PRACTICE**

405

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

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

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**Table 1. Participant Demographic Characteristics**

<b>Variable</b>	<b>Mean <math>\pm</math> SD or % Total n=76</b>	<b>Mean <math>\pm</math> SD or % Non-frail n=59</b>	<b>Mean <math>\pm</math> SD or % Frail n=17</b>	<b>p values</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 $\pm$ 4.9	29.1 $\pm$ 4.8	30.2 $\pm$ 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 $\pm$ 10.8	97.8 $\pm$ 11.1	102.0 $\pm$ 9.3	0.15
WHR <sup>a</sup>	0.92 $\pm$ 0.8	0.92 $\pm$ 0.1	0.92 $\pm$ 0.6	0.70
Unintentional weight loss, %	9 (11.8)	6 (10.2)	3 (17.6)	0.41
Supplement use, %	30 (39.5)	24 (40.7)	6 (35.3)	0.46
Energy intake (Kcals)	1243.5 $\pm$ 524.4	1379.9 $\pm$ 507.9	819.7 $\pm$ 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)	
$\geq 2$	17 (22.4)	0 (0)	17 (100)	

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

**Table 2. Association Between Frailty Syndrome and Frailty Criteria According 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 syndrome	17.6	29.4	52.9	3.11 (0.56-17.35)	6.58 (1.01-43.08) <sup>b</sup>
Frailty criteria:					
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 strength	18.2	26.9	17.6	0.57 (0.15- 2.16)	1.23 (0.14-10.26)
Slow walking speed	6.1	15.4	47.1	0.85 (0.11-6.79)	1.86 (1.13-3.07) <sup>b</sup>

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

**Table 3. Frailty Syndrome Associated with Specific Low Nutrient Intakes (n=76)**

<b>Nutrient intake <sup>a</sup></b>	<b><u>Frailty syndrome <sup>b</sup></u> 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>

<sup>a</sup> Defined as the lowest quintile of each selected nutrient, <sup>b</sup> Adjusted for low energy intake, age and number of diagnosed diseases, <sup>c</sup> p<0.05