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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7   **INTRODUCTION**

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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.[1-3] Furthermore, longitudinal studies have

14   demonstrated a greater prevalence of cardiovascular disease and diabetes among frail

15   older people,[4] and a greater frailty burden for women in comparison to men.[5,6]

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.[7,8]

19

20   One of the most widely used definitions of frailty is the frailty phenotype proposed

21   and validated by Fried and colleagues.[2] 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.[2-3] 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.[9]

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.[8] 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.[8] 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 (≥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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55   **Study Design**

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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[10] 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.[11] 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.[12] 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.[13]

93 Information was also obtained on nutrient supplement use. A photographic food atlas

94 assisted with the estimation of portion sizes.[14] 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,[8] 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 (kg/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.[2] 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 ≥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 ≤ 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   ≤25.8 kg/m^2 and ≤ 12 kg; >25.9- 29.6 kg/m^2 and ≤ 11 kg; >29.7- 31.6 kg/m^2 and ≤12

139   kg; and ≥31.7 kg/m^2 and ≤14 kg. A low level of PA was defined as the lowest quintile

140   of caloric expenditure (< 60 kcal/week) using the International Physical Activity

141   Questionnaire short-form modified for the elderly (IPAQ-E).[15] 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 ϰ

144   (95%CI)= 0.448 (0.18-0.72, p < 0.001) with accelerometry.[16]

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.[8] Therefore, participants with

149   >2 positive criteria were categorized as frail, while those with ≤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.[17] 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.[18]

195

196 **RESULTS**

197

198

199   Table 1 includes the demographic characteristics of participants. On average,

200   participants (mean age= 70.5 ± 7.6 years) reported having 2.3 ± 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.[19] 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.[20] 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.[8] Poor nutritional status and low serum levels of several

313 nutrient biomarkers (serum carotenoids, α-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.[21-23] 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.[3]

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.[24] 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,[25] while both retinol and zinc play an important role in maintaining the integrity

327 of the immune system.[26] 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.[27] 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.[28] 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.[29] 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,[30] 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.[31-33] Although this

351   association has been found to be stronger in non-obese individuals,[32] 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.[34]

361   The major strength of the present study is the inclusion of a population commonly

362   under-represented in research,[35] 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,[36] 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.[8, 23,37] 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.[34] 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.[38] 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.[39] 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.[40] 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**

Variable	Mean ± SD or % Total n=76	Mean ± SD or % Non-frail n=59	Mean ± SD or % Frail n=17	p values
Age (y)	70.5 ± 7.6	69.9 ± 6.5	74.1 ± 9.3	0.04
Residency in the UK (y)	38.73 ± 17.1	37.2 ± 17.8	44.1 ± 13.5	0.10
No. of diseases	2.3 ± 1.5	2.1 ± 1.5	3.3 ± 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 (9.20	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^2)	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) [a]	98.8 ± 10.8	97.8 ± 11.1	102.0 ± 9.3	0.15
WHR [a]	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 [a] n=68, BMI= Body Mass Index, IMD= Index of Multiple Deprivation, WC= waist
575 circumference, WHR= waist-to-hip ratio, NA=not applicable.
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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** [a]	
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) [b]

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 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) [b]

580 [a] Adjusted for low energy intake, age and number of diseases; [b] $p < 0.05$

581

582

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

584 **(n=76)**

	Frailty [b]
Nutrient intake [a]	**OR (95% CI)**
Protein (g/day)	0.76 (0.09-5.99)
Retinol (µg/day)	10.33 (1.55- 68.94) [c]
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) [c]

585 [a] Defined as the lowest quintile of each selected nutrient, [b] Adjusted for low energy

586 intake, age and number of diagnosed diseases, [c] $p < 0.05$

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