

1 **Title:** A cross-sectional feasibility study of nutrient intake patterns in people with  
2 Parkinson's compared to government nutrition guidelines.

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20

21 **Abstract**

22 Diet could have implications for disease progression and management in people with  
23 Parkinson's (PwP). However, the knowledge of diet intake patterns in PwP is limited.

24

25 Objectives

26 We set out to assess the feasibility of collecting diet data in PwP to determine food and  
27 nutrient intake, in order to compare to national nutrition guidelines and thus understand the  
28 habits in this population.

29

30 Methods

31 In this cross sectional feasibility study PwP were approached through local support groups  
32 through out the Thames Valley and were asked to complete a Food Frequency Questionnaire.  
33 Eligibility criteria included a self-reported neurologist confirmed diagnosis of Parkinson's.  
34 Completeness of questionnaires was reported and 80% was considered appropriate for each  
35 measure including demographic information.

36

37 Results

38 Response rate was 61% and missing data for the 121 returned questionnaires was 74%,  
39 however of the 90 used for analysis there was 100% completion of the questionnaires.  
40 Compared to the UK government guidelines, protein was significantly higher for both males  
41 and females and fluid intake lower for both genders ( $p < 0.001$ ). There were several other  
42 differences in nutrient intake compared to guidelines.

43

44 Conclusion

45 We observed high levels of engagement from PwP and found that assessing food and nutrient  
46 patterns in PwP was feasible. Importantly, the diet was generally healthy overall, yet there  
47 were specific nutrients that may affect medication metabolism in PwP which were found to  
48 be high. Therefore further research into this emerging and important area is warranted.

49

50 Keywords: Protein; diet; Parkinson's

51

52 **Introduction**

53

54 A healthy diet is known to benefit physical and cognitive functioning throughout the lifespan  
55 [1, 2], and to protect against a number of long term conditions and associated symptoms [3,  
56 4]. However there is limited evidence of the role of diet in disease progression and symptom  
57 management in people with Parkinson's (PwP) [5, 6].

58

59 Whilst diet is known to impact on the effectiveness of drug metabolism [7], dietary patterns  
60 are not typically measured clinically in PwP and there is a need to consider diet in both  
61 disease progression and management. Although only a modest effect of diet on risk of  
62 Parkinson's has been shown [8], the role of diet after diagnosis is more promising [9, 10].  
63 Evidence so far has suggested a more healthy diet is associated with lower levels of disability  
64 and symptom severity in PwP, yet good quality comprehensive research is lacking and  
65 subsequently there are no specific nutritional guidelines for PwP [6, 11].

66

67 PwP have been found to consume less fluids than the control population, partially as a result  
68 of symptoms such as dysphagia [12]. High protein intake have also been noted in PwP and  
69 the higher the intake the larger the dose of levodopa required, with a correlation seen between  
70 higher protein intake and levodopa related motor complications [13]. A recent study looked  
71 into the effect of food groups on Parkinson's progression and found that 'healthy' food such  
72 as fresh vegetables, fresh fruit, nuts and seeds, non fried fish, olive oil, wine, coconut oil,  
73 fresh herbs, and spices were related to a reduced progression of disease, where as fruits and  
74 vegetables, diet and non diet soda, fried foods, beef, ice cream, yogurt, and cheese were  
75 associated with increased progression [14].

76

77 The aim of the present study is to determine the feasibility of collecting information about  
78 food and nutrient intakes in PwP using a standardised comprehensive diet questionnaire, and  
79 to highlight habits and potential areas of concern for PwP considering the disease and its  
80 management.

81

## 82 **Methods**

83

84 This was a cross sectional pilot study designed to assess aspects of feasibility including the  
85 efficiency of data collection methods through completion and return of questionnaires,  
86 identification of missing data and recruitment rate. Participants were recruited throughout  
87 Buckinghamshire and Oxfordshire either via the Parkinson's UK Research Network or  
88 through Parkinson's UK support groups and questionnaires were administered in person and  
89 were returned through mail. Potential participants were provided with information about the  
90 study and if they agreed to take part, consent was implied through the completion and return  
91 of anonymised questionnaires. Eligibility criteria included a self-reported neurologist  
92 confirmed diagnosis of Parkinson's. Ethical approval for this study was granted by University  
93 Ethics Committee (150895).

94

95 The EPIC-Norfolk Food Frequency Questionnaire [15] was used to measure habitual food  
96 intake over the previous 12 months. It included questions about specific food items, such as  
97 seasonal consumption of fruit and vegetables and habitual consumption of meat, fish, dairy  
98 products, potatoes, breads, rice, fats and sugars. The FFQ was analysed using software from  
99 the European Prospective Investigation into Cancer (EPIC-Norfolk) Cohort study; from  
100 which the accuracy of the analysis was originally validated and therefore has not been

101 validated in those with Parkinson's. Demographic information was self reported and included  
102 weight, height, gender, and date of birth.

103

104 Dietary Reference Values (DRVs) are a series of estimates of the energy and nutritional  
105 requirements of different groups of healthy people and are based on the UK populations [16].  
106 These were set by the Committee on Medical Aspects of Food and Nutrition Policy (COMA)  
107 in 1991. Therefore in the current study the nutrient intakes from the participants were  
108 compared with the optimal intake values based on the government guidelines.

109

110 Statistical analysis

111 A sample size of 82 PwP was calculated based on a population of 554 PwP throughout  
112 Oxfordshire (assuming 227 new diagnoses annually and 227 existing), a confidence interval  
113 of 10% and a confidence level of 95%. Demographic data was described using descriptive  
114 analysis and recruitment rate was determined. Completeness of questionnaires was reported  
115 and 80% was considered appropriate for each measure including demographic information  
116 [17].

117 Nutrient data was compared to the SACN guidelines to identify any obvious and  
118 major differences in nutrient intake in PwP compared to the UK population ( $\pm 1$  SD). These  
119 nutrients were then further analysed. Therefore, the data were first descriptively analysed  
120 before performing further analysis.

121 Significance level was set at 5%. Multicollinearity was assessed and collinear  
122 variables were not included. Data were analysed using SPSS Statistics Version 23 (IBM  
123 SPSS Statistics for Windows, IBM Corp, Armonk, NY, USA). Independent two sided t tests  
124 for males and females were performed to compare mean values for each nutrient to the UK  
125 guideline recommendation for these nutrients.

126

127 **Results**

128

129 This was a cross-sectional feasibility study including 90 PwP (men 52; women 38) over 18  
130 years of age (mean years  $68 \pm 9.64$  SD, body mass index  $25.02 \pm 4.27$  SD  $\text{mg}/\text{k}^2$ ) recruited  
131 between 2016 to 2017. 200 questionnaires were administered randomly in the support group  
132 meetings and of those 121 returned (61%), 90 were used for analysis (45%). Missing data for  
133 the 121 returned questionnaires was 74%, however of the 90 used for analysis there was  
134 100% completion of the questionnaires (fig 1).

135

136 [See appendix for: figure 1]

137

138 Comparison to UK nutrition guidelines

139

140 In the current study, the nutrient intake in PwP was compared to the SACN guidelines and  
141 table 1 represents nutrients that were significantly different from the UK guidelines. Protein  
142 intake was significantly higher compared to the UK guidelines and fluid intake lower in both  
143 genders ( $p < 0.001$ ). Also, other nutrients were shown to have significance compared to SACN  
144 guidelines, for example energy intake was lower for men ( $p = 0.002$ ), zinc was higher for  
145 females ( $p < 0.001$ ) and fibre and vitamin D were lower for both genders ( $p < 0.001$ ) yet iron,  
146 vitamin C, folate, phosphorus, B6, B12, calcium were higher for both genders ( $p < 0.001$ ).

147

148 [See appendix for: table 1]

149

150 **Discussion**

151

152 We assessed diet in a representative sample of PwP and notably observed that protein intake  
153 was twice that recommended by UK guidelines. Other interesting findings were lower fluid,  
154 fibre and vitamin D intake and more differences were found in men compared to SACN  
155 guidelines who generally had a poorer diet than women. Although research is limited,  
156 nutritional status may play a significant role in symptoms in PwP [17]. Our findings suggest  
157 that monitoring diet is feasible and well received and that the development of approaches to  
158 effectively support optimal and specific diets for PwP may be important for management of  
159 the disease and symptoms.

160

161 Although fluid consumption tended to be similar between the sub groups in this cohort of  
162 PwP, the intake of fluids was at the lower end of ‘optimal’ when compared to UK guidelines.  
163 In the current study intakes were around 800 ml whereas guidelines recommend a minimum  
164 of 1200 ml a day for health [18]. Men have been found to have fewer coping strategies when  
165 it comes to bladder management and may restrict fluid intake in order to manage urinary  
166 frequency, resulting in dehydration [19], however the reason for lower intakes in women is  
167 not known. Symptoms such as dysphagia may be responsible for the lower fluid intake in  
168 PwP as reported previously [12].

169

170 PwP in the current study were found to have double the required intake of protein which  
171 confirms findings from 2006, when a smaller study observed similar high intakes of protein  
172 [6]. Protein intake interrupts the efficiency of levodopa and therefore PwP are advised to  
173 reduce and redistribute their protein intakes. Therefore it may be detrimental for PwP to be  
174 consuming above the recommendations for this nutrient, especially if on disease modifying  
175 medication for their condition. However, when limiting protein intake, Virmani et al. [7]



176 found 60% of patients experienced weight loss and therefore this must be monitored closely  
177 for optimal effects especially considering the low energy intake particularly in men. This  
178 shows that dietary behaviour does not appear to have altered over time and the need for  
179 research of possible interventions to support optimal diet for symptom management in PwP.

180

181 The interaction between protein restriction for improving GABA and glutamate  
182 concentrations in the brain may show potential in neurodegenerative disorders including  
183 Parkinson's and therefore may be another incentive for reducing protein intake in those with  
184 the condition [20].

185

186 Interestingly, intake of vitamin B6 was greater in this sample of PwP compared to the UK  
187 recommendations. Low vitamin B6 intake has been shown to increase risk of developing  
188 Parkinson's may slow disease progression [21]. Vitamin B6 is an essential cofactor in the  
189 conversion of homocysteine to cysteine and alpha-ketobutyrate, and homocysteine is thought  
190 to be linked to neurological pathogenesis in Parkinson's. However the vitamin could interact  
191 with certain Parkinson's medications and therefore high levels may be harmful to some PwP.

192

### 193 Limitations

194 In order to provide more comprehensive results a larger sample size would be beneficial from  
195 other geographical locations and the collection of more demographic information and  
196 possible confounders (smoking, exercise habits etc) would have provided a stronger statistical  
197 analysis of the results. Data was self-reported, including diagnosis of PD (no clinical  
198 confirmation obtained). The sample may have been biased as those who attend support  
199 groups are more likely to be physically able and also to be retired.

200

201 The EPIC FFQ is a good indicator of nutritional intake as significant correlations have been  
202 found between nutrients derived from the FFQ in comparison to biological analysis markers  
203 [22]. Despite it being comprehensive and a detailed assessment of food intake over a year  
204 time span, it does have several limitations such as it may not include all foods consumed  
205 and/or all cooking methods. Also, intake is not necessarily an indicator of nutritional status  
206 due to factors such as bioavailability, nutrient absorption and combination of food consumed  
207 [23].

208

## 209 Conclusion

210

211 This study provides a current snapshot of comprehensive assessment of the food and nutrient  
212 patterns in PwP compared to nutritional guidelines. Research into the diet patterns in this  
213 group was shown to be feasible and well received. This study is the first to show that PwP  
214 generally have healthy diets compared to the UK guidelines, yet may be unhealthy on some  
215 critical dietary components for their condition. The development of clear specific dietary  
216 guidance and pathways for implementation may be required to maintain the health of PwP  
217 and to help them understand the importance of optimal dietary manipulation for their  
218 condition.

219

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## 225 Author contributions

226 All authors contributed to the writing, data analysis, project design and data collection.

227

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232

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234

235 **References**

236

237 [1] de Souto Barreto P, Delrieu J, Andrieu S, et al. Physical Activity and Cognitive Function  
238 in Middle-Aged and Older Adults, Mayo Clin Proceed. 2016;91(11): 1515-1524.

239

240 [2] Lourida I, Soni M, Thompson-Coon J, et al. Mediterranean Diet, Cognitive Function, and  
241 Dementia: A Systematic Review, Epid. 2013; 24(4): 479-489.

242

243 [3] Coe S, Axelsson E, Murphy V, et al. Flavonoid rich dark cocoa may improve fatigue in  
244 people with Multiple Sclerosis, yet has no effect on glycaemic response: an exploratory trial.  
245 Clin Nutr ESPN. 2017; doi.org/10.1016/j.clnesp.2017.07.002

246

247 [4] Erro, R., Brigo, F., Tamburin, S. et al. Nutritional habits, risk, and progression of  
248 Parkinson disease. J Neuro. 2017; <https://doi.org/10.1007/s00415-017-8639-0>

249

250 [5] Seidl SE, Santiago JA, Bilyk H et al. The emerging role of nutrition in Parkinson's  
251 disease, Fron Ag Neuro. 2014;6(36).

252

253 [6] Marczewska A, De Notaris R, Sieri S et al. Protein intake in Parkinsonian patients using  
254 the EPIC food frequency questionnaire, Mov Disor. 2006;21: 1229-1231.

255

256 [7] Virmani T, Tazan S, Mazzoni P et al. Motor fluctuations due to interaction between  
257 dietary protein and levodopa in Parkinson's disease, J Clin MovDisor. 2016;3(8).

258

259 [8] Sääksjärvi K, Knekt P, Lundqvist A, Männistö S, Heliövaara M, Rissanen H & Järvinen  
260 R. A cohort study on diet and the risk of Parkinson's disease: The role of food groups and diet  
261 quality. *BJN*, 2013; 109(2): 329-337.

262

263 [9] Mischley LK, Lau RC, Bennett RD. Role of Diet and Nutritional Supplements in  
264 Parkinson's Disease Progression. *Ox Med & Cell Long*, 2017: 1-9.

265

266 [10] Sherzai AZ, Tagliati M, Park K, Pezeshkian S, & Sherzai D. Micronutrients and Risk of  
267 Parkinson's Disease: A Systematic Review. *Ger & Ger Med*, 2016; 22(2): 1-12.

268

269 [11] Galland L. Diet and Inflammation, *Nutr Clin Pract*. 2010;25(6): 634-640.

270

271 [12] Cassani E, Barichella M, Ferri V, et al. Dietary habits in Parkinson's disease: Adherence  
272 to Mediterranean diet. *Park & Rela Disor*. 2017; 42: 40-46.

273

274 [13] Barichella M, Cereda E, Cassani E, et al. Dietary habits and neurological features of  
275 Parkinson's disease patients: Implications for practice. *Clin Nutr*. 2017; 36(4):1054-1061.

276

277 [14] Michley LK, Lau RC, Bennett RD. Role of Diet and Nutritional Supplements in  
278 Parkinson's Disease Progression. *Oxid Med Cell Long*. 2017;  
279 <https://doi.org/10.1155/2017/6405278>.

280

281 [15] Bingham S, Welch A, McTaggart A, et al. Nutritional methods in the European  
282 Prospective Investigation of Cancer in Norfolk, *Pub Health Nutr*. 2001;4(3): 847-858.

283

284 [16] British Nutrition Foundations (2018) doi: <https://www.nutrition.org.uk/>  
285

286 [17] Fereshtehnejad SM, Ghazi L, Shafieesabet M, et al. Motor, Psychiatric and Fatigue  
287 Features Associated with Nutritional Status and Its Effects on Quality of Life in Parkinson's  
288 Disease Patients, Plos One. 2014; <https://doi.org/10.1371/journal.pone.0091153>.  
289

290 [18] Benelam B, Wyness L. Hydration and health: a review, Nutr Bull. 2010;35(1): 3-25.  
291

292 [19] Collett J, Dawes H, Cavey A, et al. Hydration and independence in activities of daily  
293 living in people with multiple sclerosis: a pilot investigation, Disab Rehab. 2011; 33: 1822-  
294 1825.  
295

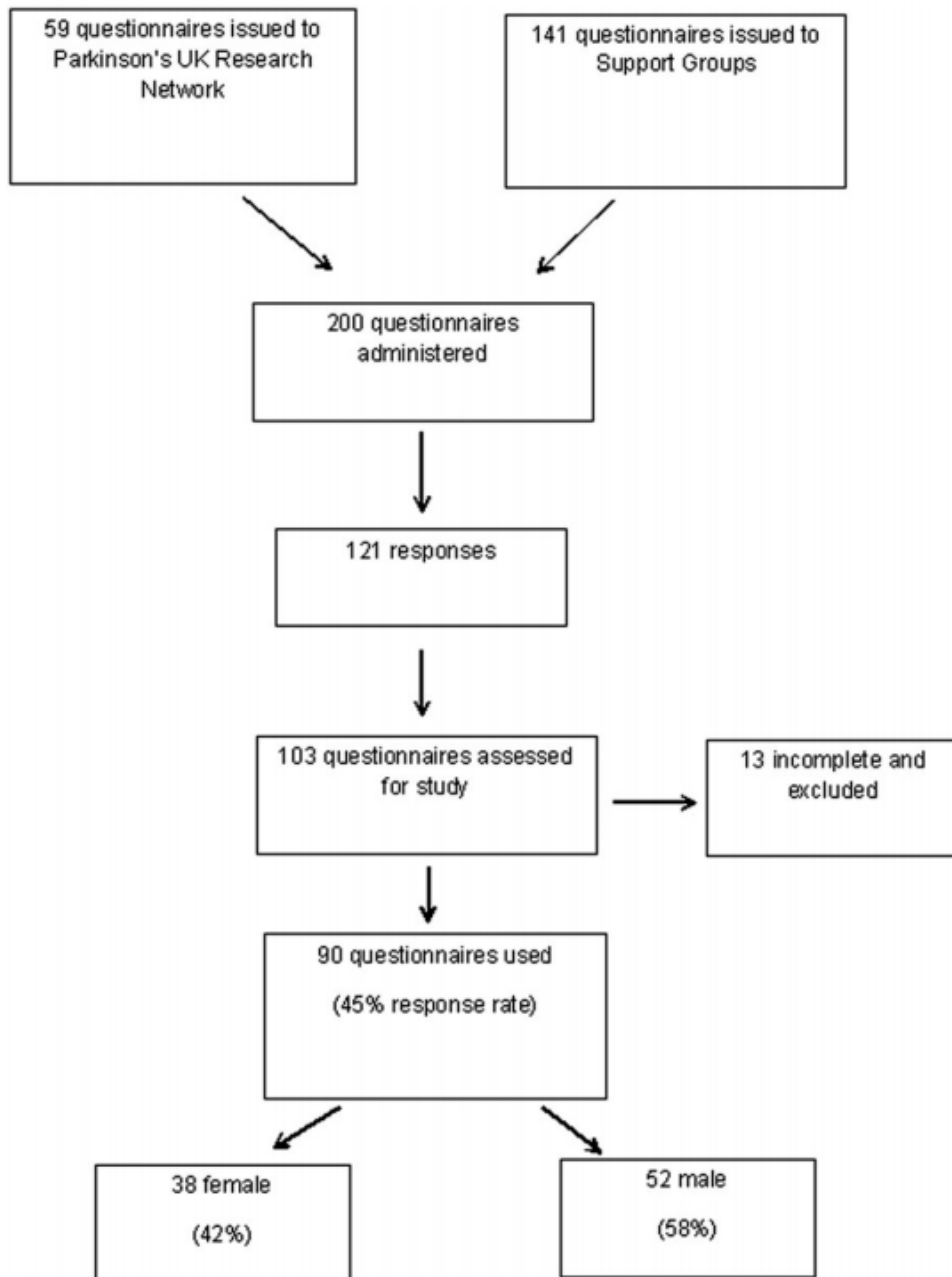
296 [20] Nayak P, Chatterjee AK. Dietary protein restriction causes modification in aluminum-  
297 induced alteration in glutamate and GABA system of rat brain. BMC Neurosci. 2003;  
298 24(4):4.  
299

300 [21] Shen L. Associations between B vitamin sand Parkinson's Disease. Nutrients. 2015; 7,  
301 7197-7208.  
302

303 [22] Sauvageot N, Alkerwi A, Albert A, et al. Use of food frequency questionnaire to assess  
304 relationships between dietary habits and cardiovascular risk factors in NESCAV study:  
305 validation with biomarkers, Nutr J. 2013;143(12).  
306

307 [23] Potischman N. Biologic and Methodological Issues for Nutritional Biomarkers, J Nutr  
308 2003;133(3): 875S-880S.

309 Figure 1.



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Table 1. Nutrient/Food Intake in People With Parkinson's (PwP) Compared to UK Government Science Advisory Committee on Nutrition (SACN) Guidelines.

Nutrient	Energy (kcal)	Protein (g)	Fiber (g)	Iron (mg)	Zinc (mg)	Calcium (mg)	Vit C (mg)	Vit D (µg)	B6 (mg)	B12 (µg)	Phosphorus (mg)	Folate (µg)	Chloride (mg)	Non alcoholic beverages (g)	Alcohol (g)
PwP															
Female	1916	83	20	12	10	962	143	3	2	7	1453	327	4315	816	39
Male	2034	85	19	13	10	993	136	3	2	8	1504	327	4190	811	196
SACN															
Female	1912	46.5	30	8.7	7	700	40	10	1.2	1.5	550	200	2500	1200	-
Male	2342	53.5	30	8.7	9.5	700	40	10	1.4	1.5	550	200	2500	1200	-

Note: Intake in PwP refers to mean data from the 90 Food Frequency Questionnaires. Nutrients were chosen from 60 nutrients and were those above or below one standard deviation from the SACN recommendations. Whole food groups were also considered. Vit C: vitamin C; Vit D: vitamin D.