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Published in:
Appetite

DOI:
[10.1016/j.appet.2015.03.011](https://doi.org/10.1016/j.appet.2015.03.011)

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Recommended citation(APA):
van der Meij, B. S., Wijnhoven, H. A., Finlayson, G. S., Oosten, B. S. H., & Visser, M. (2015). Specific food preferences of older adults with a poor appetite. A forced-choice test conducted in various care settings. *Appetite, 90*, 168-175. <https://doi.org/10.1016/j.appet.2015.03.011>

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Specific food preferences of older adults with a poor appetite: a forced-choice test conducted in various care settings

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Disclaimers

None

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This study was supported by the Netherlands Organisation for Health Research and Development

Running head of not more than 50 characters (count letters and spaces)

Food preferences of older persons

Abbreviations

BMI Body Mass Index

GLM General linear model

SNAQ65+ Short Nutritional Assessment Questionnaire 65+

Clinical trial registry

Not applicable

1 **Abstract**

2 A poor appetite in older adults is an important determinant of reduced food intake and
3 undernutrition. Food preferences may influence food intake. The aim of this study was to
4 investigate food preferences of older adults receiving a poor appetite and compare these with
5 preferences of older adults with a good appetite. Older adults (n=349, aged 65-101 y) in
6 nursing/residential care homes, hospitals or at home receiving home care participated in a
7 computer-based forced-choice food preference assessment. Self-reported appetite in the past
8 week was classified as 'good' or 'poor' using a validated instrument. Food preferences were
9 determined by counting the relative frequency of choices for food images according to 11
10 dichotomous categories: high/low 1) protein; 2) fat; 3) carbohydrates; 4) fibre; 5) variation; and
11 6) animal/vegetarian proteins; 7) sweet/savoury taste; 8) solid/liquid texture; 9) dairy/non-
12 dairy; with/without 10) sauce or 11) colour variation. Specific food preferences in participants
13 with a poor appetite were identified by one-sample t-tests comparing frequencies to 48.
14 Preference differences between those with a good and a poor appetite were analysed using
15 GLM adjusting for confounders. The results showed that older adults with a poor appetite (n=
16 113; 32.4%) preferred variation (51.6 vs. 48, $P<0.001$), colour variation (55.9 vs. 48, $P<0.01$),
17 non-dairy (53.0 vs. 48, $P<0.001$), high-fibre (51.8 vs. 48, $P<0.05$), and solid texture (53.5 vs. 48,
18 $P<0.05$). Participants with a poor appetite had a higher frequency score for variation than
19 participants with a good appetite (51.6 vs. 48.5, $P<0.001$). In conclusion, older adults with a
20 poor appetite may have specific food preferences. Their preference for variation differs from
21 those with a good appetite. These results may be used to develop meals that are preferred by
22 older adults with poor appetite in order to increase food intake and prevent undernutrition.

23 **Introduction**

24 Protein-energy undernutrition is increasingly recognised as a serious health issue affecting a
25 large and growing population of older adults. Although there is much debate on a gold standard
26 assessment tool, it can be described by 'a state of energy and protein deficiency that can cause
27 measurable adverse effects of the body' (1). Based on a body mass index (BMI) $< 20 \text{ kg/m}^2$
28 and/or unintended weight loss of 5% or more in the past 6 months, prevalence rates of
29 undernutrition among older adults are estimated at 7% in the general community, 12-16% in
30 community-dwelling older adults receiving home care, 18-21% in nursing homes and 18-33% in
31 hospitals (2, 3). Undernutrition is related to bone and muscle weakness, immune deficiencies,
32 prolonged hospitalization, diminished quality of life, an elevated mortality risk, and more health
33 care expenditures (4-9). Causes of undernutrition are multifactorial and include a number of
34 biological and psychosocial factors, such as disease, trauma and depression (10-15); likely often
35 underpinned by a poor appetite status (12, 13, 16).

36 A poor appetite is experienced by 11-66% of the older population (13, 17-19) and is an
37 important risk factor for the development of undernutrition (13, 16, 20), evidently because it
38 leads to suboptimal food intake (11, 21). Interventions that increase appetite or increase food
39 intake despite a poor appetite, would therefore contribute significantly to the prevention of
40 undernutrition. Up to now, there are only a limited number of interventions available to
41 address this issue. Orexigenic drugs have been found to increase appetite and food intake.
42 However, their use is accompanied by serious unwanted side effects and is therefore only
43 recommended for severe cases of undernutrition (22). Oral nutritional supplements are used to
44 increase protein-energy intake and short-term studies show a small but significant effect of
45 these supplements on weight gain (23). However long-term compliance rates are generally low

46 (24, 25) and oral nutritional supplements may reduce the intake of regular meals and snacks,
47 thereby reducing the overall effect (23, 25, 26).

48 So far, little research has been conducted on the specific food preferences of older adults with
49 a poor appetite. Expert opinions suggest that persons with a poor appetite prefer small
50 volumes and liquid foods (27) and dislike meat, stodgy foods and fats (28, 29). In addition,
51 dietary variety is often limited in older persons (18), while more dietary variety has been shown
52 to increase food consumption in older adults (30-32).

53 These previous studies suggest that older adults with a poor appetite may have specific food
54 preferences. This knowledge may be useful for the development of new strategies to increase
55 food intake in older adults with a poor appetite, and lower their risk of undernutrition.

56 Therefore, the purpose of this study was to examine the specific food preferences of older
57 adults with a poor appetite, and to identify potential differences in food preferences between
58 older adults with a good and a poor appetite.

59

60 **Subjects and Methods**

61 *Study participants and recruitment*

62 Study participants were men and women aged 65 years and older. Recruitment took place in
63 nursing homes, residential care homes, hospitals, and at home through home care
64 organisations, retirement villages and/or meal services. Inclusion criteria were: Dutch language
65 proficiency; able to consume a normal diet consisting of both solid and liquid foods; visual
66 ability sufficient for completing a computer test; able to understand and participate in a task for
67 at least 30 minutes. Exclusion criteria were: poor cognitive functioning (according to the

68 nursing staff or family members); radio- and/or chemotherapy in the previous month; being in
69 a fasting condition for medical examination; or receiving tube feeding or parenteral nutrition.

70 The procedures followed were in accordance with the ethical standards of the responsible
71 institutional committee on human experimentation, in accordance with the Helsinki
72 Declaration of 1975 as revised in 1983. The medical-ethical committee of the VU University
73 Medical Center Amsterdam approved this study and all participants gave oral informed
74 consent. Participants were visited at home or in their institution to perform the test.

75

76 *General characteristics*

77 Prior to the forced-choice food preference test, data on sex, age, educational level, type of
78 setting (nursing/residential care home; hospital; at home with home care), smoking status,
79 BMI, diet and nutritional status were obtained during a short interview. The time of testing was
80 recorded and classified into morning or afternoon. BMI was calculated by dividing self-reported
81 body weight (kg) by self-reported height (m) squared. When necessary, body weight or height
82 information was retrieved from staff members or medical records. Nutritional status was
83 assessed by the Short Nutritional Assessment Questionnaire 65+ (SNAQ65+), which is a
84 validated, nutritional screening instrument that can be used to assess undernutrition among
85 older adults and can be easily applied by health care professionals (33).

86 Appetite was assessed by the following question: "Did you experience a reduced appetite in the
87 previous week? (yes/no)". Participants answering "yes" were defined as having a poor appetite.

88 At the start of the computer test, current appetite status was assessed using a 9-point Likert
89 scale that varied from "very poor" (1) to "very good" (9).

90

91 *Forced-choice food preference test*

92 Food preferences were assessed using a behavioural ‘forced-choice’ methodology to identify
93 relative food preferences. This method is well-suited to situations where overall desire to eat is
94 low (34). A previously validated computerised procedure, developed by Finlayson and
95 colleagues (Leeds Food Preference Questionnaire, Leeds University, U.K.) (35), was adapted for
96 the current study. During the study, participants were randomly allocated to at least one of six
97 tests, each test consisting of 96 pairs of 16 food images presented on a computer screen in
98 high-resolution digital colour. Participants were asked to “select the food they most want to
99 eat”, by pressing the corresponding computer button. All choices were recorded as count
100 frequency scores in E-prime (v 1.2, Psychology Software Tools, ND). To assure good
101 understanding and execution of the test, participants were first given a practice run of at least
102 four paired food images. For this study, pre-validated images of foods that are usually
103 consumed by Dutch older adults were used and standardized to regular portion sizes. All
104 images were validated in a separate pilot study, after which photographs of unfamiliar or
105 misidentified foods were replaced.

106 Block randomization was performed to equally distribute the six tests among participants with
107 a good or poor appetite, while stratifying for sex and type of setting. Participants could perform
108 a maximum of three different tests on a voluntary basis if showing no signs of fatigue or
109 tiredness. To control for differences in hunger level, testing was carried out at least two hours
110 after consumption of a meal and at least half an hour after consumption of any beverages.

111

112 *Food categories examined*

113 The categories under examination were selected on the basis of the literature on food
114 preferences in older adults, as well as information on differences in food patterns between
115 older adults with various appetite levels (36-39).

116 Food preferences were examined according to 11 separate, dichotomous categories: 1) high or
117 low protein; 2) high or low fat; 3) high or low carbohydrates; 4) high or low fibre; 5) variation or
118 no variation; 6) animal or vegetarian proteins; 7) sweet or savoury taste; 8) solid or liquid
119 texture; 9) dairy or non-dairy; 10) with or without sauce; and 11) with or without colour
120 variation.

121 High-protein foods contained a minimum of 14 g of protein per 100 g, low-protein foods
122 contained a maximum of 8 g/100 g. High-fat foods were defined as containing a minimum of 30
123 % of energy from fat and low-fat foods contained a maximum of 9 % of energy from fat. High-
124 carbohydrate foods contained a minimum of 10 g/100 g of carbohydrates; low-carbohydrate
125 foods contained around 4.5 g/100 g. High fibre foods contained a minimum of 2 g fibre per 100
126 g, whereas low fibre contained a maximum of 1.5 g/100 g. High- and low-fibre foods were
127 presented with or without the addition of sauce. The category 'animal protein' contained meat,
128 poultry and fish products, in contrast to products which only contained vegetarian proteins
129 (e.g. eggs or peanuts). 'Variation' was defined as presenting two or three different types of the
130 same food product with similar colour on one plate (i.e. broccoli, green beans, peas) when
131 compared to a single type of food (i.e. broccoli only). 'Colour variation' was defined as the same
132 type of foods containing at least 2 colours and flavours (e.g. chocolate, strawberry and vanilla
133 ice-cream), compared to foods in a single colour and flavour.

134

135 *Food preferences procedure*

136 Each of the six tests comprised a pre-selected array of food images that formed categories
137 within two independent, dichotomous factors. The factors in each food image array, i.e. *protein*
138 and *variation*, were combined into four specific categories: high protein with variation, low
139 protein with variation, high protein with no variation and low protein with no variation (**Table**
140 **1**). For each category, four exemplar food images were used (**Table 2**). During each test, the
141 food images were paired so that every image from each of the four specific categories was
142 compared to every other category over 96 trials (food pairs). For each trial, participants were
143 instructed to indicate the food they wanted to eat the most at that time (“Which food do you
144 most want to eat now?”). The recorded count frequency scores indicated the relative food
145 preference for a particular category (range 0-24). Besides the preferences for specific
146 categories, preferences for each generic factor were also assessed. For example: the counts of
147 all high-protein foods (with or without variation) were compared against all low-protein foods
148 (range 0-48).

149

150 *Statistical analysis*

151 All data were analysed using SPSS 20.0 for Windows. General characteristics of participants
152 with a poor and good appetite were compared using independent t-tests and chi-square tests,
153 as appropriate. In participants with a poor appetite, general food preferences for a specific food
154 factor were identified by comparing count frequency scores to the expected values ‘48’ and
155 ‘24’. For generic factors (e.g. ‘high-fat’ or ‘variation’), the expected value was ‘48’, and for

156 combination factors (e.g. high-fat sweet or high-protein with variation), the expected value was
157 '24'. A multivariate general linear model (GLM), suitable for multiple dependent variables, was
158 used for comparing the four categories per test between appetite groups. Count frequency
159 scores of the four categories were entered to the model as dependent variables and appetite
160 (good vs. poor) was entered as independent variable. Univariate GLM was used for comparing
161 the generic factors of each test between appetite groups. In addition, potential confounders
162 (i.e. sex, care setting, education level, smoking status, diet and time of testing) were added to
163 the model when causing a >10% change of the regression coefficient of appetite. Differences in
164 preferences observed by the count frequency scores between participants with a good or a
165 poor appetite were considered significant when p-values were < 0.05. For each test, outliers of
166 the good and poor appetite groups (values that exceeded 1.5 x IQR) were excluded from data
167 analyses.

168

169 **Results**

170 *General characteristics*

171 In total 349 older adults participated in this study and performed one or more forced-choice
172 food preference tests. Participants were randomly allocated to one of the 6 different tests,
173 which resulted in 94 to 103 participants per test. Baseline characteristics of the study sample
174 are presented in **Table 3**. The average age of the included participants was 81 years (SD 8) and
175 63% ($n=219$) was female. Approximately one third ($n=113$) of the included participants reported
176 a poor appetite in the previous week. Participants with a poor appetite were more often
177 undernourished (44.2%) than participants with a good appetite (27.5%, $P<0.001$). The

178 prevalence of poor appetite was higher within the hospital setting (55.8%, $P<0.001$) compared
179 to the nursing/residential home (28.3%) and at home with home care (15.9%).

180

181 *General food preferences in older adults with poor appetite*

182 In the poor appetite group, specific food preferences were observed when the count frequency
183 score was compared to the expected values of 48 (generic factors) or 24 (combination factors),
184 respectively (**Table 4**). Older adults with a poor appetite had statistically significantly higher
185 count scores for the generic factors variation (51.6 vs. 48, $P<0.001$), colour variation (55.9 vs.
186 48, $P<0.01$), non-dairy (53.0 vs. 48, $P<0.001$), high-fibre (51.8 vs. 48, $P<0.05$), and solid texture
187 (53.5 vs. 48, $P<0.05$). Other generic factors, like for example fat, protein, and carbohydrate
188 content, showed inconsistent outcomes or showed equivocal preference scores. With respect
189 to the combination of factors, older adults with a poor appetite had statistically significantly
190 higher count scores for the combination of high protein with variation (27.4 vs. 24, $P<0.05$),
191 colour variation with non-dairy (29.0 vs. 24, $P<0.01$), high fibre with sauce (27.1, vs. 24,
192 $P<0.001$), and solid texture with high carbohydrate content (27.6 vs. 24, $P<0.05$).

193

194 *Differences in food preferences between older adults with good or poor appetite*

195 Compared to participants with a good appetite, participants with a poor appetite had higher
196 frequency score for the general factor variation (51.6 vs. 48.5, $P=0.008$) and for the
197 combination of variation with high-protein (28.6 vs. 24.0, $P=0.004$). No other (consistent) food
198 preference differences were observed (Table 4).

199

200 **Discussion**

201 By means of a computer-based forced-choice food test, this study showed that older adults
202 with a poor appetite had specific identifiable food preferences. They preferred variation, colour
203 variation, non-dairy high-fibre, and solid texture. Some combinations were also preferred: high
204 protein with variation, colour variation with non-dairy, high fibre with sauce, and solid texture
205 with high carbohydrate content. Participants with a poor appetite had a higher preference for
206 variation in food products compared to participants with a good appetite.

207 Although previous studies examined the food choices and taste preferences in older adults (38,
208 40-43), this is the first study to apply a forced-choice methodology to investigate relative food
209 preferences in older adults with a poor appetite. Several specific food preferences were
210 observed. One is the preference for color variation by older adults with both a poor appetite
211 and a good appetite. Studies in healthy subjects suggest that colour variation can enhance food
212 intake (44). To our knowledge, the impact of food colour variation on the appreciation and
213 consumption of foods has not yet been investigated in older adults at risk of undernutrition.

214 We also observed a preference for non-dairy (high-fibre) foods above dairy foods. This was
215 consistent for older adults with a poor and a good appetite, but slightly more pronounced in
216 the poor appetite group (not statistically significant). Food consumption studies among older
217 persons in the Netherlands and the United States report a lower consumption of dairy foods
218 than is recommended (45-47). For instance in the Netherlands, the median consumption of
219 dairy products among community dwelling older adults (> 70 years) is around 300 grams a day
220 instead of the recommended 650 grams a day (46, 48). Data from the United States also show a

221 suboptimal intake of dairy products, with over 90% of persons of age >71 who do not meet the
222 recommended 3 servings a day (45, 47, 49). As dairy foods are an important source of protein,
223 calcium and B-vitamins, the finding that these products are not preferred by older adults with a
224 poor appetite is of concern. One practical consequence is that the offering of dairy snacks in
225 institutions may be an ineffective way to improve energy and nutrient intake in older persons
226 with a poor appetite, as these do not meet patients' preferences. Another consequence is that
227 the necessary protein and calcium should be consumed through other food products. The
228 preference for non-dairy foods with a high fibre content may help to increase dietary fibre
229 intake, which is also known to be inadequate in older adults (46, 50, 51).

230 With regard to the structure of foods, we expected that a liquid texture would be preferred by
231 older adults because liquids require less chewing, are easier to swallow and are less satiating
232 than solid foods (27, 52). Our results suggest a preference for solid texture in both older adults
233 with a good and a poor appetite, in particular for solid foods with a high carbohydrate content.
234 This could be explained by the exclusion of subjects who had difficulties with chewing and/or
235 swallowing. Chewing and swallowing difficulties are generally highly prevalent in older
236 institutionalized persons (53), so this is probably a limitation of the generalizability of our
237 findings to this specific population.

238 We found a strong preference for variation, especially variation of high protein foods, in older
239 adults with a poor appetite, but not in older adults with a good appetite ($P < 0.01$). Interestingly,
240 studies have shown that increasing variety by offering more types of foods is an effective
241 strategy to increase short term food intake in older adults (30-32), older adults in general (30-
242 32) and older adults at risk of undernutrition (30-32). Experiments in healthy adults showed
243 that after an imposed protein deficit, food intake and food preferences appeared to change

244 towards savoury, high protein foods in order to compensate for the protein shortage (54). The
245 observed preference for foods with variation and a high protein content in older adults with a
246 poor appetite of whom 44% was considered undernourished and probably had a protein deficit
247 supports these findings. Offering a large variety of high protein foods may therefore be a novel
248 way to increase protein intake and therefore enhance nutritional status in this vulnerable
249 group. At the same time, consumption of protein-rich products by older adults could be
250 hampered by an increased experience of satiety, chewing/swallowing problems and/or
251 financial problems (55-58). This can be overcome by replacing meat by less expensive or easier
252 to chew high-quality protein sources like eggs, seafood, and poultry (56, 59). As we did not
253 observe a preference for animal protein, vegetarian protein sources such as legumes or soy
254 products are also an option.

255
256 Although this study provides novel information regarding specific food preferences among
257 older adults with a poor appetite, some study limitations need to be addressed. Due to our
258 exclusion criteria, e.g. poor cognitive functioning, our study results may not be entirely
259 generalizable to the older population in the three used settings. Another limitation inherent to
260 our study design, is that forced-choice methodology is designed to measure relative food
261 preferences and may not reflect the actual ability to consume the presented foods, as food
262 choices may differ from actual food consumption decisions (60). Experimental studies using
263 similar forced-choice food preference methodology in young healthy adults have consistently
264 shown frequency scores for specific food categories to predict actual selection and intake of
265 those foods under controlled conditions (61, 62).

266 Nevertheless, future studies should be conducted to confirm the identified food preferences in
267 older adults with a poor appetite using actual food intake data.

268 In conclusion, this study shows that older adults with a poor appetite have specific food
269 preferences that differ from those with a good appetite. These results enable the development
270 of relevant strategies to increase food intake and thus prevent undernutrition in older adults
271 with a poor appetite. The provision of adapted meals and snacks with high variation and color
272 variation could help stimulate their food intake.

Acknowledgments

Authors' contributions to manuscript

MV, HAW designed the study; BSM and BO conducted research and analyzed data, BSM performed statistical analysis; BSM, BO, GSF, MV and HAW wrote the paper; GSF shared knowledge and developed the forced choice tests. MV had primary responsibility for the final content. All authors read and approved the final manuscript.

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Table 1 Overview of the six forced-choice experiments.

Factor	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
Combination						
1.	High fat / sweet	High protein / variation	High fat / animal protein	Dairy / colour variation	High fibre / sauce	High carbohydrates / solid texture
2.	Low fat / sweet	Low protein / variation	Low fat / animal protein	Non-dairy / colour variation	Low fibre / sauce	Low carbohydrates / solid texture
3.	High fat/ savoury	High protein / no variation	High fat / vegetarian protein	Dairy / no colour variation	High fibre / no sauce	High carbohydrates / liquid texture
4.	Low fat / savoury	Low protein / no variation	Low fat / vegetarian protein	Non-dairy / no colour variation	Low fibre / no sauce	Low carbohydrates / liquid texture

Factor	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
Generic						
1.	High fat	High protein	High fat	Dairy	High Fibre	High carbohydrates
2.	Low fat	Low protein	Low fat	Non-dairy	Low fibre	Low carbohydrates
3.	Sweet	Variation	Animal protein	Colour variation	Sauce	Solid texture
4.	Savoury	No variation	Vegetarian protein	No colour variation	No sauce	Liquid texture

Table 2 Overview of food products used per test within each category

Test 1	High fat / savoury	High fat / sweet	Low fat / savoury	Low fat / sweet
	Salted peanuts Natural crisps Beef croquette Fried egg	Apple pie with cream Cake Milk chocolate Puff pastry with cream	Red wine Cucumber Salty sticks Vegetable soup	Dutch spiced cake Grapes Banana Sponge cookie
Test 2	High protein / variation	High protein / no variation	Low protein / variation	Low protein / no variation
	Bread with types of cheese Types of sliced sausages Shrimps, herring, smoked eel Types of fried meat	Meatball Chicken breast Fish fillet Cheese cubes	Mashed, baked and fried Orange, mandarin and Broccoli, French beans, peas Types of salted snacks	Spaghetti with tomato sauce Fried potatoes Slices of apple French beans
Test 3	High fat / animal protein	High fat / vegetarian protein	Low fat / animal protein	Low fat / vegetarian protein
	Fried Salmon Sausage Chicken drumstick Sausage with bacon	Salted peanuts Fried egg Vegetarian pizza slice French cheese	Steamed white fish Chicken Fillet Pork Fillet Roast beef	Kale hotchpot Pancake Salty sticks Sliced cucumber
Test 4	Dairy / colour variation	Dairy / no colour variation	Non-dairy / colour variation	Non-dairy / no colour
	Cream pie with fruits Coloured ice cream Two coloured custard Cheesecake with strawberries	Cracker with 'brie' cheese Plain yoghurt Vanilla ice cream Custard	Natural and paprika crisps Coloured cocktail nuts Coloured donuts Coloured chocolate cookies	Croissant Snack sausage Almond cake Natural crisps
Test 5	High fibre / sauce	High fibre/ no sauce	Low fibre / sauce	Low fibre / no sauce
	Chilli con carne Brown rice with satay sauce Cream cheese on rye bread Dutch spiced cake with butter	Dried fruit mix Rye bread with Gouda cheese Peanuts Currant bun	Spaghetti with sauce Nassi with satay sauce Boiled potatoes with gravy Vanilla ice cream with	Boiled egg Nassi Vanilla ice-cream Fried salmon trout

Test 6	High carbs / solid texture	High carbs / liquid texture	Low carbs / solid texture	Low carbs / liquid texture
	Milk chocolate	Orange juice	Fried salmon trout	Semi-skimmed milk
	Dutch spiced cake	Cassis	Gouda cheese	Vegetable soup
	Pancake	Custard	Snack sausage	Tomato soup
	French fries	Forest fruit pudding	Stuffed egg	Coffee

Table 3 General characteristics of the study sample, stratified by appetite status.

	Appetite status in previous week		P-value
	Poor	Good	
<i>n</i>	113	236	
Female (%)	68.1	60.2	0.149 ¹
Age (mean ± SD)	80.8 (8.1)	81.6 (8.2)	0.353 ²
Setting (%)			<0.001 ^{1*}
Hospital	55.8	30.5	
Nursing/residential home	28.3	44.9	
Home care	15.9	24.6	
Appetite status at start of test (Likert scale,	5.2 (1.3)	7.4 (1.1)	<0.001 ^{2*}
BMI (mean ± SD)	25.9 (4.9)	26.4 (4.9)	0.391 ²
Unintended weight loss ≥ 4 kg previous	35.4	20.3	0.002 ^{1*}
Undernutrition (%) ³			<0.001 ^{1*}
No	30.1	72.5	
At risk	25.7	0.0	
Yes	44.2	27.5	
Diet (%)			0.779 ¹
None	88.5	88.1	
Diabetic	6.2	4.7	
Sodium	5.3	6.8	
Unknown	0.0	0.4	
Time of testing (%)			0.512 ¹
Morning	71.7	68.2	
Afternoon	28.3	31.8	
Education (%)			0.148 ¹
Primary	47.8	39.8	
Secondary	25.7	36.0	
Tertiary	19.5	20.3	
Unknown	7.1	3.8	
Smoking (%)			0.964 ¹
Never	38.9	38.6	
Former	48.7	47.0	
Current	9.7	11.4	
Unknown	2.7	3.0	

P-values indicate statistical differences between good and poor appetite; * P-values < 0.05

¹ analysed by chi-square tests

² analysed by independent t-tests

³ assessed by the Short Nutritional Assessment Questionnaire 65+ (SNAQ65+) (33)

Table 4 General food preferences in older adults and stratified by appetite status: mean count frequency scores of the generic factors and combination factors and differences between poor and good appetite groups

FORCED-CHOICE		Total	Poor appetite	Good appetite	Poor vs. Good appetite	
EXPERIMENT					Difference ³ (SE ⁴)	
<i>n</i> Poor appetite /	Generic factors (2)	Mean (SE) ²	Mean (SE) ²	Mean (SE) ²	Crude	Adjusted
<i>n</i> Total ¹	Combination factors (4)					
Test 1	High Fat vs. Low Fat	46.1 (1.03)	42.1 (1.77)**	47.4 (1.20)	5.4 (2.32)*	-4.2 (2.29)*
21 / 84	Sweet vs. Savoury	46.7 (1.22)	47.7 (2.85)	46.3 (1.33)	-1.4 (2.83)	-0.3 (3.19)
	Low Fat / Sweet	26.1 (0.77)**	27.6 (1.45)*	25.7 (0.91)	2.0 (1.78)	2.1 (1.91)
	Low Fat / Savoury	23.8 (0.93)	26.3 (1.66)	22.9 (1.10)	3.4 (2.13)	2.6 (2.21)
	High Fat / Savoury	22.9 (0.89)	21.4 (2.00)	23.4 (0.98)	-2.0 (2.05)	-1.7 (2.18)
	High Fat / Sweet	23.2 (1.02)	20.7 (2.38)	24.0 (1.10)	-3.4 (2.35)	-3.0 (2.55)

Test 2	High protein vs. Low protein	50.3 (1.11)*	51.3 (2.27)	49.8 (1.20)	1.4 (2.33)	4.2 (2.43)
32 / 93	Variation vs. No variation	49.6 (0.67)*	51.6 (0.89)***	48.5 (0.89)	3.1 (1.38)*	3.8 (1.40)**
	High protein / Variation	25.6 (0.72)*	27.4 (1.25)*	24.6 (0.87)	2.9 (1.50)	4.6 (1.56)**
	Low protein / Variation	24.0 (0.71)	24.2 (1.29)	23.9 (0.85)	0.2 (1.50)	-0.5 (1.57)
	High protein / No variation	24.8 (0.69)	23.8 (1.50)	25.3 (0.72)	-1.4 (1.46)	-0.9 (1.52)
	Low protein / No variation	21.7 (0.77)**	20.6 (1.33)*	22.2 (0.94)	-1.7 (1.62)	-3.2 (1.74)
Test 3	Animal protein vs.	46.1 (0.77)*	47.4 (1.20)	45.6 (0.98)*	1.8 (1.65)	2.8 (1.76)
30 / 95	vegetarian protein					
	High fat vs. Low Fat	50.8 (1.41)	52.5 (2.45)	50.0 (1.73)	2.6 (3.05)	3.2 (3.19)
	High fat / vegetarian protein	26.8 (0.99)**	27.3 (1.91)	26.6 (1.18)*	0.7 (2.16)	0.3 (2.30)
	High fat / Vegetarian protein	23.9 (0.79)	25.2 (1.11)	23.3 (1.03)	1.9 (1.70)	2.8 (1.86)
	Low fat / Vegetarian protein	23.0 (0.99)	21.3 (1.73)	23.8 (1.20)	-2.5 (2.13)	-2.9 (2.22)

	Low fat / Animal protein	22.2 (0.91)	22.2 (1.53)	22.2 (1.14)	-0.1 (1.97)	-0.2 (2.15)
Test 4	Colour / No colour variation	56.1 (1.23)***	55.9 (2.48)**	56.2 (1.38)***	-0.4 (2.61)	-1.1 (2.66)
30 / 88	Non-dairy / Dairy	51.4 (0.82)***	53.0 (1.02)***	50.6 (1.11)*	2.4 (1.72)	1.9 (1.72)
	Colour variation/Dairy	28.1 (0.90)***	26.8 (1.62)	28.7 (1.08)***	-1.9 (1.90)	-1.9 (1.90)
	No colour variation /Dairy	16.5 (0.94)***	16.1 (1.64)***	16.7 (1.16)***	-0.6 (1.99)	-0.1 (1.93)
	Colour variation/Non-dairy	28.0 (0.83)***	29.0 (1.31)**	27.5 (1.07)**	-1.5 (1.76)	1.4 (1.81)
	No colour variation/Non-dairy	23.4 (0.87)	24.0 (1.58)	23.1 (1.05)	0.9 (1.85)	0.6 (1.82)
Test 5	No sauce vs. Sauce	44.0 (1.05)***	44.6 (1.75)	43.6 (1.28)**	1.0 (2.29)	1.8 (2.18)
27 / 92	High fibre vs. Low fibre	51.8 (0.87)***	51.8 (1.68)*	51.7 (1.02)**	-0.1 (1.99)	-0.3 (1.96)

	High fibre / No sauce	24.4 (0.91)	24.8 (1.85)	24.2 (1.06)	0.6 (2.05)	-0.0 (2.05)
	High fibre / Sauce	27.4 (0.64)***	27.1 (0.87)***	27.6 (0.83)**	-0.5 (1.44)	0.2 (1.55)
	Low fibre / No sauce	19.6 (0.58)***	20.8 (0.92)**	19.2 (0.72)***	1.7 (1.29)	1.2 (1.36)
	Low fibre / Sauce	24.6 (0.87)	23.3 (1.48)	25.0 (1.06)	-1.8 (1.93)	-1.4 (1.99)
Test 6	High carb vs. Low carb	48.3 (0.98)	48.8 (1.17)	48.0 (1.39)	1.0 (2.05)	1.6 (2.25)
34 / 93	Solid vs. Liquid texture	54.1 (0.98)***	53.5 (2.18)*	54.4 (0.92)***	0.9 (2.05)	-0.5 (2.12)
	High carb / Liquid texture	19.7 (0.83)***	21.4 (1.60)	18.7 (0.91)***	2.6 (1.71)	1.8 (1.90)
	High carb / Solid texture	28.6 (0.79)***	27.6 (1.37)*	29.3 (0.96)***	-1.7 (1.64)	0.0 (1.75)
	Low carb / Liquid texture	22.2 (0.69)*	21.1 (1.25)*	22.8 (0.81)	-1.7 (1.42)	-2.4 (1.50)
	Low carb / Solid texture	25.5 (0.90)*	25.9 (1.52)	25.2 (1.13)	0.7 (1.88)	0.6 (2.05)

* P < 0.05; ** P < 0.01; *** P < 0.001

¹ Outliers excluded: test 1 n=4, test 2 n=8, test 3 n=3, test 4 n=3, test 5 n=3, test 6 n=7

² P-value of one-sample t-tests of count frequency scores vs. equivocal preference score (24 or 48)

³ P-values of differences between good and poor appetite, analysed by univariate GLM (generic factors) or multivariate GLM (combination factors), corrected for confounders when applicable (sex, education, setting, smoking, diet, weight loss and/or time of testing)

⁴ SE, standard error of the mean difference between poor and good appetite