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Loss of Olfactory Function and Nutritional Status in Vital Older Adults and Geriatric Patients

Nicole Toussaint[1,*], Margot de Roon[1,*], Jos P.C.M. van Campen[2], Stefanie Kremer[3] and Sanne Boesveldt[4]

[1]Department of Dietetics, Slotervaart Hospital, Louwesweg 6, 1066 EC, Amsterdam, The Netherlands, [2]Department of Geriatrics, Slotervaart Hospital, Louwesweg 6, 1066 EC, Amsterdam, The Netherlands, [3]Consumer Science & Health, Food & Biobased Research, Wageningen UR, Bornse Weilanden 9, 6708 WG Wageningen, The Netherlands and [4]Division of Human Nutrition, Wageningen University, Wageningen, the Netherlands

Correspondence to be sent to: Sanne Boesveldt, Division of Human Nutrition, Wageningen University, Wageningen, the Netherlands. e-mail: sanne.boesveldt@wur.nl

*These authors contributed equally to this work.

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Abstract

The aim of this cross-sectional study was to assess the association of olfactory function and nutritional status in vital older adults and geriatric patients. Three hundred forty-five vital (mean age 67.1 years) and 138 geriatric older adults (mean age 80.9 years) were included. Nutritional status was assessed using the mini nutritional assessment-short form. The Sniffin' Sticks was used to measure olfactory function. Eleven percentage of the vital older adults were at risk of malnutrition, whereas 60% of the geriatric participants were malnourished or at risk. Only 2% of the vital older adults were anosmic, compared with 46% of the geriatric participants. Linear regression demonstrated a significant association ($P = 0.015$) between olfactory function and nutritional status in the geriatric subjects. However, this association became insignificant after adjustment for confounders. Both crude and adjusted analysis in the vital older adults did not show a significant association. The results indicate that, in both groups of elderly, there is no direct relation between olfactory function and nutritional status. We suggest that a decline in olfactory function may still be considered as one of the risk-factors for malnutrition in geriatric patients—once co-occurring with other mental and/or physical problems that are more likely to occur in those patients experience.

Key words: ageing, olfaction, malnutrition, geriatric

Introduction

Today, older adults aged 60 years and older compose the fastest growing population in the world that is expected to increase from 841 million in 2013 to 2 billion in 2050 (United Nations 2013). With increasing age comes increased risk of multi-morbidity. Multi-morbidity is a common problem among geriatric patients (van den Brink *et al.* 2013) and is an important cause of malnutrition (van Asselt *et al.* 2012). In the Netherlands, 32% to 61% of geriatric patients are malnourished (Rypkema *et al.* 2004; Meijers *et al.* 2009), whereas in independently-living older adults without home-care this percentage is considerably lower, namely 7% (Health Council of the Netherlands 2011). Malnutrition is often not recognized, but can be a major threat to the independence and quality of life of older adults (Volkert *et al.* 2010). It is associated with physical, mental, and social problems, such as a reduced ability to perform activities of daily living, decreased muscle mass and strength, depression, and loneliness (Amarantos *et al.* 2001). One potential cause of malnutrition is impaired olfactory function (Stratton *et al.* 2003). Several studies have shown that many older adults have a reduced olfactory function (Murphy *et al.* 2002; Hummel *et al.* 2007) that may affect the quality of life (Gopinath *et al.* 2011). It is hypothesized that a reduced olfactory function results in a decreased enjoyment of food, poor appetite, and less pleasure in food related activities, which in turn may influence nutritional status (Ferris and Duffy 1989; Duffy *et al.* 1995). However, there is no general agreement about this line of assumptions (Mattes 2002).

Besides ageing itself, morbidities associated with ageing may reduce olfactory function. Among these are dementia, Parkinson's disease, diabetes mellitus, chronic renal failure and liver disease (Seiberling and Conley 2004; Boesveldt *et al.* 2008; Makizako *et al.* 2014). In addition, several types of medication may affect olfactory function (Ackerman and Kasbekar 1997). It is therefore likely that vulnerable older adults, such as geriatric patients who are characterized by multi-morbidity and polypharmacy, suffer more often from olfactory deficits as compared with vital older adults. Furthermore, this difference may lead to dissimilarities in nutritional status of geriatric patients versus vital older adults, which may be critical for subsequent clinical interventions.

Though a recent article investigated the possible association between olfactory deficits and impaired nutritional status in geriatric patients, they did not investigate this in a population of vital, healthy older adults (Smoliner *et al.* 2013). To our knowledge there are no studies performed that relate olfactory function and nutritional status in these 2 growing populations. Therefore, the aim of this study is to assess the association between olfactory function and the nutritional status in a group of vital older adults and geriatric patients.

Materials and methods

Vital older adults

Vital older adults were recruited from the SenTo-panel (in Dutch 'Senioren van de Toekomst'; Seniors of the Future), a research initiative of Wageningen University and Research Centre that aims at gaining insight in drivers and barriers of food enjoyment in older adults, between October and December 2011. Older adults were included if they were ≥55 years, had the ability to work with e-mail and were able to come to the test location independently. Participants gave written informed consent and received a small financial compensation for their participation.

In total, 345 vital older adults (185 females; mean age 67.1 ± 6.0 years, range 56–91 years) were included. The social ethical committee of Wageningen University and Research centre approved the study protocol.

Geriatric patients

Geriatric participants were recruited from consecutive patients visiting the geriatric diagnostic day clinic or outpatient clinic of the Slotervaart Hospital in Amsterdam between March 2012 and November 2013. Cognitive status was assessed using the mini-mental state examination (MMSE) (Folstein *et al.* 1975). Participants were excluded if they scored ≤18 at the MMSE, which can indicate moderate or severe cognitive decline that can lead to unreliable test results. Other exclusion criteria were the presence of an upper respiratory tract infection and inability to take part in the tests. Participants gave written informed consent.

In total, 138 geriatric patients (91 females; mean age 80.9 ± 7.6 years, range 61–96 years) were included. The medical ethical committee of the hospital approved the study protocol.

Nutritional assessment

Nutritional status was assessed using the mini nutritional assessment-short form (MNA-SF; Nestlé; Kaiser *et al.* 2009). The MNA-SF is designed for older adults and includes questions about appetite, weight changes, mobility, neuropsychological problems, and body mass index (BMI). The MNA-SF differentiates normal nutritional status (score 12–14), at risk of malnutrition (score 8–11), and malnourishment (score 0–7).

Olfactory function testing

The Sniffin' Sticks—Screening 12 test was used to investigate olfactory function in the geriatric participants. This identification test contains 12 odor pens, is suitable in a clinical setting, and has high test-retest reliability (Hummel *et al.* 2001). The extended version of the Sniffin' Sticks (Burghart) was used to assess olfactory function in the vital older adults. However, the practitioners of the Slotervaart Hospital considered this to be too burdensome for the geriatric participants in the outpatient clinic. The extended version includes an odor identification test with 16 odor pens as well as a threshold and discrimination test (Hummel *et al.* 2007). The sum of the scores on the threshold- (T), discrimination- (D), and identification- (I) test result in a total TDI score.

Since results from the geriatric participants only consisted of the Sniffin' Sticks—Screening 12 test, the data of these 12 odor pens were used to compare the analyses in both populations.

Other measurements

Apart from demographic data, the Geriatric Depression Scale (GDS) was used to assess depression status in the geriatric participants (Yesavage and Sheikh 1986). A score of ≥6 indicates a possible depression (maximum score of 15). The Charlson Comorbidity Index was calculated to classify the level of comorbidity, with higher scores indicating a greater comorbidity (Charlson *et al.* 1987). Number of medications used was reported to indicate whether polypharmacy (≥5 different medications) was present. In the vital participants, cognitive status was assessed by means of the DemTect, to differentiate between adequate cognitive performance for age (score 13–18), mild cognitive impairment (score 9–12), or dementia-level (score <9) (Kalbe *et al.* 2004).

Statistics

Results were analyzed with SPSS statistical software version 21.0. To compare characteristics among the vital and

geriatric participants, the independent samples *t*-tests or Mann–Whitney *U* test for continuous variables, the chi-square tests for categorical variables and Fisher Exact test for dichotomous variables were performed. Based on the Sniffin' Sticks Screening—12 score, participants were classified as anosmic (score 0–6), hyposmic (score 7–10), or normosmic (score 11–12).

The Kruskal–Wallis test with post hoc analysis (pairwise comparisons) was used to compare MNA-SF scores between anosmic, hyposmic, and normosmic participants. Linear regression analysis was performed to evaluate the association between olfactory function and nutritional status (dependent variable). The association was adjusted for confounders that resulted in a difference of ≥10% in the beta-coefficient.

Results

Vital older adults

Participants' characteristics are shown in Table 1. None of the vital older adults had a score <9 on the DemTect. MNA-SF showed that the vast majority (89.0%) of vital participants (n = 345) had a normal nutritional status and only 11% were at risk of malnutrition. None of the participants were malnourished. The mean score ± SD at the MNA-SF was 13.1 ± 1.1.

The mean score ± SD on the olfactory screening test was 10.7 ± 1.4 and 32.0 ± 4.5 for the extended test. According to the Sniffin' Sticks—Screening 12 test, 2.3% of the vital participants was anosmic, 32.5% hyposmic and the vast majority (65.2%) had normal olfactory function. Based on the extended version of the Sniffin' Sticks, these percentages were similar (0.3% anosmic, 31.6% hyposmic, and 68.1% normosmic). There was no significant difference in the MNA-SF scores between these 3 groups. Figure 1 shows the median score (25th–75th percentile) at the MNA-SF for anosmic, hyposmic, and normosmic participants identified with the Sniffin' Sticks—Screening 12 test and extended version of the Sniffin' Sticks.

Men scored significantly higher on the MNA-SF compared with women (P = 0.026). At odor identification women scored significantly higher compared with men (P = 0.032). Linear regression analysis showed no significant association (β = 0.014, P = 0.724) between olfactory function and nutritional status. After adjustment for age and gender, still no significant association (β = 0.031, P = 0.456) was found (Tables 2A–C). Using the extended olfactory data, these findings did not change (Tables 2A–C).

Geriatric patients

The mean score ± SD at the MMSE was 25.0 ± 3.1, range 19–30. About one-third (34.7%) of the geriatric patients were identified with possible depression. MNA-SF showed that most of the geriatric participants (n = 138) were either at risk of malnutrition (44.2%) or malnourished (15.9%),

Table 1 Participant characteristics

	Vital older adults (n = 345)	Geriatric patients (n = 138)	P value
Percent			
Female	53.6	65.9	0.015
Smoking	6.4	15.2	0.004
Living situation			
Independent	99.1	84.1	<0.001
Rest home	0.9	14.5	
Nursing home	0.0	1.4	
Polypharmacy		57.2	
Mean ± SD			
Age (years)	67.1 ± 6.0	80.9 ± 7.6	<0.001
BMI (kg/m^2)	24.9 ± 4.0	26.5 ± 4.6	<0.001
MNA-SF (score 0–14)	13.1 ± 1.1	10.2 ± 2.7	<0.001
Sniffin' Sticks extended test (score 0–48)	32.0 ± 4.5		
Sniffin' Sticks—Screening 12 test (score 0–12)	10.7 ± 1.4	6.5 ± 2.6	<0.001
MMSE (score 0–30)		25.0 ± 3.1	
GDS (score 0–15)		4.9 ± 3.7	
DemTect (score 0–18)	14.0 ± 1.4		
Charlon comorbidity		2.3 ± 1.7	

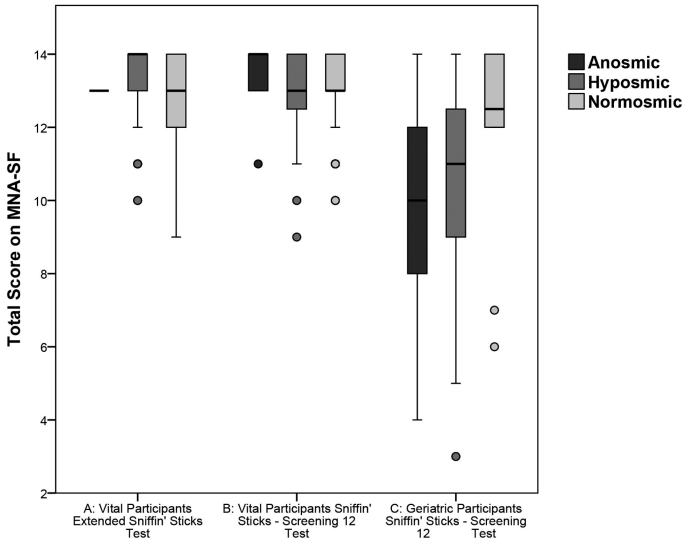

Figure 1 (**A**) Total score on the MNA-SF for the vital participants that were anosmic (n = 1), hyposmic (n = 109), or normosmic (n = 235) according to the results of the extended version of the Sniffin' Sticks. Shown are box plots with median, 25th and 75th percentile and minimum and maximum values. (**B**) Total score on the MNA-SF for the vital participants that were anosmic (n = 8), hyposmic (n = 112), or normosmic (n = 225) according to the results of the Sniffin' Sticks—Screening 12 test. Shown are box plots with median, 25th and 75th percentile and minimum and maximum values. (**C**) Total score on the MNA-SF for the geriatric participants that were anosmic (n = 64), hyposmic (n = 64), or normosmic (n = 10) according to the results of the Sniffin' Sticks—Screening 12 test. Shown are box plots with median, 25th and 75th percentile and minimum and maximum values.

only 39.9% had a normal nutritional status. The mean score ± SD at the MNA-SF was 10.2 ± 2.7.

In total, 46.4% of the geriatric patients was anosmic, 46.4% hyposmic, and 7.2% normosmic. The mean score ± SD at the Sniffin' Sticks—Screening 12 test was 6.5 ± 2.6. There was no gender difference for MNA-SF (P = 0.378) neither for odor identification scores (P = 0.813).

The median score (25th–75th percentile) at the MNA-SF was 10.0 (8.0–12.0) for the anosmic, 11.0 (9.0–12.5) for the hyposmic, and 12.5 (12.0–14.0) for the normosmic group (Figure 1). MNA-SF scores differed significantly between the 3 groups of olfactory function (P = 0.048), with the anosmic group having lower median scores compared with the normosmic group (P = 0.047).

As presented in Tables 2A–C, there was a significant association (β = 0.227, P = 0.015) between olfactory function and nutritional status. However, after adjustment for age, MMSE and GDS, this association was no longer significant (β = 0.121, P = 0.161).

Discussion

The aim of this study was to assess and compare the association of olfactory function and nutritional status between vital older adults and geriatric patients. No association between olfactory function and nutritional status was found in the vital older adults, while at first sight, a positive association was found in the geriatric patients. However, after adjusting for confounding factors such as age, cognitive status, and depressive symptoms, this association was no longer significant.

The prevalence of malnutrition was higher in the group of geriatric patients, namely 15.9%, while none of the vital older adults was malnourished. Only 39.9% of the investigated geriatric participants had a normal nutritional status compared with almost 90% of the vital older adults. A recent study by Smoliner *et al*. indicated that about 40% of (German) geriatric patients were at nutritional risk or malnourished (Smoliner *et al.* 2013), though even higher numbers have been reported in the Netherlands (Rypkema *et al.* 2004; Meijers *et al.* 2009). Our results emphasize that malnutrition is a common problem among geriatric patients.

Besides malnutrition, a high prevalence of olfactory impairment has been reported among older adults. (Murphy *et al.* 2002). Indeed, the present findings concur with this, and the geriatric participants (mean age 80.9 years) show a higher prevalence of anosmia (46.4 % vs. 0.3%) and hyposmia (46.4% vs. 31.6%) than the vital older adults (mean age 67.1 years). A recent study in geriatric patients reported somewhat lower percentages (39.3% hyposmia, 31.9% anosmic), but used slightly different, more lenient cut-off scores to define normal olfactory functioning (Smoliner *et al.* 2013). Nonetheless, the high prevalence of malnutrition and anosmia in this group of patients makes the findings highly relevant.

In a review, Schiffman describes that loss of olfactory function in older adults can affect their nutritional status. It can, among others, reduce the motivation to eat and cause involuntary weight loss (Schiffman 1997). For example, Boesveldt *et al.* (2011) examined the correlation between olfactory function and BMI in a large national probability sample of US older adults, and found that lower scores on an odor identification task were associated with lower BMI. Indeed, in the present study, anosmic geriatric patients had on average the lowest nutritional status. However, since the positive association between olfactory function and nutritional status in the group of geriatric patients was no longer significant after correcting for confounders and there was no association found in vital older adults, our results suggest there is no direct association between olfactory function and malnutrition, and such findings might be mediated by health-compromising factors that start to play a role in older, less healthy ageing. Consistent with this, Smoliner *et al.* (2013) found no association between nutritional status and olfactory function in geriatric patients, but did for instance show that there was an influence of self-caring capacity on MNA scores. Similarly, Mackay-Sim *et al.* (2006) found that age-related reduction in olfactory function is relatively small in healthy participants that do not smoke or use medication, compared with participants who take medication or have a

Table 2A The association between olfactory function and nutritional status in geriatric patients and vital older adults

	Vital older adults				Geriatric participants			
	β	SE	95% CI	*P*	β	SE	95% CI	*P*
Crude model[a]	0.014	0.041	–0.065 to 0.094	0.724	0.227	0.092	0.045 to 0.409	0.015
Crude model[b]	0.004	0.013	–0.022 to 0.030	0.756				
Adjusted model[a,c]	0.031	0.041	–0.050 to 0.112	0.456	0.121	0.086	–0.049 to 0.291	0.161
Adjusted model[b,d]	0.011	0.014	–0.016 to 0.038	0.416				

Shown are unstandardized coefficients (β), standard errors (SE), 95% confidence intervals (CI), and *P*-values (*P*).
[a]According to the Sniffin' Sticks—Screening 12 test.
[b]According to the Extended Sniffin' Sticks test.
[c]Adjusted for age, mini-mental state examination, and the Geriatric Depression Scale in geriatric participants and adjusted for age and gender in vital older adults.
[d]Adjusted for age, gender, and DemTect.

Table 2B Associations between nutritional status and age, gender, smoking, cognition, depression, comorbidity, and polypharmacy in geriatric patients

	β	SE	95% CI	*P*
Age	–0.015	0.031	–0.076 to 0.046	0.623
Gender	0.435	0.493	–0.539 to 1.409	0.378
Smoking	0.205	0.651	–1.083 to 1.493	0.753
Mini-mental state examination	0.208	0.075	0.059 to 0.357	0.007
Geriatric Depression Scale	–0.378	0.057	–0.491 to –0.265	<0.001
Charlson comorbidity index	–0.223	0.137	–0.493 to 0.048	0.106
Polypharmacy	–0.669	0.470	–1.598 to 0.260	0.157

Shown are unstandardized coefficients (β), standard errors (SE), 95% confidence intervals (CI), and *P*-values (*P*).

Table 2C Associations between nutritional status and age, gender, smoking, and cognition in vital older adults

	β	SE	95% CI	*P* value
Age	0.006	0.010	–0.014 to 0.025	0.562
Gender	0.259	0.116	0.031 to 0.488	0.026
Smoking	–0.008	0.239	–0.478 to 0.461	0.973
DemTect	0.053	0.043	–0.032 to 0.138	0.221

Shown are unstandardized coefficients (β), standard error (SE), 95% confidence intervals (CI), and *P* values (*P*).

history of nasal and/or neurological problems. They conclude that age-related reduction in olfactory function may result from other age-related factors that have an effect on olfactory function, such as co-occurring pathological conditions. Moreover, a recent paper demonstrated that olfactory dysfunction predicts 5-year mortality in older adults (Pinto *et al.* 2014), suggesting that olfaction may be used as a marker for general health. Hence it may be the accumulation of several age-related mental and/or physical problems that plays a crucial role in the high prevalence of anosmia and hyposmia and malnourishment in the group of geriatric patients, in contrast to the vital older adults. However, although co-morbidity and polypharmacy are typically seen as proxy measurements for the occurrence of such problems, in the current study they did not contribute substantially to the association between olfactory and nutritional status, and thus do not provide an easy explanation to this.

In addition, several studies have indicated that a decreased sense of smell is related to a poor appetite, or changes in food preferences and dietary patterns (Mattes *et al.* 1990; Duffy *et al.* 1995; de Jong *et al.* 1999; Aschenbrenner *et al.* 2008), but not necessarily to low energy intake or low BMI (Mattes *et al.* 1990; Duffy *et al.* 1995; de Jong *et al.* 1999). Moreover, research has shown no relation between (loss of) olfactory function and liking of (flavor-enhanced) foods (Kremer *et al.* 2007; Kremer *et al.* 2014) indicating that changes in olfactory performance can, but do not automatically, lead to changes in dietary patterns and nutritional status. Though it is clear that the olfactory sense is vital for food and flavor perception, the relation between olfaction and nutritional status appears complex, rendering the need for more research to be able to ultimately guide people toward better dietary patterns.

There were several limitations to this study that should be mentioned. At first, the study design is cross-sectional and therefore a causal effect between olfactory function and nutritional status cannot be claimed. Future research with longitudinal data may clarify the direction of this association. Second, geriatric patients were only excluded from participation if the scores 18 or less on the MMSE, indicating

moderate or severe cognitive problems. If we had used a more strict criterion for this, perhaps the olfactory test scores and other results would have been even more comparable with the vital older adults. Lastly, the results of the Sniffin' Sticks—Screening 12 test were used in the geriatric patients, whereas the extended version of the Sniffin' Sticks, used in the vital older adults, is more precise and perhaps could provide a wider range of olfactory function scores. However, the extended test was considered as too burdensome for the geriatric participants in the outpatient clinic, and additional results from analysis in the vital older adults using the extended version were similar to the screening test.

In conclusion, this study shows that olfactory function is not directly associated to nutritional status in vital older adults and geriatric patients. However, a decline in olfactory function may still be considered a risk-factor for malnutrition, once co-occurring with other mental and/or physical problems that geriatric patients are more likely to experience.

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