Risk of Malnutrition in Retirement Homes Elderly Persons Measured by the “Mini-Nutritional Assessment”

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Background. The combined influence of age-associated factors such as general health, degree of dependency, diminished odor perception, and poor oral health on the risk for malnutrition was explored.

Methods. A total of 81 persons living in retirement homes took part in the study (mean age 83.4 years, SD = 6.6, range 61-98). The Mini-Nutritional Assessment (MNA) was used to evaluate the risk of malnutrition. Odor perception was measured by the detection threshold for isovalerylacetate. The number of drugs taken by each person was counted. General health status was determined by the Medical Outcome Study (MOS) scores. Oral examinations were carried out to count the number of natural teeth and type of dentures.

Results. On average, women had slightly, but significantly, lower MNA scores than men (respectively, 23.4, SD = 2.8; and 24.6, SD = 2.6; p = .048). The correlations between age and MNA score and between odor perception and MNA score were not significant. Significant correlations were found between age and number of natural teeth (r = -.26; p = .001) and between MNA score and number of natural teeth (r = .27; p = .001). The mean MNA score of complete denture wearers (22.8, SD = 2.9) was significantly lower than that of partial denture wearers (25.8, SD = 2.9; p = .0005). The total MOS and MNA scores were not correlated, but a significant correlation was found with the subscales mental functioning (r = .29; p = .003), social functioning (r = .19; p = .045), and perceived health (r = .19; p = .047). No relation was found between the activities of daily living (ADL) and MNA scores. A significant negative correlation was observed between number of drugs taken and the MNA score (r = -.34; p = .001). When participants without risk of malnutrition (MNA ≥ 24) were compared with those at risk (MNA < 24), the number of drugs taken was significantly different (on average, respectively, 4.5, SD = 2.9; and 7.0, SD = 2.6; p < .0005). Using multiple regression to test the separate effects of the different independent variables, the number of drugs taken showed a significant negative regression coefficient (β = -.31; p = .008), as did the mental health score (β = .27; p = .02), giving a total R² = .32. The other parameters did not contribute significantly.

Conclusion. Among the elderly in retirement homes, the health state (as measured by the MOS subscale mental health and by the medication use) appears to be the most clinically relevant parameter to explain the risk for malnutrition. Loss of natural teeth and perceived health are less independently contributing, whereas no contribution derives from decline of odor perception, degree of dependency, and age itself.

The prevalence of malnutrition in free-living elderly population is estimated to be between 5 and 10%. In home-bound elderly persons and in elderly persons living in retirement homes, prevalences even range from 30 to 60% (1,2). In retirement homes, both degree of dependency and general health of elderly persons are expected to influence nutritional status.

Many studies show a decline of odor perception with age and an association with poor general health and various diseases (3-5). Many nutrients have been suggested to play a role in odor perception (6,7). Although elderly persons are prone to develop undetected malnutrition (2), the literature about the relation between odor perception and nutrition is controversial. It has become clear that, in general, odor perception is variable with age and for elderly persons living in the community, health problems are important in explaining diminished odor perception (8).

Sensory properties of food such as texture and flavor are important determinants of food choice, and flavor perception has been rated as the strongest determinant of food consumption in the elderly population (9). It has been suggested that poor odor perception can cause changes in food consumption, diminished food appreciation, and poor nutritional state among the elderly population (10,11).

Poor oral health is widespread among elderly persons. Caries, periodontal disease, defective or ill-fitting dentures and poor oral or denture hygiene are quite common (12). In addition, missing teeth can have negative effects on mastication, oral health, and nutrition (13). It has been suggested that the proportion of persons with an insufficient intake of nutrients is higher among edentulous than in dentate persons (14). Moreover, the oral cavity is an area where microorganisms metabolize a variety of substances to produce malodors. Such malodors may cause masking or adaptation of the olfactory receptors and hence lead to diminished food odor perception (15).

With increasing age, a combined influence of odor perception and dental state on nutritional state is expected because both odor perception and dental state might affect food consumption (14,15). In this study, it is explored which age-associated factors, such as general health, degree of dependency, diminished odor perception, and poor dental state, are accompanied by increased risk for malnutrition among elderly persons living in retirement homes.
In this experiment, a validated screening tool for the detection of malnutrition, the “Mini-Nutritional Assessment” (MNA) was used.

SUBJECTS AND METHODS

Mini-Nutritional Assessment
The Mini-Nutritional Assessment (MNA) as a rapid assessment tool was used to evaluate the risk of malnutrition (1). The protocol comprises 18 measure items involving anthropometry, general assessments, dietary assessments, and subjective assessment. MNA has recently been validated (1,2) and can accurately assess the nutritional status of elderly persons as normal or well-nourished, borderline or at risk of malnutrition, and malnourished. The scoring categorizes each person as well-nourished (224 points), at risk of malnutrition (17–23.5 points), and malnourished (<17 points).

Odor Perception
For the determination of odor perception, the detection threshold for isoamylacetate (fruity banana/pear odor) was determined as the lowest detectable odor concentration. The described method has been widely used with many substances and has been calibrated in previous studies (5,16,17). The isoamylacetate solutions were prepared according to the procedure and substances described by Laska and Hudson (18). Odors were presented in 250-mL polyethylene squeeze bottles containing 40 mL of solution and equipped with a flip-up spout with an interchangeable nose-piece (Teflon). Each person received series of paired bottles (one blank containing the solvent only and one containing the odor). According to the so-called “forced-choice” paradigm, the participants were asked to sniff and to indicate which one smelled stronger. An intertrial interval of 30 seconds was chosen to allow recovery from adaptation. Detection thresholds were determined by using an ascending method of limits, starting at the lowest of the 14 prepared concentrations. Threshold was reached when five subsequent pairs were correctly indicated. All measurements were carried out in a well-ventilated and quiet room. Gas chromatography verification showed that headspace concentrations of freshly prepared solutions in the bottles remained constant over the whole testing period. During preliminary testing with this procedure, in which odor thresholds were obtained from 25 healthy young persons (aged 19 to 25 years, mean age 22.3) it was shown that the mean threshold fell within the range found by others (19).

General Health
The general health status was determined by the Medical Outcome Study (MOS) scores. The scale has been validated by Stewart and colleagues (20). The MOS scale allows a quantitative measure of functional health of elderly persons on the following concepts:

- Mental functioning: general mood, well-being, depression, and fear
- Perceived health: general judgment concerning the current health state
- Perceived pain: amount of experienced pain

The items were chosen to represent six health concepts by using the World Health Organization (WHO) definition of health (20).

Medication
Because nutritional state was expected to be associated with medication use, the number of drugs taken by each person was counted.

Dental State
Concomitant with the sensory tests, oral examinations were carried out in a standardized way by a dentist (KC). The number of natural teeth and dentures was counted and type of dentures were identified. Accordingly, participants were partitioned in three groups: those with only natural teeth, and partial or complete denture wearers.

Study Population
All participants were without obstructions in the nasal cavity and without acute infections. Participants with alcohol abuse, mental deterioration, and dementia were excluded. The degree of dependency for basic activities of daily living (ADL) was evaluated according to Katz and colleagues (21). Score A corresponds to complete independence whereas scores B to G indicate increasing degrees of dependency.

A total of 81 persons living in retirement homes took part in the experiment (mean age 83.4 years, SD = 6.6, range 61–98). Eleven used no medication, 9 used medication for preventive purposes only, and 61 used therapeutic agents. Fifty-seven participants were independent according to the Katz score, 11 participants presented minor dependency (scores B, C), and 13 participants were highly dependent (scores D–G).

Statistical Analysis
The equation for the calculation of the sensory detection threshold used for statistical analysis was described by Stevens and Cain (22). Normal distribution was tested with the Kolmogorov-Smirnov test. To test the hypothesis whether two group means were equal or not, a Student’s t test was applied when data were normally distributed. When more than two groups were compared, one-way analysis of variance (ANOVA) was used. When ANOVA detected differences, this was followed by a Student’s t test to evaluate which groups were responsible. When two categorical variables were compared, cross-tabulations were used and tested with the chi-square test. When two continuous variables were compared, Pearson correlation coefficients (r) were calculated and tested for significance. To test the combined contribution of different independent variables on the dependent variable of interest, multiple regression was used with a forward-selection approach.

RESULTS
In Table 1, the characteristics of participants are shown. The MNA scores for women were significantly lower compared to those for men (t test, p = .048). There was no correlation be-
between age and MNA score \( (r = .07, p = .22) \), nor between odor perception and MNA score \( (r = -.03, p = .40) \). Participants with only natural teeth had a mean number of 10.8 teeth \( (SD = 6.9) \), those with partial dentures had a mean number of 9.0 teeth \( (SD = 5.3) \). Significant correlations were found between age and number of natural teeth \( (r = -.26, p = .001) \), as well as between MNA score and number of natural teeth \( (r = .27, p = .001) \), as can be seen in Figure 2. The ANOVA test indicated a relationship between the MNA score and the presence of a denture \( (p = .001) \). The mean MNA score of complete denture wearers was 22.8 \( (SD = 2.9) \), which was significantly lower compared to partial denture wearers, who had a mean score of 25.8 \( (SD = 2.9; t \text{ test}, p = .0005) \). No significant difference was observed in MNA score between partial denture wearers and those with only natural teeth \( (\text{mean of } 24.0, \text{ SD } = 2.3; t \text{ test}, p = .2) \), nor between those with only natural teeth and those wearing complete dentures \( (t \text{ test}, p = .3) \).

Although the total MOS score was not significantly correlated with MNA score \( (r = .16, p = .077) \), analysis of the subscales of the MOS scores showed a highly significant correlation between the MNA score and mental functioning \( (r = .29, p = .003) \). The correlations between social functioning \( (r = .19, p = .045) \) and between perceived health \( (r = .19, p = .047) \) and the MNA score were also significant.

The ADL and MNA scores were not related \( (\text{ANOVA}, p = .30) \).

A significant negative correlation was observed between number of drugs taken and MNA score \( (r = -.34, p = .001) \), showing that elderly persons at risk for malnutrition took more medication compared to those without such a risk.

The MNA score allows a classification into elderly persons

### Table 1. Comparison of Age-Associated Parameters Between Those With and Without Risk for Malnutrition in Retirement Homes

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
<th>Group Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>16</td>
<td>65</td>
<td>81</td>
</tr>
<tr>
<td>Mean MNA score</td>
<td>24.6 ( \pm ) 2.6</td>
<td>23.4 ( \pm ) 2.8</td>
<td>23.7 (2.8)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>82.8</td>
<td>82.6</td>
<td>83.4</td>
</tr>
<tr>
<td>Odor perception ( -\text{log} M )</td>
<td>2.06 (1.51)</td>
<td>2.47 (1.81)</td>
<td>2.39 (1.76)</td>
</tr>
<tr>
<td>Number of teeth ( n )</td>
<td>3.7 (5.4)</td>
<td>4.2 (6.4)</td>
<td>4.0 (6.2)</td>
</tr>
<tr>
<td>ADL ( n )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Katz score A</td>
<td>11</td>
<td>46</td>
<td>57</td>
</tr>
<tr>
<td>Katz score B, C</td>
<td>4</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Katz score D-G</td>
<td>1</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>MOS score (%)</td>
<td>71.3 (13.9)</td>
<td>60.9 (17.7)</td>
<td>62.9 (17.3)</td>
</tr>
<tr>
<td>Medication (mean number of drugs taken)</td>
<td>5.6 (3.3)</td>
<td>5.4 (3.0)</td>
<td>5.5 (2.9)</td>
</tr>
<tr>
<td>Type of dentures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No dentures</td>
<td>3</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Partial dentures</td>
<td>4</td>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>Complete dentures</td>
<td>9</td>
<td>37</td>
<td>46</td>
</tr>
</tbody>
</table>

\* \( p = .048 \) compared to women.
who are malnourished (<17 points), those at risk for malnutrition (17–23.5 points), and those without such a risk (≥24 points). Twenty-eight persons (37%) were at risk for malnutrition and two persons (2%) were malnourished. In order to elucidate what age-associated parameters accompanied the shift to a risk of malnutrition conceptualized by the MNA score, the groups were compared in terms of the different potential variables. These are shown in Table 2. Again, the number of drugs taken was significantly different and higher in the participants at risk of malnutrition (p < .005); this group was slightly younger (p = .036).

A combined effect of gender, dental state, mental and social functioning, perceived health, and use of medication on variability in MNA score is to be expected. To test separate effects of the different independent variables on the risk of malnutrition and to determine the relative importance, multiple regression was used. The forward-selection approach was used in order to evaluate which of the potential variables were the most important. These results are presented in Table 3.

The most important variable was number of drugs taken, showing a significant negative regression coefficient (β = −.31, p = .008). The second most important variable was mental health, showing a significant positive regression coefficient (β = .27, p = .02). None of the remaining variables showed a significant separate effect and were not entered in the final equation (total $R^2 = .32$).

DISCUSSION

Many elderly persons have monotonous or inadequate food consumption and are in marginal nutritional status. Energy intake is often found to be below recommended daily allowances, making it extremely difficult to meet requirements for vitamins and minerals (23). High prevalences of deficiencies have been reported for vitamin A, B1, B2, D, B12, B6, folic acid, and iron. Malnutrition is associated with increased mortality, fragility, increased risk for several diseases, susceptibility to infection and reduced quality of life (1). In our study, the risk of malnutrition was evaluated by MNA, which is a composite measure of 18 nutrition-related items. MNA has been validated as a quantitative evaluation tool and appears to be appropriate to assess the risk of malnutrition of elderly persons. It is a comprehensive nutritional assessment including measures of anthropometry, evaluation of dietary intake, and measures of nutritional biological markers. In a larger validation study, it correctly assessed nutritional status of elderly persons without the use of biochemical measures, thus making expensive laboratory investigations unnecessary (1). By evaluating odor perception, dental state, general health, and medication use in function of nutritional risk, it became clear in this study that relations between these parameters and nutritional risk are complex.

In general, previous studies which explored the relation between odor perception and nutritional state did not use composite measures of nutritional risk but focused on single nutritional components, blood chemistries, or anthropometric sites. The MNA is an overall evaluation score of nutritional state and does not provide information with regard to specific nutrients or biochemical indices. The results from previous studies are therefore difficult to compare with MNA scores. In general, focusing on the overall dietary pattern is more important for health, qual-

Figure 2. Number of teeth, gender, and MNA score.
MOS scores
Age
Parameter
the participants without risk and those at risk of malnutrition.
Men vs. Women (»)
N (%)
Gender
Odor perception (-log M)
Mean MNA score
Number of teeth («)
ADL
Number of teeth
Katz score A
Katz score B, C
Katz score D-G
MOS score (%)
Medication (mean number of drugs taken)
Type of dentures
Partial regressions
Coefficient (β)
Statistical Result*
Comparisons of Age-Associated Parameters Between Those With and Without Risk for Malnutrition in Retirement Homes
Table 3. Relationship Between MNA Score and Age-Related Parameters Under Investigation, Summary of Statistical Results
Parameter
Univariate Results
Partial Regression Coefficient (β)
Age
.07 (p = .22)
MOS scores
Physical
.14 (p = .11)
Role
.06 (p = .28)
Mental
.29 (p = .005)
Social
.19 (p = .045)
Perceived health
.19 (p = .047)
Perceived pain
-.11 (p = .17)
Odor perception
.03 (p = .40)
Gender
p = .048
Number of teeth
.27 (p = .001)
ADL
p = .30
Medication
-.34 (p = .001)
Note: For age, MOS scores, odor perception, medication, and number of teeth, Pearson correlations were tested for significance. For gender and ADL, differences in mean values were tested with a one-way ANOVA, followed by a t test. Multivariate results are indicated with the partial regression coefficients.

Table 2. Comparison of Age-Associated Parameters Between Those With and Without Risk for Malnutrition in Retirement Homes

Table: Parameters Under Investigation, Summary of Statistical Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MNA ≥ 24 (No Risk of Malnutrition)</th>
<th>MNA 17–23.5 (At Risk of Malnutrition)</th>
<th>MNA &lt; 17 (Malnourished)*</th>
<th>p Value of Statistical Result*</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (%)</td>
<td>51 (61)</td>
<td>28 (37)</td>
<td>2 (2)</td>
<td></td>
</tr>
<tr>
<td>Mean MNA score</td>
<td>25.5 (23)</td>
<td>21.2 (1.89)</td>
<td>15.8 (35)</td>
<td>&lt; .0005</td>
</tr>
<tr>
<td>Age (years)</td>
<td>84.0 (6.8)</td>
<td>82.1 (6.9)</td>
<td>82.5 (71)</td>
<td>.038</td>
</tr>
<tr>
<td>Men/Women (n)</td>
<td>11/40</td>
<td>5/23</td>
<td>0/2</td>
<td>.31</td>
</tr>
<tr>
<td>Odor perception (-log M)</td>
<td>2.27 (1.68)</td>
<td>2.32 (1.92)</td>
<td>3.39 (2.6)</td>
<td>.93</td>
</tr>
<tr>
<td>Number of teeth (n)</td>
<td>4.8 (6.2)</td>
<td>3.3 (6.4)</td>
<td>0.00 (0.00)</td>
<td>.20</td>
</tr>
<tr>
<td>Katz score A</td>
<td>38</td>
<td>17</td>
<td>2</td>
<td>.14</td>
</tr>
<tr>
<td>Katz score B, C</td>
<td>8</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Katz score D–G</td>
<td>5</td>
<td>8</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>MOS score (%)</td>
<td>62.3 (15.0)</td>
<td>63.4 (20.1)</td>
<td>47.0 (11.3)</td>
<td>.81</td>
</tr>
<tr>
<td>Medication (mean number of drugs taken)</td>
<td>4.5 (2.9)</td>
<td>7.0 (2.6)</td>
<td>12.0 (0)</td>
<td>&lt; .0005</td>
</tr>
</tbody>
</table>

*Because only two persons were malnourished, no statistical analysis was performed for the comparisons with this group; all p values concern the comparisons of the participants without risk and those at risk of malnutrition.

One would expect the nutritional status to be related to the sense of smell, but this association is controversial (25). Among elderly persons living in the community, where health status was assessed using the SENIEUR protocol, Griep and colleagues (5,6,8) showed that both nutritional and health state were associated with decreased odor perception. Associations were found between anthropometric measures of nutritional state, chemical indices from blood, and odor perception (5,8). Nutrient intake levels, derived from food questionnaires, were only weakly related to odor perception; in several cases they only emerged when other parameters were controlled for (6).

In the study presented here, where only elderly persons living in retirement homes were included, no relation was found between nutritional state and odor perception. We have tested odor perception by detection thresholds of isoamylacetate, using an ascending method of limits under forced choice conditions. It has been described that most olfactory test devices and methodologies (26), and we therefore may conclude that the odor thresholds that we obtained from 98 apparently healthy free-living adults, age 19 to 86, showed a test-retest coefficient of .55 (p < .001) and significant interodorant relations .42–.52 (p < .001). The obtained thresholds fell within the normal range for the chosen threshold methodology (26), and we therefore may conclude that the odor thresholds that we obtained can be generalized to a larger range of substances and reflect a valid measure of olfactory performance (17).

The controversy about the relation between odor perception and nutrition can be due to the effect of general health and use of medication, which turn out to be key variables for both parameters in many studies (5,8,27). The populations under investigation, indeed, differ greatly in terms of overall health and drug use. In order to distinguish the effect of general health from other parameters (such as odor perception) on the variability in nutritional state, we used the MOS scale. Validation
studies of the MOS scale by others showed that it is a useful, reliable, and valid instrument for measuring general health of elderly persons (20). Here, we found a relation between MNA score and the MOS subscale scores, mental, social functioning, and perceived health, but not with the total MOS score. Medication use, as a parameter of general health, was found to be more frequent in elderly persons at risk for malnutrition compared to those without such a risk.

In this study, the univariate analysis thus showed significant relationships of the nutritional state with several parameters of general health, but not with age. Because the relation of MNA score with medication use and a MOS subscale was confirmed in the multivariate analysis, it must be concluded that health state and nutrition are independently related, and that this relation cannot be ascribed to age itself. Along this line, it has been suggested that, in general, health status might become more important than age in explaining malnutrition of elderly persons (5). It has to be noted that, due to partial regression effects, the relation between nutrition and other health-related variables (i.e., some MOS subscales) might have become masked.

Because the results reported are cross-sectional in nature, they do not present a definitive support to the hypothesis that malnutrition is caused by poor health and medication use or that improvement of general health might lead to an improved nutritional state.

Denture problems are intuitively related to malnutrition. Volatile odors, originating from food, enter the nasal cavity retronasally during mastication; declining chewing ability among elderly persons can prevent the release of these odors from the food. Decreased appetite and ability to eat can cause restrictions in food selection (13), leading to poor nutrition. Among denture wearers the chewing ability is particularly reduced, often forcing them to choose only soft food which frequently is nutritionally unbalanced (14). Tooth loss causes a significant loss in chewing ability and complete dentures do not restore full oral function. Impaired mastication alters the sensory and psychological aspects of eating, causing restrictions in food selection. Population-based studies suggest that edentulousness is correlated with lower nutrient intakes and multiple dietary inadequacies. Edentulous individuals are more likely to have an atherogenic diet (13,28). Our univariate results with MNA show that the risk of malnutrition increases with a loss of natural teeth and wearing of dentures. However, the relation did not resist the removal criteria of the multivariate analysis and could therefore also be ascribed to other age-associated factors.

In conclusion, our results show that elderly persons at risk for malnutrition tend to have a poorer health and have less natural teeth compared to elderly persons without such a risk. By distinguishing the effect of general health from other factors, compared to odor perception and dental state, health state and medication dominate in the explanation of nutritional risk among elderly persons living in retirement homes. Because health state and medication use remained significant in the final multivariate model, they are probably the variables with the highest clinical relevance emerging from the present study. However, from both the clinical and statistical perspective, the variables considered in the present study do not completely account for the total variance associated with the risk of malnutrition; thus, other predictive variables might be added to the model in future studies.

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**Geriatric and Extended Care Service Line Director**

**THE VETERANS INTEGRATED SERVICE NETWORK 1 (VISN 1)** is seeking applicants to serve as the Senior Clinical Director of the Extended Care Service Line, responsible for the coordination of extended care service delivery throughout the Network. VISN 1 includes VA Medical Centers in West Haven and Newington, CT; Providence, RI; Northampton, Bedford, Brockton, and Boston Health Care System (which includes Boston and West Roxbury), MA; Manchester, NH; White River Junction, VT; and Togus, ME; as well as numerous community-based outpatient clinics throughout the New England area. The Extended Care Service Line Director is a critical member of the interdisciplinary VISN 1 leadership team and is expected to possess the clinical, managerial, and leadership expertise needed to integrate the separate Medical Centers and clinics into a coordinated service line. Duties include coordinating, planning, and monitoring, with extended care site and network managers, all extended care service activities, including service delivery, education and research. Applicants must be board certified in a specialty and preferably board certified in geriatrics and have demonstrated experience appropriate to the duties and responsibilities of the position. The Department of Veterans Affairs is an Equal Opportunity Employer. Salary commensurate with background and experience. Please forward letter describing relevant experience and your CV to VA Medical Center, Human Resources Management Service (05D), Attn: Suzanne Wilkinson, 940 Belmont Street, Brockton, MA 02301.