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Oral hypofunction and association with need for daily assistance among older adults in long-term care

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Abstract

Background: Oral hypofunction (OHF) is related to occlusal status and bite force. It has specific symptoms and varying degrees of severity.

Objectives: OHF was determined with five signs. The relationships between OHF and need for assistance in oral hygiene, moving, eating and occlusal status in older adults living in long-term care (LTC) were examined.

Methods: A comprehensive clinical oral examination was conducted on 393 residents who lived in LTC in Helsinki, Finland. The five signs to determine OHF were mouth dryness, visible food residue on oral or denture surfaces, ability to keep the mouth open during examination, clearness of speech, and diet of pureed or soft food. Score points of 0–2 were given for each sign, and the sum was categorised as mild, moderate or severe OHF. Participants were divided into three groups accordingly, and occlusal status was determined based on contact units. In addition, nurses collected background information on number of medications and level of cognition. Need for assistance was based on oral hygiene, moving and eating.

Results: Of participants ($n = 319$), 21% showed severe and 41% moderate OHF. Occlusal status differences between the OHF groups were significant. OHF severity associated linearly with increased severity of cognitive impairment and increased need for assistance in oral hygiene, eating and moving.

Conclusions: OHF score based on the five signs can be used to determine OHF severity. OHF was common and associated with occlusal status, cognitive impairment and need for assistance in oral hygiene, moving and eating in older adults living in LTC.

KEYWORDS
daily assistance, long-term care, occlusal status, older adults, oral hypofunction

1 | INTRODUCTION

The complex masticatory system combines multiple anatomical structures.[1] Ability to chew is related to masticatory muscle strength and function, condition of teeth and jaw muscles, and salivary flow.[2]

Chewing ability and performance affect general well-being. Chewing impairment impacts the daily activities of older adults. Numerous variables have been used to identify the reasons underlying the changes in oral hypofunction (OHF) such as number of teeth remaining,[3] dry mouth,[4] sensory function and force of the

tongue and muscles,[5] and contact area between opposing teeth.[6] Some studies have included decline in occlusal force and motor ability of the tongue as part of OHF, a functional pathophysiological condition consisting of several deteriorated oral functions.[7,8] Also, a few studies have investigated whether impaired mastication has a relationship with decline in systemic conditions such as dysphagia, frailty and sarcopenia.[9-11] According to recent studies, impaired oral function leads to a gradual deterioration of dietary habits and malnutrition.[12] Impaired function per se can also affect the structure, composition, size and shape of edible food.[13] In addition to a clinical examination, questionnaires have been developed to screen for oral frailty and OHF.[14-16] No consensus exists on the definition for either OHF or oral frailty.[1,7,17,18]

Daily activity has been assessed by several indices. The most commonly used are activity of daily living (ADL) and instrumental activities of daily living (IADL), designed as scoring systems for evaluating independent living at home.[19-21] Other popular indices are oral health impact profile (OHIP)[22] and geriatric oral health assessment index (GOHAI).[23,24] In addition, it has been pointed out that poor oral health and ADL are associated with cognitive impairment.[25] Moreover, low ADL has been found to be associated with decreased chewing ability and cognitive functioning.[26]

Our aim was to determine the OHF of older adults living in LTC with five signs presented in earlier studies—mouth dryness, visible food residue on oral or denture surfaces, ability to keep the mouth open during examination, clearness of speech and diet of pureed or soft food. Furthermore, we present a scoring system to categorise the severity of OHF that is precise and easy to use in clinical practice by the staff of LTC facilities.[4,5,13,27,28] Finally, we examined the relationships between OHF and occlusal status, cognition, need for assistance in oral hygiene, moving and eating in older adults in LTC in Helsinki, Finland.[19,29]

We hypothesised that OHF severity can be determined by using the score of five signs and that severe OHF in older adults living in LTC is associated with occlusal status, cognitive impairment and need for assistance in oral hygiene, moving and eating.

2 | MATERIALS AND METHODS

Older adults in this oral health study had participated in a previous nutrition study.[30] A total of 393 individuals or their guardians gave their consent. Older residents participated between 8 September 2017 and 1 February 2019 in the comprehensive FINORAL study (the FINish ORAL health studies in older adults). The detailed FINORAL study protocol and clinical procedures have been described earlier.[30]

Registered nurses collected the following data on residents using a standardised questionnaire and medical records: demographic factors, length of residence, cognitive disease (no or mild/moderate/severe), number of medications and need for assistance with oral hygiene, moving and eating.

In the clinical oral examination, data on occlusal status, number of teeth and dentures in use were collected. Also, the following five signs describing OHF were examined: mouth dryness,[31] visible food residues on oral or denture surfaces, ability to keep the mouth open during oral examination, clearness of speech and from the questionnaire, food consistency. These five signs were available for 319 older adults; those who lacked one or more entries needed for OHF determination were excluded from the analysis (n = 74) (Table 1).

A study participant was determined as dentate if she/he had at least one visible tooth or root remnant left. The tooth was determined as a whole natural tooth if it had a crown of dental material, filling material or a fixed prosthetic crown. Removable dentures were determined to be partial or complete. The occlusal contact units were determined visually as follows after the subject had been asked to bite the teeth together: contact between natural teeth (natural contact unit), contact between natural tooth and removable dentures (mixed contact unit), contact between removable dentures (denture contact unit) or no contact.

The individual OHF signs were divided into three categories: no (0 point), moderate (1 point) and severe OHF (2 points), except for the consistency of food, which was categorised into two categories: ordinary (0 points) and soft/pureed food (2 points) (Table 1). The total number of points forms the final OHF severity score

TABLE 1 Scoring system of severity of oral hypofunction (OHF) based on five signs similar line markings

Sign of OHF	0 points	1 point	2 points
Mouth dryness	No clinical signs of dry mouth	Some clinical signs of dry mouth	Dry mouth (mirror sticks to tongue and buccal mucosa with other clinical signs)
Visible food residues on oral or denture surfaces	No food residues	On teeth surfaces	On all oral or dentures surfaces
Ability to keep mouth open	No difficulties in keeping mouth open	Some difficulties in keeping mouth open or requires encouragement	Mouth opening fails completely or requires a lot of encouragement
Clearness of speech	Clear	Unclear but understandable	Not understandable or does not speak
Consistency of food	Ordinary	–	Soft/pureed

(Table 1), and the formation of study groups (Gr 1–3) was carried out accordingly: Gr1 0–3 no or mild, Gr2 4–6 moderate and Gr3 7–10 severe OHF.

3 | STATISTICS

Ordinal variables were expressed as n (%) and continuous variables as mean (standard deviation, SD). The linearity across the OHF groups was evaluated using chi-square linear-by-linear association or with the Jonckheere–Terpstra test for linear trend. Pairwise comparisons of continuous variables between study groups were adjusted by the Bonferroni correction for multiple tests. Correlations between individual signs of OHF and medical and functional characteristics of study participants were analysed by Kendall's Tau-b correlation method with 95% bias-corrected and accelerated (BCa) bootstrap confidence intervals.

The association between severe OHF determined with five signs (dependent variable), and categories of occlusal status (independent variable, each separately included in the analysis dummy-coded as 0 or 1) were determined with an unadjusted model and with a confounder (age as continuous and sex as categorised covariate)—adjusted binary logistic regression model.

All statistical analyses were performed with SPSS Statistics 25 (IBM Japan). Differences were considered significant at $p < 0.05$.

4 | RESULTS

Of participants ($n = 319$), 123 (38%) had no OHF (Gr1), 130 (41%) moderate OHF (Gr2) and 66 (21%) severe OHF (Gr3) (Table 2).

Table 2 shows demographics and clinical oral examination occlusal findings in three study groups. Of all participants, 74.6% were female and the mean age was 83 years. There was no significant difference in age between study groups, but the proportion of female participants increased linearly from Gr1 with no OHF (68.3%) to Gr3 with severe OHF (83.3%). Gr3 participants had spent a significantly longer time in the current institution (mean 59.3 months) than Gr2 and Gr1 participants (41.9 and 41.3 months, respectively) ($p = 0.001$; in pairwise comparisons, difference significant for Gr3/Gr2 and Gr3/Gr1).

Of Gr1 and Gr2 participants, 79% used more than five daily medications, while for Gr3 participants with severe OHF, the figure was 45%. Moderate-to-severe cognitive impairment was diagnosed for 82.5% in Gr2 and for 82.8% in Gr3, while in Gr1, the figure was 58.7%. Almost all (>90%) participants in Gr3 needed daily assistance with oral hygiene, moving and eating, with the need for assistance in these activities decreasing linearly from Gr3 to Gr1 (Table 2).

Number of teeth was identical in all groups. The highest proportion (37%) of participants in Gr1 had mixed or denture contact units (natural teeth and a removable denture or denture/denture

contact units). In Gr3 with severe OHF, most common (42%) were edentate participants or those without occlusal contact units. The occlusal status differences between the OHF groups were significant (Table 2).

Manifestation of the five signs of OHF as a percentage in each study group can be seen in Figure 1. The manifestation percentage of all five OHF signs scored by 2 points increased linearly from Gr1 to Gr3, and the absence of signs (0 points) was linearly reversed (p-value for linearity through study groups for each sign <.001).

In unadjusted logistic regression, occlusal status 'no contact units or edentate' was associated with severe OHF significantly (OR 2.567, 95% CI 1.031–6.394, $p = .043$), and the association with '<10 natural contact units' approached significance (OR 2.304, 95% CI 0.912–5.817, $p = .077$). When the model was adjusted for age and sex, both 'no contact units or edentate' (OR 3.1, 95% CI 1.189–8.231, $p = .021$) and '<10 natural contact units' (OR 2.75, 95% CI 1.043–7.242, $p = .041$) were associated significantly with severe OHF.

The 95% confidence intervals (95% CIs) for correlations between the signs of OHF and medical and functional characteristics of study participants are shown in Figure 2. Clearness of speech, consistency of food and ability to keep the mouth open were negatively correlated with cognitive impairment and need for assistance with oral hygiene, eating and moving. The same OHF variables were positively correlated with number of medications. The OHF items food residues in mouth and mouth dryness were not correlated with any medical or functional characteristics.

5 | DISCUSSION

In this study, we aimed to find a simple and effective tool to identify signs that could describe the severity of OHF and its relationship with occlusal status, daily need for help and cognitive impairment in LTC facilities. We found that OHF based on five signs (mouth dryness, visible food residues on oral or denture surfaces, ability to keep the mouth open during oral examination, clearness of speech and diet of pureed or soft food) is common among older LTC residents. Clinically, the clearest difference between severe OHF and no or mild OHF seemed to emerge with three signs: unclear speech, ability to keep the mouth open during examination and a soft-food diet. Furthermore, OHF was strongly associated with occlusal status and correlated with cognitive impairment, and the need for daily assistance in oral hygiene, moving and eating. The present findings support the study hypothesis that OHF severity can be determined by using the score of five signs.

Masticatory ability and efficiency depend on dental status, location and number of remaining teeth, and bite force, which is determined by jaw muscle mass, activity and coordination.[2] Masticatory muscle strength and bite force are used to evaluate chewing or muscle function.[32] Masticatory muscle weakness and associated detectable signs are related to muscle size, accuracy of function and maintenance of mastication activity.[8] Furthermore, a recent study

TABLE 2 Demographics and findings of the clinical oral examination (%) in the FINORAL study of older adults with different grades of oral hypofunction (OHF) living in long-term care in Helsinki, Finland (N = 319), in study groups 1–3 (Gr1-3)

Demographics, findings of clinical examination	Gr1, no OHF, 123 (38)	Gr2, moderate OHF, 130 (41)	Gr3, severe OHF, 66 (21)	p-value
Female, n (%)[†]	84 (68.3)	99 (76.2)	55 (83.3)	.020[*]
Age, years mean (SD)[‡]	81.6 (8.6)	85.1 (7.6)	82.7 (8.2)	.126
Institutional period, months mean (SD)[‡,¶]	41.3 (38.0)	41.9 (35.3)	59.3 (33.1)	.001[*]
Number of medications, n (%)[†]				
≤5	25 (21)	26 (21)	36 (55)	<.001[*]
>5	96 (79)	100 (79)	30 (45)	
Cognitive impairment, n (%)[†]				
No or mild	50 (41.3)	22 (17.5)	11 (17.2)	<.001[*]
Moderate to severe	71 (58.7)	104 (82.5)	53 (82.8)	
Daily oral hygiene, n (%)[†]				
By oneself	47 (40)	17 (13)	1 (2)	<.001[*]
Needs help with oral hygiene	70 (60)	111 (87)	64 (98)	
Moving, n (%)[†]				
No need for assistance	83 (68)	43 (33)	5 (8)	<.001[*]
Needs assistance	39 (32)	87 (67)	61 (92)	
Eating, n (%)[†]				
No need for assistance	103 (84)	60 (46)	5 (8)	<.001[*]
Needs assistance	20 (16)	70 (54)	60 (92)	
Number of teeth, mean (SD)[‡]	10.7 (9.4)	10.7 (9.7)	12.4 (9.5)	.426
Occlusal status, n (%)[§]				
≥10 natural contact units	24 (19)	19 (15)	7 (11)	Gr3/Gr1 <0.001[*]
<10 natural contact units	23 (19)	41 (31)	24 (36)	Gr3/Gr2 0.032[*]
Mixed or denture contact units	45 (37)	34 (26)	7 (11)	Gr2/Gr1 0.061
No contact units or edentate	31 (25)	36 (28)	28 (42)	

[†]Chi-square test, linear-by-linear association.

[‡]Jonckheere–Terpstra test for linear trend.

[§]Pairwise comparisons with Chi-square test.

[¶]Time in long-term care before the oral examination.

[*]Indicates $p < .05$.

concluded that selected signs could be used to determine oral frailty and that oral frailty is associated with Fried's frailty phenotype.[11] There is no consensus on the definitions of OHF, masticatory performance and oral frailty, although a few indices have been created. The underlying signs also vary from study to study.[1,14–16] According to our knowledge, no method or assessment score exists that could be used both in dental practice and in long-term care facilities for older adults, and that would be beneficial to caretakers of older persons, although points or assessment methods exist at least for research purposes.[14,16] Expecting older adults to reliably carry out complex biting or swallowing tests or to fill out questionnaires is unreasonable, and assigning a diagnosis should be simple and practical for medical staff in the course of daily care.[1,14,16]

Sensory and motor function of a tongue for allocation and transportation of food bolus is necessary for effective masticatory performance.[5] The pressure caused by the movement of the tongue is the main factor in the formation of food bolus.[33] The accumulation of food residues and microorganisms on the surfaces of the oral cavity or dentures indicates a decrease in motor function.[34] Mastication has been found to be associated with, for example, cognitive activity, food intake and some activities in daily life.[35,36] Fruits, vegetables, nuts and meat in meals are considered to be difficult to chew, and intake of these is affected by masticatory function.[37] Our findings are consistent with the earlier study and suggest that OHF may lead to selection of softer and easier-to-chew food.[36]

One of the signs in the OHF score was clearness of speech. Coordinated movements of masticatory organs are part of speech, and oral dexterity represents articulatory oral motor skill of a person.[18] Tongue–lip motor function is said to be a major component of

FIGURE 1 Manifestation of five signs of oral hypofunction (OHF) as a proportion in each study group of older adults living in long-term care in Helsinki, Finland (n = 319), with no or mild, moderate or severe OHF
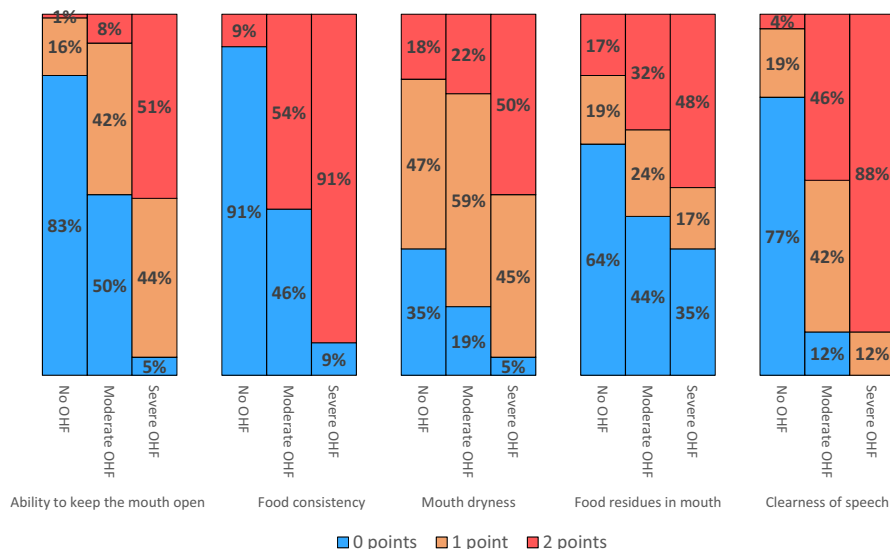
masticatory function, and according to previous studies, the importance increases with a lower number of occluding pairs of teeth.[16,28] Because evaluating speech is challenging, our researchers first evaluated the voice communication of older residents as follows: speech was clear/understandable/non-existent or unclear.[14,38] According to the findings, clearness of speech can be considered one of the main signs of OHF severity. An older person's vocal communication or its disappearance is a crucial change in OHF; this finding is consistent with previous reports.[14,16,28] By observing speech, anyone taking care of an older person can detect the first signs of a change in OHF.

Mouth dryness has been investigated as one of the reasons for OHF.[7,39] Saliva aids in swallowing, oral cleansing, speech, digestion and taste.[40,41] In our study, neither mouth dryness nor food residues correlated with functional capabilities of a person, but participants with severe OHF had the highest prevalence of poor scores for both signs relative to the other groups, in line with earlier studies.[40–42]

Masticatory muscles undergo skeletal muscle atrophy and weakness, which can affect both maximal mouth opening and occlusal force as well as the ability to keep the mouth open for longer periods of time.[27,32] According to our findings, the ability to keep the mouth open correlated with functional capacity of a participant and is consistent with studies reporting occlusal force deterioration.[7,32] It is readily apparent to those caring for an older adult when the person has difficulty in keeping their mouth open while eating or brushing their teeth.

The association of oral health with need for daily assistance and with cognitive impairment has been evaluated using ADL, GOHAI and OHIP.[25] Also, the need for assistance in walking to reflect mobility limitations in older people with cognitive disease has been used.[25,43] Questionnaires like OHIP and GOHAI require a lot of time and adequate cognitive ability from an older adult to be able to answer them properly.[23,24] Moreover, such indices as IADL and ADL are used to determine future residency, but they are not appropriate for our aim of evaluating daily assistance need in LTC.[20–22]

A practical and useful way to identify problems related to the need for daily assistance in an older adult is observation of ordinary daily tasks such as maintenance of oral hygiene, moving and eating. Most of our participants were unable to understand the guidelines and instructions of complicated experiments or questionnaires.

Our findings confirmed a close relationship between especially three of the analysed five signs of OHF and need for daily assistance in older residents in LTC. In addition, among our participants, severity of cognitive impairment and need for assistance increased linearly from no OHF to severe OHF, consistent with earlier research.[25,44,45] Our results, in accordance with previous publications, strongly suggest that OHF is associated with the need for assistance in oral hygiene, moving and eating.[46–48]

Low chewing capacity has been associated with lower ADL, poor cognitive function, depression and lack of food intake in community-dwelling older people.[26] Number of teeth did not significantly differ between the study groups, contradicting earlier findings.[49] On the contrary, according to our findings, the status of occlusion had an association with OHF. Edentulousness and reduced occluding pairs have traditionally been perceived as part of masticatory impairment and our categorisation of OHF follows the same pattern.[39,50] In the age- and sex-adjusted logistic regression model, severe OHF was associated with both no occlusion (OR 3.1) and fewer than 10 natural contact units (OR 2.7), further supporting our scoring system. The results suggest that the number of natural teeth does not determine OHF or its severity. The number and quality of occlusal contacts are more significant. Also, noteworthy is the role of occlusal contact units created with a removable denture among those who had natural tooth/denture or denture/denture occlusal units. We conclude that occlusal contact units provided by a removable denture are more important in maintaining occlusion than has been assumed.

A strength of our study is that no oral examinations as comprehensive as ours have been done in very old populations to evaluate the severity of OHF. Moreover, all methods that we used are easy to replicate in both research and clinical evaluations. Such signs as clearness of speech, ability to keep the mouth open, food residues
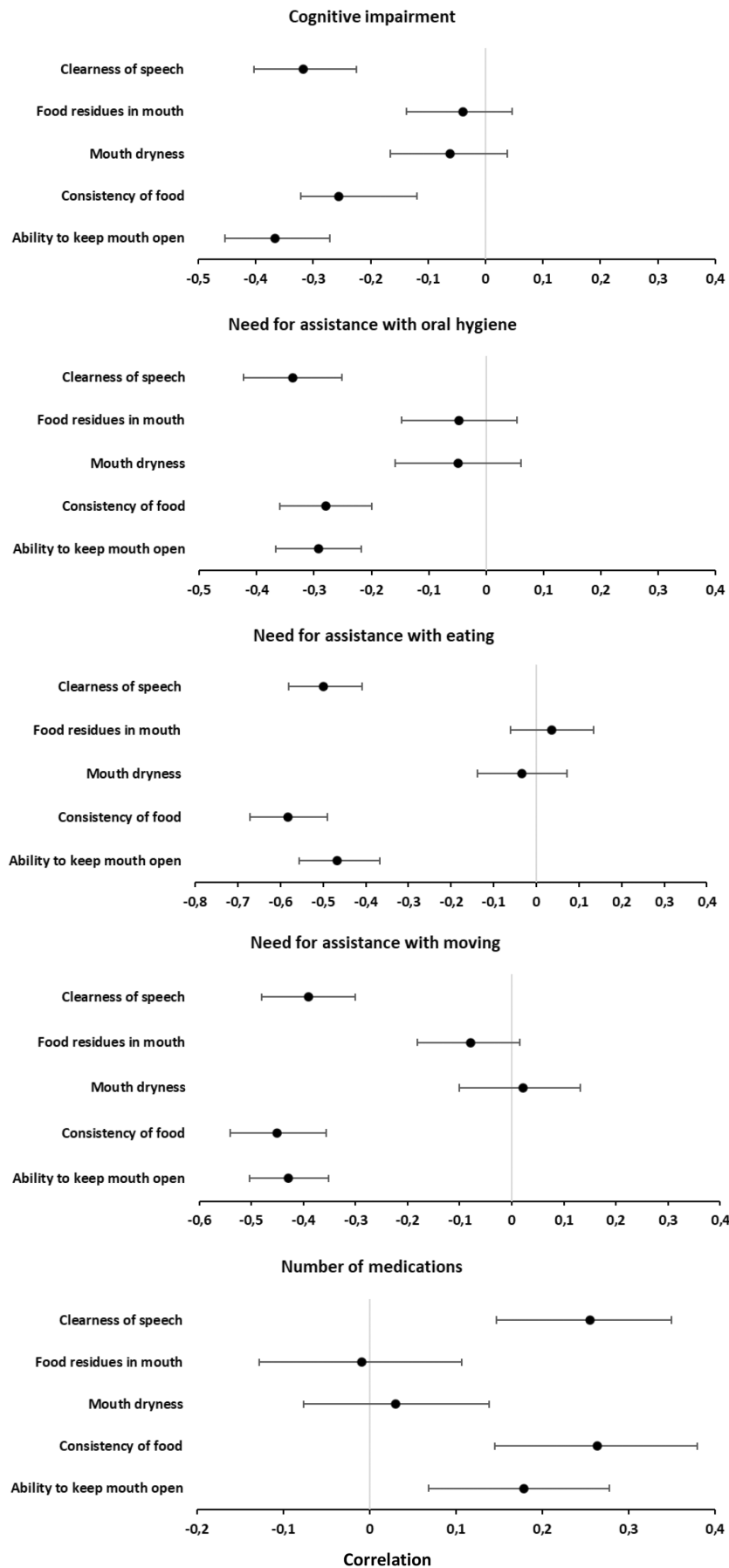
FIGURE 2 95% confidence intervals for Kendall's Tau-b correlation coefficients for individual signs of oral hypofunction (OHF) and medical and functional characteristics of older adults living in long-term care in Helsinki, Finland

on oral surfaces and inability to eat normal foods are easy to detect by members of nursing staff or other caretakers. Dryness of mouth may not be as reliable to detect by healthcare staff without additional training.[31]

Because participants of our study were old, frail and multimorbid, diseases were cumulative and can affect the outcomes of each parameter examined here. Accordingly, some limitations of the study should be addressed. There was no occlusal foil used for the counting of contact units, but we were able to determine occluding pairs adequately by inspecting with handheld dental mirrors and other dental equipment. Most of the participants were lying in bed or sitting in a chair during the oral examination, which can affect the ease of keeping the mouth open.

The OHF severity score is the first step towards a more accurate categorisation of OHF among LTC residents. This study needs to be replicated in other study populations, and its applicability to the general population determined. In addition, it should be confirmed whether OHF can be assessed based on three main signs: unclear speech, the ability to keep the mouth open during clinical examination and a soft-food diet.

6 | CONCLUSION

According to our findings, oral hypofunction can be identified by using five signs combined into a three-grade severity score. Furthermore, it is possible for anyone taking care of an older person to use a few signs to describe oral hypofunction both at the dentist's office and in different clinical settings. Oral hypofunction is common in LTC and is associated with cognitive impairment, occlusal status and need for assistance in oral hygiene, moving and eating.

AUTHOR CONTRIBUTIONS

Päivi Mäntylä, Riitta Saarela and Kaija Hiltunen contributed to the study concept and design. Riki Oura, Päivi Mäntylä acquired the data. Päivi Mäntylä, Riki Oura and Kaija Hiltunen contributed to the analysis and interpretation of the data. Päivi Mäntylä, Riitta Saarela, Kaija Hiltunen and Riki Oura drafted the manuscript and critically revised it for important intellectual content.

CONFICT OF INTEREST

The authors have no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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