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Dental Related Function and Oral Health in Relation to Eating Performance in Assisted Living Residents With and Without Cognitive Impairment

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Abstract

Aims: Despite the physiologic relationship, there is lack of evidence on how dental related function and oral health impact eating performance. This study aims to examine the association of eating performance with dental related function and oral health among assisted living residents.

Methods and Results: This study was a secondary analysis of observational data collected from an instrument development study. Participants included 90 residents with normal to severely-impaired cognition from three assisted livings. Multilevel mixed-effects ordered logistic models were used. The dependent variable was eating performance measured by the single “eating” item (scored from 0 to 4 on level of dependence). Independent variables were resident age, gender, dental related function, and oral health. The resident and facility clustering effects accounted for 88% of variance in eating performance, among which 84% was explained by dental related function and oral health. Eating performance was associated with dental related function (coefficient = −0.10, 95%CI = −0.19, −0.01, $p = 0.025$), and was not associated with other characteristics.

Conclusion: Eating performance is influenced by the complex relationship with dental related function and oral health. Novel interventions using interdisciplinary partnerships are needed to maintain dental related function and oral health to optimize eating performance.

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Impact Statement: We certify that this work is novel in finding that eating performance is significantly associated with dentally related function in assisted living residents. Despite the integral physiologic relationship between oral related conditions and eating performance, there is lack of evidence on the relationship in older adults residing in residential care facilities. We suggest that interdisciplinary partnerships should be utilized to develop and implement novel interventions that maintain dental related function and oral health to optimize eating performance and nutritional outcomes in institutionalized older adults.

Keywords

dental related function; eating performance; oral health

Introduction

Eating performance, defined as the functional act to get food and drink into the mouth and swallow it regardless of skills[1, 2], is one of the most fundamental activities of daily living (ADLs) to perform among older adults[3]. Cognitive impairment affects 68–70% persons in residential care settings (residents) in the United States[4]. Residents with cognitive impairment experience declined eating performance at a higher rate when compared to cognitively intact residents, and these declines in eating performance become more profound as cognition worsens[5,6]. Around 32–87% residents experience compromised eating performance and need different levels of assistance[1, 7]. Residents face additional barriers to independent eating including aversive feeding behaviors, undereducated staff, and institutional and environmental barriers[8, 9]. Declines in eating performance can lead to staff-resident stress, decreased food and fluid intake, comprised nutritional status, weight loss and loss of ability to eat[10], which further increases the likelihood of death in residents[11, 12]. Optimizing eating performance is an important strategy to maintain nutritional intake and hydration, and support quality of life[13–15]. Interventions to promote eating performance traditionally focus on cognitive function and eating skills training for residents, feeding skills training for care staff, mealtime assistance, and environmental modifications[2, 16].

Persons living in the residential care settings are also at risk for oral health problems. Around 82–92% of residents experience at least one dental caries or retained root as well as declined dental related cognitive function interfering oral hygiene activities[17]. According to World Health Organization, oral health refers to “a state of being free from mouth and facial pain, oral and throat cancer, oral infection and sores, periodontal (gum) disease, tooth decay, tooth loss, and other diseases and disorders that limit an individual’s capacity in biting, chewing, smiling, speaking, and psychosocial wellbeing”[18]. Multiple oral related conditions including poor chewing ability, swallowing difficulty, candidiasis, edentulism (toothlessness), denture problems, dry mouth, and taste change are associated with poor oral intake, malnutrition and weight loss[6, 19–21]. Although it is commonly assumed that oral health impacts eating performance and subsequently nutrition status, there is lack of research evidence on the association between oral health and eating performance[1], or the use of oral health interventions to improve eating performance[2].

Dental related function is the ability to perform oral hygiene and health related activities, including medication management, comprehension and following instructions, oral self-care, and perception and response to oral health problems[22, 23]. Dental related function is associated with but differs from basic and instrumental ADLs. It is a group of skills that are essential to maintain oral health. While decline in dental related function is associated with cognitive impairment[22, 24], and cognitive impairment is associated with eating performance[1], there is little research on the role of dental related function on eating performance.

The association between eating performance and dental related function and oral health in residents is complex and multifaceted. A better understanding of the dental related factors that influence eating performance is important to direct the development and implementation of oral health related programs to improve eating performance and nutritional outcomes. While the role of resident-level factors including cognitive impairment, physical capability, comorbidities, and behavioral disturbances on eating performance in residents with cognitive impairment has been examined[1], the role of dental related function and oral health on eating performance has yet to be discussed. Despite the integral physiologic relationship between oral related conditions and eating performance, there is lack of research evidence on the relationship in residents with and without cognitive impairment.

Objective

The objective of the study was to examine the relationship between eating performance, and dental related function, and oral health (i.e., gingival inflammation, number of remaining teeth, and number of broken or decayed teeth) among assisted living residents with and without cognitive impairment. It is hypothesized that eating performance would be significantly associated with dental related function and oral health.

Material and Methods

Design

This study was a secondary analysis of observational data collected from an instrument development study that psychometrically tested the Dental Activities Test (DAT)[22, 23], a clinical tool for measuring dental related function in persons with and without cognitive impairment. Ethical approvals for the parent study and this study have been obtained through Institutional Review Boards of the universities where the parent study and this study were conducted.

Participants

In the parent study, a convenience sample of residents was recruited from three assisted living residences in North Carolina. Resident participants were eligible if they were 1) aged 50 and older; 2) not blind, deaf, or severely physically disabled (e.g., hemiplegia); and 3) English speaking. Individuals with an oral health condition that required antibiotic prophylaxis before dental treatment or an immediate dental referral were excluded. There were a total of 234 residents living in the three assisted livings at the time of the parent study. Among the 234 residents, 90 residents met the eligibility criteria and agreed to participate in the parent study.

Data Collection

Resident characteristics including age, gender, cognition, oral health, and dental-related function were collected during March 2014 to February 2015. Oral health was evaluated by a geriatric dentist using the Gingival Index, which assesses the gingival inflammation condition of teeth on a four-point scale from 0 (normal gingiva) to 4 (severe inflammation)[25]. The number of remaining teeth and the number of decayed or broken teeth were also assessed by the same geriatric dentist to measure oral health.

Within one week of the oral health assessment, a research staff, who had no dental background and was blinded to results of the oral health assessment, visited the resident to assess dental related function based on interview and observation of the resident, and interviewed staff to assess resident cognition and ADLs. Cognition was measured using the Minimum Data Set 3.0 Cognition Scale (MDS-COGS) with total score of 0 representing no cognitive impairment, 1 as mild impairment, 2–4 as moderate impairment, 5–8 as severe impairment, and 9–10 as very severe impairment[26]. Dental related function was assessed using the DAT[22], which has nine items including medication schedule, rinse and spit, open and close mouth, tongue movement, tooth brushing, putting toothpaste on toothbrush, finding a tooth, perceiving an oral health condition, and response to oral infection. Each item is scored as 0 (no) or 1 (yes) based on whether the participant can perform each of the nine tasks following instructions. Total score ranged from 0 to 9, with higher score indicating better dental related function. The DAT has excellent internal consistency (Cronbach alpha = 0.9), test-retest reliability (r = 0.84) inter-rater reliability (r = 0.9), has good construct validity through a positive association with cognitive function measures (MDS-COGS and Saint Louis University Mental Status examination), MDS-ADL, Lawton-Brody IADL function scale, and oral hygiene status (Debris Index, Gingival Index, and Denture Plaque Index)[22], and assesses a unidimensional construct of dental-related function in assisted living residents with and without cognitive impairment[23].

The dependent variable, eating performance, was measured by the single “eating” item (i.e., how the resident eats or drinks, regardless of skill) in Minimum Data Set 3.0 Physical Activities of Daily Living (MDS-ADL) scale based on observation of the resident by the research staff[27]. Eating performance is scored on a five-point scale: 0 = totally independence, no staff oversight, 1 = supervision, oversight, encouragement or cueing, 2 = limited assistance, resident highly involved in activity, staff provide guided maneuvering of limbs or other non-weight bearing assistance, 3 = extensive assistance, resident involved in activity, staff provide weight bearing support, and 4 = total dependence, full staff performance. The MDS-ADL scale shows excellent reliability (kappa = 0.94) and good construct validity based on factor analysis of ADL independence[27].

Data Analysis

Participant characteristics were analyzed using descriptive statistics. As eating performance is an ordinal variable, Spearman’s correlation (r_s) for continuous and ordinal variables was used to examine the bivariate association between eating performance (dependent variable) and each of the other resident characteristics (exploratory variables). A correlation coefficient within the range of 0.00 to 0.20 was considered very weak or no relationship, 0.20 to 0.40 weak, 0.40 to 0.60 moderate, 0.60 to 0.80 strong, and 0.80 to 1.0 very strong[28]. Further, Spearman’s correlation (r_s) was used to examine the correlations among the independent variables to detect collinearity. Collinearity is indicated if there is a strong to very strong correlation between two independent variables[28]. In case of collinearity between two independent variables, only one of the two variables was used in the model.

Multilevel mixed-effects ordered logistic models were used to examine the relationship between eating performance and dental related function and oral health using STATA

software version 13.0 (StataCorp, College Station, TX, USA). First, a null model that only adjusted for clustering effects at resident and facility levels (model 1) was used to demonstrate the independent effects of resident characteristics on eating performance. Independent variables were added to the null model by order: a) resident age and gender (model 2); b) oral health measures (gingival index, number of remaining teeth, and number of broken or decayed teeth, model 3); and c) dental related function (model 4). The Intra-class Correlation Coefficient (ICC) of each model, which was generated by adjusting for the clustering effects within the resident and/or facility identifications, indicated variance in eating performance that was accounted for by resident and facility levels clustering effects. Coefficients with 95% confidence intervals (95% C.I.) for fixed effects of all covariates and the intercept, and the log likelihood ratio were reported for each model. The likelihood ratio difference was computed when the models used the same sample to compare model fit. The level of significance was 0.05 for all analyses.

Results

Participant characteristics

A total of 90 residents from three assisted living facilities were included in this study. The participant characteristics are shown in Tables 1 and 2. The participants were on average 84 years old. The majority of participants were female, white, non-Hispanic, and never married, widowed, separated or divorced. Almost one third of the residents were black (29.7%). Of all the participants, the majority had moderate (25.6%) or severe to very severe (37.8%) cognitive impairment; less than one third were cognitively intact (27.8%); and only 8.8% had mild cognitive impairment. Participants had moderate levels of impairment in dental-related function (Mean = 5.77) and gingival inflammation (Mean = 1.51). Twenty five out of the 90 residents had no teeth, resulting in missing data in three oral health measures (Gingival Index, number of remaining teeth, and number of decayed or broken teeth). Among the 65 residents who had one or more teeth, there were on average 19 remaining teeth, and 8 broken or decayed teeth. More than half of the participants were able to eat and drink independently (55.5%), leaving less than half requiring supervision (17.8%), limited assistance (20%), or extensive or total assistance (6.7 %).

Eating performance was correlated with cognition (r_s = 0.44, p<.001), gingival index (r_s = 0.28, p =.022), and dental related function (r_s = −0.34, p = .001). Eating performance was not significantly associated with age, gender, the number of remaining teeth, or the number of decayed or broken teeth. Regarding the correlations among the independent variables, oral health as measured by gingival index was significantly correlated with cognition level (r_s =0.264, p=0.034), the number of broken and decayed teeth (r_s = 0.522, p < 0.001), and dental related function (r_s =−0.335, p=0.006). Dental related function was strongly correlated with cognition level (r_s =−0.676, p<0.001), indicating there is collinearity between dental related function as measured by DAT and cognition level as measured by MDS-COGS. Therefore, dental related function rather than cognition was added to the model to address the objective of the study. The other independent variables were not significantly correlated. Specifically, the number of remaining teeth was only weakly

correlated with gingival index, cognition level, dental related function, and the number of decayed or broken teeth (r_s ranging from −0.093 to 0.071).

Multilevel modeling

The percentage of variance in eating performance remaining at the resident and facility levels due to clustering effects changed across models (Table 3). More than 88% of variance in eating performance was accounted for by the clustering effects at the resident (83.6%) and facility (4.8%) levels (model 1). After oral health variables were added to the null model, the variance that remained at the facility and resident levels substantially decreased (model 3). The variance further decreased to only 4.2% after dental related function was added in model 4. The majority of variance (84%) in eating performance was explained by the combination of dental related function and oral health characteristics. Model 4 fit significantly better than model 3 (p=0.03). In model 3, eating performance was significantly associated with gingival index (coefficient = 0.62, 95%CI =0.04, 1.19), indicating that as the gingival inflammation level increased, eating performance declined. The significance of gingival index disappeared after adding dental related function in model 4. The final model (model 4) showed the association between eating performance and all the resident characteristics. Eating performance was significantly associated with dental related function as measured by DAT (coefficient = −0.10, 95%CI = −0.19, −0.01, $p = 0.025$), indicating that as dental related function increased, eating performance improved. Eating performance was not significantly associated with resident age, gender, or any oral health characteristics.

Discussion

This study examined the role of dental related function and oral health on eating performance among assisted living residents with normal to severely-impaired cognition. While dental related function was the only significant independent variables among all being studied that was associated with eating performance, the selected oral health characteristics explained the majority of variance in eating performance indicating the important role of dental related function and oral health on eating performance assisted living residents with normal to severely-impaired cognition. Further, findings of the study showed that 26.7% of the assisted living residents with normal to severely-impaired cognition required different levels of assistance for eating. Compared to prior work that indicated that 32–87% persons with dementia need different levels of eating assistance[1, 7], this finding seems reasonable and further supports that dependence in eating is more prevalent among residents with higher severity of cognitive impairment[4].

This study found that better eating performance was associated with higher dental related function. The finding was indirectly supported by prior research on the association between cognitive impairment and eating performance. Dental related function as measured by DAT assesses the cognitive, physical, and other factors that underline and influence oral health related activities. The cognitive domains involved in oral health related activities such as attention, procedural memory, executive function, orientation in space and praxis, may also influence eating activities[29]. For example, procedural memory (i.e., the knowledge of how to perform activities without instructions) is required for independently performing all dental

related activities such as teeth brushing and rinsing mouth, as well as all eating and drinking procedures such as preloading food onto utensils (or picking up food using fingers) and putting it into the mouth[24, 29]. Declines in or loss of these cognitive functions will result in impaired performance in dental related activities as well as eating and drinking activities[4, 30].The findings add to current research on the role of dental related function on eating performance in residents with and without cognitive impairment, and provide preliminary information to guide the development of functionally targeted strategies to improve dental related function for the purpose of optimizing eating performance and nutritional intake.

Though eating performance was significantly associated with gingival inflammation, one of the measured oral health characteristics, before adding dental related function, the final model showed no relationship between eating performance and any oral health measures. The findings indicate that while dental related function is the stronger predictor of eating performance, gingival inflammation can be a potential risk factor of eating performance. The non-significance of the relationship between eating performance and oral health may be due to the small sample size and limited variability in eating performance. Despite the non-significant relationship, these oral health variables accounted for the majority of the variance in eating performance. The strong impact oral health has on eating performance is likely related to the physiologic relationship between eating performance and unmeasured oral health conditions such as chewing ability, swallowing ability, oral infections, teeth or denture pain, dry mouth, and appetite change[6, 19–21]. Future research is needed to assess these oral related conditions and examine their association with eating performance among residents with and without cognitive impairment.

With limited research in terms of the role of oral health on eating performance in residents especially those with cognitive impairment, multiple studies showed relationships between oral hygiene and oral health and nutritional outcomes in other older adult populations. For instance, poor oral health was associated with nutritional deficiency[20] and weight loss[21] in cognitively-intact adults. The inability or lack of autonomy to complete oral hygiene activities (e.g. tooth-brushing, rinsing mouth, cleaning dentures) was associated with loss of self-feeding ability[31], and malnutrition[19] in hospitalized adults. Whereas both cognitive impairment and edentulism (toothlessness) predicted malnutrition in nursing home residents, cognitive impairment is the stronger predictor[32]. With limited research evaluating the role of oral health on eating performance in cognitively impaired residents, this relationship should be further explored in larger diverse populations with cognitive impairment.

The findings of this study have important implications for clinical practice by highlighting the need for partnership between dental and nursing professionals to address the issues of declined eating performance and subsequent malnutrition in residents with and without cognitive impairment. When oral self-care and other dental related function decline, appropriate supervision or assistance from professional caregivers is needed to maintain oral hygiene and oral health[17]. Simple oral hygiene interventions to maintain oral self-care capacity, such as tooth brushing, denture care and mouth rinsing, mediate the effect between cognitive impairment and oral health outcomes such as plaque index[33] and dental caries[34]. With proper oral hygiene, the risk of dental caries, periodontal disease and oral infection can

be reduced, and oral health can be maintained in residents with and without cognitive impairment[34].

Maintaining oral hygiene and health in residents with and without cognitive impairment remains difficult due to the following reasons: (1) residents not receiving the amount of assistance needed to maintain oral hygiene due to inability to perceive and communicate oral care needs, receive assistance, and have regular access to professional dental care[35, 36]; (2) traditional oral health and hygiene educational interventions to long-term care staff have low quality and fail to show effectiveness in improving oral health related knowledge and attitude, and decreasing dental and denture plaque[37, 38]; and (3) dental professionals report difficulty assessing dental related function and applying appropriate interventions in cognitively impaired older adults in addition to multiple systematic barriers preventing access to professional dental care[24, 39, 40]. Long term care staff perceive assisting residents with oral hygiene tasks as unpleasant, especially among residents who resist[41], indicating the need for staff education to manage oral hygiene in the presence of resistiveness to care among residents. Maintaining oral health and dentition status is interdisciplinary in nature and signifies cooperation between nursing and dental professionals[42]. A team based approach is needed in developing and implementing oral hygiene and health interventions to improve eating performance and nutritional outcomes in residents with and without cognitive impairment.

Limitations

The study had several limitations. A small sample was used, among which the majority were female and white. Future work needs to use a larger diverse sample where persons with cognitive impairment can be evaluated separately. Findings of this study may only be generalized to the assisted living resident population with and without cognitive impairment who met the eligibility criteria of the parent study (e.g., English speaking; not blind, deaf, or severely physically disabled). Eating performance was measured as an ordinal variable using a single eating item, and the sample had limited variations toward dependence. Future work should use multiple-item validated measure to assess this outcome. Oral health measures could be expanded to include chewing difficulty, oral pain, dry mouth, plaque index, and other oral health measures to enable a comprehensive assessment of the impact of oral health on eating performance. This study only examined the role of resident-level characteristics on eating performance, and the role of factors at staff and environmental levels should be explored.

Conclusion

Eating performance can be impacted by the complex relationship with dental related function and oral health in persons with and without cognitive impairment residing in residential care facilities. The DAT is a reliable and valid measure to assess dental related function, a significant factor that influences eating performance. Oral health measures contributed to the majority of variance in eating performance, indicating the important role of maintaining good oral health. Future interdisciplinary partnerships should be utilized to develop and implement novel interventions to maintain dental related function and oral

health to optimize eating performance and nutritional outcomes for people with and without cognitive impairment.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Ethics Statement: The parent study was approved by the Institutional Review Boards at two participating Universities. Written consent was obtained from participants with cognitive capacity and from the legal authorized representative of participants with cognitive impairment.

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Table 1.

Participant Characteristics (Continuous) (N = 90)

Variables (Measure or concept)	Mean	SD	Range	Missing
Resident age (years)	84.26	8.96	54 – 102	1
DAT Score (Dental Related Function), *Higher = better dental-related function*	5.77	2.95	0 – 9	0
Gingival Index (Oral Health), *Higher = more gingival inflammation*	1.51	.52	.58 – 2.83	25 *
Total number of remaining teeth (Oral Health)	19.25	8.20	2–29	25 *
Total number of decayed or broken teeth (Oral Health)	7.89	8.055	0–29	25 *

Note.

* 25 residents had no teeth, resulting in missing data in the three oral health measures.

Table 2.

Participant Characteristics (Categorical) (N = 90)

Characteristics	N	%
Gender		
Male	18	20.0
Female	72	80.0
Current marital status		
Married	16	17.6
Never married, widowed, separated or divorced	67	73.6
Racial background		
Black	27	29.7
White	62	68.1
Others (e.g., American Indian/Alaskan Native)	1	2.2
Ethnic background		
Hispanic Origin	4	4.4
Non-Hispanic Origin	86	95.6
Cognitive Impairment		
None	25	27.8
Mild	8	8.8
Moderate	23	25.6
Severe to very severe	34	37.8
Eating: How (he/she) eats and drinks (regardless of skill)		
Independent	50	55.5
Supervision	16	17.8
Limited assistance	18	20.0
Extensive or total assistance	6	6.7

Note. Numbers in categories of current marital status do not add up to 90 due to missing.

Table 3.

The Association between Eating Performance (Outcome variable) and Resident Characteristics

Variables (measure or reference)	Model 1 (N=90)	Model 2 (N=89)	Model 3 (N=64)	Model 4 (N=64)
		Coefficient (95% CI)		
Resident age (years)		.004 (−.02, .03)	−.01 (−.04, .02)	−.01 (−.04, .02)
Resident gender (0=male)		−.13 (−.73, .47)	.24 (−.49, .97)	.21 (−.49, .91)
Gingival Index (*Higher = more gingival inflammation)*			.62 * (.04, 1.19)	.38 (−.21, .97)
Number of remaining teeth			−.01 (−.05, .02)	−.02 (−.05, .01)
Number of broken or decayed teeth			.0004 (−.04, .04)	.003 (−.04, .04)
DAT Score (*Higher = better dental related function*)				−.10 * (−.19, −.01)
Constant	.82 *** (.47, 1.16)	.66 (−1.41, 2.73)	.52 (−2.20, 3.25)	1.74 (−1.09, 4.58)
ICC at facility level	.0477	.0627	.0001	.0001
ICC at resident & facility levels	.8841	.8819	.0539	.0424
Log Likelihood ratio	−133.40 (no p)	−129.83	−.94.59	−92.18
Likelihood ratio difference, x^2(df)				4.81(1) *a

*** p<.001,

** p<.01,

* p<.05.

95% CI=95% Confidence Interval.

ICC = Intra-class Correlation Coefficient.

Eating performance was measured using a single item from 0 (totally independent) to 4 (totally dependent).

[a]Comparison of model 4 and model 3.

There is 1 missing case in age, so the total sample size for model 1 is 89. There is 25 additional missing cases in oral health measures in model 3 and model 4, resulting in a total sample size of 64 for these two models.