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Original Study

Improving Nursing Home Residents' Oral Hygiene: Results of a Cluster Randomized Intervention Trial



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A B S T R A C T

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Objective: A 2-year cluster randomized trial of *Mouth Care Without a Battle* (MCWB) was conducted in nursing homes (NHs) to determine if recommended mouth care practices provided by NH staff could improve residents' oral hygiene and denture outcomes.

Design: Cluster randomized trial of NHs.

Setting and Participants: Seven MCWB NHs and 6 control NHs. A total of 219 NH residents completed baseline and 24-month oral examinations and, if applicable, denture assessments (control = 98, intervention = 121).

Intervention: The intervention consisted of training NH staff in the MCWB protocol, and providing support in its use for 2 years.

Measures: Descriptive data from the Minimum Data Set and clinical oral health assessments: the Plaque Index for Long-Term Care (range 0–3), the Gingival Index for Long-Term Care (range 0–4), and the Denture Plaque Index (range 0–4), with lower scores indicating better oral health.

Results: There were no significant demographic or health differences between groups at baseline. Residents' mean age (standard deviation) was 77.8 years (13.5), 71% were female, and 49% had cognitive impairment. At 24 months, there were significant improvements in oral and denture hygiene in the intervention group compared with control (all $P < .05$) with mean changes in indices that were 0.44 (Plaque Index for Long-Term Care), 0.55 (Gingival Index for Long-Term Care), and 0.67 (Denture Plaque Index) points lower in intervention NHs than control NHs.

Conclusions and Implications for Practice: Training NH staff to attend to residents' oral hygiene and denture care had a sustained, favorable impact on residents' oral and denture hygiene after 24 months compared with usual care. The protocol, MCWB, can be used by direct caregivers to improve the oral hygiene and denture care of NH residents.

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The oral health of older adults is important for many aspects of quality of life— eating, speaking, self-esteem, social interactions, and freedom from pain. Poor oral hygiene can lead to plaque accumulation,

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gingival inflammation, bad breath, dental caries, periodontal diseases, and tooth loss, as well as systemic conditions including pneumonia, complications from diabetes, and even mortality.^{1–4} Some medical conditions have oral health consequences, and medications can cause xerostomia (dry mouth) and difficulty swallowing.⁵

Accumulation of plaque on teeth and dentures occurs when they are not frequently and thoroughly cleaned. Concerns regarding oral hygiene are especially notable among nursing home (NH) residents, where many require assistance with oral care. Poor oral health and hygiene in NH residents has been noted across the United States. For example, one-half of NH residents in a Florida study had oral problems,

including 37% with gingivitis and 26% with caries.⁶ Given that more than 1.4 million residents reside in US NHs,⁷ attending to their oral hygiene is important.

Four relevant systematic reviews assessed interventions to improve the oral health of older adult residents in NHs/long-term care settings^{4,8–10}; a fifth review focused on older adults with cognitive impairment.¹¹ All reviews noted the lack of high quality studies, insufficient description of interventions, and the heterogeneity of study designs, interventions, outcome measures, and follow-up. Most interventions were designed to improve caregiver or resident oral health knowledge, with interventions administered by different types of personnel and of different duration and intensity. Other interventions used behavioral change strategies for residents or caregivers.^{8,10} A few included provision of clinical dental hygiene services.⁹ In these systematic reviews, no specific intervention could be identified that was more effective than others, and higher quality studies were recommended. Interventions were likely to improve knowledge, but not necessarily oral health.

Our research team previously developed and pilot tested the *Mouth Care Without a Battle* (MCWB) program in NHs. This comprehensive, multicomponent program was developed to teach staff how to treat gingivitis, remove plaque, prevent tooth decay, provide denture care, meet behavioral challenges, and assess and monitor care.¹² MCWB pilot test results, obtained in 3 NHs and 97 residents, found significant improvement in tooth brushing and reductions in dental plaque and gingivitis over 6 months.¹³ The favorable results from this small study of short duration warranted examination on a larger scale over a longer time period.

As part of a 2-year quality improvement effort and evaluation of MCWB, the oral hygiene status of NH residents was obtained in intervention and control NHs, either using or not using MCWB, respectively. The goals of this analysis were to assess baseline plaque, gingival and denture hygiene status, and changes in these parameters over 2 years in the 2 groups.

Methods

Data for this study were collected as part of a matched pairs cluster randomized trial examining change in oral hygiene and pneumonia incidence. Seven pairs ($n = 14$) of NHs were matched based on their size and pneumonia rate during the 6 months prior to the initiation of the intervention. One NH within each pair was then randomized to the intervention; in the remaining NHs, staff continued to provide standard mouth care.

Intervention

MCWB was developed by an interdisciplinary team of clinician scientists, and is described in detail elsewhere.^{12,14} Briefly stated, MCWB provides instruction highlighting that mouth care is healthcare (eg, relates to pneumonia incidence); techniques and products to clean and protect the teeth, tongue, gums, and dentures (eg, use of antimicrobial rinses); care provision in special situations (eg, when teeth are broken or loose); and providing care to people who are resistant (eg, singing, as a strategy to encourage residents to open their mouth). Additional details of MCWB are available at <http://www.mouthcarewithoutabattle.org/>.¹²

The intervention included an in-service presentation of MCWB conducted by a dementia specialist/dental hygienist, and monthly visits over 2 years by that same person to provide input and guidance on mouth care techniques; at 12 months, a second in-service presentation was held. All nursing assistants, nurses, and an administrator were invited to the training, and all NH residents were expected to have mouth care provided by staff using skills

learned from MCWB. In each NH, a nursing assistant “champion” was identified to be a dedicated oral care aide who was most involved in the monthly visits; this person provided support to the staff and tended to provide care to the residents who required the most time. Quality improvement techniques were used for monitoring and documentation activities, which included quarterly visits by investigators who shared reports of residents’ oral hygiene status.

Oral Hygiene Sample and Eligibility Criteria

Inclusion criteria for oral hygiene evaluation were being age 21 years and older, having natural teeth or using a denture, not requiring antibiotic prophylaxis before dental assessment, and not being in the NH for short-term rehabilitation. The sampling design of the MCWB trial consisted of repeated cross-sectional samples of up to 60 randomly selected eligible residents per NH at baseline and 24 months. The oral hygiene sample for data analysis described in this article consisted of the subset of residents referred to as a “cohort” who were randomly selected into both samples and who completed the baseline and follow-up oral hygiene exams. Written consent was obtained from participants or legally authorized representatives. All study procedures were approved by the Office of Human Research Ethics of the University of North Carolina at Chapel Hill.

Measures

The oral health examination consisted of 3 measures. Each NH was asked to provide a private space with access to a sink and a reclining chair or wheelchair. The study data were collected by a research dental hygienist.

Oral hygiene was assessed using two modified measures: the Plaque Index for Long-Term Care (PI-LTC) and the Gingival Index for Long-Term Care (GI-LTC). The PI-LTC is a modified version of the Debris Index of the Simplified Oral Hygiene Index¹⁵ scored from 0 (no plaque or stain) to 3 (soft plaque covering more than two-thirds of tooth surface). The GI-LTC is a modified version of the Gingival Index¹⁶ scored from 0 (no inflammation) to 4 (severe inflammation). For both the PI-LTC and GI-LTC, a score was assigned for the worst (ie, most plaque, most inflammation) buccal or lingual surface within each sextant. Scores were documented for both buccal and lingual surfaces across 3 maxillary and 3 mandibular sextants for a total of 12 possible PI-LTC and GI-LTC scores per resident. These individual scores were then used to create a mean summary score. Denture hygiene was assessed using the Denture Plaque Index (DPI).¹⁷ The DPI was obtained by immersing dentures in a disclosing solution for 30 seconds, rinsing off excess dye for 15 seconds, and assigning a score of 0 (“no plaque”) to 4 (“very heavy plaque covering >75% of the area”). Scores were assessed for each maxillary and mandibular facial and basal quadrant for a total of 16 possible DPI scores per resident which, in turn, were used to create a mean summary score. Residents with partial dentures were assessed using all 3 indices.

Additional resident-level and NH-level data were obtained to describe the sample and serve as potential covariates. Data on residents were abstracted from the Minimum Data Set (MDS) version 3.0, required for completion at admission, annually, and when a significant change in status occurs. The MDS data abstracted for this study were those most recent to baseline data collection. They included 21 characteristics shown in [Table 1](#); missing data were present on 9 of these variables, but at a rate of 1.4% or less per variable. Data on NH-level characteristics included the Centers for Medicare & Medicaid Services Five-Star Quality Rating and others obtained from the administrator, shown in [Table 2](#). There were no NH-level missing data.

Table 1
Comparison of Baseline Resident Characteristics by Intervention Group

Variables	Total N = 219 M or % (SD)	Control n = 98 M or % (SD)	Intervention n = 121 M or % (SD)	P
Demographic characteristics				
Age at assessment, y	77.6 (13.7)	77.4 (13.8)	77.9 (13.6)	.99*
Female	71.2	73.5	69.4	.55 [†]
Race/ethnicity				.16 [‡]
White	65.1	68.0	62.8	
African American	29.4	29.9	28.9	
Other	5.5	2.1	8.3	
Resistance to care	10.5	11.2	9.9	.83*
Hospice care	0.9	1.0	0.8	1.00*
Health problems[§]				
Chronic renal disease	7.8	4.1	10.7	.08*
Alzheimer's/dementia	47.5	39.8	53.7	.04*
Malnutrition	2.3	2.0	2.5	1.00*
Asthma/COPD	16.4	15.3	17.4	.72*
Recent weight loss	5.6	6.2	5.0	.77*
Swallowing issues	2.3	1.0	3.3	.38*
Feeding and diet issues[§]				
Hands on eating assistance	27.9	28.6	27.3	.88*
Feeding tube	4.6	3.1	5.8	.52*
Mechanically altered diet	27.9	31.6	24.8	.29*
Therapeutic diet	45.7	52.0	40.5	.10*
Dental issues[§]				
No teeth or fragments	4.1	5.1	3.3	.52*
Likely cavities	5.0	5.1	5.0	1.00*
Other dental issues	2.3	1.0	3.3	.38*
Medications/vaccinations[§]				
Antipsychotic	19.7	20.4	19.2	.87*
Antianxiety	22.0	18.4	25.0	.26*
Hypnotic	5.5	6.1	5.0	.77*
Oral health				
PI-LTC	1.7 (.8)	1.6 (.8)	1.7 (.7)	.43*
GI-LTC	1.5 (.8)	1.4 (.9)	1.6 (.8)	.17*
DPI	2.2 (1.3)	2.2 (1.3)	2.1 (1.3)	.63*

COPD, chronic obstructive pulmonary disease.

P values test intervention vs control.

*Wilcoxon rank-sum test.

[†]Fisher exact test.[‡]One-way independent ANOVA; 2-tailed.[§]Source = Minimum Data Set.^{||}Source = clinical examination.

Data Analysis

Improvement in oral hygiene would be demonstrated by statistically significant decreases in the 3 oral hygiene measures. First, to assess success of randomization, differences in baseline resident characteristics between study arms were assessed with two-tailed tests (ie, Wilcoxon rank-sum, Fisher exact). Second, unadjusted outcome analyses compared longitudinal changes in observed oral hygiene scores between study arms using Wilcoxon rank-sum tests applied to NH-level 24-month change scores averaged across residents within the NH; tests for intra-arm longitudinal changes were not conducted due to the small number of NHs per arm. Third, adjusted resident-level outcome analyses compared mean change between study arms using linear mixed effects models controlling for baseline oral hygiene scores, and random effects for NHs. Additional resident-level covariates considered to be potentially associated with oral hygiene outcomes were included as fixed effects based on a prespecified criterion of an approaching significant ($P \leq .15$) bivariate difference across study arms. The random NH effects adjusted for clustering of residents within NHs. All analyses were conducted using Stata v 15.1 (StataCorp, College Station, TX).

Table 2
Baseline Nursing Home Characteristics by Randomized Group

Variables	Total N = 13 % or M (SD)	Control n = 7 % or M (SD)	Intervention n = 6 % or M (SD)
Nursing home characteristics			
For profit	76.9	71.4	83.3
Continuing Care Retirement Community	7.7	0.0	16.7
Hospital	7.7	14.3	0.0
Length of operation, y	27.2 (10.9)	25.3 (12.4)	29.3 (9.6)
Administrators in 3 y	1.5 (0.8)	1.4 (0.8)	1.5 (0.8)
Directors of nursing in 3 y	1.8 (0.8)	2.0 (0.8)	1.5 (0.8)
Room characteristics			
Number of licensed beds	105.8 (25.7)	104.3 (25.1)	107.7 (28.7)
% Licensed beds occupied	89.5 (7.6)	89.7 (8.2)	89.4 (7.5)
% Private rooms	27.2 (27.4)	25.1 (20.2)	29.8 (36.0)
Resident case mix percentage			
Incontinent of urine	74.8 (10.7)	74.0 (12.3)	75.8 (9.7)
Chairfast	71.2 (18.5)	72.1 (21.8)	70.0 (15.8)
Bedfast	9.3 (9.4)	5.9 (6.5)	13.3 (11.1)
Mentally retarded	1.1 (0.9)	1.0 (1.0)	1.2 (0.8)
Wheelchair bound	80.0 (22.4)	81.4 (28.4)	78.3 (15.1)
Dementia diagnosis	60.4 (13.4)	56.6 (14.3)	64.8 (12.0)
Memory problems without dementia	18.9 (16.6)	21.4 (22.7)	16.0 (5.1)
Behavior problems	14.2 (15.9)	7.1 (4.9)	22.5 (20.7)
Medicaid coverage	60.5 (20.6)	62.1 (15.0)	58.7 (27.3)
Medicare coverage	21.9 (14.7)	20.4 (16.8)	23.7 (13.3)
Receiving short-term rehab	17.6 (13.4)	15.4 (14.4)	20.2 (13.0)
Nursing home star quality[*]			
Overall	3.6 (1.4)	3.6 (1.5)	3.7 (1.4)
Health	2.9 (1.3)	2.9 (1.1)	3.0 (1.7)
Staffing	3.2 (1.3)	3.1 (1.1)	3.3 (1.6)
Quality measures	4.2 (1.2)	4.3 (1.0)	4.2 (1.6)
Registered nurse staffing	3.2 (1.0)	2.9 (0.7)	3.5 (1.2)
Staffing			
Assignments change >mo	53.9	42.9	66.7
Licensed nurse min	109.2 (42.0)	112.6 (48.5)	105.2 (37.2)
Registered nurse min	44.6 (21.5)	37.9 (9.2)	52.5 (29.5)
Licensed practical nurse min	55.3 (11.3)	57.3 (13.7)	53.0 (8.1)
Certified nursing assistant minutes	154.1 (49.7)	145.6 (27.4)	164.0 (69.4)
Oral health services			
On site dentist visits	46.2	28.6	66.7
On site hygienist visits	15.4	0.0	33.3

Source = Nursing home administrator survey.

*Medicare.gov.

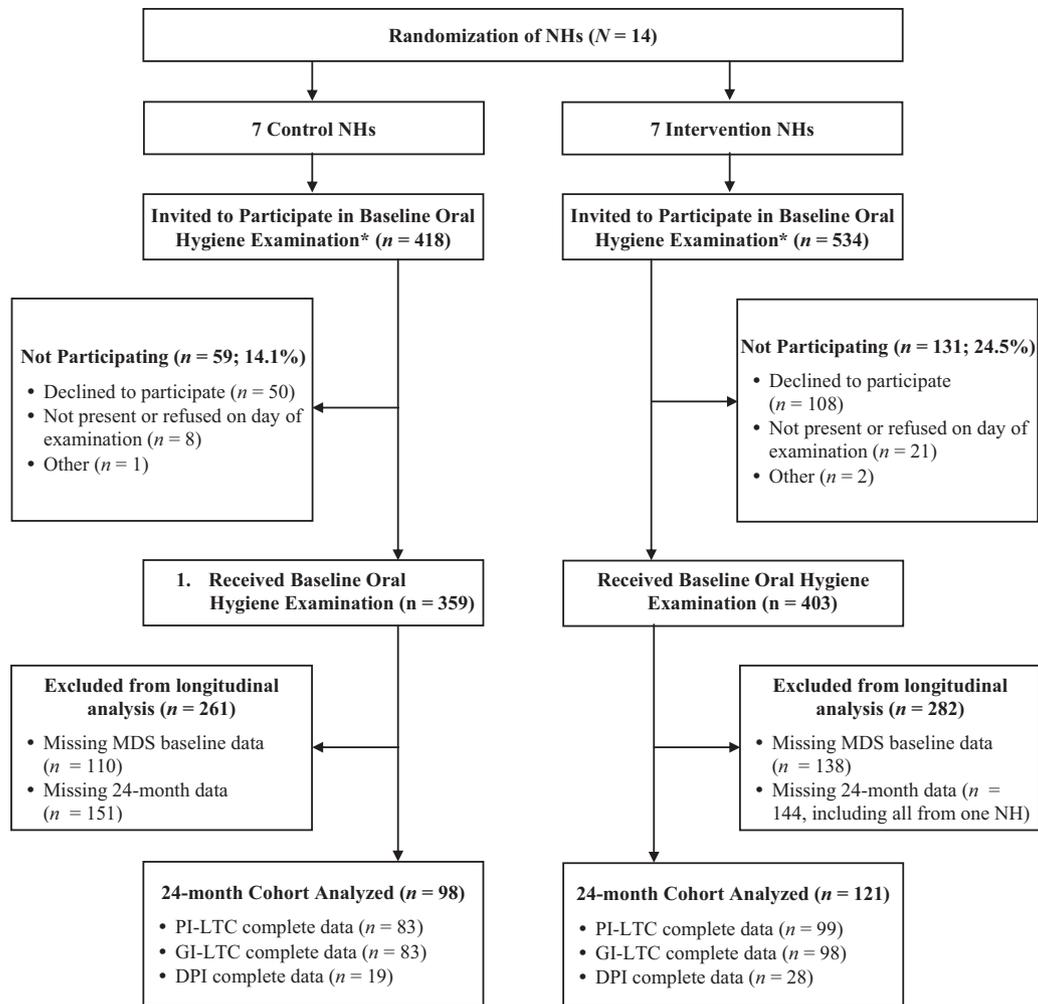
Results

Study Enrollment and Retention

Sample sizes for participant enrollment, allocation, and follow-up are shown in Figure 1. In total, 952 eligible residents were invited to participate across all 14 sites at baseline (control = 418, intervention = 534); of these, 158 (16.6%) declined to participate, and 32 (3.4%) agreed but were not examined. Overall, 762 residents received baseline oral hygiene examinations. One intervention NH dropped out of the study at 1 year, so 24-month data are available for 13 homes. The analysis of change in oral hygiene is limited to the cohort of 219 residents (28.8%) with complete baseline and 24-month oral hygiene data, and complete MDS data: 98 and 121 in the control and intervention group, respectively. Of these 219, 186 (84.9%) had PI-LTC and GI-LTC data, 30.1% had DPI, and 14.6% had both.

Resident Baseline Characteristics

The 219 study residents' mean age at baseline was 77.6 [standard deviation (SD) = 13.7] years, with 71.2% being female, 65.1% white, and



* See text for selection criteria

Fig. 1. Flow diagram of resident participation.

29.4% African American (Table 1). Almost one-half (47.5%) had a diagnosis of Alzheimer’s disease or dementia. Over one-quarter (27.9%) required hands-on supervision during eating, necessitating either extensive or complete assistance from NH staff. Over one-quarter (27.9%) had a mechanically altered diet and almost one-half (45.7%) had a therapeutic diet. Residents in the intervention group were significantly more likely to have an Alzheimer’s or other dementia diagnosis ($P = .04$).

The baseline characteristics of the 219 analytic sample residents were compared with the 543 residents for whom mouth care data were collected but were excluded for longitudinal analyses because of missing data (Figure 1; control = 261, intervention = 282). Bivariate tests found that residents included in the analytic sample were significantly younger (-2.7 years, $P = .03$), less likely to be in hospice care (-4.2% ; $P < .01$), less likely to have no natural teeth or tooth fragments (-4.1% ; $P = .05$), and more likely to have worse PI-LTC scores ($+0.2$, $P < .01$) and GI-LTC scores ($+0.2$, $P < .01$). Thus, the analytic sample was somewhat healthier and more likely to have teeth but to have worse oral hygiene than the other participants.

There were no significant differences in mean baseline PI-LTC [mean (M) = 1.7; standard deviation SD = .8], GI-LTC (M = 1.5; SD = .8) or DPI (M = 2.2; SD = 1.3) scores between study arms

(Table 1). These scores indicate, on average, teeth with up to one-third of the surface covered with plaque or debris or presence of extrinsic stain, between mild and moderate gingival inflammation, and areas of moderate to heavy plaque covering denture surfaces, respectively. Almost one-half (48.1%) of residents had at least 1 tooth with a PI-LTC score of “3”, indicating at least 1 tooth with soft plaque covering more than two-thirds of the surface. A considerable proportion (40.8%) of residents had at least 1 tooth with a GI-LTC score of “3” or higher, indicating a tooth with moderate inflammation. One-half of residents had at least one DPI score of “3” or higher, indicating at least 1 denture surface quadrant with plaque covering 51%–75% of the surface.

NH Characteristics

Table 2 presents the characteristics of the 13 NHs. They were largely for-profit (76.9%), had on average 106 beds, and a mean overall quality rating of 3.6 (possible range 1–5, higher scores more favorable). NHs reported varying levels of mouth care and oral hygiene practices (data not shown); all but 1 (92.4%) reported that oral health services provided by a dentist were available to residents either inside or outside the NH, and all but 4 (69.3%) reported similar availability of services provided by a dental hygienist. The majority of NHs (69.3%;

Table 3
Observed Nursing Home Residents' Baseline, 24-Month and Changes for Mean Plaque, Gingival, and Denture Plaque Scores by Intervention Group ($N_{\text{Residents}} = 219$)

Hygiene Examination	Control Group (n = 7)			Intervention Group (n = 6)			
	Baseline M (SD)	24-Mo M (SD)	Δ	Baseline M (SD)	24-Mo M (SD)	Δ	P
PI-LTC (0–3; $N_{\text{Control}} = 84$; $N_{\text{Intervention}} = 103$)							
Total	1.60 (.34)	1.67 (.33)	+07	1.65 (.31)	1.26 (.36)	–.39	.03
Maxillary	1.44 (.36)	1.49 (.28)	+05	1.55 (.32)	1.08 (.28)	–.47	.03
Mandibular	1.74 (.38)	1.81 (.35)	+07	1.74 (.31)	1.34 (.37)	–.40	.03
GI-LTC Care (0–4; $N_{\text{Control}} = 84$; $N_{\text{Intervention}} = 103$)							
Total	1.42 (.38)	1.73 (.52)	+31	1.54 (.33)	1.19 (.35)	–.35	.02
Maxillary	1.28 (.46)	1.56 (.42)	+27	1.42 (.36)	1.09 (.32)	–.33	.03
Mandibular	1.56 (.40)	1.79 (.53)	+23	1.66 (.33)	1.27 (.34)	–.39	.02
DPI (0–4; $N_{\text{Control}} = 26$; $N_{\text{Intervention}} = 40$)							
Total	2.69 (1.00)	2.29 (1.23)	–.39	2.02 (.54)	1.34 (.41)	–.68	.04
Maxillary facial	2.60 (1.08)	2.29 (1.21)	–.07	1.88 (.80)	1.37 (.38)	–.51	.15
Maxillary basal	2.83 (.93)	2.89 (1.02)	+26	2.10 (.47)	1.54 (.65)	–.56	<.01
Mandibular facial	2.36 (1.06)	1.38 (1.13)	–.39	1.79 (.81)	0.60 (.21)	–1.19	.14
Mandibular basal	2.51 (.91)	2.19 (.91)	+21	1.79 (.83)	0.74 (.43)	–1.05	.02

P values compare longitudinal changes in observed oral hygiene scores between arms using Wilcoxon rank-sum tests applied to NH-level mean 24-month change scores.

n = 9) indicated that dental services were typically scheduled on an on-call or as-needed basis. Over one-half (53.9%; n = 7) indicated that a dentist never visited the NH, with the remaining reported visits ranging from once or twice a year to monthly. Almost all (84.6%; n = 11) NHs indicated that a dental hygienist never visits. There were no statistically significant NH differences between control and intervention sites in these variables.

Changes in Oral Hygiene

Observed mean NH oral hygiene scores are presented in Table 3. In the control group, plaque and gingival scores worsened at 24 months (+.07 and +.31, respectively), whereas the denture score improved (–.39). In contrast, MCWB participants demonstrated improvements to all 3 measures (–.39, –.35, –.68). Wilcoxon rank-sum tests demonstrated that change was significantly different between study arms for all three measures (PI-LTC: $P = .03$, GI-LTC: $P = .02$, DPI: $P = .04$).

Linear mixed models estimating the effect of MCWB on oral hygiene adjusted for 3 resident-level characteristics that met the criterion for inclusion (Alzheimer's/dementia, chronic renal disease, therapeutic diet). As shown in Table 4, all 3 outcomes were improved significantly in intervention homes compared with control homes. The intraclass correlation coefficients ($\leq .14$) suggest that small to moderate amounts of inter-NH variation remained in the models after covariate adjustment. For PI-LTC, the MCWB intervention effect was $\beta = -.44$ ($P = .01$), meaning that residents in intervention NHs had, on average, greater improvement in PI-LTC scores (–0.44 points) compared with residents in control NHs. Having a diagnosis of Alzheimer's or dementia was associated significantly with worsening PI-LTC. For GI-LTC scores, the intervention effect was $\beta = -.55$ ($P = .01$); being on a therapeutic diet was associated significantly with improved gingival health, and having an Alzheimer's or dementia diagnosis approached a significant association with worsening gingival health ($\beta = .15$; $P = .06$). Finally, for DPI scores, the intervention effect was $\beta = -.67$ ($P = .01$), and having a diagnosis of chronic renal disease was significantly associated with improved hygiene ($\beta = -.48$; $P = .02$).

Discussion

The MCWB intervention was efficacious in improving oral and denture hygiene and reducing gingival inflammation over a 24-month period. For all 3 outcomes, participation in MCWB was associated with improvement when compared with the control group and after adjusting for NH variation, baseline scores, and differences in resident-level characteristics across study arms.

At baseline, maxillary teeth were somewhat cleaner and had less gingivitis than mandibular teeth. Thus, overall mean scores may not reflect poor conditions in some parts of the mouth. Importantly, only 1.8% (n = 4) of residents received "0" scores on their oral health measures, exhibiting no plaque or gingivitis and/or clean dentures. Many people had extensive areas of plaque, inflamed gums, and very poor dental hygiene, indicating mouth care neglect. The biggest improvements in the intervention group were for denture cleanliness, especially the mandibular dentures. The control group's 24-month scores reflected oral conditions that did not change or worsened compared with baseline.

A large number of barriers to performing mouth care have been described, including a heavy staff workload, lack of time, inadequate knowledge and skills, lack of prioritization for this activity, need for clear oral health guidelines, and uncooperative residents.¹⁸ MCWB helps to overcome some of these barriers by including instruction on providing oral hygiene for NH residents, behavioral techniques, easy access to mouth care supplies, and an on-site oral health champion.

Some aspects of the longitudinal cohort in this study may influence the findings, such as that participants had to reside in the NH for at least 24 months. In 2015, the average length of stay in a US NH was 6 months (including residents admitted for rehabilitation, who were ineligible for participation), indicating these residents were markedly longer-stay than most.¹⁹ An advantage of this study was that among those participating at baseline, 28.7% were still living and participated 24 months later.

Table 4
Linear Mixed Effects Model Estimates of Intervention Effect on 24-Month Change in Oral Hygiene and Denture Hygiene Adjusting for Covariates

Parameters	PI-LTC	GI-LTC	DPI
	N = 182	N = 181	N = 47
	β (SE), P	β (SE), P	β (SE), P
Fixed effects			
Intercept	.68 (.18), <.001	.68 (.18), <.001	1.00 (.27), <.001
Baseline score	–.43 (.08), <.001	–.28 (.07), <.001	–.54 (.07), <.001
Intervention	–.44 (.18), .01	–.55 (.22), .01	–.67 (.26), .01
Chronic renal disease	–.14 (.23), .56	–.25 (.27), .35	–.48 (.20), .02
Alzheimer's/dementia	.21 (.06), <.001	.15 (.08), .06	.10 (.22), .66
Therapeutic diet	–.05 (.13), .68	–.25 (.10), <.01	.32 (.18), .08
Random effects			
Residual	.424	.568	.806
Intercept (NH)	.046	.095	<.001
Intraclass correlation	.098	.143	<.001

SE, standard error.

Estimated with empirical sandwich SEs. Negative parameter estimates indicate improvement in oral health.

As noted by others, having Alzheimer's disease or other dementias was significantly related to worse oral hygiene.^{5,20} Nevertheless, this study had favorable outcomes even with one-half of the study population having dementia, attesting to the ability of MCWB to improve oral hygiene among persons with dementia. Similarly, the intervention was effective considering that many participants had eating issues that may be detrimental to oral hygiene, and many were taking medications that can cause xerostomia, which increases the risk of gingival inflammation and dental caries.

It is not clear why renal disease was associated with improvement in the DPI. In hospitalized older adults, renal impairment is strongly associated with poor oral health.²¹ It can be manifested in the mouth by mucosal pathologies, making denture insertion and removal more difficult and less appealing for the caregiver. Also unclear is the inconsistent relationship of therapeutic diet to the DPI and gingival inflammation. Almost one-half of the residents were on a therapeutic diet (likely low-salt or low-sugar) to manage health conditions such as hypertension or diabetes. If diet is acting as a surrogate for control of these conditions, it could potentially explain reduced gingival inflammation; it is not clear why denture cleanliness somewhat worsened without knowing how diets may have changed during the study.

Limitations

As noted earlier, the analytic sample was not representative of the overall NH population. Because the study included repeat cross-sectional random samples of residents, the a priori goal was to compare population-averaged oral health from baseline to 24 months. The present analysis was conducted on a post hoc cohort defined after study completion. Second, because of a change in research personnel, the dental hygienist was not blinded to treatment condition for the second half of the study; therefore, it is possible that some bias may have been introduced into the 24-month evaluations. However, no study personnel knew which residents were or were not actually receiving mouth care, tempering this concern. Third, the number of teeth per sextant was not collected, and only the most affected tooth/sextant was scored; thus, the worst scores may overestimate what might have been obtained if all teeth were scored. Fourth, the nature of standard dental care residents received was unknown. Finally, residents' diabetes status was not assessed, although diabetes is strongly associated with periodontal disease,²² and it has been estimated that 42% of NH residents aged 65–84 years have diabetes.²³ People with uncontrolled diabetes may have more inflammation and higher GI-LTC scores.

Conclusions/Relevance

The NH residents' baseline status indicated a need for improved oral hygiene and denture cleanliness. The mouth care intervention was successful in reducing dental plaque, gingival inflammation, and denture cleanliness among the residents measured 2 years after program implementation. Thus, it is possible, and recommended, that NH staff better attend to the mouth care of their residents. MCWB is one such program to do so.

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