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Oral Health Problems and Significant Weight Loss Among Community-Dwelling Older Adults

Christine S. Ritchie,[1] Kaumudi Joshipura,[2] Rebecca A. Silliman,[3] Barbara Miller,[4] and Chester W. Douglas[2]

[1]Division of General Internal Medicine and Geriatrics, Department of Medicine, University of Louisville, Louisville, Kentucky.
[2]Department of Oral Health Policy and Epidemiology, Harvard School of Dental Medicine, Boston, Massachusetts.
[3]Boston University Schools of Medicine and Public Health, Boston, Massachusetts.
[4]Department of Social and Behavioral Sciences, Boston University School of Public Health, Boston, Massachusetts.

Background. Studies of hospitalized and institutionalized older adults suggest a relationship between poor oral health and subsequent weight loss. Given the association between weight loss and subsequent mortality and morbidity, we evaluated how oral health problems contributed to significant weight loss over a 1-year period among a representative sample of community-dwelling older adults.

Methods. The study population consisted of 563 adults aged 70 years and older living at home in rural and urban areas in six New England states. Baseline data included information regarding health status, functional status, physical activity, disease diagnoses, lifestyle behaviors, and cognitive and affective status. Dentists performed oral health assessments. One year later, participants were called and asked questions regarding their health and dietary practices and their current weight.

Results. Over the 1-year period of follow-up, approximately one third of the sample had lost 4% or more of their previous total body weight; 6% of men and 11% of women lost 10% or more of their previous body weight. Of the subjects, 37% were edentulous; most of these individuals wore full dentures. With gender, income, advanced age, and baseline weight controlled for, edentulousness remained an independent risk factor for significant weight loss (odds ratio 1.63 for 4% weight loss and 2.03 for 10% weight loss). Individuals with increasing numbers of posterior teeth and functional units were at slightly lower risk for weight loss; however, these associations did not reach statistical significance.

Conclusions. Dentate status is an important risk factor for clinically significant weight loss among community-dwelling older adults.

MANY epidemiologic studies have demonstrated an association between weight loss and increased morbidity and mortality (1–4). Although weight loss may be a marker for underlying disease, several studies indicate that weight loss remains independently associated with mortality, even after adjustment for baseline health status (3–5). The association between weight loss and subsequent morbidity and mortality is particularly prominent among older adults (2,6,7).

The etiology of and risk factors for significant weight loss among older adults remain unclear (8) and have been evaluated more commonly in hospital or institutional rather than community settings. Commonly cited risk factors for weight loss in hospital and nursing home settings include depression, gastrointestinal disease, cancer, chronic medical conditions, and functional dependence (9–13).

Several studies in hospital and nursing home populations suggest that oral health problems may contribute to weight loss in older adults (14,15). The study by Sullivan and colleagues (15) of elderly rehabilitation patients demonstrated a strong association between the number of general oral problems and subsequent involuntary weight loss. General oral problems included halitosis, poor oral hygiene, xerostomia, inability to chew, nonocclusion, temporomandibular joint syndrome, inflammation, lesions, and oral pain. Which oral problems contributed most to weight decline was not clear (15). Blaum and colleagues (14) examined factors associated with weight loss among nursing home residents. Chewing problems, but not oral dental problems (poor teeth, ill-fitting dentures, and mouth pain), were associated with an increased likelihood for weight loss among nursing home residents (14). We sought to evaluate how oral health problems contributed to significant weight loss in a 1-year period in a population of community-dwelling older adults.

METHODS

Study sample.—The study sample was a subset of the New England Elders Dental Study (NEEDS) (16). The sample consisted of 563 older adults aged 70 years and older living at home in rural and urban areas in six New England states for whom weight information was available on both the initial assessment and follow-up 1 year later. The sampling strategy for the initial assessment used a two-stage stratified cluster sampling design described previously (16). Subjects were excluded from the initial assessment if they had experienced a myocardial infarction or stroke within the previous 6 months or had severe dementia. Subjects were excluded from periodontal assessment if they met the American Heart Association criteria for being at risk for bacterial endocarditis or if they had a prosthetic joint replacement.

Data collection.—The population from which the sample was derived is shown in Figure 1. For the initial assessment 2,598 persons were determined to be eligible, and 2,057 (79.2%) participated in a telephone interview that collected information on sociodemographic characteristics, perceived physical and oral health, and health care utilization. Some 1,156 people (44% of the overall sample) agreed to an in-home visit, which included an in-depth personal interview, oral examinations, and measurements of height and weight. The interviewers obtained information regarding health status, functional status, physical activity, disease diagnoses, lifestyle behaviors, and cognitive and affective status. Four oral epidemiology postdoctoral fellows and one full-time gerodontist served as the dental examiners. Intraexaminer and interexaminer consistency was established through training and calibration sessions at the Harvard School of Dental Medicine. Kappa coefficients for these sessions were 0.67 for root caries, 0.86 for coronal caries, 0.85 for distance from the free gingival margin to the cementoenamel junction, and 0.65 for the greatest periodontal probing depth (16). The dental examiners assessed number and location of teeth; decayed, missing, and filled tooth surfaces; periodontal status; and presence of any oral lesions. Periodontal examinations were performed only on dentulous subjects who were not at risk for bacterial endocarditis and who had not had a prosthetic joint replacement. Gingival bleeding was assessed after the periodontal probe was swept from the midbuccal to the mesiobuccal aspect of each tooth. Recession was assessed by measurements of probing depths at the buccal, mesiobuccal, and distolingual aspect of each tooth and at a deepest site (if a site existed that was greater than the previous three sites). Attachment loss was assessed by measurement of the distance from the base of the pocket to the cementoenamel junction and again was measured at four sites.

One year later, the study team attempted to telephone the initial 1,156 study participants. When those who were institutionalized, had died, or had difficulty speaking English were excluded, 979 subjects remained eligible for the interview. Of the 979 eligible subjects, 749 (77% response rate) were administered a 5–7 minute interview that included information about health and dietary practices and self-reported current weight. For this study, we excluded persons who did not have a baseline weight or a self-reported weight at follow-up (n = 186). The analyses reported here are based on the 563 subjects for whom weights were available at baseline and follow-up.

Exposure variables.—The oral health measures of interest included both self-reported measures (chewing difficulty or oral pain) and objective measures. Objective oral health measures included dentate status (the presence or absence of natural teeth), number of teeth, attachment loss, gingival bleeding, and gingival recession. Teeth were also evaluated in terms of the number and presence of posterior (premolars and molars) and anterior (canines and incisors) teeth, the number of functional units, and the number of adjacent functional units (chewing surface). We defined a functional unit as a pair of opposing natural teeth. We defined chewing surface as the maximum number of intact functional units adjacent to each other.

Potential confounders.—The variables initially considered as potential confounders of significant weight loss fell

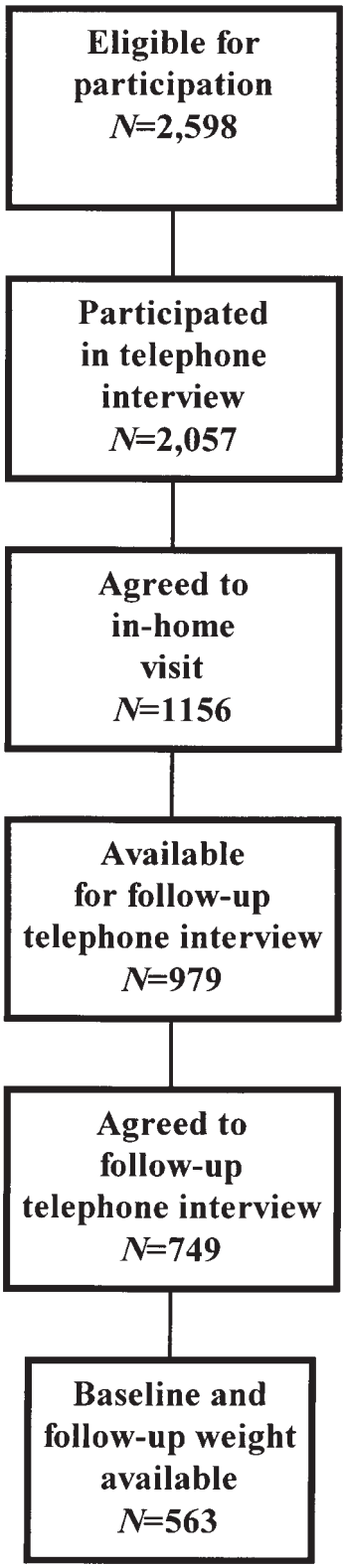

Figure 1. Population from which sample was derived.

into three categories: demographic factors, behavioral confounders, and general health status measures. Demographic variables included standard health survey questions about respondents' age, gender, marital status, living arrangement, education, and annual income. Health behavior variables included a self-reported measure of regular alcohol intake and tobacco use and physical activity level. We defined regular alcohol intake as drinking alcoholic beverages 5 or more days per week. We identified tobacco use by those who were current smokers, former smokers, or those who had never smoked. Physical activity level was defined by whether subjects walked one or more blocks each day. General health status measures included the number of self-reported chronic medical conditions [arthritis, diabetes, osteoporosis, stroke, congestive heart failure (CHF), lung disease, heart attack, hypertension, and cancer], dependence in activities of daily living (ADLs) (17), affective status (assessed by the question "How often have you felt downhearted and blue?") (18), and mental status (judged by the interviewer as the presence or absence of mild confusion). Functional status was categorized as either independent in ADLs or dependent in one or more ADLs. Definitions of the study variables are listed in Table 1.

Statistical analysis.—The primary objective of this study was to determine the impact of oral health factors on significant weight loss over a 1-year period. From the literature, we assessed significant weight loss on two levels. On the first level we defined significant weight loss as a loss of 4% or more of one's total body weight over a 1-year period. The threshold of 4% was chosen based on data (4) suggesting a better predictability for subsequent 2-year mortality than for other thresholds. We also evaluated a second threshold of 10% or more of one's total body weight. This threshold has a very high specificity (but lower sensitivity) for 2-year mortality and has been demonstrated in several studies to be associated with both mortality and increased morbidity (4,7,19).

We tested the crude relationship between each of the predictor variables at baseline and subsequent significant weight loss over a 1-year period by using chi-square analysis for categorical variables. For the primary analyses we performed multiple logistic regression separately by using a binary measure for the occurrence of 4% weight loss and 10% weight loss in 1 year as outcome and separately for each predictor of interest. To control for confounding factors, we considered all important potential confounders for inclusion in the model and retained those that had an impact on the association, conditional on factors already in the model. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated as approximations of the relative risk (RR) for the development of significant weight loss. SAS software (release 6.11; SAS Institute Inc, Cary, NC) was used for the statistical analysis.

Because of the substantial overlap between edentulousness and the use of full prostheses (only 11% of the 202 edentulous subjects did not wear dentures), only edentulousness was entered into the regression model.

The confounders included in the final model were selected based on their potential impact on the relative risk between exposure and the outcome of interest—weight loss—and included gender, age, income, comorbidity, functional status, affective status, smoking and alcohol use, and physical activity (1,20). In the interest of parsimony, potential confounders that did not have an impact on the RR conditional on factors already

Table 1. Study Variables and Definitions

Variable	Definition
Demographic factors	
Gender	0 = male, 1 = female
Age	70–74, 75–79, 80+ years (range: 70–96)
Years of education	High school or less: 0 = no, 1 = yes
Annual income	Less than $10,000: 0 = no, 1 = yes
Marital status	Married: 0 = no, 1 = yes
Living situation	0 = lives with others, 1 = lives alone
Oral health status	
Dentate status	0 = dentures, no teeth, or root tips only, 1 = at least one tooth
Number of teeth	Among dentate, number of natural teeth
Periodontal disease	
Mean attachment loss	Among dentate, mean attachment loss for all teeth (in millimeters)
Attachment loss ≥4 mm	Percentage of sites with attachment loss ≥4 mm
Gingival bleeding	Among dentate, percent of sites with gingival bleeding
Mean recession	Among dentate, mean recession (in millimeters)
Difficulty chewing	0 = no, 1 = yes
Oral pain	0 = no, 1 = yes
General health status	
Comorbidity	Total number of diagnoses (arthritis, diabetes, osteoporosis, stroke, CHF, lung disease, heart attack, high blood pressure, cancer)
Mental status	0 = normal, 1 = mild confusion
Activities of daily living	0 = independent, 1 = dependent in 1 or more of the following: walking, bathing, dressing, eating, toileting, transfering, getting outside
Affective status	Felt downhearted or blue a good bit or more of the time: 0 = no, 1 = yes
Health behaviors	
Tobacco use	Smoke or chew tobacco: 0 = no, 1 = yes
Alcohol use	Drinks alcohol 5 or more days per week: 0 = no, 1 = yes

Note: CHF = congestive heart failure.

in the model were excluded. Only age, gender, and income had an impact on the RR and were retained in the final model.

Results

The study sample included 563 persons, 326 women and 237 men. Comparison of the final study sample with those from the original cohort who were not available for the second interview showed that those not available for follow-up were slightly older, more confused, and more dependent in their ADLs. Characteristics of the sample are shown in Table 2. The mean age of the men was 77.3 ± 4.7 and that of the women was 78.1 ± 5.3 years. Most were white and approximately half were married. One third had higher than a high school education.

Thirty-six percent of the subjects were edentulous; three quarters of these subjects wore full prostheses (dentures). Thirty-six percent had a mean gingival recession of greater than 1 mm; 4% had a mean gingival recession greater than 3 mm. Forty-two percent had a mean attachment loss greater than 3 mm. Eighty-six percent exhibited gingival bleeding. Thirty-eight percent of the subjects complained of chewing difficulty or oral pain. Those who were edentulous or who wore full prostheses were more likely to complain of chewing difficulty ($p < .01$) and oral pain ($p = .1$) than those with natural dentition.

Over the 1-year period of follow-up, one third of the women lost 4% or more of their previous total body weight; 6% and 11% of men and women, respectively, lost 10% or more of their previous total body weight.

Table 3 provides the unadjusted associations between potential predictors and significant weight loss among the 563 subjects. The only univariate predictors of 4% weight loss were edentulousness and the use of full prostheses. Univariate predictors of 10% weight loss included female gender, the presence of more than two medical diagnoses, dependence in one or more ADLs, and edentulousness. There was no significant difference in rates of weight loss among edentulous subjects who wore dentures and those who did not ($p = .2$ for 4% weight loss and .6 for 10% weight loss).

In the unadjusted analysis among dentate subjects, individuals with increasing numbers of posterior teeth, increasing numbers of functional units, and larger chewing-surface areas appeared to be at slightly lower risk for significant weight loss; in all instances, however, CIs included one.

Tables 4 and 5 show the results of our multiple logistic regression analysis. With baseline weight, female gender, age greater than or equal to 80 years, and annual income adjusted for, edentulousness remained an independent predictor of 4% weight loss with an OR of 1.63 (1.09, 2.43) (Table 4). Furthermore, with baseline weight, female gender, income, more than two diagnoses, and dependence in one or more ADLs adjusted for, edentulousness remained an independent predictor of 10% or greater weight loss in 1 year with an OR of 2.03 (1.05, 3.96) (Table 5). None of the other oral health

Table 2. Characteristics of Sample

Study variable	Percentage of people (*N*) Baseline Assessment Only: $n = 593$	Percentage of People (*N*) Follow-Up Cohort: $n = 563$
Female	57 (341)	58 (326)
Race: white	93 (554)	96 (540)
Age		
70–74	29 (174)	33 (185)
75–79	34 (205)	35 (198)
80	37 (224)	32 (180)
Education: high school or less	70 (421)	67 (373)
Annual income > $10,000	61 (325)	67 (341)
Married	48 (286)	51 (288)
Lives alove	39 (237)	38 (212)
Edentulous	39 (238)	36 (202)
Wears dentures	29 (175)	27 (149)
Mean number of teeth (*SD*)	10 (10.3)	11 (10.4)
Mean gingival recession (mm) (*SD*)	0.95 (1.12)	0.9 (0.06)
Mean attachment loss (mm) (*SD*)	3.2 (1.3)	3.1 (1.3)
Percentage of sites with gingival bleeding	37 (34)	35 (30)
Chewing difficulty	26 (157)	24 (135)
Oral pain	25 (151)	22 (123)
Mean baseline weight (kg) (*SD*)	70 (14.5)	71 (15.3)
Mean total diagnoses	2 (1.3)	2 (1.2)
Dependent in 1 or more ADLs*	24 (146)	17 (95)
Depressed	12 (71)	11 (61)
4% weight loss over 12 months	†	33 (186)
10% weight loss over 12 months	†	9 (51)
Impaired cognition*	13 (79)	8 (46)
Current smoker	10 (58)	8 (46)
Regular alcohol use	16 (97)	17 (95)

Notes: *SD* = standard deviation; ADL = activity of daily living.

*Significant difference between the study sample and the original cohort ($p < .05$).

†No baseline measure of weight loss.

Table 3. Unadjusted Analysis: Characteristics Predictive of 4% and 10% Weight Loss Over 1 Year

Characteristic	Odds Ratio (95% CI) for 4% Weight Loss	Odds Ratio (95% CI) for 10% Weight Loss
Exposure variables		
Oral health:		
Edentulousness	1.78 (1.24, 2.56)*	2.08 (1.16, 3.70)*
Wears full prostheses	1.99 (1.38, 2.87)*	1.55 (0.87, 2.78)
Mean recession	1.30 (0.97, 1.74)	1.24 (0.70, 2.19)
Percent of sites with gingival bleeding	1.01 (0.99, 1.02)	1.01 (0.99, 1.03)
Mean attachment loss	0.90 (0.72, 1.13)	0.95 (0.63, 1.44)
Potential confounding variables		
Female gender	1.06 (0.74, 1.52)	2.04 (1.08, 3.87)*
Age ≥80	1.24 (0.58, 1.80)	1.18 (0.64, 2.16)
More than two diagnoses	1.24 (0.82, 1.86)	2.15 (1.17, 3.95)*
Dependent in one or more ADLs	1.05 (0.66, 1.67)	2.51 (1.32, 4.74)*
Depression	0.97 (0.43, 2.18)	0.36 (0.05, 2.70)
Current smoker	0.89 (0.46, 1.70)	0.95 (0.33, 2.77)
Regular alcohol use	0.89 (0.56, 1.42)	0.63 (0.26, 1.53)
Physical activity	1.03 (0.72, 1.46)	0.78 (0.43, 1.38)

Notes: CI = confidence interval; ADL = activity of daily living.
*$p < .05$.

measures among dentate subjects, including gingival recession, number of teeth, number of functional units, and chewing surface, significantly predicted subsequent weight loss.

We conducted an additional analysis to determine if edentulousness and functional dependency had an interactive effect on significant weight loss. The OR for edentulousness on weight loss was the same both for individuals who were dependent and those who were not dependent in their ADLs, suggesting that the joint effect of functional dependency and edentulousness was no different from that expected on the basis of their separate effects. In addition, the impact of edentulousness on weight loss did not affect those with an initially high baseline weight any more than it affected those with an initially low baseline weight.

Discussion

The findings of this research suggest that dentate status may be an important risk factor for significant weight loss among community dwelling older adults. Even after age, gender, dependency and comorbidity were controlled for, edentulousness conferred an independent risk for weight loss.

Table 4. Multiple Logistic Regression Results of Predictors of 4% Weight Loss Over 1 Year

Characteristic	Odds Ratio (95% CI)
Female gender*	1.68 (1.08, 2.61)
Age ≥80*	1.61 (1.05, 2.46)
Annual income ≥$10,000	1.17 (0.76, 1.80)
Baseline weight*	1.02 (1.01, 1.03)
Edentulousness*	1.63 (1.09, 2.43)

Notes: All factors listed in the table were simultaneously included in a multivariate logistic regression model. The odds ratio for edentulousness is adjusted for all the factors listed in the table. Addition of other potential confounders (depression, smoking, alcohol use, physical activity) did not change the estimates. CI = confidence interval.
*$p < .05$.

Table 5. Multiple Logistic Regression Results of Predictors of 10% Weight Loss Over 1 Year

Characteristic	Odds Ratio (95% CI)
Female gender*	3.77 (1.71, 8.33)
Age ≥80*	1.46 (0.73, 2.93)
Annual income ≥$10,000	1.27 (0.62, 2.58)
Baseline weight*	1.02 (1.01, 1.03)
More than two diagnoses	1.67 (0.83, 3.38)
Dependent in one or more activities of daily living*	2.27 (1.08, 4.78)
Edentulousness*	2.03 (1.05, 3.96)

Notes: All factors listed in the table were simultaneously included in a multivariate logistic regression model. The odds ratio for edentulousness is adjusted for all the factors listed in the table. Addition of other potential confounders (depression, smoking, alcohol use, physical activity) did not change the estimates. CI = confidence interval.
*$p < .5$.

Among individuals with only 4% weight loss, functional dependence did not appear to contribute meaningfully to a decline in weight. However, individuals who lost 10% or more of their body weight tended to be more functionally impaired.

These results corroborate the findings of the study by Sullivan and colleagues of older rehabilitation patients. In their study, oral health problems were a strong predictor of subsequent significant weight loss (15). Their study, however, did not delineate which oral health problem contributed most to weight change. In studies of weight loss among nursing home residents, chewing difficulty has been associated with weight loss, but number of teeth and dentate status were not evaluated per se (14,20). Of the specific oral health conditions evaluated, edentulousness was the strongest predictor of subsequent weight loss. Almost all of the edentulous subjects in this study wore dentures, so it appears that denture use did not mitigate against weight loss. Although the association between edentulousness and subsequent weight loss has not been demonstrated before, edentulousness and denture use have been associated with poor dietary quality and poor masticatory performance (20–24). In the study by Hildebrandt and colleagues of older adults, individuals with decreased natural functional units complained of chewing difficulty, avoided certain foods, and complained of difficulty swallowing (25). In the study by Steele and colleagues of British older adults, edentate individuals had a lower daily intake of energy, protein, and micronutrients such as calcium and vitamins A, C, and E. (21). The food avoidance and decrease in energy intake noted among edentate or dentally compromised older adults in these studies may explain the relationship between edentulousness and weight loss noted in our study. Masticatory force has also been shown to be significantly diminished in edentulous subjects and in denture wearers. In the study by Krall and colleagues of older veterans, individuals with compromised dentition and full dentures had decreased masticatory performance and a parallel decreased intake of calories, protein, and fiber (24). Many older adults who wear dentures do not replace or reline poorly fitting dentures. This may further contribute to chewing difficulty and oral discomfort.

Chewing difficulty and oral discomfort may in turn contribute to food aversion, diminished intake, and subsequent weight loss.

The presence of opposing teeth (functional units), the number of posterior teeth, and chewing-surface area all appeared to decrease the risk of significant weight loss in unadjusted analyses; these trends, however, did not reach statistical significance. Because the average number of natural teeth in this sample was relatively small (a mean of 17 among dentate subjects), inadequate power may have precluded our ability to detect the impact of tooth type and chewing-surface area.

Limitations of the data.—The data for assessment of weight history reflected only two points in time with a direct measurement only at baseline. Other studies, however, demonstrate reasonable correlation between self-reported weight and measured weight, even in older persons (26,27). In addition, we did not differentiate between involuntary and voluntary weight loss. Thus the impact of edentulousness on involuntary weight loss may have been underestimated. However, in the study by Wallace and colleagues of weight loss among older outpatients, increased mortality rates were observed among all weight losers, regardless of whether weight loss was intentional (4). Finally, our study sample was not fully representative of community-dwelling older adults, as the nonresponders tended to be older and more functionally and cognitively impaired.

In our study there was substantial overlap between edentulous subjects and subjects with dentures. It is unclear therefore whether, among the edentulous, denture use is associated with weight loss. It also remains to be determined whether denture fit, comfort, and quality are associated with subsequent weight loss in older adults.

CONCLUSION

Our study further clarifies the role of oral health in the development of weight loss; namely, that edentulousness is an important, independent risk factor for significant weight loss among community-dwelling older adults. Future studies will be required for delineating whether denture fit or lack of natural teeth contributes most to weight change. Research will also be needed to determine whether edentulous individuals with dental implants are at the same increased risk as their denture-wearing counterparts for significant weight loss. Finally, research is needed not only to examine the impact of dentate status on weight loss but its mediating impact on food and nutrient intake as well.

Acknowledgments

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Address correspondence to Dr. Christine Ritchie, University of Louisville Division of General Internal Medicine and Geriatrics, Ambulatory Care Building 3rd floor, 530 S. Jackson Street, Louisville, KY 40202. E-mail: csritchie@louisville.edu

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