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RESEARCH ARTICLE **OPEN ACCESS**

The Association between Periodontal Status and Frailty in Elderly Individuals

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Abstract:

Background: The number of older people in Indonesia is projected to continue rising. Periodontal disease and frailty are frequent among the elderly. Both are recognized to share some existing risk factors.

Objectives: This study aimed to evaluate the association between periodontal status and frailty in elderly individuals.

Methods: This is a cross-sectional study of people aged 60 and older. Periodontal status assessed was plaque score, bleeding on probing (BOP) score, calculus index, number of teeth, and stage of periodontitis. The FRAIL scale, comprised of Fatigue, Resistance, Ambulation, Illness, and Loss of weight, was used to evaluate the frailty state.

Results: There were 60 subjects in total, with 46.6% having frailty. There was a significant correlation between periodontal status and frailty in older people ($p<0.05$). There were significant differences in plaque scores between frail and normal subject groups ($p=0.000$), in the BOP between the frail and normal subject groups ($p=0.003$) and the pre-frail and frail subject groups ($p=0.003$), and in the number of teeth between the subject groups, frail to normal ($p=0.011$) and pre-frail subjects to frail ($p=0.023$).

Conclusion: The findings of this study suggest a link between periodontal status and frailty in the elderly; however, longitudinal research is needed to confirm this.

Keywords: Periodontal status, Frailty, Elderly, Periodontal disease, Bleeding on probing (BOP), Aging population.

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1. INTRODUCTION

Globally, as life expectancy rises, so does the proportion of the elderly in the general population. The older population is expected to increase to 994 million by 2030 and 1.6 billion by 2050 [1]. There are numerous challenges in the aging population, including frailty, a state of increased susceptibility caused by aging-related declines in reserve and function across various physiologic systems, compromising the ability to cope with daily or acute stressors [2, 3]. Periodontal disease is also a frequent issue among the elderly. Frailty and periodontal disease both have a detrimental influence on quality of life, and they are known to share some existing risk factors, including diabetes mellitus, obesity, dementia, tobacco use, and increasing age [4, 5].

Periodontitis is a periodontal disease that is a common cause of multiple tooth loss. When the residual dentition is not functioning, tooth loss affects chewing function and

may compromise nutrient intake. Poor nutrition is not a direct result of reduced dentition, but it may contribute to elderly frailty [6]. Periodontitis is also known to be linked *via* the inflammatory pathway to numerous systemic diseases that are risk factors for frailty [6-8].

Previous studies have shown a correlation between poor oral health and frailty [9-12]. However, a systematic review by Tôrres *et al*. revealed that none of the longitudinally evaluated studies showed whether poor oral health increases the likelihood of developing signs of frailty [13]. Other systematic reviews identified five longitudinal studies that provide evidence of a correlation between the number of teeth and oral function with the incidence of frailty, yet the correlation between periodontal diseases and frailty was equivocal [14]. Therefore, in this study, we aimed to evaluate the association between periodontal status and frailty in older Indonesian people.

2. MATERIALS AND METHODS

This cross-sectional study was conducted at two nursing homes in Banten province, Indonesia, from June 2022 to November 2022. The inclusion criteria were nursing home residents aged ≥60 years who were willing to participate in the study. This study excluded subjects who were unable to speak, wore dentures, were edentulous, had undergone periodontal treatment within the previous six months, and had taken antibiotics within the previous three months. The sample size and appropriate power calculations were determined based on the correlation test, resulting in a total sample size of 60. Written informed consent to participate in the study was obtained from the participant. This study was approved by the Dental Research Ethics Committee of the Faculty of Dentistry, Universitas Indonesia (number 20/Ethical Approval/FKGUI/IV/2022).

Examination of periodontal status and frailty in this study was carried out by two calibrated dentists. The intra-class correlation coefficients for numerical periodontal status consistency measurement were all > 0.9, and the kappa values representing the inter-examiner reliability for scoring frailty were 0.9.

Periodontal status assessed was plaque score, bleeding on probing (BOP) score, calculus index, number of teeth, and stage of periodontitis. Plaque and BOP scores were evaluated using a periodontal probe (Osung, Korea) at six sites per tooth on all remaining teeth (mesial-mid-distal buccal and palatal/lingual) [15]. A calculus examination was performed on all remaining teeth on both the buccal and palatal/lingual sides [16]. The number of teeth was the total number of remaining teeth, excluding third molars and radix.

The periodontitis stage was determined based on the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions, which divides periodontitis severity into four stages: I, II, III, and IV. Clinical attachment loss (CAL) examination and probing depth (PD) were performed on all remaining teeth. Initial periodontitis, or stage I, has an interdental CAL of 1-2 mm and a maximum PD of ≤4 mm. Moderate periodontitis, with an interdental CAL of 3–4 mm and a maximum PD of ≤5 mm, is stage II. Stage III is severe periodontitis with the potential for additional tooth loss, and stage IV is advanced periodontitis with extensive tooth loss and the potential for loss of dentition. Stages III and IV have interdental CAL ≥5 mm and probing depth ≥6 mm but differ based on tooth loss due to periodontitis and complexity [17].

The FRAIL scale, comprised of Fatigue, Resistance, Ambulation, Illness, and Loss of weight, was used to evaluate the frailty state. Fatigue was assessed by asking subjects how much time they felt tired in the previous four weeks, with responses of “all of the time” or “most of the time” earning one point. Resistance was determined by asking subjects if they had difficulty walking up 10 steps without resting and without aids, and ambulation by asking if they had any difficulty walking several hundred yards alone and without aids; “yes” answers were scored one point each. Illness was assigned a score of 1 for subjects who reported 5 or more diseases out of a total of 11 illnesses. Weight loss received a score of 1 for subjects who reported a weight loss of 5% or more in the previous 12 months. Frail scale scores range between 0 to 5, indicating frail (3-5), pre-frail (1-2), or non-frail (0) [18].

A significance level of $p < 0.05$ was deemed appropriate for all statistical analyses. The statistical studies were conducted using SPSS version 23 (IBM, USA). Descriptive analysis was used to obtain an overview of the proportions and frequency distributions of each variable. The study employed inferential analysis to investigate the correlation between two variables, specifically frailty and periodontal status among the elderly subjects. The Spearman correlation test was employed to assess the association between frailty and periodontal condition, utilizing variables, such as plaque score, bleeding on probing (BOP), calculus index, and number of teeth. This research used the Kendall tau-b correlation test to investigate the association between the level of frailty and the stage of periodontitis. A set of comparative experiments was undertaken to determine the differences between numerical variables and the level of frailty in the elderly population. The Kruskal-Wallis test was used to investigate the relationship between frailty and age, plaque score, BOP score, alongside calculus index, respectively. The One-way Analysis of Variance (ANOVA) test was utilized to investigate the relationship between the number of teeth and frailty.

3. RESULTS

There were 60 research participants in this study, including 17 non-frail subjects, 15 pre-frail subjects, and 28 frail subjects. Table **1** displays the demographics of the study participants, which included 21 male subjects (35%) and 39 female subjects (65%). The highest proportion in the normal group were women (13.3%), had a high school education level (11.7%), were married (23.3%), did not smoke (18.3%), had a number of teeth ≤20 (16.7%), and the severity of periodontitis stage III (15%). Subjects that

were classified as pre-frail were mostly women (18.3%), had junior high school education (8.3%), were married (23.3%), did not smoke (16.7%), had a number of teeth >20 (13.3%), and had stage III periodontitis severity (11.7%). Whereas the frail group was dominated by women (33.3%), the majority had elementary school level education (23.3%), were married (41.7%), did not smoke (36.7%), had a number of teeth ≤20 (46.7%), and stage IV periodontitis severity (40%).

The findings from the correlation analysis indicated a statistically significant relationship ($p<0.05$) between frailty and all variables pertaining to periodontal status among the elderly population (Table **2**). The correlation coefficient (r), which quantifies the strength and direction of the association between frailty and periodontal state, exhibits variability. The results of the statistical analysis indicated a noteworthy association ($p<0.05$) between plaque score ($r=0.457$), bleeding on probing (BOP) ($r=0.430$), periodontitis severity ($r=0.413$), and frailty. This correlation was found to be moderately positive. The results of the statistical analysis indicated a statistically significant association ($p<0.05$) between the calculus index and frailty, with a weak positive link ($r=0.273$) seen. It also revealed a statistically significant correlation ($p<0.05$), indicating a weak negative correlation ($r=-0.385$) between the number of remaining teeth and frailty.

Table 1. Characteristics of subjects (n=60).

Variable	Frailty			Total n=60
	Non-frail	Pre-frail	Frail	
Gender	-	-	-	-
Male	9 (15%)	4 (6.7%)	8 (13.3%)	21 (35%)
Female	8 (13.3%)	11 (18.3%)	20 (33.3%)	39 (65%)
Education level	-	-	-	-
Bachelor	1 (1.7%)	2 (3.3%)	0 (0%)	3 (5%)
Highschool	7 (11.7%)	2 (3.3%)	4 (6.7%)	13 (21.7%)
Middle school	2 (3.3%)	5 (8.3%)	2 (3.3%)	9 (15%)
Elementary school	4 (6.7%)	2 (3.3%)	14 (23.3%)	20 (33.3%)
Never went to school	3 (5%)	4 (6.7%)	8 (13.3%)	15 (25%)
Length of Education	-	-	-	-
≥ 9 years	10 (16.7%)	9 (15%)	6 (10%)	25 (41.7%)
< 9 years	7 (11.7%)	6 (10%)	22 (36.7%)	35 (58.3%)
Marital status	-	-	-	-
Married	14 (23.3%)	14 (23.3%)	25 (41.7%)	53 (88.3%)
Unmarried	3 (5%)	1 (1.7%)	3 (5%)	7 (11.7%)
Smoking status	-	-	-	-
Non-smokers	11 (18.3%)	10 (16.7%)	22 (36.7%)	43 (71.7%)
Smokers/ Former smokers	6 (10%)	5 (8.3%)	6 (10%)	17 (28.3%)
Number of teeth	-	-	-	-
> 20 teeth	7 (11.7%)	8 (13.3%)	3 (5%)	18 (30%)
≤ 20 teeth	10 (16.7%)	7 (11.7%)	28 (46.7%)	42 (70%)
Stage of Periodontitis	-	-	-	-
Stage I	1 (1.7%)	2 (3.3%)	0 (0%)	3 (5%)
Stage II	1 (1.7%)	1 (1.7%)	1 (1.7%)	3 (5%)
Stage III	9 (15%)	7 (11.7%)	3 (5%)	19 (31.7%)
Stage IV	6 (10%)	5 (8.3%)	24 (40%)	35 (58.3%)

Table 2. Correlation between frailty and periodontal status (n=60).

-	Periodontal Status	Correlation Coefficient (r)	P-value
Frailty	Plaque Score	0.457	0.000*
	Bleeding on Probing	0.430	0.001*
	Calculus Index	0.273	0.035*
	Number of Teeth	-0.385	0.002*
	Stage of Periodontitis	0.413	0.000**

Note: * = Spearman test ; ** = Kendall test; $p < 0.05$ significant correlate.

Table 3. Comparison test between frailty group and numeric variables (age, plaque score, calculus index, bleeding on probing and number of teeth) in elderly individuals (n=60).

Variable	Frailty						P-value
	Mean ± SD			Median (Min-Max)			
	Non-frail	Pre-frail	Frail	Non-frail	Pre-frail	Frail	
Age	67.18±7.33	70.13 ± 8.37	74.14 ± 9.60	66 (60-89)	66 (60-86)	73 (61-97)	0.024*
Plaque Score	39.65 ±31.01	51.33 ± 39.01	77.96 ± 28.41	29 (5-100)	33 (0-100)	88 (5-100)	0.002*
Calculus Index	0.72 ± 0.43	1.04 ± 0.88	1.17 ± 0.73	0.77 (0.10-1.90)	0.78 (0.20-3.00)	1.00 (0-3.00)	0.124
BOP Score	33.18 ± 23.36	32.40 ± 30.97	62.00 ± 28.42	23 (3-77)	17 (0-100)	64 (13-100)	0.001*
Number of teeth	16.65 ± 8.05	16.27 ± 8.64	9.79 ± 6.05	18 (4-28)	20 (2-28)	9 (1-23)	0.004**

Note: * = Kruskal Wallis test; ** = One-way ANOVA test; p < 0.05 significant different.

Table 4. Post hoc test between frailty group and numeric variable (age, plaque score, bleeding on probing score, and number of teeth) in elderly individuals (n=60).

Numeric Variable	-	Non-frail	Pre-frail	Frail
Age	Non-frail	-	0.297	0.007*
-	Pre-frail	0.297	-	0.184
-	Frail	0.007*	0.184	-
Plaque Score	Non-frail	-	0.256	0.000*
-	Pre-frail	0.256	-	0.083
-	Frail	0.000*	0.083	-
BOP Score	Non-frail	-	0.650	0.003*
-	Pre-frail	0.650	-	0.003*
-	Frail	0.003*	0.003*	-
Number of Teeth	Non-frail	-	1.000	0.011**
-	Pre-frail	1.000	-	0.023**
-	Frail	0.011**	0.023**	-

Note: *= Mann Whitney; **= Bonferroni; p < 0.05 significant different.

Inferential statistical analysis on age, plaque score, BOP, and number of teeth showed significantly differed between non-frail, pre-frail, and frail individuals (Table **3**). The level of frailty in the elderly goes up with age, plaque score, BOP, and the number of teeth. There was no significant difference between the calculus index and frailty. The findings of the bivariate analysis revealed that the frail group had an older mean age (74.14) than the non-frail group (67.18). The frail group had relatively high plaque scores (77.96%) and BOP (62%).

The findings presented in Table **4** illustrate the outcomes of a post hoc comparison analysis conducted to ascertain the presence of significant differences across various groups. There was a statistically significant difference ($p<0.05$) observed between the frail and non-frail groups based on age and plaque scores. According to the standpoint of the BOP, there was a statistically significant distinction seen between individuals categorized as non-frail and frail, as well as between those classified as pre-frail and frail ($p<0.05$). Significant differences were also seen between the non-frail and frail groups, as well as the pre-frail and frail groups, based on the number of teeth ($p<0.05$).

4. DISCUSSION

Our study shows that older people who are frail have a higher plaque score, BOP score, and calculus index than older people who are not frail but have fewer teeth. We discovered a significant difference in plaque score and number of teeth between the frail and non-frail groups. This finding is consistent with a cross-sectional study conducted by Hasegawa *et al*. on elderly individuals aged 65 years who resided in Hyogo, Japan, despite the use of a distinct frailty assessment. Their research demonstrates that the proportion of participants who were found to have poor hygiene was significantly higher in the frail group than in the pre-frail and robust groups. Additionally, the frail group had fewer teeth than the pre-frail and robust groups [19].

Prior studies have also examined the correlation between the number of teeth and frailty. A national cross-sectional study found that the likelihood of frailty decreased as the number of teeth increased [20]. Kuo *et al*. examined 903 community-dwelling persons aged ≥ 65 years and discovered that the average number of teeth is 8.9, and the number of teeth declines as the degree of frailty increases [21]. Several possible pathways are involved in the mechanism of tooth loss in developing frailty. Elderly individuals who have tooth loss and do not

wear dentures may have difficulty chewing and are more likely to eat soft foods. If this condition persists, it may result in inadequate nutrient intake, raising the risk of malnutrition and frailty. Additionally, dietary patterns are known to be linked to frailty [22-24]. Aside from that, the elderly with tooth loss may become less confident, which interferes with their activities and leads to depression, which contributes to frailty [14, 20, 25-27].

The BOP score is a periodontal status that measures the degree of gingival inflammation [15]. There was a significant difference in BOP scores between the frail and non-frail groups in our study. In contrast, a prospective cohort study found no significant difference in BOP scores between frail and non-frail groups [28].

The strength of our study is the use of periodontitis staging to determine the severity of periodontitis according to the current classification of periodontal diseases. Periodontitis was found in all of the subjects, with the frail group having the highest proportion of periodontitis stage IV. A bivariate analysis revealed a significant correlation between periodontitis stage and frailty. Education is one factor that may contribute to this, as the majority of frail subjects in this study had less than nine years of education, and eight of them had never attended school. A systematic review revealed that individuals with low educational attainment experience a higher risk of periodontitis [29]. In a recent study, Walther *et al*. identified a significant relationship between periodontitis and level of education, particularly when comparing individuals with low to high levels of education [30].

The findings of this study support the concept that maintaining periodontal health is an important component of healthy aging. Early detection and treatment of periodontal disease, which leads to tooth retention, may be associated with improved overall quality of life and delayed frailty [31]. Simple, prevention-focused dental treatment plans that aim to halt the progression of oral diseases and restore masticatory function through tooth replacement are necessary for achieving healthy aging [32].

Our study was carried out in nursing homes, which may have limited access to dental services. The poor periodontal health of elderly people living in nursing homes has been demonstrated in several studies [33-35]. According to Zhang *et al*., nursing home staff members should take steps to preserve natural teeth and develop a strategy to encourage elderly people living in nursing homes to practice good oral hygiene [20]. Regular oral health examinations and improved access to dental care should be required for residents of nursing homes [31, 36].

There are some limitations to this study. The subjects of the study did not represent the Indonesian population. The pathophysiology of frailty was multifactorial, and our study did not include all risk factors. Also, the cross-sectional study design makes it difficult to infer causal linkages from the outcome.

CONCLUSION

Our study findings suggest a link between periodontal status and frailty in the elderly; however, longitudinal studies are needed to confirm this and understand the particular mechanisms underlying how periodontal status is related to frailty. Moreover, a more thorough knowledge of these associations could result in improved management of periodontal disease and frailty in older people.

LIST OF ABBREVIATIONS

BOP	=	Bleeding on Probing
CAL	=	Clinical Attachment Loss
PD	=	Probing Depth

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Dental Research Ethics Commission (KEPKG), Faculty of Dentistry, Universitas Indonesia, Indonesia (No:20/Ethical Approval/FKGUI/IV/2022).

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All human research procedures were followed in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was obtained from all subjects involved in the study.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from the corresponding author [F.T] upon reasonable request.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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Declared none.

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