Association Between Physical Function and Edentulism in Older Adults: Findings from the Indonesian Family Life Survey 2014

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Abstract

This study aimed to determine the association between physical function and edentulism among older adults. The fifth wave of Indonesian Family Life Survey (IFLS-5) data was used. Physical function was evaluated through physical performance, physical capability, and appendicular skeletal muscle mass (ASM). Edentulous was found in 10.96% of 2554 older adults. Low physical performance (OR 2.02, 95% CI 1.32-3.09; $P = .001$) was shown to be associated with edentulism in the 60 to 69 age group. In the 70 to 79 age group, both low physical performance (OR 1.62, 95% CI 1.04-2.53; $P = .033$) and 1 dependency in ADL/IADL (OR 1.75, 95% CI 1.02-2.98; $P = .04$) were significantly associated with edentulism. Two or more dependencies in ADL/IADL (OR 4.02, 95% CI 1.15-13.99; $P = .029$) demonstrated significant association with edentulism in older adults ≥80 years. These findings highlighted the importance of maintaining natural teeth and improving oral health during the aging process.

Keywords

edentulism, physical function, physical performance, activity daily living, older adults

Introduction

Complete tooth loss, also known as edentulism, indicates poor oral health. A global study revealed that approximately 23% of older adults suffer from edentulism.[1] Several studies suggested that the prevalence of edentulism rises with age. A study in the United States demonstrated that the prevalence of edentulism was 13.54% among persons 65 years and older.[2] In South Korea, the prevalence of edentulism was 3.9%, 7.4%, 13.1%, and 18.1% in persons aged 65 to 69, 70 to 74, and 75 to 79, and >80 years, respectively. Meanwhile, in Sweden and Finland, the prevalence of edentulism was 23.8% and 37.3%, respectively, among persons aged 70 and 80 years.[3,4] Even though Sweden and Finland had greater prevalence rates than the United States and South Korea, the overall trend was identical, as indicated.

Edentulism in older adults can result in difficulty chewing and thus can influence dietary intake, overall health, and quality of life.[5,6] Several studies indicated edentulism as a risk factor for physical function decline, including reduced mobility in the lower limb, lower levels of physical activity, and impaired instrumental activities of daily living (IADL).[7] Edentulism was also found to be a risk factor for frailty, an age-related syndrome with multiple physiological declines, such as low levels of physical activity, exhaustion, unintentional weight loss, weakness, and reduced walking speed.[8,9] These conditions can increase the risk of falls, hospitalization, and mortality among frail individuals.[10]

In contrast, studies have also revealed that edentulism can also be influenced by physical function. A study utilizing the China Health and Retirement Longitudinal study found a relationship between reduced physical function and the occurrence of edentulism in middle-aged and older persons.[11] Consistent with this finding, another study found that individuals over 65 years with IADL dependency were 1.48 times more likely to experience edentulism.[4] The progressive loss of IADL capabilities can eventually lead to impairments in activities of daily living (ADL) as functional decline progresses. Evidence also indicated that ADL and IADL disabilities increased with increasing age, emphasizing the

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association of physical function and oral health outcomes, particularly edentulism.[12] On the other hand, physical activity was also associated with edentulism in addition to ADL and IADL.[13,14]

Despite these findings, there is a scarcity of research examining the impact of physical function on edentulism. This study aimed to determine the associations between physical function and edentulism among older adults.

Methods

Study Design

This study utilized data from the fifth wave of the Indonesian Family Life Survey conducted in 2014 to 2015. This survey gathered several data on social and economic well-being, which was conducted in 83% of the total population, through random sampling in 13 provinces. The dataset was accessible and is available at the RAND Corporation website https://www.rand.org/labor/FLS/IFLS.html.[15]

Participants

Individuals aged 60 years and older were included in the study. Conversely, individuals with incomplete data on any relevant variables were excluded. According to the formula for cross-sectional study, the minimum sample needed was 246.[16] This sample size was calculated with a 95% confidence interval and a desired precision of 0.05, whereas the prevalence of edentulism in older adults was presumed to be 20%.

Measures

All the data were collected by regular interviewers who obtained training to do the interview and measure health conditions.[15]

Dependent variable: Edentulism. Edentulism was assessed utilizing a single question, "Have you lost all of your teeth?"

Independent variable: Physical function. Physical function in older adults was evaluated through physical performance, physical capability, and appendicular skeletal muscle mass (ASM).

A 5-time chair stand test (5CST) was used to measure physical performance in older individuals.[17,18] The performance on the 5CST was categorized as low if the time to complete the task is ≥12 s.[18]

The physical capability was evaluated using the Katz index of independence in ADL and the Lawton IADL. Both measurements were easy to use. The Katz index was focused on evaluating the ability to perform essential activities in daily life, including dressing, bathing, transferring, eating, and toileting. Although the Katz index is sensitive to changes in health status, it is less accurate to evaluate more advanced activities. Therefore, the Lawton and Brody IADL was utilized to measure more complex activities, such as shopping, cooking, taking medication, doing household chores, shopping, and managing finances.[19,20] Functional capability was categorized into 3: no dependency, dependency on 1 ADL/IADL activity, and dependency on ≥2 ADL/IADL activities.

The gold standard for determining ASM was dual-energy x-ray absorptiometry or bioelectrical impedance analysis.[18] However, numerous anthropometric models have been presented for estimating ASM.[21-23] Equations based on gender, weight, and waist circumference demonstrated a strong association with dual-energy x-ray absorptiometry ($r = .963$, $P < .001$). Therefore, the classification of ASM is fundamentally based on measurements obtained through dual-energy x-ray absorptiometry.[23] Low muscle mass was identified when the dual-energy X-ray absorptiometry measured ASM divided by height squared (ASM/height²) was less than 7.0 kg/m² for men and less than 5.4 kg/m² for women.[18]

Covariates. The sociodemographic variables were age (aged 60-69, 70-79, or 80 years or older), gender (male or female), place of residence (urban or rural), and educational attainment was classified lower (≤9 years or education) or higher (>9 years of education).

The body mass index (BMI) was calculated by dividing weight (kg) by square height (m^2). Recommended BMI value for Asia Pacific was then used to define BMI as underweight (BMI ≤ 18.5 kg/m^2), normal (BMI 18.6-22.9 kg/m^2), and overweight (BMI ≥ 23.0 kg/m^2).[24]

Subjective general health was assessed by asking, "In general, how is your health?" The responses to this question were then categorized into healthy (very healthy or somewhat healthy) and unhealthy (somewhat unhealthy or unhealthy).

Systemic diseases, such as hypertension and diabetes, were collected by asking the subjects whether they were diagnosed with those diseases by doctors, paramedics, nurses, or midwives.

The depression scale used by the Centre for Epidemiologic Studies, consisting of 10 items, was utilized to determine the degree of depression. Cross-cultural adaptation of this scale in Indonesia showed good reliability with Cronbach alpha .72.[25] Using a four-point Likert-type format to indicate the frequency of each item applied to them during the past week, the response options ranged from 0 to 3 (0 = rarely or none of the time, 1 = some or little of the time, 2 = occasionally of a moderate amount of time, and 3 = most of the time).[26] The sum of these responses was then calculated to yield a total score, where a score of ≥10 indicated depressive symptoms.

Several questions were used to assess smoking status such as, "Have you ever chewed tobacco, smoked a pipe, smoked self-rolled cigarettes, or smoked cigarettes/cigars?" Individuals who replied "no" to this question were classified as non-smokers. Those who replied "yes" were then asked a

follow-up question: "Do you still have the habit, or have you quit?" Older persons who stated that they continued to smoke were classified as current smokers. Those who reported having entirely stopped smoking were classified as former smokers.

The food consumption score was the sum of scores related to dietary diversity, food frequency, and nutritional relevance across different food groups. It was used to evaluate household food availability and security. This was done by asking families how frequently they consumed food items from each of the 8 main food groups for 7 days and then weighting them on the relative nutritional content of the food groups consumed.[27-29] Nevertheless, the IFLS-5 data only obtained 6 dietary groups: staples (sweet potatoes, rice), fruits (banana, papaya, mango), vegetables (carrots, green leafy vegetables), dairy, meat/fish (fish, meat, eggs), and sugar (soft drinks, sweet snacks). The food consumption scores were classified as low (score <21), borderline (score 21-35), and acceptable (score >35).[27]

The International Physical Activity Questionnaire was used to evaluate physical activity in older adults. This questionnaire evaluated several activities, such as walking, doing moderate activity, and vigorous activity for the previous 7 days. Physical activity was classified as low (no activities or not meeting moderate and high criteria), moderate (combination of walking, moderate activity, or vigorous activity for at least 600 MET minutes per week, or at least 20 min of vigorous activity 3 or more days, or walking for at least 30 min 5 days in a row), and high (a combination of walking, moderate, or vigorous activities for 7 days, achieving at least 3000 MET minutes, or vigorous exercise for 3 or more days, collecting at least 1500 MET minutes per week).[30]

Statistical Methods

Continuous variables (age and BMI) were tested for normality using the Shapiro-Wilk test. Mann-Whitney *U* test was employed to identify the association between continuous variables and edentulism, which was categorized as a binary (yes/no). On the other hand, the association between categorical variables and edentulism was investigated using a bivariate analysis employing Chi-square tests. A multivariate analysis of multiple logistic regression was conducted to better understand the independent impact of physical function on edentulism and to adjust for potential confounders. Stata software version 14.0 for MacBook was used for the data analysis. The odds ratio (OR) was estimated with a 95% confidence interval, and a *P*-value $<.05$ was considered statistically significant.

This study was reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies.[31] The IFLS-5 survey was approved by the Institutional Review Boards at RAND in the United States (s0064-06-01-CR01) and written informed consents were obtained prior to participating.

Results

Characteristics of the Study Participants

A total of 2554 older adults were included in the study with a mean age of 67.11 ± 6.08 years. This sample was derived after a selection process that excluded 28 248 participants younger than 60 years old and an additional 361 participants who had missing values in their data (Figure 1). This number exceeded the minimum sample size needed, ensuring high statistical power (more than 90%).

Two hundred eighty participants were edentulous (10.96%; Table 1). Most were in the 60 to 69 age group (48.21%) and had lower educational levels (90%). Additionally, nearly half of them, 46.63% had normal BMI, and 48.39% were non-smokers. Regarding physical functionality, the majority of them exhibited no dependency on daily activities (61.43%) and had normal physical performance (62.50%). However, 40.71% were classified as less physically active as shown in Table 2. Age group, education level, BMI, subjective general health, diabetes, physical capability, physical performance, and ASM were associated with edentulism, but not for gender, residency, hypertension, depressive symptoms, smoking, food consumption score, and physical activity.

Association Between Physical Function and Edentulism in Older Adults

Given that physical function and edentulism were age-related conditions, analysis was conducted across different age groups (Figure 2). The analysis revealed different findings regarding the relationship between physical performance and edentulism. Low physical performance and edentulism were significantly associated with those aged 60 to 69 years (OR 2.06, 95% CI 1.38-3.08; $P=.000$). In contrast, for those aged 70 to 79 years, low physical performance (OR 1.69, 95% CI 1.13-2.52; $P=.010$), low ASM (OR 1.58, 95% CI 1.05-2.36; $P=.028$), and the presence of 1 dependency on ADL/IADL (OR 1.86, 95% CI 1.11-3.10; $P=.018$) were associated with edentulism. However, for those aged 80 years or above, the analysis did not find any significant associations between physical function variables and edentulism.

Figure 3 illustrates the association between physical function and edentulism after adjusting for all possible confounders in all age groups. In the 60 to 69 years age group, edentulism was found to be associated with low physical performance (OR 2.02, 95% CI 1.32-3.09; $P=.001$). For older adults aged 70 to 79 years, low physical performance (OR 1.62, 95% CI 1.04-2.54; $P=.033$) and 1 dependency on ADL/IADL (OR 1.75, 95% CI 1.02-2.98; $P=.04$) were associated with edentulism. Meanwhile, in older adults aged ≥ 80 years, having 2 or more dependencies on ADL/IADL (OR 4.02, 95% CI 1.15-13.99; $P=.029$) was significantly associated with edentulism.

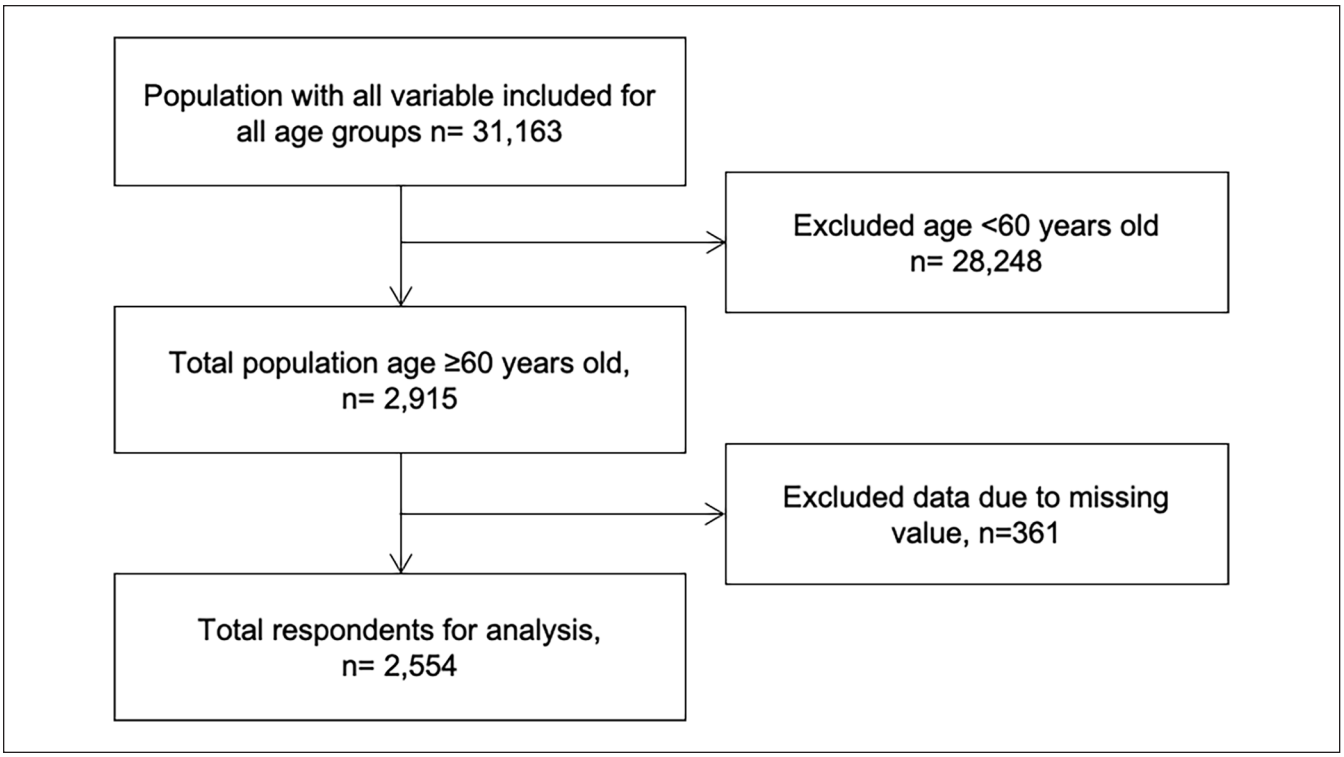

Figure 1. Participant selection.

Table 1. Prevalence of Edentulism Based on Sociodemographic Characteristics.

Sociodemographic characteristics	Prevalence (%)	95% CI
Overall	10.96	9.81-12.24
Age group (years)		
60-69	7.68	6.52-9.02
70-79	17.39	14.74-20.41
≥80	23.58	16.43-32.63
Education level		
Lower	11.67	8.69-18.96
Higher	7.07	4.92-10.06
Gender		
Female	11.13	9.52-12.98
Male	10.8	9.21-12.62
Residency		
Rural	11.14	9.48-13.07
Urban	10.8	9.26-12.57

Discussion and Conclusions

This study revealed statistically significant associations between several sociodemographic characteristics and edentulism. In particular, this study showed a substantial association between age groups. The prevalence of edentulism increased significantly throughout age, with 7.67% in those aged 60 to 69 years, 17.39% in those aged 70 to 79 years, and 23.58% in the population aged ≥ 80 years. Similar to previous studies, this result indicated an increased risk of edentulism with advancing age.[3,32,33] This may be attributed to cumulative oral health problems, chronic diseases, adverse drug reactions, dietary choices, limited access to dental services, and physical limitations.[34-37]

Low physical performance was also found to be associated with edentulism in the 60 to 69 and 70 to 79 groups, highlighting that decreased physical function was a strong predictor of edentulism in older adults.[11] However, several studies have shown different findings. Reduced muscular strength, which is the main cause of declining physical function in older adults, may make it more challenging for older individuals to maintain good oral hygiene and schedule dental visits.[11,38,39] Inadequate oral hygiene subsequently increases the risk of periodontitis, leading to tooth loss.[40,41] Moreover, poor oral health may negatively impact systemic health, which is frequently associated with low physical performance.[42] In this study, 679 older adults were hypertensive and 155 were diabetic. Both hypertension and diabetes were known as risk factors for edentulism. The analysis in this study was adjusted not only for sociodemographic and health behavior, but also for systemic diseases, yet the association between low physical performance and edentulism remained significant. Interestingly, no significant association was found among 80 years and older. This may be explained by the increased prevalence of chronic and long-term conditions

Table 2. Characteristics of the Study Participants.

Variable	Total (N = 2554)	Edentulism		*P*-value
		No (n = 2274)	Yes (n = 280)	
Sociodemographic characteristics				
Age, median (IQR)	66 (62-71)	65 (62-71)	70 (64-74)	<.001[a]
Age group, n (%) (years)				
60-69	1758 (68.83)	1623 (71.37)	135 (48.21)	<.001
70-79	690 (27.02)	570 (25.07)	120 (42.86)	
≥80	106 (4.15)	81 (3.56)	25 (8.93)	
Gender, n (%)				.789
Female	1276 (49.96)	1134 (49.87)	142 (50.71)	
Male	1278 (50.04)	1140 (50.13)	138 (49.29)	
Education level, n (%)				.007
Higher	396 (15.51)	368 (16.18)	28 (10.00)	
Lower	2158 (84.49)	1906 (83.82)	252 (90.00)	
Residency, n (%)				.779
Urban	1361 (53.29)	1214 (53.39)	147 (52.50)	
Rural	1193 (46.71)	1060 (46.61)	133 (47.50)	
General health				
BMI, median (IQR)	21.87 (19.21-24.90)	22.07 (19.30-25.03)	20.91 (18.60-23.80)	<.001[a]
BMI, n (%)				.001
Underweight	471 (18.44)	406 (17.85)	65 (23.21)	
Normal	1059 (41.46)	929 (40.85)	130 (46.43)	
Overweight	1024 (40.09)	939 (41.29)	85 (30.36)	
Subjective general health, n (%)				.039
Healthy	1691 (66.21)	1521 (66.89)	170 (60.71)	
Unhealthy	863 (33.79)	753 (33.11)	110 (39.29)	
Hypertension, n (%)				.097
No	1875 (73.41)	1681 (73.92)	194 (69.29)	
Yes	679 (26.59)	593 (26.08)	86 (30.71)	
Diabetes, n (%)				.034
No	2399 (93.39)	2128 (93.58)	271 (96.79)	
Yes	155 (6.07)	146 (6.42)	9 (3.21)	
Depressive symptoms, n (%)				.790
No	2274 (89.04)	1738 (88.95)	536 (89.33)	
Yes	280 (10.96)	216 (11.05)	64 (10.67)	
Health behavior				
Smoking, n (%)				.156
Non-smoker	1388 (54.35)	1251 (55.01)	137 (48.93)	
Former smoker	307 (12.02)	269 (11.83)	38 (13.57)	
Current smoker	859 (33.63)	754 (33.16)	105 (37.50)	
Food consumption score, n (%)				.283
Poor	191 (7.48)	166 (7.30)	25 (8.93)	
Borderline	508 (19.89)	461 (20.27)	47 (16.79)	
Acceptable	1855 (72.63)	1647 (72.43)	208 (74.29)	
Physical activity, n (%)				.212
Highly active	823 (32.22)	733 (32.23)	90 (32.14)	
Moderate active	796 (31.17)	720 (31.66)	76 (27.14)	
Less active	935 (36.61)	821 (36.10)	114 (40.71)	
Physical function				
Physical capability, n (%)				.001
No ADL/IADL	1808 (70.79)	1636 (71.94)	172 (61.43)	
1 ADL/IADL	417 (16.33)	359 (15.79)	58 (20.71)	
2 or more ADL/IADL	329 (12.88)	279 (12.27)	50 (17.86)	
Physical performance, n (%)				<.001
Normal	1971 (77.17)	1796 (78.98)	175 (62.50)	
Low	583 (22.83)	478 (21.02)	105 (37.50)	
Appendicular skeletal muscle mass, n (%)				<.001
Normal	1534 (60.06)	1395 (61.35)	139 (49.64)	
Low	1020 (39.94)	879 (38.65)	141 (50.36)	

Note. IQR = interquartile range; BMI = body mass index; ADL = activities of daily living; IADL = instrumental activities of daily living.
[a]Mann-Whitney *U* test was performed to determine the differences between edentulism status.

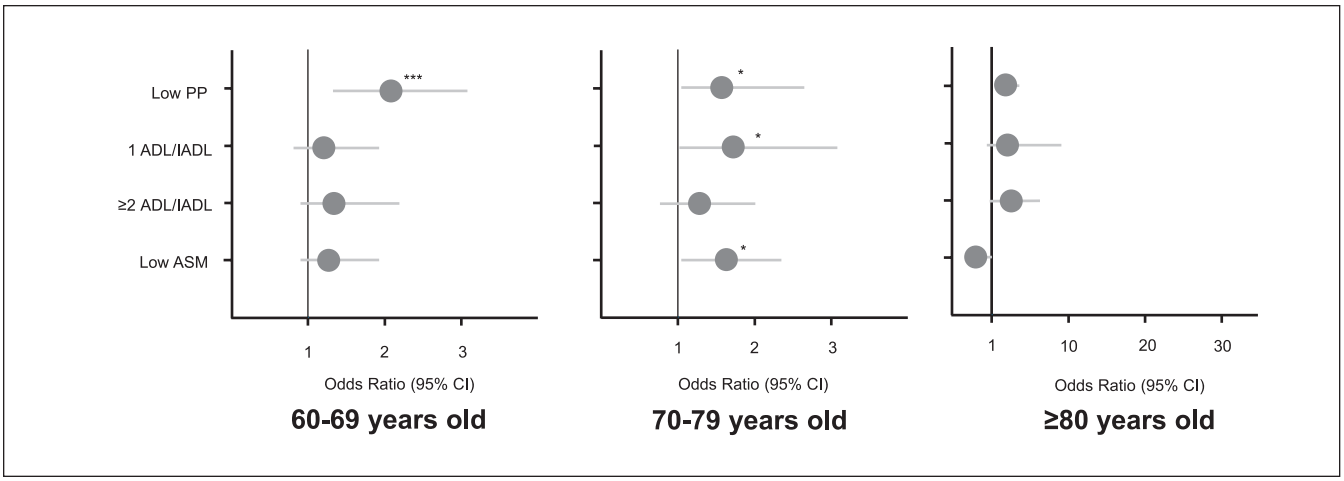

Figure 2. Crude odds ratio between physical function and edentulism by age groups.
Note. PP = physical performance; ADL = activity daily living; IADL = instrumental activity daily living; ASM = appendicular skeletal muscle mass.
*$P < .05$. ***$P < .001$.

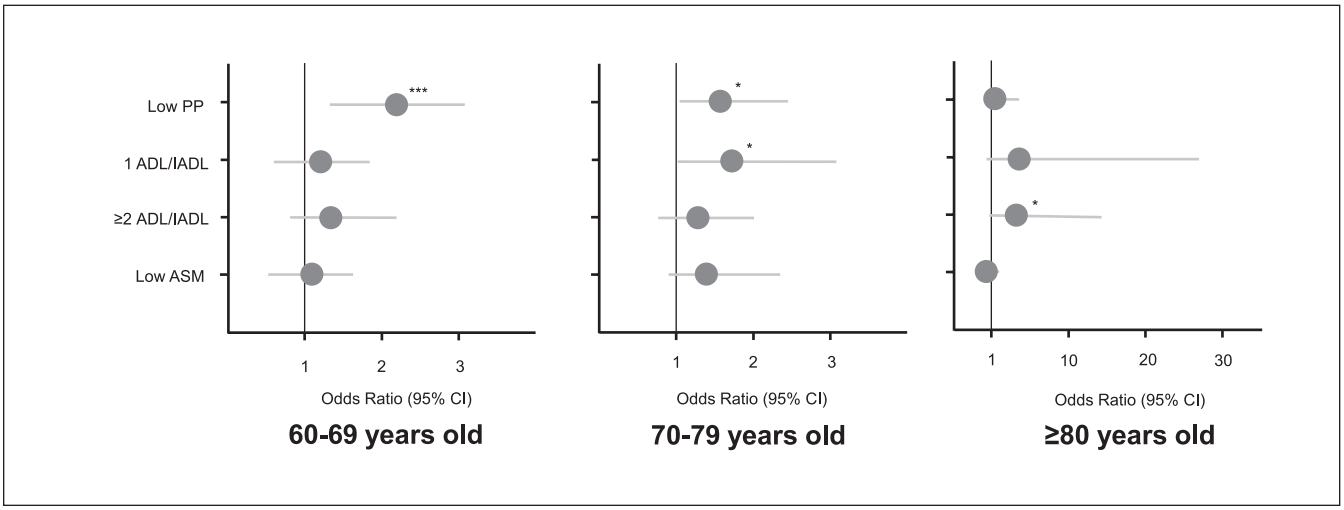

Figure 3. Adjusted odds ratio between physical function and edentulism by age group after controlling for all potential confounders.
Note. PP = physical performance; ADL = activity daily living; IADL = instrumental activity daily living; ASM = appendicular skeletal muscle mass.
*$P < .05$. ***$P < .001$.

increase with age, which resulted from physiological and psychological changes over time.[43,44] These conditions may have already impacted older adults earlier in life and influence both edentulism and declines in physical function.[45] Consequently, the direct association between physical function and edentulism could be less distinct among this age group. Additionally, the lack of significant association might also be related to the low number of participants (8.93%).

Dependency on ADL/IADL was another factor associated with edentulism. According to a cohort study, disabilities tend to increase gradually at first and then accelerate with age.[46] This study found that dependency on ADL/IADL was significantly associated with an increased risk of edentulism in the 70 to 79 age group and ≥80 age group, even after adjusting for all potential confounders, but not in the 60 to 69 age group. Similar studies demonstrated that IADL scores increased significantly after 14 years and were affected by cognitive decline.[47] Dependency on ADL was associated with an increased risk of oral health problems. The likelihood of having oral health problems was sixfold more likely in older persons with ADL dependency than in those without.[48] Several studies suggested that physical dependency may influence their ability to maintain oral health, possibly due to limitations in oral self-care.[48] Inadequate oral hygiene habits and the necessity for help with daily activities were the primary risk factors for developing dental caries.[49] As

reported previously, older adults with ADL dependency experienced poor oral hygiene.[48] Besides the limitations on oral self-care, people with ADL/IADL dependency may also have difficulty receiving dental services, which might be a contributing factor to this association.[50,51] Consequently, this situation is comparable to how low physical performance is linked to higher rates of edentulism. This finding was similar to previous research.[4,48,52]

However, this study has several limitations that need to be considered. First, there was a chance of potential bias because the edentulism data was self-reported. Secondly, the study was cross-sectional, which makes it challenging to identify the cause-and-effect relationship. Therefore, the results should be interpreted with caution. Future studies should incorporate an oral examination in addition to added information on denture wear and functional dentition to completely comprehend the relationship between physical function and edentulism.

In conclusion, this study demonstrated that low physical performance was significantly associated with edentulism in the 60 to 69, and 70 to 79 age groups, with the association diminishing in advanced age. Dependency on ADL/IADL also demonstrated a significant association with edentulism in older adults aged 70 to 79, and ≥80 years. These findings highlighted the importance of maintaining natural teeth and improving oral health during the aging process, especially for individuals with physical function limitations. Comprehensive interventions targeting both physical function and oral health are crucial to enhancing the quality of life in older adults.

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Author Contribution

RP designed the analysis, analyzed and interpreted the data, and drafted the manuscript. MF analyzed and interpreted the data. OMMR reviewed the manuscript. DH and YM supervised the study and reviewed the manuscript. All authors read and approved the final manuscript.

Data Availability

The datasets supporting the conclusions of this article are available in the RAND repository, https://www.rand.org/well-being/social-and-behavioral-policy/data/FLS/IFLS.html

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical Considerations

The IFLS-5 survey was approved by the Institutional Review Boards at RAND in the United States (s0064-06-01-CR01).

Consent to Participate

All participants provided written informed consent prior to participating. The consent was obtained from the parties conducting the IFLS-5 survey.

Consent for Publication

Not applicable.

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