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Investigating The Influence of Tooth Loss on Salivary Flow Rate: A Community-Based Report

Aida Fadhilla Darwis[1], Wilda Hafny Lubis[1], Pocut Astari[1], Nasya Ayu Viandini[2], Jesslin Priskila[2]
[1] *Oral Medicine Department, Faculty of Dentistry, Universitas Sumatera Utara, Medan, 20155, Indonesia*
[2] *Faculty of Dentistry, Universitas Sumatera Utara, Medan, 20155, Indonesia*
Corresponding Author: aida.fadhilla@usu.ac.id

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ABSTRACT

Increasing age has been reported to be associated with a higher prevalence of tooth loss and a greater risk of decreased salivary flow rate. This is because physiological aging affects both the dentition and salivary gland function. Degenerative changes in the oral tissues has also been shown to reduce glandular efficiency. Therefore, this study aims to analyze salivary flow rate based on the number of missing teeth in the elderly. The current study is part of a Community Service activity conducted at Martubung Public Health Center, Medan, in 2023. The sample population included elderly individuals aged ≥60 years who regularly participated in elderly posyandu (integrated health service posts) activities, with a total sample of 50 participants consisting of 38 females and 12 males. For each participant, the number of remaining teeth was counted, followed by the collection and measurement of both unstimulated and stimulated salivary flow rate for 5 minutes. The data obtained were then analyzed using the Pearson test. The results showed that the group with 15–24 missing teeth had the highest number of elderly individuals, totaling 21. In addition, unstimulated and stimulated salivary flow rate were highest in the group with 1–14 missing teeth, with mean values of 1.79±0.90 ml/min and 2.73±1.39 ml/min, respectively. The Pearson test showed a significance value of 0.05. Based on the analysis results, a higher salivary flow rate is associated with fewer missing teeth among the elderly.

Keywords: Number of Teeth, Salivary Flow Rate, Elderly

ABSTRAK

Penambahan usia memengaruhi peningkatan prevalensi kehilangan gigi dan risiko untuk mengalami penurunan laju alir saliva. Penelitian ini bertujuan untuk menganalisis laju alir saliva berdasarkan jumlah kehilangan gigi pada lansia. Penelitian ini merupakan hasil kegiatan Pengabdian kepada Masyarakat yang diadakan di Puskesmas Martubung Medan tahun 2023. Populasi pada penelitian ini meliputi lansia yang berusia ≥60 tahun dan rutin mengikuti kegiatan posyandu lansia dengan besar sampel sebanyak 50 subjek, terdiri dari 38 perempuan dan 12 laki-laki. Setiap sampel dihitung jumlah gigi yang tersisa kemudian dilakukan pengumpulan dan perhitungan laju alir saliva tidak terstimulasi dan terstimulasi selama 5 menit. Data dianalisis menggunakan Uji Pearson. Hasil penelitian ini mendapatkan jumlah kehilangan gigi sebanyak 15-24 gigi menjadi kelompok dengan jumlah lansia terbanyak, yaitu 21 orang. Laju alir saliva, baik tidak terstimulasi maupun terstimulasi, berdasarkan jumlah kehilangan gigi sebanyak 1-14 gigi signifikan menjadi kelompok dengan laju alir saliva tertinggi, yaitu 1,79±0,90 dan 2,73±1,39. Hasil uji Pearson mendapatkan nilai signifikansi sebesar 0,05. Berdasarkan hasil analisis pada penelitian ini dapat disimpulkan bahwa semakin tinggi laju alir saliva maka semakin sedikit kehilangan gigi yang dialami lansia.

Kata kunci: Jumlah Gigi, Laju Alir Saliva, Lansia

1. Introduction

According to the United Nations (2024), the number of individuals aged 60 years and older is rapidly increasing in developing countries, with global projections reaching 2.1 billion by 2050. [1] Statistics Indonesia (BPS) also reported a demographic shift, where the elderly population (≥60 years) reached about 12% in 2024, with a dependency ratio of 17.08% [2]

Several studies have shown that tooth loss and reduced salivary flow remain major oral health concerns in the elderly. A 2024 cross-sectional study reported that 61.5% of participants (mean age 65.6 years) had hyposalivation, and 43.85% experienced xerostomia. [3] Similarly, a Japanese study found that 40% of individuals aged ≥70 years had reduced stimulated salivary flow (SSFR), and 20% had both low unstimulated flow (USFR) and xerostomia. These results showed that salivary hypofunction often occurred without dry mouth symptoms. [3,4] In Indonesia, 30.6% of individuals aged >65 years and 29% aged 55–64 years had experienced tooth loss, [5] which reduced salivary flow rate and masticatory efficiency. [6] Diminished saliva flow impairs its cleansing, protective, and lubricating functions, making the oral mucosa more prone to irritation, pain, and burning sensations. [7]

Despite the prevalence of these oral health conditions, there are no studies on the direct correlation between the number of remaining teeth and both stimulated and unstimulated salivary flow rateamong the elderly population in Indonesia. Therefore, the current study contributes new insights by integrating clinical measurements and community-based data to better understand oral physiological changes in aging. This can serve as a foundation for preventive and therapeutic innovations in geriatric dentistry.

2. Materials and Methods

This study received ethical approval under number 1108/KEPK/USU2023. Data was collected through a Community Service Program titled *Analysis of Salivary Flow Rate Affected by Tooth Loss in the Elderly: A Community Service Report*, conducted at Martubung Health Center in 2023. A total of 3841 (>60 years) elderly people in the sub-district were included in this study, though only 100 to 150 regularly visited the Health Center. The program ran over 4 consecutive days in different locations, with an average of 64 elderly attendees daily. On one of those days, 67 attended, with 50 who met the inclusion criteria and were selected as samples using a purposive sampling method. The inclusion criteria were elderly individuals (≥60 years), both male and female, who regularly attended posyandu activities, had controlled systemic diseases (e.g., hypertension or diabetes mellitus), were under medical supervision at the Martubung Community Health Center, had experienced tooth loss without using prostheses, and were physically and mentally healthy (no dementia or psychiatric disorders). The exclusion criteria included those with uncontrolled systemic diseases, those taking medications known to significantly alter salivary flow (such as anticholinergics, antidepressants, or sedatives) beyond standard therapeutic doses, and individuals unwilling or unable to cooperate during data collection.

Participants were asked to avoid food or drink, except water, for 30 to 60 minutes before saliva collection. The process required counting the remaining functional permanent teeth, especially in chewing, in the oral cavity, directly using a mouth mirror and a sonde. Subsequently, both unstimulated and stimulated salivary flow rate were collected using the spitting method, starting with the unstimulated salivary flow rate first. Salivary flow rate was collected for 5 minutes by collecting saliva in the oral cavity, after which the saliva was spat out into a measuring cup every 1 minute. This was measured by observing the scale printed on the measuring cup and then dividing the result by 5 to get the salivary flow rate value in ml/minute. [8]

All collected data were analyzed using the Statistical Package for the Social Sciences (SPSS). The Pearson correlation test was applied to determine the significance of the relationship between unstimulated and stimulated salivary flow rate based on the number of remaining teeth. The number of missing teeth was categorized into 3 groups, as well as the correlation and strength of association among these groups were further evaluated using the Pearson correlation coefficient. Statistical significance was set at $p < 0.05$.

3. Results

This study was attended by 50 elderly individuals, the majority were women (38).

Table 1. Gender demographics of the study subjects

Gender	Frequencies (n)	Percentage (%)
Men	12	24%
Women	38	76%
Total	50	100%

The elderly participants in this community service activity were aged between 60 and 93 years, with the majority lower than the 60 to 65 age range. The mean age of participants in this study was 68 years.

Table 2. Age demographics of the study subjects

Age (year)	Frequencies (n)	Percentage (%)
60-65	25	50
66-70	16	32
71-75	5	10
76-80	2	4
86-90	1	2
91-95	1	2
Total	50	100

Table 3. Frequency distribution of the number of missing teeth

Number of missing teeth	Frequencies (n)	Percentage (%)
1-14 teeth	18	36%
15-24 teeth	21	42%
25-32 teeth	11	22%
Total	50	100%

Based on Table 3, the group with 15 to 24 missing teeth represented the largest proportion of elderly participants, accounting for 42% of the total sample. However, the group with 25 to 32 missing teeth had the smallest number of participants, comprising only 22% of the sample.

Table 4. Frequency distribution of unstimulated and stimulated salivary flow rate

Variable	Mean±SD (ml/min)	Min (ml/min)	Max (ml/min)
Unstimulated salivary flow rate	1.42±0.75	0.50	3.30
Stimulated salivary flow rate	2.16±1.04	0.75	4.60

Based on Table 4, the values obtained the mean and standard deviation of stimulated salivary flow rate were 2.16±1.04 ml/minute, and unstimulated was 1.42±0.75 ml/minute.

Table 5. Analysis stimulated salivary flow rate in relation to the number of missing teeth

Number of missing teeth	Stimulated salivary flow rate (r)	P-Value
1-14 teeth	-0.388	0.0147
15-24 teeth	-0.581	0.0023
25-32 teeth	-0.539	0.0015

Based on the analysis using the Pearson test, there was a significant difference ($p<0.05$) in stimulated salivary flow rate according to the number of missing teeth, with several p-value: 0.0147, 0.0023, 0.0015. The stimulated salivary flow rate tended to decrease as the number of missing teeth increased.

Table 6. Analysis stimulated salivary flow rate in relation to the number of missing teeth

Number of missing teeth	Unstimulated salivary flow rate (r)	P-Value
1-14 teeth	-0.197	0.228
15-24 teeth	-0.486	0.014
25-32 teeth	-0.470	0.007

Based on Table 6, a moderate and significant negative correlation was observed between the number of remaining teeth and unstimulated salivary flow rate in Groups 2–3 ($r = –0.486$, $p = 0.014$) and Groups 3–1 ($r = –0.47$, $p = 0.007$), showing that a higher tooth count was associated with lower unstimulated salivary flow.

Table 7. Analysis of the variation in salivary flow rate according to the number of missing teeth

Number of remaining teeth	Unstimulated salivary flow rate (*Mean*±*SD*) (ml/min)	r	Stimulated salivary flow rate (*Mean*±*SD*) (ml/min)	r
1-14 teeth	1.64±0.90	-0.400*	2.43±1.39	-0.419*
15-24 teeth	1.46±0.63		2.00±0.57	
25-32 teeth	0.86±0.13		1.27±0.49	

Pearson Test, r = correlation, *p<0.005=significant

Pearson's analysis showed a significant moderate negative correlation between the number of remaining teeth and salivary flow, with $r = –0.400$ ($p = 0.0036$) for stimulated and $r = –0.419$ ($p = 0.0022$) for unstimulated saliva.

4. Discussion

The majority of participants in this study were women (n = 38), consistent with national data from Statistics Indonesia (BPS), reporting that elderly women (51.81%) outnumbered men (48.19%).[2] Elderly women were generally more vulnerable to health problems, visited health centers more frequently, and were more active in health education activities. [9–11] The mean age of participants was 68 years, with most having lost 15 to 24 teeth (Table 3). Similar studies by Yuan et al. in China (mean age 74 years) and Okamoto et al. in Japan (mean age 71 years) reported fewer than 10 missing teeth on average. [6,11] In this study, the extent of tooth loss was influenced by education level and accessibility to dental health services. Most participants had only completed elementary school, which could limit their understanding of oral health. [11] In addition, the considerable distance from their homes to dental facilities reduced the frequency of dental visits, contributing to the high prevalence of tooth loss among the elderly. [12]

This study showed a significant negative correlation between the number of remaining teeth and the stimulated salivary flow rate across all group comparisons. The Pearson correlation values (Table 5) were –0.388 ($p = 0.0147$) for groups 1 vs 2, –0.581 ($p = 0.0023$) for groups 2 vs 3, and –0.539 ($p = 0.0015$) for groups 3 vs 1. These results showed that individuals with fewer teeth had lower stimulated salivary flow. Reduced dentition limited chewing efficiency and occlusal contact, decreasing mechanical stimulation to salivary glands, which subsequently lowered salivary secretion. This result was consistent with the physiological understanding that mastication acted as a key trigger for stimulated saliva production through activation of gustatory and masticatory reflexes. [13,14]

Many studies have shown a clear connection between tooth loss, weak occlusal support, and lower saliva production. Older adults with fewer teeth usually have a much lower salivary flow rate [15], and when occlusal support is reduced, it also leads to weaker salivation and changes in the kind of food texture they prefer [16]. Other findings showed that tooth wear can reduce both salivary flow and buffering capacity, which then increases problems like dry mouth, poorer oral health, and a higher chance of caries [17,18]. In line with these earlier results, this study also found a strong negative relationship between the number of remaining teeth and salivary flow. People who still had around 25 to 32 teeth showed higher stimulated saliva flow compared to those with moderate or severe tooth loss. This pattern suggests a dose–response effect, meaning that the more teeth lost, the lower the salivary stimulation becomes. From a clinical point of view, keeping the gums healthy, stopping caries early, and offering prosthodontic care when needed are important for protecting chewing ability and supporting the salivary glands. Overall, preserving teeth plays a major role in maintaining oral balance in older adults [13,15,17].

The grouped correlation analysis in this study showed a weak and non-significant negative link between the number of remaining teeth and unstimulated salivary flow in Groups 1–2 (Pearson $r = -0.20$, $p = 0.23$). But when Group 3 was included, the negative relationship became moderate and statistically meaningful. This means that people who had more teeth could sometimes show lower unstimulated saliva flow, especially when those with many teeth were compared to those with fewer. These findings agree with earlier studies showing that reduced saliva is often seen in people with higher levels of caries or periodontal problems, and highlight how oral structure and salivary gland function can interact in complicated ways [19,20].

Mechanistically, the association reflected the interdependence of masticatory function, salivary gland health, and oral homeostasis. Greater tooth retention often implied preserved occlusion and chewing load, but in populations maintaining higher dentition, there could also be increased age, medication use, or latent salivary gland compromise, leading to reduced flow. Clinical investigations documented that salivary gland hypofunction correlated with dental status and protective salivary roles [21,22]. This supported the notion that routine assessment of unstimulated salivary flow must be integrated into dental examination, specifically in patients with extensive dentition or prosthetic retention. Due to these results, dental practitioners must consider salivary support strategies (hydration, sialogogues, fluoride supplementation) in patients with high tooth count yet low flow to pre-empt irreversible oral disease sequelae.

Similar to Liang S et al.'s study, this study (table 6, table 7) found out salivary flow rate was good in either unstimulated or stimulated conditions, based on the number of remaining teeth. Approximately 18 to 31 teeth significantly had the highest mean and standard deviation values (unstimulated flow rate 1,790.90 ml/minute and stimulated flow rate 2.73±1.39 ml/minute) compared to the group with fewer remaining teeth. [19] A decrease in salivary flow rate could occur in the elderly with a few remaining teeth because the natural stimulus that stimulated saliva secretion was chewing, and during mastication, a complete set of teeth was needed in order to produce maximum chewing force. [20] Takeuchi's study showed that the number of remaining teeth could influence the rate of saliva flow in the elderly.[21] Sawair et al. conducted a study on the elderly in Jordan and found that the lower the number of remaining teeth, the lower the salivary flow rate.[22]

This study showed a significant moderate negative correlation between the number of remaining teeth and both stimulated ($r = -0.400$, $p = 0.0036$) and unstimulated ($r = -0.419$, $p = 0.0022$) salivary flow rate. In addition, these results showed that individuals with fewer teeth tended to exhibit lower salivary secretion. This relationship was attributed to reduced masticatory activity and diminished mechanical stimulation of the salivary glands following tooth loss, which limited salivary reflexes. Similar results were reported by Sari et al, who found that older adults with tooth loss and reduced occlusal support showed decreased salivary flow and altered food texture preferences, reflecting impaired oral function. [23] In addition, Islas-Granillo et al observed that older adults with compromised dentition had lower stimulated salivary flow, confirming that tooth retention was an important factor in maintaining salivary gland function. [24]

Salivary secretion was known to be influenced by both physiological and mechanical factors. According to Schwerdt et al, variations in salivary ion composition and flow rate were regulated independently in healthy individuals, suggesting that tooth loss primarily affected the mechanical, rather than the biochemical, component of salivation. [25] In addition, Winnier et al showed that masticatory stimulation,

such as chewing xylitol or stevia gum, significantly increased salivary flow rate, reinforcing the role of oral activity in maintaining glandular stimulation. [26]

5. Conclusion

In conclusion, a higher salivary flow rate is associated with fewer missing teeth among the elderly. Participants with a greater number of remaining teeth (18–31) have significantly higher salivary flow rate in both conditions. This is consistent with previous study suggesting that retaining more natural teeth supports stronger chewing function and greater saliva secretion.

6. Acknowledgements

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7. Conflict of Interest

The authors declare no conflicts of interest.

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