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ORIGINAL ARTICLE

Salivary Changes, Systemic Conditions, and Medication Use in Independently-Living Aged: A Cross-Sectional Study

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ABSTRACT

Objective: To determine the unstimulated salivary flow, pH, and buffering capacity and their associations with systemic conditions and medication use in independently living aged. **Material and Methods:** This cross-sectional study included 72 participants with a minimum of 60 years recruited in Belo Horizonte, Brazil. A questionnaire was used to collect age, sex, presence of systemic diseases, and medications in continuous use. Salivary data collection was performed to determine unstimulated salivary flow, pH, and buffering capacity. Descriptive, bivariate, and multivariate analyses were performed ($p<0.05$). **Results:** Most of the sample had at least one systemic disease (81.9%) and used at least one medication (79.2%). Female participants ($p=0.01$), those with five or more systemic diseases ($p<0.01$), and hypertension ($p=0.04$) had reduced salivary flow. Participants with systemic diseases ($p=0.02$), taking any medication ($p=0.04$), in a polypharmacy regimen, and presenting hypertension ($p=0.02$) had more acidic salivary pH. Participants with diabetes had average salivary buffering capacity ($p=0.02$). In the adjusted multiple regression models, no explanatory variable was significantly associated with the salivary outcomes. **Conclusion:** Systemic alterations and medication use appear to be related to salivary changes in older adults. Integrative assessment of older adults is fundamental to identifying and controlling the factors that may modify their salivary characteristics.

Keywords: Aged; Saliva; Xerostomia; Dental Care for Aged.

Introduction

Saliva is related to the prevention and progression of oral diseases, playing essential roles in cleansing and maintaining homeostasis of the oral cavity [1,2]. Its composition consists of fluids from salivary glands, desquamated cells from the oral mucosa, bacterial products, and food debris [3,4]. Saliva is responsible for oral lubrication necessary for speech, chewing, swallowing, oral trauma reduction, and mucosa and teeth protection against aggressive agents [1,3,5]. Through its buffering capacity, it also works to maintain oral pH and neutralize acids present or in contact with the mouth [1,3,5].

The functional properties of saliva can be affected when its flow decreases, increasing the risk and susceptibility to oral diseases [1,6,7]. Salivary flow is reduced when ≤ 0.1 mL/min at rest or ≤ 0.5 mL/min after stimulation, thus defining hyposalivation [1,8]. Hyposalivation is commonly associated with xerostomia, described as a "dry mouth" complaint. A higher prevalence of dry mouth was found in the aged [9], and it is estimated that approximately 30% of the population over 65 years suffer from salivary hypofunction [4]. The presence of systemic conditions, like hypertension and diabetes, is familiar in older adults, which may affect their salivary function, along with medications to control them [10-15]. In addition to the older population using a significant amount of medication and being susceptible to their side effects, about 80% of the most prescribed drugs can cause xerostomia [4,5,16-18].

Salivary changes become more severe in older people [9], and their causality is the subject of studies in the literature. Although without a defined consensus [19], it is suggested that associated factors are related not only to aging but also to systemic changes, the use of medications, and head and neck radiotherapy [5,16,20,21]. The controversy arises from the doubt whether salivary hypofunction is a consequence of factors such as polypharmacy and polypathology or is related to degenerations of the glands' parenchyma [22]. Besides, results from different systematic reviews are still conflicting regarding the role played by systemic changes and medication use in salivary alterations [20,23].

Due to population aging and increased life expectancy, studies on the older population are relevant for improving public policies and practices in disease prevention, diagnosis, and treatment. This study aimed to heighten the theme and seek new evidence by determining whether saliva's unstimulated salivary flow, pH, and buffering capacity are associated with systemic conditions and medication use in the independently living elderly.

Material and Methods

Ethical Considerations

The study was approved by the Research Ethics Committee of the Federal University of Minas Gerais (CAAE: 12045119.7.0000.5149). Those who agreed to participate signed an Informed Consent Form.

Study Design and Selection of Participants

This cross-sectional study comprises a non-probabilistic sample and continuous data collection between March and December 2019. The participants were patients treated at the Faculty of Dentistry of the Federal University of Minas Gerais, Belo Horizonte, Brazil, employees, and local community members. Inclusion criteria were older adults 60 years of age or older – the minimum age classified as elderly in Brazil – who could follow the instructions for saliva collection. Those previously or currently submitted to head and neck radiotherapy, patients with Sjögren's Syndrome or other pathological changes in the salivary glands, and residents of long-term institutions were excluded.

Data Collection

After obtaining consent, a questionnaire was used to collect data regarding the participant's age and sex. All participants were asked about systemic diseases and the continuous use of medications. Those with five or more pathologies were classified as having polypathology, and the use of five or more medications was defined as polypharmacy [24].

Saliva Collection and Analysis

Saliva collections were carried out in the morning, and the participants were instructed to fast for one hour before the collection [25]. They were also advised not to smoke or perform oral hygiene during this period. While collecting, participants remained at rest, seated, without swallowing, chewing, or speaking movements. The salivary fluid was collected by depositing saliva in a graduated container on ice for five minutes. The volume of saliva was analyzed, and the measurement of the salivary flow per minute was determined.

The salivary pH was assessed using colorimetric strips (Saliva-Check BUFFER®, GC America Inc., Alsip, IL, USA) inserted into the fluid immediately after collection. According to the manufacturer's information, the pH value was established, and the saliva was classified as normal or moderately acidic. The buffering capacity of saliva was also assessed using strips (Saliva-Check BUFFER®, GC America Inc., Alsip, IL, USA). The saliva was deposited on the specific test strip, and its color changed after a chemical reaction. Then, the graph of color change provided by the manufacturer was consulted, and the buffer capacity was determined and classified as very low, low, or normal.

Statistical Analysis

The collected data were recorded in spreadsheets in Microsoft Excel® and later imported into the IBM SPSS Statistics® v.19 for descriptive and bivariate analysis ($p<0.05$). Multivariate analysis was performed ($p<0.05$) using Stata v.15. Regression models were constructed and adjusted for the three salivary outcomes: salivary flow (Poisson Regression), pH, and buffer capacity (Logistic Regression).

Results

Descriptive Analysis

Seventy-two participants were included in the study (Table 1), with an average age of 67.29 (SD = 6.12). Most individuals were female (55.6%) and were less than 70 years old (69.4%). Most of the sample had at least one systemic alteration (81.9%) and used at least one medication (79.2%).

Considering the salivary outcomes, the salivary flow's median (interquartile distance) was 0.6 (0.4) mL/minute. Most samples had a healthy pH (63.9%) and a lower buffering capacity (72.2%).

Table 1. Descriptive analysis of independent variables.

Variables	N	%
Sex		
Male	32	44.4
Female	40	55.6
Age		
60-69 years	50	69.4
≥ 70 years	22	30.6
Systemic diseases		
No	13	18.1
Yes	59	81.9

Polypathology		
No	62	86.1
Yes	10	13.9
Medication use		
No	15	20.8
Yes	57	79.2
Polypharmacy		
No	51	70.8
Yes	21	29.2
Hypertension		
No	41	56.9
Yes	31	43.1
Diabetes		
No	56	77.8
Yes	16	22.2

Salivary Outcomes Analysis

Table 2 shows the results considering the outcome of salivary flow. In the bivariate analysis, female participants (p=0.01), those with five or more systemic diseases (p<0.001), and hypertension (p=0.004) had lower unstimulated salivary flow. In the multivariate analysis by Poisson regression, no explanatory variable was significantly associated with the salivary flow.

Table 2. Factors associated with unstimulated salivary flow (mL/min) in independently-living elderly.

Variables	Salivary Flow Median (IR)	Bivariate Analysis p-value[1]	Multivariate Analysis PR (95% IC)[2]
Sex			
Male	0.70 (0.45)	0.01*	1
Female	0.40 (0.40)		0.75 (0.42-1.35)
Age			
60-69 years	0.60 (0.40)	0.87	1
70-84 years	0.60 (0.43)		0.98 (0.52-1.87)
Systemic diseases			
No	0.70 (0.51)	0.06	1
Yes	0.60 (0.34)		0.79 (0.39-1.62)
Polypathology			
No	0.60 (0.42)	<0.001*	1
Yes	0.35 (0.30)		0.57 (0.20-1.64)
Medication use			
No	0.70 (0.6)	0.09	1
Yes	0.60 (0.32)		0.81 (0.41-1.61)
Polypharmacy			
No	0.60 (0.5)	0.27	1
Yes	0.50 (0.45)		0.82 (0.41-1.61)
Hypertension			
No	0.60 (0.55)	0.04*	1
Yes	0.44 (0.40)		0.81 (0.44-1.48)
Diabetes			
No	0.60 (0.40)	0.45	1
Yes	0.55 (0.38)		0.96 (0.47-1.96)

[1]Mann-Whitney test; [2]Poisson Regression; IR = Interquartile Range; PR = Prevalence Ratio; IC = Confidence Interval; *p<0.05.

The results for the salivary pH are shown in Table 3. In the bivariate analysis, participants with systemic diseases (p=0.02), taking any medication (p=0.04), in a polypharmacy regimen (p=0.02), and presenting hypertension (p=0.02) had more acidic pH. However, no explanatory variable was significantly associated with salivary pH in the adjusted logistic regression model.

Table 3. Factors associated with unstimulated salivary pH in independently-living elderly.

Variables	Individuals with normal pH N (%)	Bivariate Analysis p-value[1]	Multivariate Analysis OR (95% IC)[2]
Sex			
Male	22 (68.75)	0.44	1
Female	24 (60.00)		0.63 (0.18-2.14)
Age			
60-69 years	33 (66.00)	0.57	1
70-84 years	13 (59.09)		1.22 (0.35-4.33)
Systemic diseases			
No	12 (92.31)	0.02*	1
Yes	34 (57.63)		0.18 (0.01-3.64)
Polypathology			
No	42 (67.74)	0.09	1
Yes	4 (40.00)		0.93 (0.17-5.18)
Medication use			
No	13 (86.67)	0.04*	1
Yes	33 (57.89)		1.43 (0.12-17.28)
Polypharmacy			
No	37 (72.55)	0.02*	1
Yes	9 (42.86)		0.47 (0.12-1.80)
Hypertension			
No	31 (75.61)	0.02*	1
Yes	15 (48.39)		0.41 (0.11-1.48)
Diabetes			
No	36 (64.29)	0.90	-
Yes	10 (62.50)		-

[1]Chi-square test; [2]Logistic Regression; IC = Confidence Interval; OR = Odds Ratio; *p<0.05.

Table 4 represents the analysis considering salivary buffering capacity. In the bivariate analysis, participants with diabetes had normal salivary buffering capacity (p=0.02). In the adjusted logistic regression model, no explanatory variable was significantly associated with the outcome.

Table 4. Factors associated with unstimulated salivary buffering capacity in independently-living elderly.

Variables	Individuals with Normal Salivary Buffering Capacity N (%)	Bivariate Analysis p-value[1]	Multivariate Analysis OR (95% IC)[2]
Sex			
Male	9 (28.13)	0.95	1
Female	11 (27.50)		1.02 (0.32-3.25)
Age			
60-69 years	13 (26.00)	0.61	1
70-84 years	7 (31.82)		1.23 (0.36-4.21)
Systemic diseases			
No	1 (7.69)	0.07	1
Yes	19 (32.20)		6.40 (0.31-130.61)
Polypathology			
No	16 (25.81)	0.35	-
Yes	4 (40.00)		-
Medication use			
No	2 (13.33)	0.16	1
Yes	18 (31.58)		0.57 (0.05-6.61)
Polypharmacy			
No	12 (23.53)	0.21	1
Yes	8 (38.10)		1.04 (0.26-4.07)
Hypertension			
No	10 (24.39)	0.46	-
Yes	10 (32.26)		-

Diabetes			
No	12 (21.43)	0.02*	1
Yes	8 (50.00)		3.04 (0.78-11.78)

[1]Chi-square test; [2]Logistic Regression; IC = Confidence Interval; OR = Odds Ratio; *p<0.05.

Discussion

This study evaluated salivary flow, pH, and buffering capacity in independent-living older adults, assessing their association with systemic conditions and medication use. Females, those with five or more systemic changes, and those with hypertension had lower salivary flow. More acidic salivary pH was found in participants with systemic alterations, including hypertension, using some medications, and polypharmacy. Of note, elders with diabetes were associated with normal salivary buffering capacity. However, including possibly correlated variables in the multiple models, systemic conditions and medications in use were not directly related to salivary alterations.

In this study, the frequency of systemic changes and medications in use was high, consistent with a study that showed 86% of the aged reporting disease and 81% using some medication [22]. In the Brazilian independent-living elderly, 89.3% used at least one medication [11], while the institutionalized ones presented a frequency of 76.5% [26].

Polypathology was associated with decreased salivary flow. Moreover, more acidic salivary pH was found in older adults who had systemic diseases, were using medications, and were taking a polypharmacy regimen. Previous studies have shown dual results. A survey of the Danish older population observed that lower resting flow was associated with a high number of illnesses and medications [22]. Furthermore, as the number of medications increased, the total flow was reduced by 6%, even after age adjustment [22]. Otherwise, no associations were found between the use of medications and saliva production in the Brazilian older population [11,27]. In another study, medication use was associated with a lower salivary flow, but the resting salivary pH was not statistically significant [26]. In our study, the salivary flow was not related to the use of medications since average flow rates were found in most individuals. In addition, we analyzed the use of drugs without distinction between classes or considering the synergistic effect of specific categories. Notwithstanding, the relevance of polypathology and polypharmacy in older adults should be considered since they can induce unwanted drug interactions [22].

Hypertensive individuals had lower salivary flow and pH in the present study. A systematic review failed to correlate hypertensive individuals using specific medication with a significant reduction in salivary flow, even though most included studies have observed this in their samples [13]. Of these reports, only five were exclusively for the older population. A comparison with previous studies also demonstrates the duality of the results. Comparing Japanese elderly without using medications or exclusively under antihypertensive medications, no association was found between the medicated group and salivary flow [12]. However, the multiple regression analysis identified more acidic salivary pH in hypertensive individuals. Likewise, hypertension did not influence the salivary flow, while more acidic stimulated salivary pH was found in hypertensive Indian individuals [10]. These results suggest that such factors alone may not directly affect the salivary characteristics under analysis.

Decreased salivary flow can lead to dietary changes with increased intake of cariogenic foods, in addition to a reduction in the protective properties of saliva, such as diminished buffering capacity [1,8]. The role of salivary buffer systems is to prevent the drop in salivary pH, neutralizing intrinsic and extrinsic acids in the diet [2]. In this study, buffering capacity did not have significant associations, except for diabetes, in the bivariate

analysis. Although diabetes mellitus is often associated with changes in salivary flow and composition [7], previous studies have found no association between diabetes and salivary buffering capacity [28], and there has been a reduction in this feature [29]. Regarding salivary flow, no significant associations between diabetes and total unstimulated salivary flow were found in the current study, which agrees with previously published reports [28,30]. Accordingly, systemic conditions' co-existence seems more relevant for flow alterations since diabetic individuals with associated hypertension and under treatment with beta-blockers showed lower salivary flow [28].

The relationships between the variables are complex since aging is associated with an increase in chronic medical conditions, consequently increasing the use of medications [9,17,18]. However, in the present study, age was not associated with the salivary changes studied: flow, pH, and buffering capacity. This may have happened due to characteristics inherent to the sample evaluated, mainly older individuals under 70 (69.4% of our sample). This may justify the difference in results between the bivariate and multivariate analyses performed here. A bivariate analysis, however, revealed explanatory factors related to salivary changes. Such factors deserve attention and further research.

There is evidence of histomorphological changes in salivary glands due to aging [21], as well as the potential for reducing saliva due to systemic changes and the use of medications [18,23]. Herein, even though the pathophysiology of the salivary glands was not directly assessed, the current data indicate that systemic conditions and drug intake may be partially responsible for the salivary changes observed. According to Smidt et al. [22], factors such as age, systemic diseases, and medications could still affect the salivary glands differently, considering their function and structure.

The present study has some limitations that must be considered. The sample was obtained at a university clinic for convenience, which may lead to selection bias. Although data from this survey cannot be fully extrapolated to the rest of the population, it is vital to acknowledge the broad analysis proposed here. Variables such as age and gender were considered, including a significant number of morbidities and polypharmacy. Such analysis is considered relevant since no consensus has been reached on causal factors leading to salivary changes in the aged [19]. It is known that oral health is directly affected by changes in salivary composition, reduced buffering capacity, altered concentrations of electrolytes, and antibacterial components [8]. Such changes can lead to dysbiosis processes and an increased risk of oral diseases [2,3].

Conclusion

The presence and number of systemic alterations, hypertension, and the use of many medications were initially associated with decreasing essential salivary properties for maintaining oral balance. However, the multivariate model did not sustain this direct association for the different outcomes. This highlights the importance of fully assessing older patients to identify and control the factors that, together, may modify their salivary characteristics.

Authors' Contributions

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All authors declare that they contributed to a critical review of intellectual content and approval of the final version to be published.

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Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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