Pesquisa Brasileira em Odontopediatria e Clínica Integrada 2024; 24:e220006
https://doi.org/10.1590/pboci.2024.014
ISSN 1519-0501 / eISSN 1983-4632

ORIGINAL ARTICLE

Factors Associated with Hyposalivation in Brazilian Adults

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Academic Editor: Wilton Wilney Nascimento Padilha

Received: January 09, 2022 / **Review:** March 30, 2023 / **Accepted:** Abril 20, 2023

How to cite: Carvalho HN, Santos YL, Lima KC, Bernardino IM, Granville-Garcia AF, Firmino RT, et al. Factors associated with hyposalivation in Brazilian adults. Pesqui Bras Odontopediatria Clín Integr. 2024; 24:e220006. https://doi.org/10.1590/pboci.2024.014

ABSTRACT

Objective: To determine the occurrence of hyposalivation in Brazilian adults and its association with individual determinants, such as the use of medications, systemic conditions, smoking, and alcohol consumption. **Material and Methods:** A cross-sectional study with 402 adults was developed. Information was collected on sociodemographic and general health characteristics, and sialometry was performed with stimulated salivary flow. It indicated low salivary flow when ≤ 0.7 mL/min. Bivariate and multivariate analyses were conducted using a decision tree ($p<0.05$). **Results:** The sample was comprised predominantly of women (68.2%) aged ≤ 29 years (25.4%). Most participants did not use medication (56.7%). Among systemic diseases, the most cited was hypertension (25.1%). More than a third of the participants presented hyposalivation (40.3%), being associated with the following variables: age between 50 to 59 years ($p=0.011$), female sex ($p<0.001$), menopause ($p=0.001$), use of alcohol ($p=0.033$), systemic disease ($p=0.002$) and medication use ($p<0.001$). In multivariate analysis, in addition to sex ($p<0.001$) and hypertension ($p=0.005$), an association was also found between hyposalivation and diabetes ($p=0.014$). **Conclusion:** Factors associated with hyposalivation in adults were sex and the presence of hypertension or diabetes.

Keywords: Prevalence; Epidemiology; Salivation; Hyposalivation; Xerostomia.

Introduction

Hyposalivation is a disorder that consists of decreased saliva production or its total absence [1,2]. The reduction in salivary flow or changes in its composition are conditions that can produce the sensation of "dry mouth" [1,3,4]. The "dry mouth" sensation is called xerostomia and can cause discomfort and numerous disorders [5-7].

Hyposalivation can trigger several effects with a negative impact on quality of life. Most individuals with hyposalivation are constantly thirsty, leading to frequent sleep interruptions to drink water. This routine can negatively impact memory, in addition to favoring insomnia and depression [8,9]. Hyposalivation can also hinder food intake, predisposing nutritional deficits and weight loss [10,11]. For users of complete dentures, hyposalivation can also compromise the retention of the denture, which can lead to embarrassing situations [6,12,13].

Hyposalivation in the presence of a decreased immune response favors the occurrence of oral infections [1,5], such as tooth decay due to the accumulation of dental biofilm and low saliva buffering capacity [6,14,15]. Fungal infections, especially candidiasis, can also occur due to the imbalance of the oral microbiota [5,6]. The main complaints of individuals with hyposalivation are dysphagia, dysgeusia, and a burning sensation in the oral cavity [10,12]. It is essential to analyze social determinants in cases of hyposalivation since this condition is noted to be correlated with socioeconomic and sociodemographic factors, lack of benefits such as retirement/pension, residents in nursing homes, dental factors, individuals with poorer oral hygiene such as those who brush their teeth less than twice a day, and edentulous individuals without denture use [2]. Due to the critical role that saliva plays in the oral cavity, the numerous disorders resulting from hyposalivation reduce the quality of life of affected individuals [7,16], reinforcing the need to detect the presence of this condition. Studies generally address hyposalivation in specific groups, such as the elderly population or individuals with systemic diseases [2,9,17], such as diabetes mellitus and Sjögren's syndrome [10,18], and social factors, such as alcohol and tobacco [1,11]. The diagnosis of hyposalivation is obtained from sialometry, a technique that collects saliva to measure the amount of secretion produced per minute [9,19,20]. Saliva produced by the flow at rest reflects the secretion released by the sublingual and submandibular glands responsible for tissue protection and lubrication. The stimulated flow, on the other hand, triggers the production of the parotid glands, reflecting the functional capacity of saliva to aid mastication and digestion [12,21,22].

Considering that most studies evaluated only specific groups with vulnerability to the disease [3,9,17], it is relevant to verify hyposalivation in the general adult population, especially assessing the influence of stimulated salivary flow, which requires greater stimulation of the salivary glands, consequently reflecting on swallowing [23-25]. This study aimed to determine the prevalence of hyposalivation in adults and identify possible associated factors.

Material and Methods

Ethical Considerations

This study received approval from the Human Research Ethics Committee of the State University of Paraíba (certificate number: 2,412,702). All procedures involving study participants were carried out per the ethical standards of Resolution 466/12 of the Brazilian Ministry of Health and the Helsinki Declaration of 1964. Informed consent was obtained individually from all participants. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist guided the reporting of this study.

Study Design and Characteristics of Sample

The cross-sectional study was carried out in a micro-area covered by a Basic Health Unit (UBS) located in the interior of the state of Ceará, in the Northeast region of Brazil, and the dental clinic school of the State University of Paraíba (UEPB), campus Campina Grande, PB, with a non-probabilistic sample of adults (> 19 years old), between August 2017 and January 2018. The sample size was estimated using the following formula: n = 1,962 x [p (1-p)] / EF2, where n is the sample size, p is the estimate of the sensitivity measure of the screening tool (70%, based on a preliminary data analysis in a pilot study) and EF is the expected error or error factor (5% in this case). The minimum sample size was determined in 322 individuals.

Eligibility Criteria

Those who agreed to participate after receiving clarifications regarding the objectives and procedures of the study and met the following eligibility criteria were included in the study: inclusion criteria – age ≥ 19 years [26], not having smoked or ingested any food in the previous two hours, not having ingested food more than three hours earlier; exclusion criteria – self-report of systemic infection, having been submitted to dental treatment on the same day prior to data collection and having been submitted to any oral hygiene procedure in the hour before participating in the study.

Pilot Study

A pilot study was conducted with a convenience sample of 30 adults to test the methods proposed for the main study (data collection procedure and determination of salivary flow). These individuals were not part of the sample in the main study. The results of the pilot study revealed that no changes to the methods were necessary.

Data Collection

Two trained interviewers collected data on sociodemographic characteristics (age, sex, and menopause), lifestyle (tobacco use, type of tobacco use, ex-tobacco user, time since giving up smoking and alcohol intake) and general health conditions (systemic diseases and types of medication). After providing this information, each participant was submitted to stimulated whole salivary flow rate chewing a tablet (1.5 x 1.5 cm) made from a piece of parafilm measuring 5 x 3 cm. The participant swallowed the saliva produced during the first minute and then spat into a recipient for five minutes. The saliva produced was deposited in a graduated glass test tube to determine salivary flow. A rate lower than 0.7 mL/min indicated hyposalivation [2,10]. This procedure was always performed between 7:30 and 9:30 am in a quiet, reserved room to ensure privacy during the exam and minimize the influence of external factors.

Data Analysis

Descriptive statistics were first performed to characterize the sample, followed by bivariate and multivariate statistical analyses. Absolute frequencies and percentages were calculated for categorical variables. In addition, mean and standard deviation values were reported for numerical variables. Ether Pearson's chi-squared test (χ^2) or Fisher's exact test, when appropriate, was used to identify associations between hyposalivation (outcome variable) and the independent variables. Explanatory variables with a p-value < 0.20 in the bivariate analysis or with epidemiological relevance to the subject in question were incorporated into the multivariate model of the decision tree analysis using the Chi-squared Automatic Interaction Detector (CHAID

algorithm). This approach enables optimizing the prediction process and identifying the most relevant factors to understand the outcome studied, revealing high-risk groups that are generally undetected through traditional statistical analyses. Only those variables with a p-value < 0.05 from the chi-square test with the Bonferroni correction remained in the final diagram of the decision tree. Ten subsamples were used to validate the results through the cross-validation procedure, and the level of adjustment of the models was evaluated based on the general risk estimate, which compares the difference between expected and observed values, indicating the extent to which the algorithm correctly predicts the results. All analyses were conducted using the IBM SPSS Statistics (SPSS for Windows, Version 20.0, IBM Corp., Armonk, NY, USA).

Results

A total of 402 participants were included. Table 1 displays the descriptive characterization of the sample. The majority was female (68.2%), and the largest age group was those 29 years or younger (25.4%). The prevalence of tobacco and alcohol use was 8.2% and 27.4%, respectively. Hyposalivation was detected in 40.3%.

Table 1. Distribution of participants according to sociodemographic and clinical characteristics.

Variables	N	%
Sex [402]		
Male	128	31.8
Female	274	68.2
Age group [402]		
≤ 29 years	102	25.4
30-39 years	76	18.9
40-49 years	72	17.9
50-59 years	69	17.2
≥ 60 years	83	20.6
Menopause [274]		
Yes	61	22.3
No	213	77.7
Tobacco use [402]		
Yes	33	8.2
No	369	91.8
Type of tobacco use [33]		
Smoked	33	100.0
Not smoked	0	0.0
Ex-tobacco user [402]		
Yes	87	21.6
No	315	78.4
Time since quitting [87]		
Mean (SD): 17.01 (11.06)		
Median (IQR): 15.00 (8.00-22.00)		
Alcohol intake [402]		
Yes	110	27.4
No	292	72.6
Frequency of alcohol intake [110]		
1 time/month or less	74	67.3
2 to 4 times/month	33	30.0
2 to 3 times/week	2	1.8
4 or more times/week	1	0.9
Hyposalivation [402]		
Yes	162	40.3
No	240	59.7

Numbers in brackets indicate the total number of valid cases for each variable.

Table 2 shows that nearly half of the participants had at least one systemic disease (40.8%), the most prevalent of which were hypertension (25.1%), depression (6.0%) and diabetes (5.5%).

Table 2. Distribution of participants according to assessment of health status and systemic conditions.

Variables	N	%
Presence of disease [402]		
Yes	164	40.8
No	238	59.2
Diabetes [402]		
Yes	22	5.5
No	380	94.5
Hypertension [402]		
Yes	101	25.1
No	301	74.9
Rheumatoid arthritis [402]		
Yes	6	1.5
No	396	98.5
Depression [402]		
Yes	24	6.0
No	378	94.0
Epilepsy [402]		
Yes	2	0.5
No	400	99.5
Parkinson's [402]		
Yes	1	0.2
No	401	99.8
Alzheimer's [402]		
Yes	1	0.2
No	401	99.8
Psychological disorder [402]		
Yes	1	0.2
No	401	99.8
Hypothyroidism [402]		
Yes	6	1.5
No	396	98.5
Allergy [402]		
Yes	12	3.0
No	390	97.0
Other [402]		
Yes	53	13.2
No	349	86.8

Numbers in brackets indicate the total number of valid cases for each variable.

A high prevalence of medication use was also found (43.3%), the most frequent of which were antihypertensive agents (24.4%) and antidepressants (5.5%) (Table 3). Table 4 displays the bivariate analysis results of the sociodemographic and clinical characteristics. The following factors exerted a significant independent effect on the occurrence of hyposalivation: sex ($p<0.001$), age group ($p=0.011$), menopause ($p=0.001$), systemic disease ($p=0.002$), and the use of medication ($p<0.001$).

Table 3. Distribution of participants according to the use of different types of medication.

Variables	N	%
Use of medication [402]		
Yes	174	43.3
No	228	56.7
Antidepressant [402]		
Yes	22	5.5

No	380	94.5
Antihypertensive [402]		
Yes	98	24.4
No	304	75.6
Anti-histamine [402]		
Yes	3	0.7
No	399	99.3
Anticonvulsant [402]		
Yes	2	0.5
No	400	99.5
Anxiolytic [402]		
Yes	20	5.0
No	382	95.0
Drugs for the treatment of cancer [402]		
Yes	5	1.2
No	397	98.8
Anti-Parkinson's [402]		
Yes	1	0.2
No	401	99.8
Muscle relaxant [402]		
Yes	4	1.0
No	398	99.0
Other [402]		
Yes	96	23.9
No	306	76.1

Numbers in brackets indicate the total number of valid cases for each variable.

Table 4. Bivariate analysis of the occurrence of hyposalivation according to sociodemographic and clinical characteristics.

Variables	Hyposalivation			p-value
	Yes N (%)	No N (%)	Total N (%)	
Sex				<0.001[a]*
Male	35 (27.3)	93 (72.7)	128 (100.0)	
Female	127 (46.4)	147 (53.6)	274 (100.0)	
Age group				0.011[a]*
≤ 29 years	35 (34.3)	67 (65.7)	102 (100.0)	
30-39 years	27 (35.5)	49 (64.5)	76 (100.0)	
40-49 years	28 (38.9)	44 (61.1)	72 (100.0)	
50-59 years	41 (59.4)	28 (40.6)	69 (100.0)	
≥ 60 years	31 (37.3)	52 (62.7)	83 (100.0)	
Menopause				0.001[a]*
Yes	40 (65.6)	21 (34.4)	61 (100.0)	
No	87 (40.8)	126 (59.2)	213 (100.0)	
Tobacco use				0.395[a]
Yes	11 (33.3)	22 (66.7)	33 (100.0)	
No	151 (40.9)	218 (59.1)	369 (100.0)	
Ex-tobacco user				0.468(a)
Yes	38 (43.7)	49 (56.3)	87 (100.0)	
No	124 (39.4)	191 (60.6)	315 (100.0)	
Alcohol intake				0.033[a]*
Yes	35 (31.8)	75 (68.2)	110 (100.0)	
No	127 (43.5)	165 (56.5)	292 (100.0)	
Presence of disease				0.002[a]*
Yes	81 (49.4)	83 (50.6)	164 (100.0)	
No	81 (34.0)	157 (66.0)	238 (100.0)	
Diabetes				0.065
Yes	13 (59.1)	9 (40.9)	22 (100.0)	
No	149 (39.2)	231 (60.8)	380 (100.0)	

Hypertension				0.004[a]*
Yes	53 (52.5)	48 (47.5)	101 (100.0)	
No	109 (36.2)	192 (63.8)	301 (100.0)	
Rheumatoid arthritis				0.999[b]
Yes	2 (33.3)	4 (66.7)	6 (100.0)	
No	160 (40.4)	236 (59.6)	396 (100.0)	
Depression				0.888[a]
Yes	10 (41.7)	14 (58.3)	24 (100.0)	
No	152 (40.2)	226 (59.8)	378 (100.0)	
Hypothyroidism				0.041[b]*
Yes	5 (83.3)	1 (16.7)	6 (100.0)	
No	157 (39.6)	239 (60.4)	396 (100.0)	
Allergy				0.922[b]
Yes	5 (41.7)	7 (58.3)	12 (100.0)	
No	157 (40.3)	233 (59.7)	390 (100.0)	
Use of medication				< 0.001[a]*
Yes	88 (50.6)	86 (49.4)	174 (100.0)	
No	74 (32.5)	154 (67.5)	228 (100.0)	
Antidepressant				0.340[a]
Yes	11 (50.0)	11 (50.0)	22 (100.0)	
No	151 (39.7)	229 (60.3)	380 (100.0)	
Antihypertensive				0.006[a]*
Yes	51 (52.0)	47 (48.0)	98 (100.0)	
No	111 (36.5)	193 (63.5)	304 (100.0)	

[a]Pearson's chi-squared test; [b]Fisher's exact test; *p<0.05.

Figure 1 displays the results of the multivariate analysis using a decision tree (CHAID).

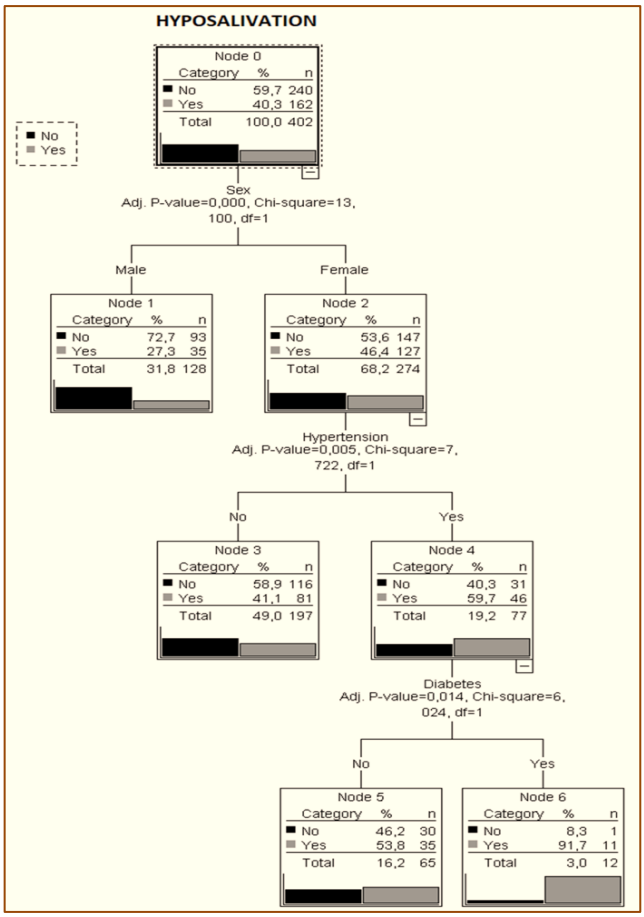

Figure 1. Multivariate analysis using decision tree (CHAID) for hyposalivation adjusted by sociodemographic and clinical factors.

The final model demonstrated interactions between the factors through gradual pathways for explaining the occurrence of hyposalivation in the sample studied. After evaluating the end-nodes, or leaves, until reaching the root node in the final diagram of the decision tree, the following variables were significantly associated with hyposalivation: feminine sex (adjusted p-value <0.001), hypertension (adjusted p-value = 0.005) and diabetes (adjusted p-value = 0.014).

Discussion

The literature reports a variable prevalence of hyposalivation, ranging from approximately 20% of adults to up to half of this population [2,8,27]. In the present study, hyposalivation was diagnosed in 40.3% of the sample, within the range identified [28].

Hyposalivation was statistically more frequent in females, which coincides with data described in previous studies [9,12]. Menopausal women can often develop various disorders of the oral mucosa, such as xerostomia and decreased salivary flow [29]. During this physiological period, low estrogen levels can lead to oral changes, including reduced salivary flow, which can produce xerostomia, burning mouth syndrome, increased incidence of dental caries, dysesthesia, taste alterations, atrophic gingivitis, and periodontitis [30]. Xerostomia is highly associated with patients over 50 years of age, being particularly common in peri- and postmenopausal women [31]. Additionally, postmenopausal women, compared with premenopausal women, had a decreased flow of unstimulated and stimulated submandibular and sublingual salivary glands, unrelated to any medication effect [32].

Studies show that social factors, such as the use of alcohol and tobacco, can also modulate the production of saliva [1,2,12]. However, no association was found between hyposalivation and smoking habits in the present study. A similar finding was also reported in a study conducted in Thailand [3]. In the present study, the variable "having consumed more than 100 cigarettes during life and currently smoking" was considered to determine smoking, a criterion used by the Brazilian Ministry of Health [33]. This methodological aspect may explain the difference between our results and the literature. On the other hand, an association was identified between hyposalivation and alcohol use. It is known that alcohol consumption, in addition to producing dehydration1 causes atrophy or death of acinar cells [34], leading to a reduction in salivary flow.

Hyposalivation was associated with hypertension and hypothyroidism, as well as with the use of medications, with antihypertensives being the group that had a statistically significant association, which is in accordance with previous investigations [10,11]. The use of medications is one of the main determinants of changes in salivary flow [12,34], with antihypertensives being one of the most critical determinants of hypofunction of salivary glands [3].

Studies have shown that other medication types can also reduce saliva production, such as antidepressants and anxiolytics [1,6,8,10,35]. These associations were not found in the present investigation, and this can be explained by the possibility of individuals not making continuous use of these drugs or by the fact that this influence is not a general characteristic of all antidepressants and anxiolytics. The intensity of the medication's effect on saliva production depends on the number of medications used, the types, and the frequency of use [12,36].

We also found a statistically significant association between hyposalivation and hypothyroidism [37]. Thyroid hormones play a role in the body's metabolism, modulating the sensitivity and stimulation of the salivary glands. A previous study [38], in rats with hypothyroidism, demonstrated a significant reduction in the amount of secreted saliva and changes in its composition. Another study investigated the histopathological alterations of

the parotid in rats with experimentally induced postnatal hypothyroidism and observed that as the duration of hypothyroidism increases, so does the atrophy of the acinar serous structure [39]. Investigations conducted with humans have also reported results in the same direction. A study in patients diagnosed with Hashimoto's thyroiditis and hypothyroidism revealed an association with xerostomia and hyposalivation [40], and another investigation also found an association between hypothyroidism and reduced salivary flow [41].

The multivariate analysis also revealed a significant association between hyposalivation and diabetes mellitus. Poor blood sugar control exerts an effect on the structures and function of the salivary glands [9,10,17]. In diabetic individuals, changes can occur in the microcirculation of the salivary glands and parenchyma of these structures, along with degenerative complications, reducing the activity of enzymes in these glands [4,34].

Study limitations should also be considered. Questionnaire responses are subject to information bias. The non-probabilistic sample may have resulted in selection bias. Furthermore, considering the data collection, time, and sample size, only the stimulated salivary flow was tested. Mechanically stimulated sialometry is the method most suitable for large-scale collections, as occurs in epidemiological studies, due to its ease of use, which is a crucial feature in studies with a large number of participants [28]. The study did not address xerostomia in individuals with hyposalivation and whether there was an impact on the quality of life, especially related to oral health and oral health status. The authors suggest new studies evaluating unstimulated salivary flow. Thus, investigations using conceptual, theoretical models in which health determinants can be assessed through structural equation modeling would also be interesting. Therefore, the direct and indirect relationships between the variables could be identified.

On the other hand, this study contributes to advancing scientific knowledge, as it evaluated hyposalivation in the general adult population, examining a considerable number of patients. Future studies should be performed using a different reference standard for salivary flow, such as unstimulated sialometry, to compare results.

The results of the present study highlight the importance of an early diagnosis and management of hyposalivation in adults, as it can be one of the indicators of systemic conditions [8,37]. In addition, hyposalivation can lead to numerous disorders, causing a deficit in quality of life [6,35]. Thus, early diagnosis and treatment of this condition are necessary to promote a better quality of life for the individual.

Conclusion

Factors associated with hyposalivation in adults were sex and the presence of hypertension or diabetes.

Authors' Contributions

HNC	https://orcid.org/0000-0003-1498-2474	Conceptualization, Methodology, Investigation, Writing - Original Draft and Writing - Review and Editing.
YLS	https://orcid.org/0000-0002-3567-6452	Conceptualization, Methodology, Investigation, Writing - Original Draft and Writing - Review and Editing.
KCL	https://orcid.org/0000-0002-5668-4398	Conceptualization and Methodology.
IMB	https://orcid.org/0000-0003-4750-5666	Formal Analysis.
AFGG	https://orcid.org/0000-0002-6054-8372	Formal Analysis and Writing - Review and Editing.
RTF	https://orcid.org/0000-0001-5581-0658	Writing - Review and Editing.
EMMBC	https://orcid.org/0000-0002-3166-709X	Conceptualization, Methodology, Investigation, Writing - Review and Editing and Supervision.

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

Financial Support

None.

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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