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DOCTORAL THESIS

STUDIES ON THE ASSESSMENT AND SOCIO-EMOTIONAL IMPACT OF HALITOSIS IN YOUNG PATIENTS

ABSTRACT

Doctoral supervisor: PROF. UNIV. DR. HABIL. AURELIANA CARAIANE

PhD student: RALUCA BRICEAG

C o n s t a n ț a

CONTENTS

LIST OF ABBREVIATIONS

BMI	– Body Mass Index
CBT	– Cognitive-Behavioral Therapy
CI	– Confidence Interval
HALT	– Halitosis Associated Life-Quality Test
ICC	– Intraclass Correlation Coefficient
KMO	– Kaiser-Meyer-Olkin
OHIP	– Oral Health Impact Profile
OSF	– Open Science Framework
PRISMA	– Preferred Reporting Items for Systematic Reviews
SCL	– Symptom Checklist
SD	– Standard Deviation

INTRODUCTION

This research aims to explore the multifaceted impact of halitosis on young patients, focusing on emotional well-being, self-esteem, social inclusion, and academic performance. Through both quantitative and qualitative approaches, the study will assess how the perception and reality of bad breath affect various aspects of a young person's life.

The significance of this research transcends academic interest, potentially informing public health policies, educational programs, and clinical practices. By understanding the emotional and social burden carried by young individuals with halitosis, targeted interventions can be developed to alleviate the negative effects and improve the quality of life for these patients.

The primary objectives and key research questions in this study reflect a multifaceted approach to understanding the impact of halitosis on young patients, placing a particular emphasis on the emotional, social, and psychological aspects of their lives. The first objective aims to assess the emotional impact of halitosis on these individuals, digging deeper into how a seemingly superficial condition can affect their internal emotional landscape. The secondary focus of this study is to analyze the influence of halitosis on social relationships and peer interactions. Young patients suffering from halitosis often find themselves at the crossroads of judgment and empathy, where perceptions and realities blend to shape their social experiences. It's vital to recognize how these influences play out in daily interactions, friendships, and social networks.

The third objective is to identify the coping strategies and support mechanisms available to young patients with halitosis. Beyond the clinical remedies, there is a dire need to understand what emotional and social support structures exist and how they can be optimized to help these patients navigate the complexities of their condition. By uncovering the ways young individuals cope with halitosis, this research can provide insights into developing tailored interventions, educational programs, and support groups.

THE CURRENT STATE OF KNOWLEDGE

I. Historical Perspective and Literature Review

Halitosis, commonly known as bad breath, is a condition characterized by an unpleasant odor emanating from the mouth. Its etymology is itself a window into how this condition has been perceived over the ages, with roots in the Latin word "halitus," meaning breath, and the Greek suffix "-osis," signifying a pathological condition. This ancient linguistic origin underscores the condition's status as more than a mere annoyance, but as a disorder with significant implications [1].

The historical consciousness of halitosis spans several civilizations, with the earliest recorded awareness found among the Egyptians, Greeks, and Romans. These ancient societies were no strangers to the condition, and they developed various remedies to combat it, such as chewing herbs and utilizing aromatic mouth rinses. These early treatments were not merely about addressing a physical symptom but underlined a deep-rooted concern with oral hygiene and social etiquette. The desire to have fresh breath was tied to social propriety and acceptance, showing that the social implications of halitosis were understood even in ancient times.

A review of the methodologies employed in previous research underscores the dominance of quantitative methods, such as surveys and clinical assessments. There is a noticeable lack of qualitative and mixed-methods studies that might provide more nuanced insights into the lived experiences of young patients with halitosis.

While significant strides have been made in understanding the physiological aspects of halitosis, there is a clear need for more comprehensive research into its emotional and social ramifications, particularly for young patients. The existing literature highlights a need for more intersectional and culturally sensitive approaches that recognize the multifaceted nature of halitosis. Future research should seek to bridge these gaps by employing diverse methodologies and focusing on the interplay between the medical, psychological, and social dimensions of the condition.

II. The Psychological Dimensions of Halitosis

Halitosis, while often perceived as merely a physical condition, has significant psychological ramifications, particularly among young patients. Understanding these connections requires a comprehensive examination of various mental health aspects, including self-esteem, identity, anxiety, depression, and the relevant theoretical frameworks that shed light on these relationships [8].

The connection between halitosis and depression is not merely a direct result of the chronic nature of the condition. Social isolation, stemming from fear of judgment and stigmatization due to bad breath,

compounds the emotional toll. When combined with decreased self-esteem, this social withdrawal can create a fertile ground for the development of mood disorders, including depression [16].

The impact of halitosis on depression is not confined to the immediate emotional response. These emotional challenges can have lasting effects, influencing general well-being and quality of life over the long term. The persistent nature of both depression and halitosis means that they can become mutually reinforcing, with each condition exacerbating the other, leading to a cycle that is difficult to break [16].

Addressing the psychological dimensions of halitosis requires more than just medical treatment of the condition itself. Counseling, support groups, and education about the condition can alleviate emotional distress and foster resilience. Tailoring interventions to the specific needs and experiences of young patients is vital to ensure their mental and emotional well-being.

The psychological dimensions of halitosis extend beyond the mere physical experience of the condition. By understanding the connections between halitosis and various mental health issues, medical professionals and caregivers can provide a more empathetic and comprehensive approach to treatment. The exploration of relevant theories and models, coupled with targeted interventions, can contribute to a nuanced understanding that recognizes the profound impact of halitosis on the lives of young patients.

III. Social Stigma and Peer Interaction

At its core, social stigma refers to the negative perceptions and stereotypes attributed to individuals based on particular characteristics or conditions that differentiate them from societal norms [18]. Halitosis, as a condition that is often detectable in social situations, can serve as a catalyst for such stigmatization. Young patients with chronic bad breath can become targets of unfavorable societal judgments, primarily because bad breath is frequently, albeit mistakenly, associated with poor hygiene or an undesirable lifestyle.

The specific challenges faced by those with halitosis can vary, ranging from light-hearted jesting to outright ridicule or exclusion. While the teasing might be intended as harmless by some peers, it can be deeply hurtful to the individual with halitosis, particularly when these comments or behaviors become repetitive. Ridicule and exclusion are even more damaging, reinforcing a sense of being different or deficient in some way [19].

These negative peer interactions can lead to a diminished self-worth and feelings of isolation. The young individuals may begin to view themselves through the critical and unforgiving lens of their peers, internalizing the negative perceptions and letting them shape their self-image. This erosion of self-esteem can become a persistent issue, affecting their confidence and interactions well into adulthood.

The consequence of this diminished self-worth can be social withdrawal, as the individual attempts to avoid situations where their halitosis might be noticed or commented upon. This avoidance can limit their social experiences, hindering opportunities for personal growth, and reinforcing feelings of isolation. The effect is a self-perpetuating cycle where the fear of judgment continues to drive social withdrawal [20].

In the context of young individuals, who are often at a critical stage of social development, the stigma of halitosis can be particularly harmful. Therefore, a targeted approach within schools and youth organizations can be an effective means of raising awareness. Providing age-appropriate information can help young peers relate to those with halitosis in a more empathetic and respectful manner [24].

IV. Coping Mechanisms and Support Systems

The various coping mechanisms that young patients employ can be both adaptive and maladaptive. While some might seek professional help or communicate openly about their condition, others might resort to withdrawal or denial. Recognizing these varied responses is key to understanding the multifaceted nature of coping with halitosis. Individual coping strategies can be influenced by a multitude of factors such as family support, peer interactions, personal resilience, and cultural norms. A young person's coping mechanisms might differ significantly based on their support system and personal attributes, further underscoring the complexity of this process [26].

Professional counseling has emerged as a critical component in the support network for young individuals grappling with halitosis. Unlike general support systems, trained therapists bring specialized knowledge and skills that can address the specific mental and emotional challenges associated with the condition. These mental health professionals work to understand the unique experiences and needs of each patient, crafting interventions that align with their individual circumstances. This personalized approach allows for the creation of targeted strategies, addressing not only the physical symptoms of halitosis but also the underlying feelings of embarrassment, anxiety, or isolation [29].

Cognitive-behavioral therapy (CBT) may be employed as one of the techniques to help young individuals manage their thoughts and emotions related to halitosis. By exploring and challenging negative thought patterns, therapists can help patients develop a more positive and resilient mental framework. Therapists also play a role in educating patients about halitosis, dispelling myths, and providing accurate information. This educational component can empower individuals to manage their condition more effectively, reducing feelings of helplessness or shame [29].

Ultimately, both educational programs in schools and community-based support efforts represent essential components of a multi-faceted approach to supporting young individuals with halitosis.

Lastly, a comprehensive support system for young individuals with halitosis is likely to involve a combination of these strategies. Family, peer groups, professionals, schools, and community organizations each have a role to play. Their collaborative efforts can create a multi-dimensional support network that acknowledges the complex nature of halitosis and its impacts.

V. Methodological Approaches and Stomatological Challenges

Periodontitis, another oral health concern, can also be a contributing factor to halitosis. This condition, characterized by the inflammation of the tissues that surround and support the teeth, can lead to pockets where odor-causing bacteria can thrive. The study of how periodontitis interacts with halitosis must consider factors like the depth of periodontal pockets, the types of bacteria present, and the effectiveness of different treatment approaches in controlling both the periodontitis and the associated halitosis.

Dental caries, or cavities, can also be intricately linked to halitosis. The decay process can trap food particles and bacteria, leading to unpleasant odors. The relationship between dental caries and halitosis requires an exploration of dental anatomy, the bacteria involved in decay, the dietary factors that may accelerate or prevent cavities, and how different restorative treatments may impact the overall oral odor [39].

In addition to these specific diseases, a more general examination of oral hygiene practices is critical in understanding halitosis. This includes an evaluation of brushing, flossing, and rinsing habits, the use of various oral hygiene products, and regular dental check-ups. The role of healthcare professionals in advising and educating patients about effective hygiene routines, tailored to their specific oral health needs, is an essential part of managing and preventing halitosis.

Objective measures in the assessment of halitosis play a critical role in obtaining quantifiable data about the condition. Laboratory testing of breath samples can reveal the presence and concentration of volatile sulfur compounds, which are often responsible for the malodor associated with halitosis. Methods such as gas chromatography can provide detailed insights into the specific compounds present, allowing for a more nuanced understanding of the underlying causes and the effectiveness of various treatments.

The use of specialized instruments like halimeters offers another objective approach to assess halitosis. These devices measure the concentration of volatile sulfur compounds directly in the breath and are often used in clinical settings. The reliability and reproducibility of halimeters make them a valuable tool, but they also require careful calibration and handling by trained professionals to ensure accurate results [40].

PERSONAL CONTRIBUTION

1. STUDY 1: EMOTIONAL AND SOCIAL IMPACT OF HALITOSIS ON ADOLESCENTS AND YOUNG ADULTS: A SYSTEMATIC REVIEW

1.1 INTRODUCTION

1.1.1 BACKGROUND

In summary, while halitosis may initially seem to be a physiological issue, its effects are predominantly psychological. It affects not only interpersonal interactions but also intrapersonal well-being, often resulting in a significant decline in mental health. The challenges posed by halitosis extend beyond simple oral care, demanding a holistic approach that addresses both the physical manifestations of the condition and the complex psychological barriers that arise from it.

1.1.2 PURPOSE OF THE RESEARCH

Therefore, the present review aims to fill this significant gap in the literature by focusing on the emotional and social impact of halitosis on adolescents and young adults.

1.2 MATERIALS AND METHODS

1.2.1 STUDY DESIGN AND SEARCH STRATEGY

The systematic review was meticulously designed in alignment with the Preferred Reporting Items for Systematic Reviews (PRISMA) guidelines [60], and its protocol was registered on the Open Science Framework (OSF) platform. The review aimed to encapsulate all relevant studies published up until November 2022. The search was carried out across four major electronic databases: Scholar, Scopus, Web of Science, and ProQuest Central.

1.2.2 STUDY SELECTION AND DATA EXTRACTION

The eligibility criteria for the systematic review were clearly delineated to guide the selection of pertinent studies. The inclusion criteria specified that articles must report the presence of halitosis, either through clinical examinations such as organoleptic tests or self-reported questionnaires.

1.2.3 QUALITY ASSESSMENT

The quality assessment process as described provided a robust and systematic method to appraise the existing literature.

1.3 RESULTS

1.3.1 STUDY CHARACTERISTICS

The systematic review process commenced with an extensive search that yielded 593 records. Following the removal of duplicates, the abstracts of the remaining records were screened, resulting in eight articles being selected for full-text assessment.

Table I. Demographic characteristics of studies

Publication	Country	Quality Assessment	Number of Participants	Age	Gender	Frequency of Halitosis
Colussi et al. (2017)	Brazil	Good	736	15-19 years old	56.1% females	40.0%
Mumena et al. (2015)	Rwanda	Fair	354	23.5 mean age	48.6% females	23.1%

Alade et al. (2020)	Nigeria	Good	361	14.1 mean age	59.6% females	32.7%
Deolia et al. (2018)	India	Excellent	200	18-25 years old	N/A	77.5%
Miotto et al. (2020)	Brazil	Fair	680	15-19 years old	59.8% females	43.0%
Rani, Puranil & Uma (2022)	India	Good	320	21.5 mean age	40.6% females	51.9%

1.3.2 IMPACT OF HALITOSIS

A significant pattern emerged across all the studies included in this review, highlighting the strong association between halitosis and the quality of life, particularly in the context of social dimensions. Individuals suffering from halitosis reported experiencing substantial challenges in their social lives.

Table II. Study characteristics

Publication	Design	Study Aims	Halitosis Assessment	Impact Assessment	Results
Colussi et al. (2017)	Cross-sectional	Impact of oral health on the quality of life	Self-reported halitosis using a single question answered with a Likert scale	Oral Health Impact Profile (OHIP-14)	Self-reported halitosis impacts quality of life
Mumena et al. (2015)	Cross-sectional	Prevalence of self-perceived halitosis, its effects to social life, and associated factors	Self-reported halitosis using a structured self-administered questionnaire	Specific questions related to the consequences of bad breath	Self-reported halitosis impacts quality of life
Alade et al. (2020)	Cross-sectional	Prevalence and impact of self-reported halitosis on the oral health-related quality of life	Self-reported halitosis using a single question with a dichotomous answer	Oral Health Impact Profile (OHIP-14)	Self-reported halitosis impacts quality of life
Deolia et al. (2018)	Cross-sectional	Psychosocial effects of halitosis	Organoleptic test—FitScan Breath Checker	Self-administered questionnaire which includes questions related to the psychological and social impact of halitosis	Halitosis impacts social and academic life
Miotto et al. (2020)	Cross-sectional	The impact produced by oral disorders on the quality of life	Self-reported halitosis using a single question with dichotomous answer	Oral Health Impact Profile (OHIP-14)	Self-reported halitosis impacts quality of life (psychological and social dimensions)
Rani, Puranil & Uma (2022)	Cross-sectional	Assessment of psychological status and self-perception of halitosis	Self-reported questions in halitosis, Organoleptic test—Breath Alert	Symptom Checklist-90-Revised (SCL-90-R)	Self-perceived halitosis impacts psychological dimensions (depressive symptoms)

1.4 DISCUSSIONS

1.4.1 LITERATURE FINDINGS

Lastly, the issue of halitosis must be addressed across a range of contexts. This includes not only education about oral hygiene but also information about associated risk factors like tobacco or alcohol use. Understanding these interconnected influences allows for a more nuanced approach to treatment and prevention. Moreover, recognizing and addressing the symptoms that may arise from the social and emotional difficulties experienced by those with halitosis, such as anxiety or depression [72], further illustrates the multifaceted nature of this condition. This broad approach reflects the complexity of halitosis and acknowledges that its management requires a concerted effort across various domains.

1.4.2 STUDY LIMITATIONS

The outlined limitations must be carefully considered when interpreting the results of this systematic review. Caution must be exercised, and the complex interplay of the different limitations should be acknowledged.

1.5 CONCLUSIONS

Beyond the physiological manifestations, halitosis has been associated with profound psychosocial effects, particularly isolation, low self-esteem, and anxiety. Individuals afflicted with this condition often experience feelings of embarrassment and shame, which can significantly affect their mental well-being. These emotional reactions to halitosis are not merely superficial but can lead to genuine psychological distress, highlighting the urgency of understanding and addressing the mental health aspects of this issue.

The impact of halitosis is especially poignant in younger populations who lead active social lives. For these individuals, the social repercussions of bad breath can be particularly devastating, leading to poor social interaction and hindrances in academic achievement. The potential for halitosis to negatively influence critical developmental stages in life calls for specialized attention and support for this demographic. Tailored interventions that consider the unique needs and vulnerabilities of young people may be instrumental in mitigating the harmful effects of halitosis.

2. STUDY 2: VALIDATION OF THE ROMANIAN VERSION OF THE HALITOSIS ASSOCIATED LIFE-QUALITY TEST (HALT) IN A CROSS-SECTIONAL STUDY AMONG YOUNG ADULTS

2.1 INTRODUCTION

2.1.1 BACKGROUND

The Halitosis Associated Life-Quality Test (HALT) has proven to be a valuable instrument in assessing the impact of halitosis on individuals' lives. However, its application has been restricted in certain regions, primarily due to language barriers [93,94].

2.1.2 PURPOSE OF THE RESEARCH

Central to the study is the hypothesis that the Romanian version of the HALT questionnaire will exhibit good reliability and validity in evaluating the impact of halitosis on quality of life within this demographic. By achieving this validation, the study will contribute a valuable tool that can be used by healthcare providers and researchers in Romania to assess and address halitosis in a manner that resonates with the local culture and language.

The ultimate goal is to enhance the quality of life for affected individuals, leveraging a localized and validated instrument that reflects the unique characteristics and needs of the Romanian population.

2.2 MATERIALS AND METHODS

2.2.1 HALT OVERVIEW

The Halitosis Associated Life-Quality Test (HALT) has emerged as a pivotal instrument for assessing the implications of halitosis on an individual's quality of life. Structurally, HALT consists of 20 items, each crafted to probe different facets of an individual's experience with halitosis. These items are scored on a 5-point scale that ranges from 0 to 5. The scaling is purposefully constructed to represent a gradient of impact, with 5 being indicative of the most negative response. This granularity in scaling allows for a precise quantification of the patient's experience.

The total score of the HALT questionnaire is obtained by adding the individual scores from the 20 items, yielding a possible range from 0 to 100. This cumulative score provides a succinct and quantifiable measure that encapsulates the individual's overall experience with halitosis. It translates the multifaceted aspects of halitosis into a single score, allowing for an accessible and interpretable representation.

2.2.2 STUDY DESIGN AND ETHICS

The current study was characterized by a multicentric cross-sectional design, allowing for a broad and diverse examination of the subject matter.

2.2.3 CREATING THE ROMANIAN VERSION OF THE HALT

The task of translating and adapting the HALT questionnaire to the Romanian context was systematically undertaken by a qualified team of researchers following existing guidelines [98]. A comprehensive cross-cultural adaptation process was carried out to ensure that the R-HALT was properly calibrated to be used in the specific cultural context of Romania, enhancing the applicability and relevance of the questionnaire.

2.2.4 ASSESSMENT OF PSYCHOMETRIC PROPERTIES

The sample size for this study was calculated in accordance with the existing recommendations, which prescribe a range of 2 to 20 individuals per item, maintaining an absolute minimum sample size of 100 to 250 individuals [99]. Given the 20-item composition of the HALT, and using a ratio of 5 individuals per item, the chosen sample size consisted of a minimum of 100 individuals.

The data collection was meticulously planned and carried out over a three-month period, from May to July 2023.

The age classification for young adults in the study was defined as between 20 and 26 years old.

The stability of the R-HALT was assessed through a test-retest methodology, where the questionnaire was administered twice within a 7 to 10-day interval.

2.2.5 STATISTICAL ANALYSIS

All statistical analyses were performed using the SPSS v.26 for Windows (IBM Inc., Armonk, USA.), using a significance level of 5%. The R-HALT's reliability was examined through its internal consistency (Cronbach's alpha), with acceptable values being considered if higher than 0.70.

2.3 RESULTS

2.3.1 BACKGROUND DATA

The validation study for the Romanian Version of the Halitosis Associated Life-Quality Test (HALT) was conducted with a total of 150 patients, focusing on young adults. The demographic breakdown was detailed and systematic, providing an overview of the sample's characteristics. With a mean age of 23.6 ± 1.8 (16–26) years, the gender distribution was almost equal with 51% males (77 patients) and 49% females (73 patients).

The study also employed organoleptic test scores to classify and diagnose the intensity of halitosis among the participants. The scores ranged from 2 to 5, with 41% (62 patients) receiving a score of 2, 29% (44 patients) a score of 3, 21% (31 patients) a score of 4, and 9% (13 patients) a score of 5.

2.3.2 RELIABILITY OF HALT RESULTS

The mean scores of the items ranged from a low of 0.82±0.94 (Q3) to a high of 3.23±1.15 (Q11), reflecting the variability in the responses to different questions. The corrected item-total correlation was found to be generally moderate to strong across the items, with values ranging from 0.30 (Q2) to 0.90 (Q19). This indicated a substantial relationship between each item and the total score, signifying that the items were generally well-aligned with the underlying construct of the questionnaire. An Intraclass Correlation Coefficient (ICC) value of 0.87 (95% CI = 0.70–0.99) was obtained, denoting excellent agreement between the measurements.

2.3.3 ANALYSIS OF RESULTS

In order to determine this, factor analysis was conducted, commencing with an assessment of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. A KMO test result of 0.80 was identified, a value that is considered excellent, indicating that the factor analysis was suitable for this set of data. The KMO test result was instrumental in confirming the appropriateness of applying factor analysis to this particular dataset.

Table IV. Discriminative analysis – adapted from [81].

Variables	n(%)	HALT total score	P-value
Level of organoleptic test			<0.001
2	62 (41%)	38.0±9.4	
3	44 (29%)	45.9±11.8	
4	31 (21%)	52.7±12.0	

5	13 (9%)	67.5±10.7	
Self-reported halitosis			<0.001
Yes	31 (21%)	58.4±10.3	
No	119 (79%)	50.1±1.08	

2.4 DISCUSSIONS

2.4.1 LITERATURE FINDINGS

The reliability of the HALT scale was scrutinized using various statistical methods, with a specific emphasis on internal consistency. Cronbach's alpha values, ranging from 0.93 to 0.96, reflected a very high level of internal consistency [103]. This indicates that the items within the questionnaire are well correlated with one another, thereby providing a reliable measure of the underlying construct. Even the item with the least correlation (Q2) exhibited moderate alignment, contributing to the overall reliability of the instrument. In addition to internal consistency, the study also assessed test-retest reliability, revealing an excellent agreement, marked by an ICC value of 0.87. This particular aspect of the reliability confirms that the HALT scale produces consistent results over time. It underlines the quality and integrity of the Romanian version, echoing the findings from the original validation of the English version of HALT [97].

Construct validity was another essential aspect of the validation process, which was examined through factor analysis. This evaluation led to the extraction of four main factors that collectively accounted for over 85% of the total variance.

2.4.2 STUDY LIMITATIONS

One of the main limitations of this study resides in the method of sampling, by utilizing a convenience sampling method for pre-testing the Romanian version of HALT (R-HALT) that might not fully represent the broader population and could introduce a bias, affecting the generalizability of the results.

2.5 CONCLUSIONS

The present study has successfully validated the Romanian Version of the Halitosis Associated Life-Quality Test (HALT), confirming its robustness in evaluating the impact of halitosis on young adults. The examination of the tool's internal consistency has revealed strong agreement within the questionnaire, reflecting a coherent measurement of the underlying construct. The internal consistency is a key aspect that contributes to the tool's overall reliability, ensuring that the HALT functions uniformly in assessing the quality of life associated with halitosis.

A significant aspect of the validation process was the factor analysis, which showed compatibility with the original English version. This alignment strengthens the applicability of the HALT in the local Romanian context, preserving the integrity of the original tool while adapting to the cultural and linguistic nuances of the population.

3. STUDY 3:
ASSESSMENT OF ORAL HYGIENE STATUS IN A GROUP OF YOUNG PATIENTS BY DETERMINING THE SIMPLIFIED ORAL HYGIENE INDEX (OHI-S)

3.1 INTRODUCTION

The main objective of this study is to determine the value of the OHI-S simplified oral hygiene index, the purpose of the study being the evaluation of the oral hygiene status in young adult patients who self-reported oral halitosis, in order to subsequently establish a specific correlation related to well-being emotional and self-esteem, as well as the objective quantification of the degree of halitosis using gas chromatography.

3.2 MATERIALS AND METHODS

The study group consisted of 150 patients from Constanța county aged between 20 and 26 years who self-reported oral halitosis.

Only patients with completely natural permanent dentition, who had no history of dental extractions, prosthetic or orthodontic treatments, or general pathological history, and who at the time of the examination were not on drug therapy, were included.

The simplified oral hygiene index (OHI-S) represents the simplified version of the oral hygiene index – Greene and Vermilion, which is determined by examining 6 dental surfaces.

The interpretation of the OHI-S index values was done as follows:

0 = excellent; 0.1-1.2 = good; 1.3-3.0 = satisfactory; 3.1-6.0 = unsatisfactory.

3.3 RESULTS

The study was conducted on a total of 150 patients - young adults, aged between 20 and 26 years with a mean of 23.2 who self-reported oral halitosis. The gender distribution of the group was almost equal: 52% were men and 48% were women (73 patients). Only 26% of the study participants come from rural areas, the remaining 74% from urban areas.

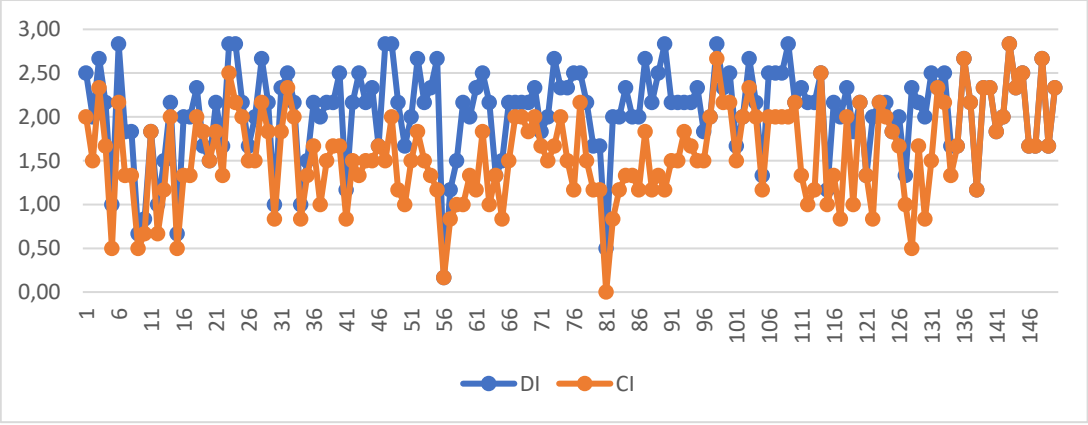

Figure 9. Distribution of mean values of DI and CI indices

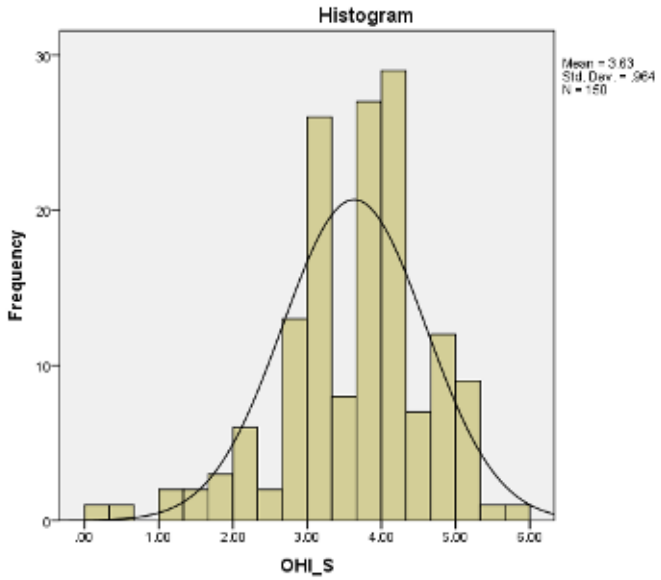

Figure 10. Histogram of OHI-S index values

The summation of the average values of the DI and CI indices for each participant led to the determination of the OHI-S index value, thus the results obtained from the statistical analysis for it are as follows:

- minimum is equal to 0.33, maximum is equal to 5.67, mean is equal to 3.63, and median is 3.67 with a standard deviation equal of 0.96.

3.4 DISCUSSIONS

There are various causes of halitosis (bad breath) that can start from lack of knowledge about maintaining oral hygiene, lack of action in maintaining oral hygiene, certain foods, smoking or alcohol consumption, which can be a predictor of periodontal disease [120].

From the intraoral examination carried out to measure the degree of oral hygiene by using the OHIS (Oral Hygiene Index Simplified) evaluation system, it was found that the average score of the 150 participants in this study was 3.63 and as a result the state of oral hygiene can be considered unsatisfactory and we expect these patients to experience a high intensity of halitosis.

3.5 CONCLUSIONS

This study on the measurement of the simplified OHI-S oral hygiene index in young patients from Constanța, Romania, emphasizes the importance of quantifying the oral hygiene status by measuring the plaque and tartar index, which may constitute the primary etiology of typical halitosis.

Our findings highlighted the fact that all participants presented high values of the OHI-S index, and as a result, an unsatisfactory oral hygiene state, which requires urgent therapeutic measures, not only to suppress the causation of halitosis, but also to prevent the installation periodontal and carious diseases.

The results of this study can be a starting point for the development of a prevention strategy regarding the removal of the microbial factor from the oral cavity, professional hygiene measures, but also through the development of strategies to raise awareness and educate the young patient regarding the impact that poor oral hygiene can have on oral health, but also on social aspects.

4. STUDY 4: EVALUATION OF HALITOSIS USING OBJECTIVE METHODS THROUGH GAS CHROMATOGRAPHY.

4.1 INTRODUCTION

The study aims to address these challenges by developing and validating objective measurement tools for halitosis in young patients. The objectives include identifying the most common etiological factors of halitosis in this demographic, establishing a correlation between these factors and the severity of halitosis, and developing a standardized diagnostic protocol. This protocol would utilize both organoleptic measurements (subjective assessment by smell) and instrumental measurements, such as gas chromatography, to detect and quantify volatile sulfur compounds.

Another objective of the study is to evaluate the effectiveness of various treatment strategies tailored to the specific causes of halitosis in young patients. This includes mechanical methods like brushing and flossing, the use of antimicrobial mouth rinses, and, where necessary, treatment of underlying systemic conditions. The study will also assess the impact of educational interventions on improving oral hygiene practices among young individuals.

4.2 MATERIALS AND METHODS

For this study, we recruited a cohort of 50 patients aged between 20 and 26 from the urban area of Constanța, Romania, aiming to investigate the prevalence and intensity of halitosis through advanced diagnostic technology.

The primary instrument used in this study was the OralChroma CHM-2 device (Figure 11), a state-of-the-art gas chromatography tool designed specifically for measuring volatile sulfur compounds (VSCs) in the breath.

Participants were instructed on how to collect the breath samples using a specially designed syringe provided by OralChroma (Figure 12). The procedure involved inserting the syringe into the oral cavity, sealing the lips around it, and waiting for 30 seconds to 1 minute to collect enough oral gas. After collecting the gas, participants carefully ejected the gas to exactly 1.0 ml using the syringe, ensuring consistency across all samples.

Once the sample was collected, it was immediately injected into the OralChroma device (Figure 13). The device automatically began the analysis, which lasted approximately 4 minutes per sample.

Data management and analysis were facilitated by the software included with the OralChroma device, known as DataManager. This software provided graphical representations of halitosis strength levels and helped manage the historical data of each participant. The numerical values and graphs generated were instrumental in tracking the progress and effectiveness of any interventions applied during the study (Figure 14).

Each patient benefited from an intraoral clinical examination and for each of the 50 patients the Simplified Oral Hygiene Index (OHI-S) values were determined.

4.3 RESULTS AND DISCUSSION

The analysis of volatile sulfur compounds (VSCs) in young patients from Constanța, Romania, reveals insightful gender-related differences in halitosis-related markers. This study assessed the levels of hydrogen sulfide, methyl mercaptan, and dimethyl sulfide, with findings indicating distinct patterns between male and female participants, with the mean age of 25.86 years for men and 23.49 for women (Table V).

Tabelul V. Gas chromatography analysis**.**

Gender	Age	Hydrogen Sulfide (H_2S) [ppb]	Methyl Mercaptan (CH_3SH) [ppb]	Dimethyl Sulfide ($(CH_3)_2S$) [ppb]
Men (mean±SD)	25.86 ± 0.13	145.43 ± 218.76	22.93 ± 38.35	39.93 ± 49.66
Women (mean±SD)	23.49 ± 0.72	88.55 ± 187.77	18.73 ± 22.34	13.95 ± 18.97

The data shows that male participants have higher mean concentrations of hydrogen sulfide (145.43 ppb) compared to females (88.55 ppb). This disparity might suggest a gender-related biological variance in metabolism or oral microbial flora, both of which are known to influence hydrogen sulfide production.

In terms of methyl mercaptan, males also exhibit a slightly higher mean concentration (22.93 ppb) compared to females (18.73 ppb). Methyl mercaptan is closely linked to periodontal disease, suggesting potential differences in gum health between genders.

The analysis of dimethyl sulfide, which is less directly linked to oral health and more to digestive health, shows a similar trend. Men have a higher mean value (39.93 ppb) and a significantly higher range and maximum (189 ppb) compared to women (maximum of 59 ppb), which may suggest differences in diet, digestion, or other systemic factors that influence sulfur compound metabolism.

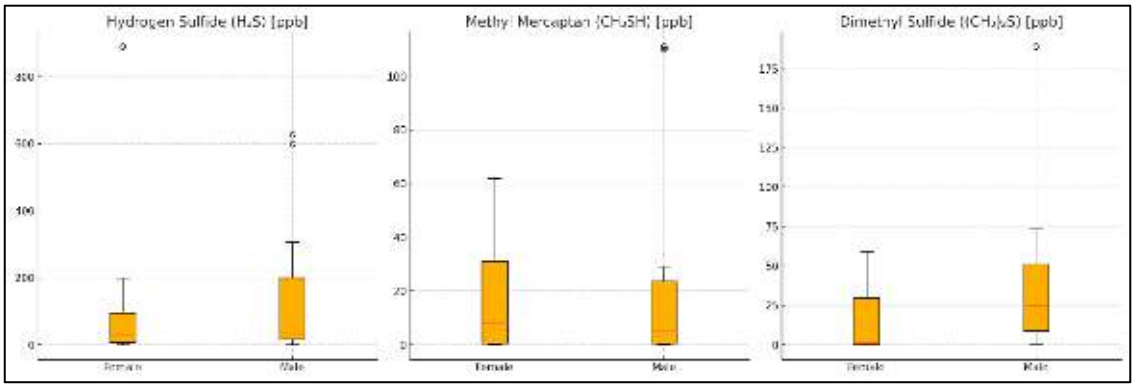

Figure 15. Analysis of halitosis by gender.

The mean value of the OHI-S index is 3.55 and the standard deviation is equal to 1.00, which signifies unsatisfactory oral hygiene for most of the study participants.

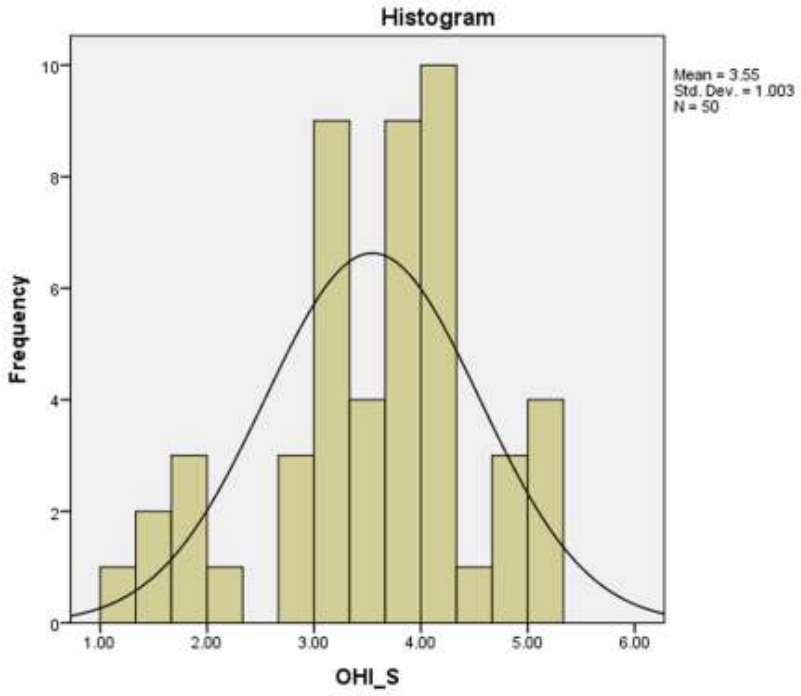

Figure 16. Histograma valorilor indicelui OHI-S

The calculation of the Pearson correlation coefficient between the value of the OHI-S index and the value of the concentration of hydrogen sulfide (H_2S) [ppb] for men revealed an index with a value equal to 0.846, which signifies the existence of a strong positive correlation (p>0.5) between the two variables. It was also established the existence of a strong positive correlation between the value of the OHI-S index and the value of methyl mercaptan (CH_3SH) [ppb], since the Pearson correlation coefficient in this case has the value p=0.912 (p>0.5).

The calculation of the Pearson correlation coefficient between the value of the OHI-S index and the value of the concentration of hydrogen sulfide (H_2S) [ppb] for women revealed an index with a value equal to 0.679, which signifies the existence of a strong positive correlation (p>0.5) between the two variables. As in the case of male patients, it was established the existence of a strong positive correlation between the value of the OHI-S index and the value of methyl mercaptan (CH_3SH) [ppb], since the Pearson correlation coefficient in this case has the value p=0.910 (p>0.5).

4.4 CONCLUSIONS

This study on the measurement of volatile sulfur compounds (VSCs) in young patients from Constanța, Romania, underscores significant gender-based differences in halitosis markers. Our findings highlight that male participants generally exhibited higher levels of hydrogen sulfide, methyl mercaptan, and dimethyl sulfide compared to their female counterparts. This suggests that men may be more prone to conditions associated with higher VSC production, such as periodontal disease and digestive disorders, which are known contributors to halitosis. The considerable variability in VSC levels among males could indicate a greater impact of external factors such as diet, oral hygiene, and possibly smoking habits, which warrants further investigation.

5. FINAL CONCLUSIONS AND FUTURE PERSPECTIVES

- We observed the critical role of socioeconomic conditions and literacy levels in the prevalence of halitosis. In developing or underdeveloped countries, where there is a scarcity of resources for education and healthcare, the challenge of raising awareness and preventing halitosis becomes especially pronounced. This lack of access to essential oral hygiene education and the necessary resources not only leads to a higher occurrence of halitosis but also presents a considerable public health challenge. Future interventions must take into consideration the unique contexts of these countries, tailoring programs that provide education, resources, and support to the most vulnerable populations. Collaborations between governments, NGOs, and healthcare providers could play a significant role in creating and implementing these interventions.
- Beyond physical manifestations, halitosis presents profound psychosocial effects. Feelings of embarrassment, shame, isolation, low self-esteem, and anxiety become debilitating for individuals afflicted with halitosis. The stigma attached to this condition may lead to genuine psychological distress, affecting overall mental well-being. These insights urge mental health professionals, educators, and healthcare providers to recognize the urgency of addressing these emotional reactions. Counseling services, educational materials, and community outreach programs that address the psychological aspects of halitosis could be instrumental in providing support to those suffering from this condition.
- Both studies illuminate the particular significance of halitosis in younger populations. For adolescents and young adults leading active social lives, halitosis can have a detrimental effect on social interaction, academic achievement, and overall quality of life. Tailored interventions considering the unique needs of young people are imperative. School-based programs, awareness campaigns targeting this age group, and family involvement could collectively mitigate the negative influence of halitosis during critical developmental stages.
- The need for a comprehensive approach to the prevention and treatment of halitosis is emphasized across both studies. Public health initiatives should strive for a wide-reaching impact, encompassing awareness, prevention, and treatment. Medical interventions must be complemented by educational campaigns that are culturally sensitive and responsive to the societal contexts where halitosis is most prevalent. Collaboration between dental professionals, healthcare providers, community leaders, and policy-makers can foster an integrated approach, enhancing accessibility and efficacy.
- The validation of the Romanian Version of the HALT highlights the importance of robust tools in evaluating halitosis. The HALT's consistency, strong correlation with oral malodour categorizations, alignment with the original version, and discriminative potential affirm its credibility and applicability. Future applications could extend to different age groups, settings, and even linguistic contexts, providing healthcare providers with a reliable instrument to inform patient care decisions and interventions.

- The direction of future research must be multifaceted, recognizing the physical, emotional, social, and cultural dimensions of halitosis. Investigating the complex psychosocial impacts, especially among younger populations, will foster a more empathetic and nuanced understanding. Extensive validation of tools like HALT across different environments can further refine our approach to halitosis management.
- Moreover, long-term studies examining the effectiveness of targeted interventions and educational programs would provide valuable insights into best practices. Partnerships between researchers, practitioners, educators, and policymakers could facilitate this comprehensive exploration, contributing to a more effective and compassionate response to halitosis.
- Our findings highlight that male participants generally exhibited higher levels of hydrogen sulfide.
- These studies present a compelling case for a more holistic approach to halitosis. By understanding its socioeconomic determinants, psychological impacts, and unique effects on younger populations, we can craft more effective and humane strategies for prevention and treatment. The validation of tools like HALT offers a methodological advancement, paving the way for more personalized care. Collaboration, cultural sensitivity, and a comprehensive understanding of halitosis's multifaceted nature will be key in future efforts to reduce its burden, enhancing individual well-being and overall public health.

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