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SHORT COMMUNICATION

# Self-awareness of olfactory dysfunction in elderly individuals without neurodegenerative diseases

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## Abstract

**Purpose** The decrease in smell in the elderly population is frequent and considered a natural process. However, sometimes it can be associated with the decline of cognitive functions, and it is considered a warning for the early stage of neurodegenerative diseases and social impairment.

**Objective** To assess the prevalence of olfactory dysfunction in previous healthy elderly that attended a tertiary hospital in Brazil as escorts and the clinical alterations associated in this population.

**Methods** Subjects 60 years or over attending the University Hospital of Campinas were evaluated. Each participant answered a questionnaire, followed by an otorhinolaryngological exam with flexible nasal endoscopy and the Connecticut smell test produced by the Connecticut Chemosensory Clinical Research Center (CCCRC). Elderly people with nasosinusal diseases or with a history of nasal surgery were excluded.

**Results** Of the total of 103 participants, 16 (15.5%) reported olfactory complaints and 68 (66%) presented impairment in the olfactory test. It was observed that older individuals showed more changes in olfactory function ($p = 0.001$). Gender, education, lifestyle, comorbidities, medications in use and exposure to pollutants did not influence the impairment olfactory function of this population.

**Conclusions** There is a significant prevalence of olfactory dysfunction in the elderly population evaluated. Most of these elderlies also present an inability to identify odours, not having awareness of this olfactory impairment.

**Keywords** Health of the elderly · Smell · Olfaction disorders · Aged · Anosmia

## Introduction

The progressive aging of the population determines a higher prevalence of senility diseases in the world [1]. Specifically, smell disorders became a common condition, because aging generates anatomical and functional changes in the nasal cavity, providing the emergence of several nasosinusal symptoms in elderly patients [2, 3]. With advancing age, there is a loss of surface area of the olfactory epithelium, loss of sensory neurons, and neuronal degeneration of the olfactory bulb [2, 3]. In addition, medications, comorbidities, exposure to pollutants, and neurodegenerative disorders contribute to the alteration of the olfaction [3]. Thus, olfactory disorders are more frequent in the elderly, causing social, psychological, and nutritional problems when not diagnosed or treated appropriately [1, 4, 5].

Differentiate the elderly with normal olfactory function and olfactory dysfunction (OD), may be key to prevent alterations in the quality of life, social interaction impairments, personal hygiene, environmental hazards, and eating-related vulnerabilities [4, 6, 7]. In addition, it may be a useful tool in the recognition of the initial stages of neurodegenerative diseases [3].

In the geriatric population, the prevalence of OD increases to about 50%, and most of these individuals are not aware of it [3, 7]. To best evaluate the olfactory function (OF) in the elderly it is necessary to study its prevalence, associated disorders, and demographic characteristics.

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The aim of this study is to analyze the OF of elderly subjects, quantitatively and qualitatively, without self-perceived olfactory disorder or neurodegenerative disorders. In addition, to evaluate the association of olfaction disorders and comorbidities, use of continuous medications, memory disorders, and exposure to pollutants.

## Methods

A cross-sectional observational study was carried out between January 2018 and June 2018. Individuals who attended as escorts to patients in the otorhinolaryngology and ophthalmology outpatient clinic in the Hospital of Clinics of the State University of Campinas (HC-UNICAMP), were invited. The use of escorts provided a sample of individuals without nasal or olfactory complaints or neurodegenerative diseases. Participants with age 60 years and older that agreed to participate and signed the term of consent before the start of the study were included. Individuals aged over 60 (sixty) years are considered elderly in Brazil according to the Elderly Statute—Law 10741 of October 1, 2003.

The study was approved by the ethics committee of the institution (CAAE 78577917.0.0000.5404) Carriers of nasosinusal diseases or individuals that underwent nasal surgical procedures were excluded. All subjects underwent an interview, followed by the Connecticut olfactory test (CCCRC) and then nasal endoscopy.

### Questionnaire

Participants were interviewed by a trained research physician to obtain information about age, sex, origin, date of birth, smoking, alcoholism, contact with pollutants, use of continuous medications, previous surgeries, history of diseases, neurodegenerative diseases (such as Parkinson's disease, Alzheimer's disease, and others) and psychiatric disorders (such as depression, anxiety, and others). These patients were also asked about the presence of olfactory complaints (such as anosmia, hyposmia, hyposmia, cacosmia, phantosmia, parosmia, and agnosia). If present, the olfactory complaint, was evaluated by a numerical scale of 0–10 (Visual Analog Scale) to determine the intensity of the change in smell and how much it interfered with its quality of life.

### CCCRC

The Connecticut Smell Test, produced by the CCCRC (Connecticut Chemosensory Clinical Research Center), is composed of two parts: the threshold research olfactory and the identification of odours [8]. The use of the CCCRC was chosen due to its cost-effectiveness and validation in the Brazilian population [9, 10].

The test was done according to the literature [9, 10]. A score from zero to seven is obtained in each nasal cavity, corresponding to the number of the respective correct butanol dilution.

The second part of the test consists of identifying odours. Seven vessels were presented to the individuals containing the following substances: talc, chocolate, cinnamon, coffee, mothballs, peanut butter, and soap. Items are presented in irregular order, in separate nostrils. For each recipient offered, the patient receives a list of twenty odour alternatives and selects the one that most closely matches the presented odour. At the end of the test, a score was obtained from each nasal cavity, corresponding to the number of correct answers between 0 and 7.

The olfactory classification of each patient was calculated using a score, which corresponds to the arithmetic mean between the threshold test and the identification of odours. The combined score is defined for each nasal cavity separately. The mean between the combined scores of the two nostrils, results in the Score index. The following values are considered for the identification of the individual's sense of smell: 6.0–7.0: normosmia; 5.0–5.75: mild hyposmia; 4.0–4.75: moderate hyposmia; 2.0–3.75: severe hyposmia; 0–1.75: anosmia.

### Flexible nasal endoscopy

Flexible nasal endoscopy was performed through the introduction of an optical flexible fiber of 3.6 mm diameter (Olympus® and Machida Cordless®), in each of the nasal cavities separately for the visualization of the internal structures of the nose. This exam allowed identification of nasal anatomic alterations and diagnosis of sinus diseases.

### Statistical analysis

The data obtained was processed with SPSS for Windows version 21.0 (Statistical Package for the Social Sciences; SPSS Inc., Chicago, IL; USA). Qualitative results were presented in absolute and relative values. For association evaluation among the variables, the chi-square test, Fisher's exact test or the test of Fisher–Freeman–Halton were applied. For the comparison of distributions of quantitative variables between two independent groups, the Mann–Whitney test was used. In all cases, a significance level of 5% ($p \leq 0.05$) was adopted.

## Results

One hundred and three elderlies were evaluated, 56 (54.4%) females, with ages varying between 60 and 93 years (mean 70.4 years). Of the total number of patients evaluated, 68

(66%) presented changes in the olfactory test. Concerning the Connecticut smell test, the following results were found: Normosmia 35 (34%), Mild hyposmia 22 (21.4%), Moderate hyposmia 25 (24.3%), Severe Hyposmia 16 (15.5%), and Anosmia 5 (4.9%) (Fig. 1).

There was a higher prevalence of altered olfactory function in elderly men (51.5%) and in the white ethnical group (65.5%), but without statistical significance. In addition, there was no difference in the olfactory function in the different education levels. Figure 2 shows the demographic and social variances in groups with normal and altered OF.

When comparing the age of the elderly between the groups with altered and normal olfactory tests, there was a difference between them ($p = 0.001$). The group with altered olfactory test was older (mean age of 72.2 years) than the group with normal OF (mean age of 66.8 years) (Fig. 3).

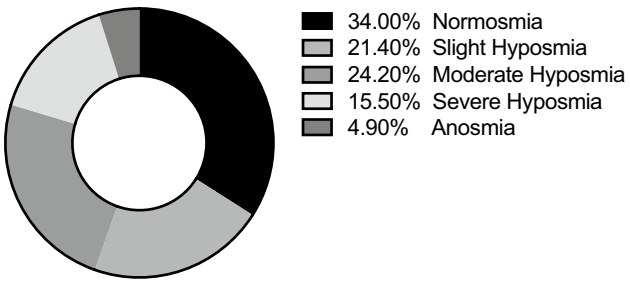


**Fig. 1** Results of The Connecticut Smell Test, produced by the CCCRC (Connecticut Chemosensory Clinical Research Center) in the elderly population evaluated in this study ($n = 103$ individuals)

Nasal endoscopy findings were divided into three groups: normal, anatomical abnormalities, and mucosal alterations. Within the OD group, 50 patients (73.5%) had normal nasal endoscopy, 16 (23,5%) had anatomical alterations, and 2 (2.9%) had mucosal alterations. In the normal OF group, 31 patients (88.6%) had normal nasal endoscopy, 4 (11.4%) had anatomical alterations and none had mucosal alterations. There was no association between OD and nasal endoscopy findings.

A total of 30 patients referred previous exposure to chemicals, including solvents, benzene, and pesticides, 24 of them (80%) showed changes in the smell test, but there was no association between this exposure and olfactory test alterations ($p = 0.055$).

Although there was a statistically significant association between the participants with and without complaints of smell and the result of the smell test, 54 individuals (62%) without complaints of OD had an altered olfactory test (Table 1).

There was no association between the presence of comorbidities or the use of continuous medications and groups with and without olfaction alterations. Forty-six (44.7%) of the evaluated participants did not present any comorbidity. Concerning psychiatric disorders, such as depression and anxiety, five patients (7.4%) in the OD group and 6 patients (17.1%) had these comorbidities. There was no association between OD and psychiatric disorders ($p = 0.178$). Self-reported memory loss, tobacco exposure, and alcoholism did not present an association with OD. None of the individuals in this study presented neurodegenerative diseases.

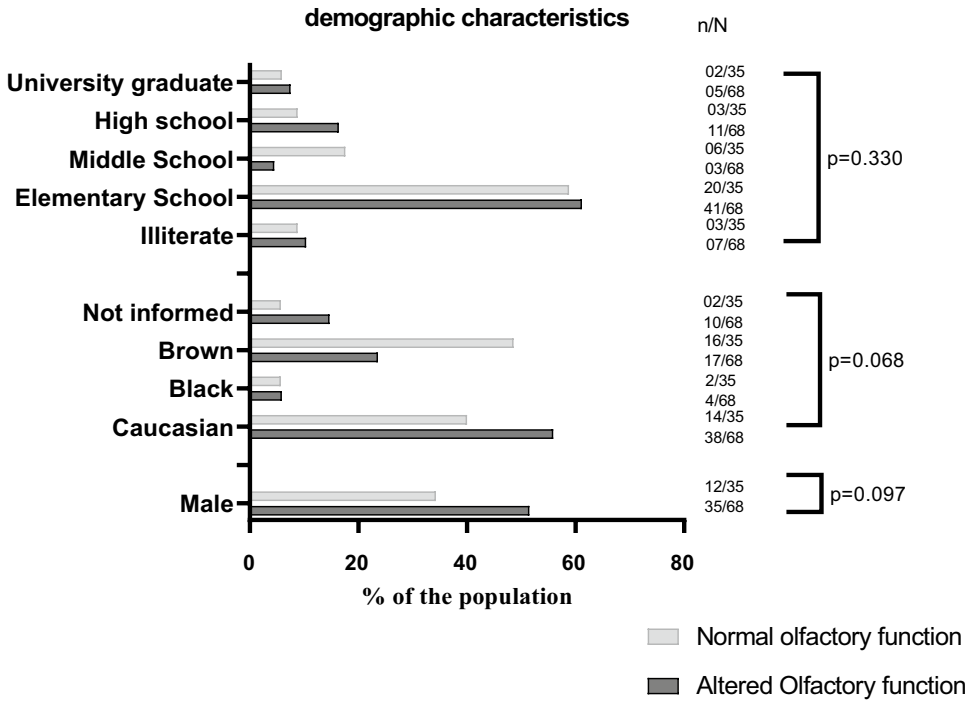


**Fig. 2** Demographic characteristics of individuals with normal olfactory function versus altered olfactory function according to The Connecticut Smell Test, produced by the CCCRC (Connecticut Chemosensory Clinical Research Center). *Fisher–Freeman–Halton test. **Chi-square test

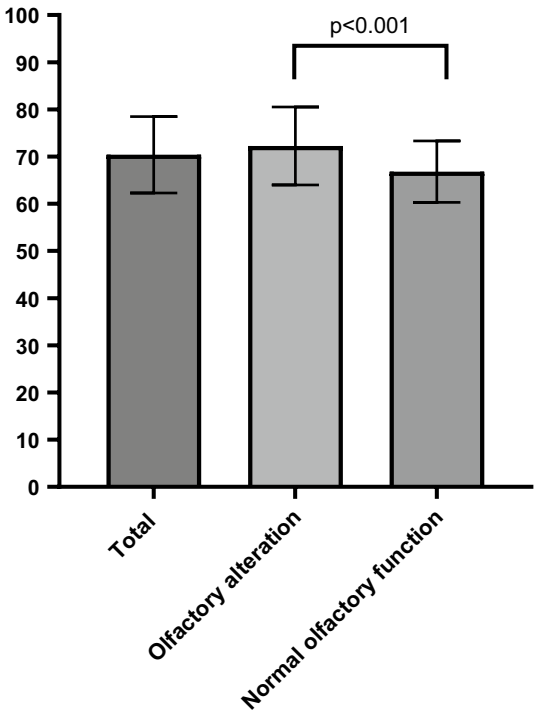


**Fig. 3** Mean age and standard deviation in the individuals in this research and according to the results of the olfactory test. *Mann–Whitney test

**Table 1** Association between olfactory function complaint and olfactory function disorder found in The Connecticut Smell Test, produced by the CCCRC (Connecticut Chemosensory Clinical Research Center)

| | Altered olfactory test, $N=68$ | Normal olfactory test, $N=35$ | Total | $p$ |
|---|---|---|---|---|
| Olfactory function complain | 14 (87.5) | 2 (12.5) | 16 | *0.048 |
| No olfactory function complain | 54 (62.1) | 33 (37.9) | 87 | |

*Fisher exact test

## Discussion

The present study evaluated the prevalence of OD and its associations with demographic and clinical factors in a sample of neurodegenerative disease-free elderly, before COVID-19 pandemics. The observed prevalence of OD was quite high (66% over 60 years), showing a slightly higher percentage compared to surveys in elderly populations free of dementia [11, 12].

In this study, the self-reported and objective olfactory functioning through the Connecticut's sense of smell test showed low correlation, as many participants with an altered olfactory test, reported no problems related to smell, indicating low awareness of OD in this age group.

Adams et al. also showed that almost a quarter of respondents was inaccurate in their self-assessment of olfactory ability: 16.3% of the population had OD, but did not recognize it, while 6.7% self-reported impairment of the smell, but the smell test was within the normal range [13]. The individuals who were not aware of their OD had greater cognitive impairment within 5 years of follow-up compared to individuals aware of their dysfunction and those with normosmia [13].

In previous studies, demographic factors explained a large portion of male-related OD and low educational level [11, 12]. Although, even showing a trend of greater OD in men and elderly with lower education levels, these factors were not significant in our research [9].

Even though literature demonstrates that olfactory impairment may be related to a high number of diseases, most participants in our study did not report previous diseases [4, 9]. Consequently, no comorbidity analyzed showed an association with olfactory impairment. Previous research that considered only elderly people demonstrated different results [14].

The assessment of medication effects on OD is limited by the lack of drug dosage data and treatment duration. Current data suggest that, at population level, medication use may not be a major contributor to the prevalence of olfactory impairment [14, 15]. Well-controlled clinical trials of effects Adverse drug chemosensory tests are needed to identify agents that cause olfaction disorders [15]. The lack of association between chemical exposure and OD in this study may be interpreted with caution as p close to 0.05 may indicate a type II error that could be different in a larger populational study.

In addition to the most varied known etiology that cause OD, several physiological mechanisms may also be involved in the olfactory impairment related to aging. Therefore, corroborating the importance of a complete clinical evaluation in this age group, as the elderly has the potential to have more than one factor involved in olfactory deficiency [11, 14].

Cognitive impairment and neurodegenerative diseases are known to be associated with OD [3]. Smell dysfunction is a promising early biomarker for Alzheimer's disease. A meta-analysis indicated a significant difference in the OF of odour identification between patients with Alzheimer's disease and control patients and among patients with mild cognitive impairment and control patients [16, 17]. In addition, OD has been identified as a potential indicator of other neurodegenerative diseases, including Parkinson's disease and multiple sclerosis [18, 19]. To better evaluate these olfactory symptoms associated with neurodegenerative diseases in the

elderly it is important to establish the prevalence and factors associated with hyposmia in a healthy geriatric population.

When analyzing a fragility index, Bernstein et al. found an association between frailty and self-reported chemo sensorial dysfunction, and this association was also present when measuring OD [5]. Frailty is defined as "a reduced physiological reserve as a function of age- and health-related deficits", and it is correlated with mortality and worse health outcomes; therefore, OD may be used in the future as a biomarker to identify greater frailty risk [5]. Although OF is not an isolated risk factor associated with nutritional status, OD may be associated with malnutrition when concomitant with other mental and physical disabilities frequently found in the geriatric population [1]. Previous studies also demonstrated an association between OD with functional disability and reduced independence, as well as poor quality of life and depression in elderly people with normal cognitive function [22–25]. The relationship with depression can go both ways, as patients with depression also tend to have more OD, in our study the small proportion of patients with psychiatric disorders may be responsible for the lack of this association [25].

The self-reported OF has little sensitivity, supporting the need to objectively test the sense of smell of elderly subjects with inaccurate or higher self-report risk of cognitive decline [26].

This study has its limitations on the sample size evaluated, but on the other hand evaluated the OF prior to the COVID-19 pandemics, which has altered the incidence of OD in the population. In addition, it ruled out possible nasal anatomical alterations that could have biased OF results. Recall bias may be present too as some individuals could not remember daily used medications or history of environmental exposure. In addition, sampling bias may present as usually patients with severe comorbidities do not attend the hospital as escorts. However, this paper can highlight the importance of active screening for olfactory disorders, especially in the older range of the elderly.

## Conclusions

The study suggests a significant prevalence of elderly people with impaired OF and many participants were not aware of this olfactory impairment.

There was no association between comorbidities, medications in use, psychiatric disorders, and exposure to pollutants with olfaction disorders in the evaluated group.

**Author contributions** MDCT drafted the article, FRD participated on data collection and drafted the article, LTG, FRC and MGAR helped with data collection and final analysis of the article, ES were responsible for the conception of the study and correcting the final version of the article.

## Declarations

**Conflict of interest** The authors have no competing interests to declare that are relevant to the content of this article.

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