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RESEARCH ARTICLE

Effect of menopause on olfactory function

Anand Kumar Singh[1], Mayank Agarwal[1], Nidhi Jain[1], Neeru Garg[1], Punam Verma[2], Sunita Mittal[3]

[1]Department of Physiology, Shri Guru Ram Rai Institute of Medical and Health Sciences, Dehradun, Uttarakhand, India, [2]Glocal Medical College, Super Speciality Hospital and Research Centre, Saharanpur, Uttar Pradesh, India, [3]Department of Physiology, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, India

Correspondence to: Mayank Agarwal, E-mail: mayankphysiology@gmail.com

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ABSTRACT

Background: Olfactory function decreases with aging. The decrease in estrogen also leads to decrease in olfactory acuity. Menopause is a physiological process of aging that is associated with a decreased ovarian reserve and, hence, estrogen secretion. Olfactory dysfunction adversely affects the quality and safety of life. **Aims and Objectives:** The aim of this study is to compare the olfactory detection and identification threshold of females in reproductive age with the females after at least 5 years of menopause. **Materials and Methods:** The current quasi-experimental cross-sectional study involved a convenient sample size of 60 females; 30 females in reproductive age (20–35 years) and 30 females in menopause for 5 years (45–60 years). Elsberg-Levy olfactometry was used to measure the olfactory detection and identification threshold for five odors asafetida, camphor, formalin, peppermint, and rosewater. Independent *t*-test was applied to compare the means, and $P \leq 0.05$ was considered statistically significant. **Results:** The olfactory detection and identification threshold were significantly ($P < 0.001$) higher in postmenopausal women for all the five odors than the reproductive age women. **Conclusion:** The decrease in the acuity of smell in postmenopausal women might be due to the normal aging process; however, it seems to be more dependent on the decreased estrogen secretion.

KEY WORDS: Menopause; Odor; Olfaction; Olfactory Threshold; Smell

INTRODUCTION

Olfaction, a chemical sense, is the ability to perceive and recognize different odors or smells. The human behavior can be strongly influenced by olfaction due to its numerous connections to the limbic system and reticular formation.[1,2] The olfactory system in humans affects numerous vegetative, visceral, and sexual functions.[1,3] For example, different smells can modulate variation in heart rate,[4] perception of pain,[5,6] mood,[6-8] cognition,[7] memory,[7,9] and arousal[8]. Olfaction, to a large degree, mediates the food flavor and significantly affects appetite.[10] Further, the most important role of olfaction in humans appears to be in interpersonal communication as the assessment of personality traits[11] and the selection of life partner[12] depends on body odor. Overall, olfactory processing impacts the quality of life that includes physical and mental well-being.

As the sixth decade of life is reached, there is a significant reduction in the overall olfactory function, which includes threshold (lowest concentration at which the presence of an odorant is reliably detected), discrimination (ability to distinguish between a variety of smells), and identification (ability to recognize and name a smell).[3,13] There is a gender variation associated with olfaction, female being superior to male.[3] The reason for female superiority in olfaction is complex, multifactorial and thus far not completely understood.[3] However, a major reason could be a complex

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interaction of neuroendocrine agents with the olfactory system.[3,14]

Menopause, a part of the normal aging process, is associated with diverse physiological and psychological changes in women. Reduced ovarian reserve and, hence, estrogen are the main cause of the physiological changes that accompany menopause.[15] There is evidence that women undergo olfactory changes after menopause.[1,15]

If we take into account, the age-gender relationship associated with olfaction, an important question arises that whether the olfactory function decline rate among older adults shows sexual dimorphism. It has been demonstrated that the age-related olfactory decline occurs greater in males as compared to females.[16] There is a lack of data regarding the effects of age-hormone interaction on olfactory function in females. Hence, the current study was designed to further enhance the current knowledge regarding the changes in the olfactory function of postmenopausal females as compared to those in reproductive age by a simple, reliable, and satisfactory method.

MATERIALS AND METHODS

The current quasi-experimental cross-sectional study was carried out in the Department of Physiology, Shri Guru Ram Rai Institute of Medical and Health Sciences (SGRRIMHS), Dehradun, Uttarakhand, India. Institutional ethical clearance was obtained before starting the study.

The participants were recruited from the adjoining areas of the SGRRIMHS (Patel Nagar). 60 (convenient sample size) apparently healthy females were involved after they fulfilled the study criteria. They were divided into two groups: (a) Group I: 30 females of reproductive age (20–35 years) with the regular menstrual cycle and (b) Group II: 30 females of menopausal age (45–60 years) with menopause for more than 5 years. History of hormone imbalance or therapy and rhinitis or any other disorder such as coryza that could have hindered in the olfaction was the exclusion criteria. The detailed otorhinolaryngological examination was done to diagnose any pathology that could have jeopardized the study results or subject's health.

The test was carried out in human physiology laboratory of SGRRIMHS at regular ambient temperature and pressure. Every effort was made to keep the room free from any odor. The sense of smell was tested in both the groups for each nostril. Five odorants that were used: Asafetida (10% aqueous solution), camphor (20%), formalin (10%), peppermint oil (20%), and rosewater (undiluted Dabur Gulabari). Before starting the test, it was assured that the subjects are familiar with the odors.

The quantitative olfactometry was carried out as per the methodology described by Elsberg and Levy.[17] The diagrammatic representation of the apparatus used is shown in Figure 1.

The subject seated comfortably in a chair with eyes closed. The nozzle of the outlet tube was inserted into the nostril to be tested. The subject was asked to manually close the other nostril. The pinch clamp was removed from both the outlet and the inlet tube. It was followed by injection of 1 ml or cm^3 air in the form of a blast from a syringe into the inlet tube of the glass bottle containing volatile odorant solution at the bottom. It was ensured that there was no leakage of air from the tubing. Different disposable sterile syringes (i.e., 2 ml, 5 ml, 10 ml, and 20 ml) were used for blowing the air into the glass bottle, to maintain the precision and accuracy, as injecting 1 ml air from 20 ml syringe could be difficult. The subjects were asked to raise the hand if they detected (able to smell something) an odor and subsequently identify (named the smell) it. If the subject was unable to perceive the smell, the same procedure was repeated increasing the amount of air by 1 ml each successive time at an interval of 30 s, until the odor was detected and identified. The result of the whole test was regarded as negative if the perception of smell does not occur even at 20 ml. After each successive procedure, both the inlet and the outlet rubber tubes were clamped to prevent the loss of odorous substance by evaporation from the glass bottle. The minimum amount of air (ml) that had to be injected into the glass bottle for detection of smell was labeled as "olfactory detection threshold," while the minimum volume of air required for identification (naming) of smell was labeled as "olfactory identification threshold." The olfactory detection and identification threshold for an odorant were measured twice in each nostril. The mean of the readings was taken as the final olfactory threshold for that particular odorant. The test was repeated for other odorants after an interval of half an hour.

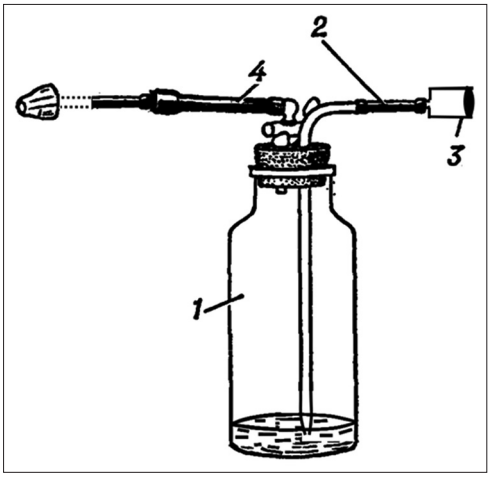

Figure 1: Diagrammatic representation of the apparatus used in the study. 1, Glass bottle containing odorant at the bottom; 2, inlet tube; 3, syringe to blast the air inside the glass bottle; and 4, long outlet tube with a nosepiece

Statistical Analysis

The data entry was done in Microsoft Excel 2013. IBM SPSS Statistics for Windows, version 22.0. Armonk, NY: IBM Corp. was used for further statistical analysis of the data. The independent *t*-test was applied to know the statistical difference in-between groups for the olfactory detection and identification threshold of a specific odorant. Analytical data were round off to nearest one decimal place and represented as means with standard deviations. $P \leq 0.05$ was considered statistically significant.

RESULTS

All subjects were able to detect and identify the smell presented to them. Olfactory detection and identification threshold of all the five odors were significantly ($P < 0.001$) lower for the Group I (reproductive age) than Group II (postmenopausal) as shown in Tables 1 and 2.

Olfactory identification threshold was higher than the olfactory detection threshold in both the groups for all the odors. The mean difference in olfactory detection and identification threshold for asafetida, camphor, formalin, peppermint, and rosewater in Group I was 0.9, 0.8, 1.2, 0.3, and 0.9 ml, respectively, while in Group II was 2.8, 4.4, 2.3, 4.2, and 4.0 ml, respectively.

The average (mean of all the five odors) olfactory detection and identification threshold for Group I (2.6 ± 1.0 ml and 3.4±1.8 ml, respectively) were significantly ($P < 0.001$) lower than Group II (10.3 ± 2.3 ml and 13.1 ± 3.2 ml, respectively).

Table 1: Odor detection threshold in Group I (reproductive age) and II (postmenopausal)

Odor	Olfactory detection threshold in ml or cm^3		*P*-value*
	Group I	Group II	
Asafetida	2.5±0.9	9.4±2.6	<0.001
Camphor	2.7±1.0	10.6±2.2	<0.001
Formalin (pungent)	2.4±1.0	9.7±1.9	<0.001
Peppermint	2.7±1.1	10.2±2.1	<0.001
Rosewater (floral)	2.4±1.0	11.5±2.2	<0.001

*$P \leq 0.05$ was considered significant; independent *t*-test was applied

Table 2: Odor identification threshold in Group I (reproductive age) and II (postmenopausal)

Odor	Olfactory identification threshold in ml or cm^3		*P*-value*
	Group I	Group II	
Asafetida	3.4±0.9	12.2±2.6	<0.001
Camphor	3.5±1.9	15.0±3.0	<0.001
Formalin (pungent)	3.6±1.8	12.0±2.0	<0.001
Peppermint	3.0±1.3	14.4±2.0	<0.001
Rosewater (floral)	3.3±1.9	15.5±3.1	<0.001

*$P \leq 0.05$ was considered significant; independent *t*-test was applied

The average (mean of Groups I and II) olfactory detection threshold was lowest for asafetida (5.9 ± 3.9 ml), followed by formalin (6.1 ± 3.9 ml), peppermint (6.5 ± 4.1 ml), camphor (6.7 ± 4.3 ml), and rosewater or floral smell (7.0 ± 4.8 ml). The average (mean of Groups I and II) olfactory identification threshold was lowest for formalin (7.8 ± 4.3 ml) and asafetida (7.8 ± 5.6 ml), followed by peppermint (8.7 ± 4.0 ml), camphor (9.3 ± 3.7 ml), and rosewater or floral smell (9.4 ± 3.8 ml).

DISCUSSION

The current study compared the olfactory detection and identification threshold of five odors presented to females in menopause (45–60 years) for at least 5 years with those in reproductive age (20–35 years). The results indicated that the olfactory function declines significantly after menopause.

The olfactory thresholds obtained in our study are in close agreement with a previous study.[18] Mann *et al*. reported the mean olfactory threshold of peppermint, formalin, camphor, asafetida, and musk odor for nine normal females belonging to 27 ± 10 years of age as 1.9, 2.3, 2.3, 1.4, and 1.6 ml, respectively.[18] The purity of the odorous substance, ambient temperature and pressure, and the precision in using the apparatus is the key determinants of olfactory threshold during quantitative olfactometry by Elsberg-Levy method. A higher value for the olfactory threshold in our study could be due to any of the mentioned factors.

Group I was able to detect and identify all the five odors at a lower air volume than Group II. This could be due to the effect of aging or decrease in estrogen after menopause or both.

Age-related loss in olfactory acuity is multifactorial that includes structural and functional degradation of the olfactory epithelium, bulb, cortex, and pathway. Moreover, with increasing age, metabolizing enzymes in olfactory mucosa decreases, ossification occurs in cribriform plate foramina, selectivity of receptor cells to odorants is lost or diminished, and changes occur in neurotransmitter and neuromodulator systems responsible for the olfaction.[19,20]

The effect of aging on olfaction usually begins after the sixth decade of life.[3,13] Savović *et al*. compared olfactory ability in 20 perimenopausal females with 20 postmenopausal females. The subjects of both the groups belonged to 41–50 years of age, still, postmenopausal women showed a greater decline in olfaction. It was concluded that the significant decrease of olfactory ability in females after menopause could be explained by the decline in sex hormone levels.[1] Caruso *et al*. reported that the hormone therapy for 8 months in 48

postmenopausal women increased their sensitivity toward the smell. Although the exact mechanism is unknown, it was concluded that estrogen could affect neuronal plasticity and neuronal conduction time into the olfactory system.[15] Doty *et al*. reported similar results.[21] Hence, in the current study, decreased estrogen after menopause could be a predominant cause of decreased olfactory acuity in Group II.

The odor detection occurred at a lower volume of air than the identification. Although the detection and identification are related measures of olfactory acuity, they are not mutually exclusive. Detection is a sensory process that depends predominantly on the function of peripheral structures of the olfactory system, while identification is a more complex processing of olfactory information that involves both sensory and cognitive processes.[22,23] Not only the cognitive domains such as episodic and short-term memory but also the personality dimensions such as assertiveness play a critical role in odor identification. Lack of assertiveness could cause indecisiveness in answering.[24] Cognition[25] and assertiveness might decrease in the elderly,[26] which could explain the results of our study.

The consequences of olfactory dysfunction are shocking not only the quality of life is impacted but also the safety of a person gets endangered.[19] Hormone replacement therapy must be considered in the postmenopausal women that would enhance the various dimensions of the quality of life, improvement in the olfactory function is one of them.

Limitations

Sample size was not calculated. The hormonal assay was not done due to limited resources. Quantitative olfactometry by Elsberg-Levy method is not considered accurate and precise.[27] It is not recommended for clinical diagnosis; however, in our opinion can be used for resource-limited setup.

CONCLUSION

The olfactory acuity decreases after menopause. A major cause could be decreased estrogen in association with the normal aging process.

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