Original Article

Comparison between Olfactory Function of Pregnant Women and Non-pregnant Women in Reproductive Age Group in Ibadan, Nigeria

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ABSTRACT

Background: Pregnant women require normal olfactory function in order to develop good appetite for healthy living and normal fetal development. This study was carried out to investigate and compare olfactory function of pregnant women with non-pregnant women. **Methods:** This was a case control study of women in reproductive age group at the University College Hospital, Ibadan, Nigeria from July 2014 to February 2015. Consecutive 70 pregnant women and 70 non-pregnant women (controls) without rhinologic symptoms were studied. A structured questionnaire was administered to obtain participants' information on socio-demographics, pregnancy history, and ability to perceive smell. They subjectively rated their olfactory function on a visual analogue scale of 0 – 100. Olfactory threshold (OT), discrimination (OD), identification (OI) scores and TDI of both groups were determined with "Sniffin' sticks" kits and compared. The level of significance was $P<0.05$. **Results:** The mean age of the pregnant women was 30.5±3.9years and control was 28.5±6.6years. There were more pregnant women (7.1%) with hyposmia than the non-pregnant women (2.9%). The subjective rating of olfactory function was 68.2±24.9 (median 70) and 72.3±21.6 (median 69) in pregnant women and controls respectively. The mean OT, OD, OI, TDI scores were higher in pregnant women than the controls. However, it was only in OI ($P=0.000$) and TDI ($P=0.012$) that the differences were significant. **Conclusions:** Pregnant women have olfactory dysfunction more than the non-pregnant women of reproductive age group. Also, they have tendency to develop loss of cognitive olfactory information more than the non-pregnant women.

KEYWORDS: *Odor, Olfaction, Olfactory perception, Pregnancy, Smell, "Sniffin sticks"*

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INTRODUCTION

Pregnancy is a normal physiologic process that is associated with a change in estrogen and progesterone levels. This change increases the vascularity of nasal mucosa with resultant nasal congestion and has been reported to affect odor perception and recognition.[1] Olfactory responses vary depending on the chemical nature of the stimuli. Olfactory thresholds depend on the level of inhibitory activity, which is generated by higher centers. Changes in nasal mucosa and its pH will alter olfactory perception.[2] Human beings are better at detecting the pleasantness of an odor rather than recognizing it. During the pregnancy period, first trimester is significant in the proper growth and development of the unborn babies and the health behavior of pregnant mothers. Hyperemesis gravidarum, a clinical condition characterized by frequent episodes of nausea, excessive salivation, and vomiting, is more associated with first trimester and first pregnancy.[3-7] Certain odorous substance cause nausea during pregnancy, thereby influencing dietary type and intake.[8] It is hypothesized that olfactory dysfunction may play a role in this

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process, hence the absence of this clinical condition in some pregnant women. Olfactory function has been reportedly better in women but decreases with an increasing age.[9,10]

Rapid growth and development of unborn babies occurs throughout the pregnancy period. Therefore, pregnant mothers need to eat well for maintenance of good health and, normal growth and development of their unborn babies. Normal olfactory function has been documented as an important factor for good appetite. It may also protect against exposure to and accidental ingestion of spoilt, contaminated food which may predispose them to food poisoning and its effects such as miscarriage, premature labor, and the other conditions. Olfactory dysfunction may cause a change in the dietary behavior of an individual.[11] The change in the level of reproductive hormone at the different trimesters of pregnancy has been documented to produce a significant change in olfactory function of pregnant mothers.[11] Cognitive processing of odors appears to change in early pregnancy.[12-15] A few studies have documented on olfactory function of pregnant women; however, there is none from Nigeria. Although some of these studies on pregnant women reported an increase in olfactory sensitivity,[11-13,16,17] the finding could not be confirmed by other similar studies.[8,11,18-20] A study reported on a decrease in olfactory sensitivity and anosmia in the pregnant women.[21] Environmental odor, which varies from place to place, may influence olfactory sensitivity to some substances due to odor desensitization. This study was therefore conducted to investigate and compare the olfactory function of pregnant women with that of non-pregnant women in Ibadan, Nigeria.

Methods

Study design

This was a case-control olfactory study involving 70 pregnant women and 70 non-pregnant women without rhinologic diseases at the University College Hospital, Ibadan. They were instructed to refrain from smoking, drinking, and eating for at least 1 hour before the olfactory tests were performed. Ethical approval was obtained from University of Ibadan/University College Hospital review board for the conduct of the study. Informed consent was also obtained from the participants in the study. Women with clinical history of rhinosinusitis, nasal tumor, previous nasal surgery, and head trauma were excluded from the study. Urine pregnancy test was done to rule out cyesis in the non-pregnant women.

Questionnaire

A structured questionnaire was administered to obtain participants' information on sociodemographics, occupation, age of pregnancy, presence of nasal disease, head injury, and ability to perceive smell or not.

Ear, Nose, Throat Examination

The participants had their noses, oral cavities, and throats examined to exclude the presence of nasal pathologies such as discharge, polyps, or tumors.

Subjective assessment of smell

Participants were asked to specify if their perception of odor was reduced, increased, or unchanged at first trimester of pregnancy.

Olfactory testing

The participants had olfactory identification, discrimination, and threshold tests done using the validated "Sniffin sticks" test battery (Burghart Messtechnik GmbH, Wedel, Germany).[22] Odors were presented in felt-tip pens. The cap was removed and the tip of the pen was positioned approximately 2 cm in front of the participants' nasal cavities for about 3s to prevent adaptation.

Odor identification (OI) testing

Each of the 16 pens already impregnated with 16 different familiar odors were placed close to the anterior nares of each participant for about 3s. The odor pens were presented at interval of 30s to prevent olfactory desensitization.[12,18] They were then asked to select the source substance that matched the presented odor from four different items in a forced choice procedure (four alternative forced choice). The number of correctly selected source substance by the participant was then recorded. The minimum point that could be scored by a participant was zero and the maximum score was 16.

Odor discrimination (OD) testing

The kit for OD contains 48 pens that were arranged in 16 triplets. In each triplet, two of the pens contained the same odor while the third contained another odor. The participant was presented with these three pens and expected to identify the pen with a different odor (three alternative forced choice).[13] They were allowed to sample each odor only once, to minimize the test duration. The triplets were presented at intervals of at least 30s and the individual odor pens at intervals of approximately 3s. When the participant correctly identified the pen with a different odor she was given a point score and when she missed it, she scored zero. The process was repeated for the 16 triplet pens. The minimum point that could be scored by a participant was zero and the maximum score was 16.

Odor threshold (OT) testing

The kit also contains 48 pens which were arranged in 16 triplets. In each triplet, two of the pens contained

no odor, whereas the third stick was impregnated with different concentrations of *n*-butanol solution in an increasing fashion from the lowest to the highest (4%–16%).[23] The three odor pens were presented in a randomized fashion and the task was for the participants to identify the pen with a different smell. After the correct recognition of the pen with *n*-butanol odor in a triplet, the triplet pens were then re-shuffled and represented in a randomized fashion. If she correctly recognized the pen with *n*-butanol in a triplet the second time, a reversal of the staircase was started with the triplet pens from the highest concentration of *n*-butanol until she was no longer able to identify the pen which contains *n*-butanol. The staircase was then reversed and the process repeated. The threshold is the mean of the last four of seven staircase reversal points. Thus, the value of the threshold will range from 1 to 16.

The sum of OT, discrimination and identification values is referred to as threshold, discrimination, and identification (TDI) score. Each of these three different tests allowed for a maximum score of 16 points and together, a total maximum score of 48 points (TDI score). In this study, anosmia was defined as TDI scores of <15 whereas hyposmia was defined as TDI scores of ≤30.5, OT scores of ≤6.5, olfactory discrimination scores of ≤10, and olfactory identification scores of ≤11 were suggestive of hyposmia.[15]

Statistical analysis

Data obtained were analyzed using IBM SPSS (Statistical Package for Social Sciences) version 20 manufactured in Armonk, New-York, USA. Demographic variables were represented using tables while summary statistics was done using means and proportions. The comparison of mean olfactory scores between pregnant and non-pregnant women was done using the independent samples *t* test. The difference in olfactory perception between pregnant women and controls was tested using the analysis of variance. The odd ratio was calculated to detect a potential association between pregnancy and hyposmia. Level of statistical significance was set at *P* value of <0.05, two-tailed level at 95% confidence interval (CI) and correlation coefficient (*r*).

Results

Sociodemographics

The age of the pregnant women ranged from 22 to 38 years, mean of 30.5 ± 3.9 while that of non-pregnant women ranged from 20 to 40 years, mean of 28.5 ± 6.6. Forty (57.1%), 28 (40%), and 2 (2.9%) of the pregnant women were in the third, second, and first trimester, respectively.

Subjective olfactory perception of pregnant and non-pregnant women

Thirty four (48.6%) pregnant women had increased perception of smell in pregnancy, three (4.3%) reported reduction, and 33 (47.1%) reported no change in the first trimester of pregnancy.

Objective olfactory testing of pregnant and non-pregnant women

The mean OI, OD, OT, and TDI of both the pregnant and non-pregnant women were within the scores of the 10th percentile for 16–35-year-old individuals defined by Hummel *et al*.[15] However, the mean OI and TDI were significantly higher in pregnant women. The comparison of the mean OI, OD, OT, and TDI values of pregnant women and the controls are shown in Table 1.

There was no significant correlation between the gestational age of pregnancy and OI (r = -0.088; P = 0.470), OD (r = 0.097; P = 0.427), OT (r = -0.219; P = 0.069), and TDI (r = 0.117; P = 0.335). There was also no significant difference in olfactory test values in the three trimesters of pregnancy—OI (P = 0.655), OD (P = 0.525), OT (P = 0.472), and TDI (P = 0.388). There was no significant correlation between the subjective assessment of olfaction and OI (r = 0.169; P = 0.162), OD (r = -0.039; P = 0.749), OT (r = -0.230; P = 0.055), and TDI (r = 0.020; P = 0.866).

The mean OI, OD, OT, and TDI scores in both the pregnant and non-pregnant women are within the normosmic values. However, the values are lower in the pregnant women than the non-pregnant women [Table 1]. TDI score revealed that five (7.1%) pregnant women and two (2.9%) non-pregnant women were hyposmic. The pregnant women had twice the tendency to develop hyposmia more than the non-pregnant women [Table 2]. However, the observation was not statistically significant (P > 0.05).

Table 1: Comparison of mean olfactory test values of pregnant women with the control group

Variables	Pregnant women (mean ± SD)	Non-pregnant women (mean ± SD)	*P*
OI	11.54 ± 1.87	12.70 ± 1.62	0.000
OD	11.71 ± 2.61	11.80 ± 1.81	0.823
OT	13.76 ± 2.69	14.13 ± 2.48	0.414
TDI	36.99 ± 4.63	38.63 ± 3.52	0.012

Table 2: Comparison of hyposmic pregnant women with hyposmic non-pregnant women

Variables	Hyposmic pregnant women	Hyposmic Non-pregnant women	Odd ratio	95% CI	*Z* statistic	*P*
TDI	5 (7.1)	2 (2.9)	2.6154	0.4900-13.9592	1.125	0.2605
OT	8 (11.4)	3 (4.3)	2.8817	0.7314-11.3535	1.513	0.1303
OD	10 (14.3)	5 (7.1)	2.1667	0.7003-6.7034	1.342	0.1797
OI	4 (5.7)	2 (2.9)	2.0606	0.3650-11.6332	0.819	0.4130

Discussion

Objectively, this study showed that majority of the pregnant and non-pregnant women had normal olfactory function and, only in mean OI and TDI score that there was a significant difference between the groups. This is similar to the report by Kolble *et al.*[24] who reported no major pregnancy related changes in olfactory sensitivity of pregnant women at first trimester when compared with non-pregnant women. The subjective increased perception of smell noted in about 49% of the pregnant women during the first trimester in pregnancy in this study is similar to the report from similar studies.[16-25] Self-report has shown that the largest changes in olfactory perception occur in early pregnancy. Human chorionic gonadotropin level peaks during the first trimester and match the profile of self-reported changes.[26] In this study, the prevalence of hyposmia in pregnant women was higher than in the non-pregnant women. Although the participants in this study were not progressively monitored in pregnancy, the five hyposmic pregnant women were identified at their second trimester of pregnancy. This supports evidence that the change in smell sensitivity occurs in the early phase of pregnancy and may normalize in the course of pregnancy and after delivery.[27] Studies have reported that effect of pregnancy on olfaction occurs during the first trimester and declines with increasing gestational age.[12,28-31]

OT reflects peripheral processing of olfactory information.[21,27] This present study did not find any difference between the OT scores of pregnant and non-pregnant women. Disease of the nose and olfactory nerve that were excluded from this study might have contributed to the finding on OT in this study. This finding agrees with what has been previously reported in the literature.[1,28,29] Few studies have reported decreased OT in the last trimester of pregnancy and during postpartum period.[30-32] It is only longitudinal studies that investigated olfaction of pregnant women across the three trimesters that can correctly report the trend in pregnancy. The levels of circulating gonadal hormones have been implicated in the observed olfactory changes in pregnancy. Estrogen levels rise throughout pregnancy. Thus one would expect that olfactory function should improve across pregnancy if estrogen alone was involved but measures of olfactory function and self-report do not support this.[33]

OI reflects the central processing of olfactory information. In this study, mean OI score in pregnant women was found to be significantly higher than that of the controls. This is in contrast with findings in other studies that documented no significant difference in OI scores between pregnant and non-pregnant women.[1,11–13,17,25,28,34] Ochsenbein-Kolble *et al.*,[32] reported that OI scores tended to be lower in pregnant women than controls. Pregnant women have been reported to identify some odors better than the controls.[11,12,17,28] Pregnant women in this study identified the odor of smoked meat, peppermint, ginger, garlic, apple, orange, grass, fish, chocolate, and lemon better than the controls. This supports the idea that olfactory changes during pregnancy appear to relate mostly to changes of the cognitive processing of olfactory information rather than in olfactory acuity.[20]

OD reflects central processing of olfactory information. There is no significant difference in OD between pregnant women and the control group in this study, which is similar to findings in other studies.[13,16]

TDI score is the summation of measurement of both the peripheral and central processing of olfactory function. TDI score of pregnant women in this study was significantly higher than that of non-pregnant women which is similar to findings in other similar studies.[11,14,18–20,30,34] This shows that pregnancy may have an effect on olfaction. Some studies have failed to demonstrate a significant effect of pregnancy on olfaction.[12,13] This varied finding in olfaction in pregnancy may be due to the fact that the effect is more cognitive (central) than sensory (peripheral).[26,28] It may also be because the effect of pregnancy on olfaction is little and may vary with individuals, hence more sensitive tests are required to reveal any appreciable change in olfaction.[28] Olfaction is linked to important cognitive and emotional domains such as the orbitofrontal cortex and the dorsomedial nucleus of the thalamus in the brain.[21] Olofsson *et al.*[35] measured odor event-related potentials (OERP) in pregnant women and non-pregnant women. He reported no significant difference in the amplitude

and latency of N1 and P1 components (which reflect sensory processing), but reported a tendency for shorter latency and higher amplitude of the more cognitive P3 component in pregnant women. Therefore, the change in olfactory perception experienced by some women during pregnancy is due to psychological changes, possibly explaining the largely negative sensitivity test results.[35] Such a high-level change in odor processing may not be detected by some standard tests of olfactory function.[33] Olfactory-induced nausea appears to be due to cognitive processing of olfactory information but not changes in olfactory acuity.[20] The heightened sense of smell in pregnancy induces aversions to certain foods that contain teratogenic and abortifacient chemicals by causing pregnant women to avoid these food.[36,37]

Conclusions

The prevalence of hyposmia is more in pregnant women than the non-pregnant women and there was tendency for pregnant women to develop loss of smell than the non-pregnant women. Awareness should be created among the pregnant women on the possible change in olfactory perception in pregnancy. They should also be educated on how to cope with it for better quality of life and maternal nutrition.

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Conflicts of interest

There is no conflict of interest.

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