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Odor identification in young and elderly African-Americans and Caucasians

Olfactory function is affected by age and gender. However, there are few data on smell function in various racial/cultural groups, in particular, in different-aged African-Americans. Therefore, this study sought to determine if there is a relationship among age, gender, and race for smell identification. Sixty healthy African-Americans and 60 Caucasians between the ages of 20-40 and 60-80 years were administered the University of Pennsylvania Smell Identification Test (UPSIT). Older persons, regardless of race, had lower UPSIT scores, were more likely to be microsmic and anosmic, and had increased chemosensory complaints. Smell performance among females was better compared with males. Overall, African-Americans had lower UPSIT scores and age- and gender-adjusted percentile rank scores compared with Caucasians, but these differences were significant only among younger subjects. In addition, both young and old African-Americans had no smell complaints. The results from this study suggest that age, gender, and race have an influence on smell identification.

Olfaction warns individuals about food spoilage, dangerous fumes, and fires, and determines the flavor and palatability of foods and beverages.¹ Unfortunately, chronic disorders of smell and taste are frequently neglected, although chemosensory disorders can be diagnostic signs of more serious diseases and anomalies.¹

There are many factors that may cause olfactory dysfunction. The most common are medications and systemic diseases such as Alzheimer's and Parkinson's diseases, diabetes mellitus, hypothyroidism, and hypertension.² Olfactory disturbances often result from head trauma, upper respiratory infection, and nasal and/or paranasal sinus disease.¹ Furthermore, indoor and outdoor environmental pollutants can contribute to olfactory dysfunction.³

Chemosensory dysfunction has a profound affect on the health and function of an individual. Patients with chemosensory dysfunction tend to present with low body weight, nutritional deficiencies, and depression.¹ There is evidence to suggest that symptoms of psychological depression are greatest in patients with smell and taste dysfunction.¹ Chemosensory dysfunction affects the quality of a person's life. Therefore, these individuals should be identified in order to prevent further morbidity and mortality.^{1,2}

Investigations of olfactory function reveal age-related declines and gender differences, with females possessing superior smell capacity compared with that of males.^{4,5} In addition,

there are cultural, geographic, and individual variations in olfactory function.³ Wysocki *et al.*³ suggested that cultural or geographic differences in olfactory preference may, in part, be influenced by an individual's social status, or by food preparation and taste preferences. In addition, genetics and physiology as well as hygiene habits influence olfactory function. However, little research has been dedicated to examining the role of cultural, geographic, or racial factors in olfaction.

In the United States, the majority of olfactory studies have focused primarily on Caucasian populations. There are few data on odor identification in various racial/cultural groups, in particular, in different-aged African-Americans. Therefore, the purpose of the present study was to determine if there is a relationship among age, gender, and race on smell identification.

Materials and Methods

Population

The study population consisted of 60 African-Americans and 60 Caucasians. Thirty-eight young (age 20-40 years) and 22 old (age 60-80 years) subjects were examined within each racial group. Young African-Americans (age 28.7 ± 5.6 years, mean \pm SD) and Caucasians (30.6 ± 5.8 yrs) were similar in age (Student's *t* test, $p > 0.05$), and old African-Americans (69.7 ± 4.8 yrs) and Caucasians (72.3 ± 6.9 yrs) were similar in age (Student's *t* test, $p > 0.05$). Caucasians were volunteer participants in the oral physiology compo-

ment⁶ of the Baltimore Longitudinal Study of Aging (BLSA) conducted by the National Institute on Aging.⁷ African-American subjects were volunteer participants in the Howard University/National Institute of Dental Research (HU/NIDR) oral physiology study of aging,^{8,9} which was designed to parallel the oral physiology component of the BLSA.

Each Caucasian subject was age- and gender-matched to an African-American subject. All subjects were community-dwelling and of middle socio-economic class. Young subjects were healthy, not being treated for any medical problems, and were not taking any prescription medications. In each older group of African-Americans (n = 22) and Caucasians (n = 22), there were nine healthy unmedicated subjects, and 13 subjects with no existing medical problems except well-controlled hypertension, according to criteria established by Weber *et al.*¹⁰ The subjects being treated for hypertension were taking one of the following medications: diuretic, calcium channel blocker, nonselective beta-adrenergic blocking agent, and angiotensin converting enzyme inhibitor. A resting blood pressure was taken on every subject, and values were similar in African-Americans and Caucasians. All diastolic blood pressures were under 95 mm Hg and all systolic blood pressures under 156 mm Hg.

In the present study, a smoking history was assessed for each subject. Subjects were categorized as non-smokers, former smokers, and current smokers. The influence of smoking status on smell identification was evaluated.

Odor identification

Odor identification was assessed with the University of Pennsylvania Smell Identification Test [UPSIT], as described previously.^{4,11,12} Briefly, the UPSIT is a standardized 40-stimulus micro-encapsulated "scratch-and-sniff" forced-choice odor identification test. In addition, a two-item chemosensory questionnaire was administered to all subjects to identify

Table. Prevalence (%) of responses¹ to chemosensory questions by race and age group.

Race/Age Group	Changesmell ²		Changetaste ³	
	No Change	Worse	No Change	Worse
Young African-Americans (n = 38)	38/38 (100%)	0/38 (0%)	36/38 (95%)	1/38 (3%) ⁴
Young Caucasians (n = 38)	36/38 (95%)	2/38 (5%)	37/38 (97%)	1/38 (3%)
Old African-Americans (n = 22)	22/22 (100%)	0/22 (0%)	21/22 (95%)	0/22 (0%) ⁴
Old Caucasians (n = 22)	17/22 (77%)	5/22 (23%)	18/22 (82%)	4/22 (18%)

¹Responses "improved" or "no change" were analyzed as "no change".

²Have you experienced any changes in your sense of smell?

³Have you experienced any changes in your sense of taste?

⁴One subject responded "other".

fy subjective complaints of smell and taste changes.¹² The questions were: (a) "Have you experienced any change in your sense of smell?" (changesmell), and (b) "Have you experienced any change in your sense of taste?" (changetaste).

Analysis

UPSIT scores were converted into three olfactory functional categories: normosmic, microsmic, and anosmic.¹³ UPSIT scores were also converted into age- and gender-adjusted percentile rank scores¹³ based upon normative data. UPSIT scores and percentile rank scores were initially analyzed according to age, gender, and racial group by MANOVA tests. UPSIT results indicated that age and race were significant, but that the interaction between these two factors was not. Percentile rank score results indicated that only race was significant. Thereafter, intra-group differences were analyzed by Student's *t* tests and Mann-Whitney tests. Differences between the hyper-

tensive and non-hypertensive groups were analyzed by Student's *t* tests and Mann-Whitney tests. The influences of age, gender, race, and hypertension status on olfactory functional categories were analyzed by Chi-square tests and Fisher's exact tests. Differences in the frequency of responses to the chemosensory questionnaire according to age, gender, racial group, and hypertension status were evaluated by Chi-square tests and Fisher's exact test. The responses of "improved" or "no change" were combined and analyzed as "no change". In addition, the sensitivity and specificity of responses to the two chemosensory questions in relation to unimpaired smell (normosmic) or impaired smell (microsmic and anosmic)¹² were evaluated.

The influence of smoking status on smell identification in African-American and Caucasian groups was analyzed by Chi-square tests and Fisher's exact test. Smoking status was similar between both groups. Forty-one African-Americans and 33 Caucasians were nonsmokers; 12

African-Americans (mean pack years = 15) and 22 Caucasians (mean pack years = 14) were current smokers; seven African-Americans (mean pack years = 15) and five Caucasians (mean pack years = 8) were current smokers. One pack year was defined as smoking one pack of cigarettes daily for one year, or one-half pack of cigarettes daily for 2 years, etc. In the present study, statistical tests revealed that smoking status had no significant influence on smell identification.

Data were analyzed by means of the RS1 software package (BBN Software Products, Cambridge, MA). A criterion of $p < 0.05$ was accepted for significance in all statistical tests.

Results

Age/gender

Age had a significant influence on UPSIT scores (Fig 1). Overall, young subjects had significantly higher UPSIT scores compared with old subjects (Student's t test, $p = 0.0001$). No gender differences were observed in either the young- or old-aged groups; however, females, in general, had higher UPSIT scores compared with males, but these differences were not significant. Young males had significantly higher UPSIT scores than old males (Student's t test, $p = 0.003$), but these age-related differences were not significant among the females.

Using normative data for comparisons with previous studies,¹³ we converted UPSIT scores to percentile rank scores (Fig 2). There was no significant effect of age or gender on percentile rank scores (MANOVA, $p > 0.05$).

Using functional categories (normosmic, microsmic, anosmic), we compared unimpaired (normosmic) with impaired (microsmic and anosmic) individuals. Overall, older people were more likely to be impaired (43%) compared with younger people (3%; chi-square, $p = 0.001$); however, no significant gender differences were observed. Younger males (97%) were more likely to be normosmic compared with older males (57%; chi-

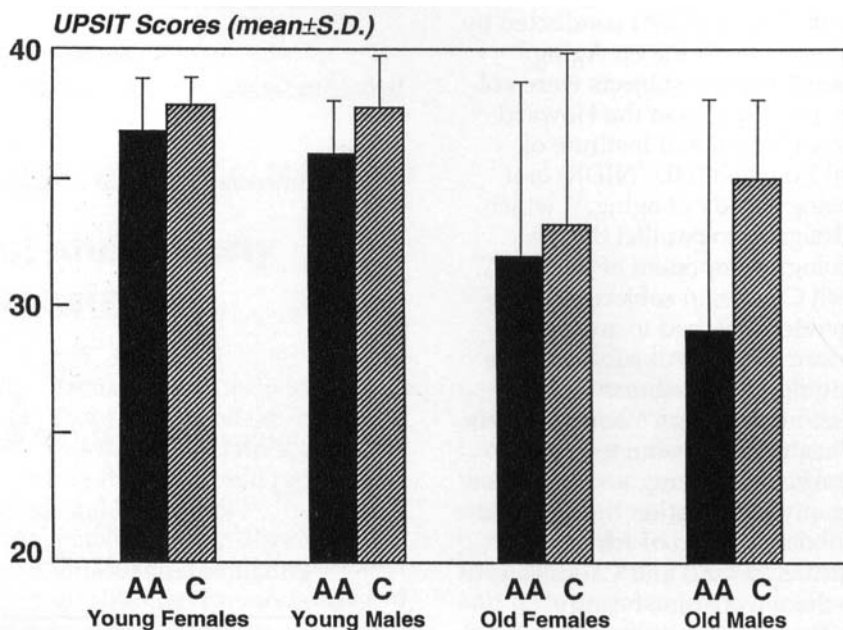


Fig 1. UPSIT scores for African-American (AA) and Caucasian (C) males and females in young (age 20-40 years) and old (age 60-80 years) groups.

square, $p = 0.001$). Similarly, younger females (97%) were more likely to be normosmic compared with older females (57%; chi-square, $p = 0.001$).

Race

Overall, Caucasians had higher UPSIT scores compared with African-Americans (Student's t test, $p = 0.002$) (Fig 1). This difference was observed in the young population (Student's t test, $p = 0.02$), but not in the old population. Old age was associated with lower UPSIT scores in both Caucasian and African-American subjects. There were no differences between males and females within each racial group; however, Caucasian males and females had significantly higher UPSIT scores compared with African-American males (Student's t test, $p = 0.02$) and females (Student's t test, $p = 0.03$). Young African-American and Caucasian males had significantly higher UPSIT scores than old African-American (Student's t test, $p = 0.002$) and Caucasian (Student's t test, $p = 0.004$) males. No significant differences were noted between young and old females within either

racial group.

Percentile rank scores for all study participants are illustrated in Fig 2. In general, there were no gender or age differences, since values were adjusted according to normative data.¹³ Caucasians had higher percentile rank scores than African-Americans (Student's t test, $p = 0.001$); however, these differences were significant only for young males (Student's t test, $p = 0.009$) and females (Student's t test, $p = 0.03$). There were no differences in percentile rank scores between males and females within each racial group; however, Caucasian males had higher scores compared with African-American males (Student's t test, $p = 0.002$), and Caucasian females had higher scores compared with African-American females (Student's t test, $p = 0.008$).

Regarding functional categories, there was a greater proportion of normosmic Caucasians (87%) compared with normosmic African-Americans (75%; chi-square, $p = 0.007$). These racial differences were consistent in both young and old groups, although they were not statistically significant. Age-related changes in the proportion of impaired subjects were great-

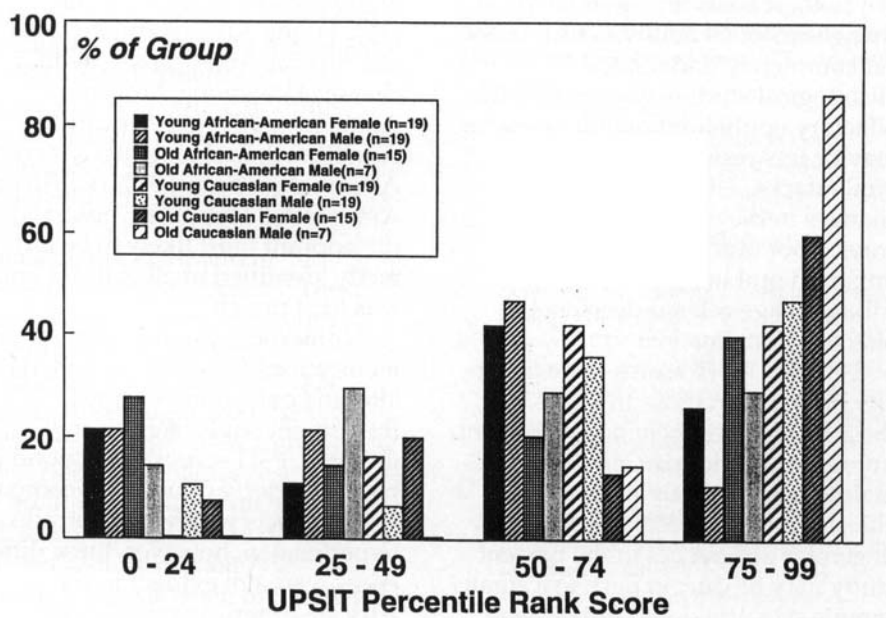


Fig 2. UPSIT percentile rank based on scores in young (age 20-40 years) and old (age 60-80 years) African-American and Caucasian males and females.

est in the African-American group, where elderly subjects (41% microsmic, 18% anosmic) had a greater prevalence of impairment compared with young subjects (5% microsmic, 0% anosmic; chi-square, $p = 0.001$). Within the Caucasian group, elderly subjects (32% microsmic, 4% anosmic) also demonstrated greater functional impairment compared with young subjects (0% microsmic, 0% anosmic; chi-square, $p = 0.001$). Overall, Caucasian males were more likely to be normosmic compared with African-American males (chi-square, $p = 0.04$), but these differences were not observed for females. Concerning the interaction of age and gender, young African-American and Caucasian females had a greater prevalence of normosmic subjects compared with old African-American (chi-square, $p = 0.04$) and old Caucasian (chi-square, $p = 0.004$) females. Young African-American males were more likely to be normosmic compared with old African-American males (chi-square, $p = 0.01$), but these differences were not observed among the Caucasian males.

Responses to chemosensory questions

Older individuals (5/44 = 11%) were more likely to complain of a change in their sense of smell, but not a change in taste, compared with young subjects (2/76 = 3%; chi-square, $p = 0.05$) (Table). Males and females responded similarly to these two questions, and there were no age-related differences in responses.

Caucasians (7/60 = 12%) were more likely to complain of a change in smell compared with African-Americans (0/60 = 0%; chi-square, $p = 0.006$). These significant racial differences were observed in the old-aged group (chi-square, $p = 0.02$), but not in the young group. In addition, significant differences were observed between young and old Caucasians (chi-square, $p = 0.04$). None of the African-Americans reported that their sense of smell had gotten worse. Overall, no differences in response to the changetaste question were observed between African-Americans and Caucasians. However, significant differences were evident between

young and old Caucasians (chi-square, $p = 0.04$), but not among African-Americans.

Sensitivity/specificity of chemosensory questions

Changesmell: The sensitivity to the changesmell question was 0% (0/2) in the young group and 9.5% (2/21) in the old group. The specificity for this question was 89% (66/74) in the young group and 88% (22/25) in the old age group. Females (14%, 2/14) had a greater sensitivity than males (0%), yet the specificity was similar between females (94%, 51/54) and males (95%, 43/45). The sensitivity to this question was lower among African-Americans (0%, 0/15) compared with Caucasians (25%, 2/8), yet the specificity was similar in African-Americans (100%, 47/47) and Caucasians (90%, 47/52).

Changetaste: The sensitivity of the changetaste question was also low and demonstrated age- and race-related differences, but no gender differences. Younger individuals (50%, 1/2) had a greater sensitivity compared with older persons (9%, 2/21). Caucasians (25%, 2/8) had a greater sensitivity than African-Americans (0%, 0/15). Specificity for this question overall was good (males 97%, 44/45; females 92%, 50/55; young African-Americans 94%, 34/36; young Caucasians 97%, 37/38; old African-Americans 100%, 11/11; old Caucasians 86%, 12/14) and demonstrated no significant age, gender, or racial differences.

Hypertension/medication effect

No gender differences for UPSIT scores were observed between healthy subjects and individuals being treated for hypertension. In the older age groups, UPSIT scores were similar in males and females for both healthy subjects and individuals being treated for hypertension, and thereafter all analyses combined males and females. UPSIT scores were significantly higher for healthy Caucasians compared with

Caucasians being treated for hypertension (Student's *t* test, $p = 0.005$), but no differences were detected in the African-American group. Percentile rank scores were similar between healthy and hypertensive groups regardless of race. For older Caucasians, the prevalence of normosmia was greater among healthy subjects (8/9, 89%) compared with hypertensive subjects (6/13, 46%), but a similar difference was not detected between healthy (4/9, 44%) and hypertensive (7/13, 54%) older African-Americans.

Discussion

The results from this study suggest that age and, to a lesser extent, race have a significant influence on smell identification in a population of generally healthy individuals. Older persons, regardless of race, had lower UPSIT scores, were more likely to be microsmic and anosmic, and had increased chemosensory complaints. Overall, smell performance among females was higher compared with males; however, these differences were not statistically significant. Racial comparisons revealed that Caucasians had higher UPSIT and adjusted percentile rank scores, were less likely to be smell-impaired, and had increased complaints of smell problems. In general, racial differences were most evident in the young groups, with no differences observed in the older groups with the exception of the chemosensory questions. Young and old African-Americans in this study had no complaints of smell problems. Finally, in a small group of older Caucasians with well-controlled hypertension and taking one antihypertensive drug, smell identification was further impaired.

These age-related findings are consistent with previous studies demonstrating that smell identification declines with increased age.^{4,12,14,15,30,31} Despite the small sample size in this study, age-related olfactory function deficits were detected in healthy African-Americans and Caucasians. These declines support an anatomic and

physiologic basis for age-related changes in smell ability, which is not yet completely understood.¹⁵ Histological studies suggest that the olfactory epithelium of older persons may be less resistant to damaging viral attacks.^{13,16-20} In addition to changes in the central neural pathways, poor oral hygiene and impaired oral health may also contribute to age-related decreases in olfactory function.^{12,22}

Female UPSIT scores were generally higher than those in males, but these differences were not significant. Interestingly, elderly Caucasian males scored slightly higher than elderly Caucasian females. The lack of gender differences in the present study may be due, in part, to a small sample size. Previous studies have demonstrated superior olfactory function in females,^{4,5,23} including healthy populations.¹² When the UPSIT was administered to four different ethnic groups in one study, women consistently outperformed men to the same relative degree.⁵ It is not yet known why olfaction is influenced by gender, although several hypotheses have been stated. Deems *et al.*¹ suggested that estrogen has a prophylactic effect on the integrity of the olfactory epithelium, protecting it from viral or toxic insults.

Racial differences existed in smell identification in the present study, but only in the young group. Doty *et al.*⁵ used a considerably larger sample size, yet also found racial differences. However, Doty's cohorts were not age-matched. Doty *et al.*⁵ collected UPSIT scores from four racial groups: American Koreans (92% correct), American Caucasians (87% correct), African-Americans (83% correct), and native Japanese (78% correct). Cultural variations in food preparation and smell and taste preference³ may account for the racial results observed in the present study and previous reports. In addition, environmental factors as well as cultural differences in familiarity with the test odors may have yielded race-dependent findings. Interestingly, the odorants most often incorrectly identified by the African-American population

in the present study were fruit punch (34% young African-Americans, 64% old African-Americans), cheddar cheese (41% young African-Americans, 50% old African-Americans), and coconut (37% young African-Americans, 32% old African-Americans). Doty *et al.*⁵ observed that the odorant most likely to be incorrectly identified in all cultural groups was fruit punch.

Numerous systemic diseases and medications have been reported to alter the perception of smell.^{2,25-27} In the present study, significantly greater UPSIT scores were found in healthy elderly Caucasians compared with subjects with well-controlled hypertension; however, these differences were not evident in the African-American population. Interestingly, the three anosmic subjects in the study were older subjects treated for hypertension (two African-Americans, one Caucasian), whereas none of the healthy elderly was anosmic. However, the small sample size and the use of several different anti-hypertensive medications preclude the establishment of any relationships between hypertension and olfactory dysfunction. It is interesting, nevertheless, that previous studies² have reported that hypertensive individuals have increased complaints of absent or diminished taste, especially for salt. Schiffman *et al.*² demonstrated that the elderly have difficulty discerning differences in salt concentrations, and reported an 11.6-fold greater salt detection threshold in older compared with younger persons.

Caucasians had more complaints of smell problems than African-Americans. There is no readily-available explanation why African-Americans had no complaints of smell problems. It is suggested that a Likert scale be utilized in future studies to assess chemosensory complaints.³² The sensitivity for the changesmell question was low for both racial groups (African-Americans 0%, Caucasians 25%), whereas the specificity was high (African-Americans 100%, Caucasians 90%). The results for the

question change taste were similar: low sensitivities (African-American 0%, Caucasians 25%) and high specificities (African-Americans 96%, Caucasians 94%). These findings indicate that the complaint of a smell problem does not necessarily indicate smell dysfunction. The high specificity establishes that normosmic individuals do not complain of chemosensory disturbances. These observations are consistent with those of previous studies.^{1,12,28} Goodspeed *et al.*²⁸ observed that patients who sought medical care for chemosensory disorders were unable to describe their chemosensory problem accurately. In general, many individuals are unable to distinguish between taste and smell.^{1,12,28} Individuals speak often of "tasting food", yet olfaction may contribute more than taste to the eating experience.²⁴ Chemosensory disorders are caused by many factors, and may not necessarily reflect an olfactory or gustatory deficit. Therefore, it is imperative that these individuals receive thorough medical attention.

It is difficult to make generalizations about smell identification based upon this small study population. Because race is a multidimensional construct,²⁹ future studies are clearly necessary to determine if race, culture, and ethnicity are significant attributes which influence chemosensory function. In addition, longitudinal studies are necessary to observe olfactory function in healthy people and individuals with systemic disease, to establish the influence of aging and disease on chemosensory performance.

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