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Olfaction is Associated with Sexual Motivation and Satisfaction in Older Men and Women

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Abstract

Background: Sensory function declines with age and may impact sexual function in older adults. Indeed, the sense of smell plays a uniquely strong role in sexual motivation. Therefore, olfactory dysfunction in older adults may be intimately linked to changes in sexual desire and satisfaction.

Aim: To test whether impaired olfactory function is associated with decreased sexual activity and motivation in older adults.

Methods: Cross-sectional analysis of a nationally representative sample of community-dwelling older U.S. adults from the National Social Life, Health, and Aging Project.

Outcomes: Two modalities of olfactory function were measured (sensitivity to n-butanol and odor identification) via validated methods (Sniffin' Sticks). Respondents answered survey questions about frequency of sexual thoughts (motivation) and sexual activity, and satisfaction

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AUTHOR CONTRIBUTIONS

Study concept and design: JKS, SYK, DWK, MKM, JMP. Acquisition and analysis of data: JKS, SYK, DWK, KEW. Drafting of the manuscript: JKS, SYK. Critical revision of the manuscript for important intellectual content: JKS, KEW, MKM, JMP.

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with their most recent sexual relationship. A wide range of demographic, health, and social information were also collected.

Results: Decreased olfactory function in older U.S. adults was associated with decreased sexual motivation (OR 0.93, $p=0.03$) and less emotional satisfaction with sex (OR 0.89, $p=0.04$), but not decreased frequency of sexual activity or physical pleasure, in analyses that were adjusted for age, gender, race, education, cognition, comorbidities, and depression.

Clinical Implications: Olfactory dysfunction may affect sexuality in older adults. Potentially treatable causes of sensory loss should be addressed by clinicians to improve quality of life.

Strengths and Limitations: These results rely on validated olfactory testing, detailed measures of sexual attitudes and behaviors, and extensive demographic, health, and social history in a nationally-representative sample of older U.S. adults. Due to the cross-sectional nature of these analyses, we cannot determine causality.

Conclusions: Olfactory dysfunction in older U.S. adults is associated with decreased sexual motivation and emotional satisfaction, potentially due to evolutionary-conserved neurological links between olfaction and sexuality.

Keywords

Smell; sensory loss; aging; sexual activity; sexual motivation

INTRODUCTION

Sex remains a regular and important part of life for older adults¹. However, frequency of sex declines with increasing age, as a result of both physical and psychosocial stressors^{1,2}. The roles of factors such as chronic illness, social isolation, and relationship dissatisfaction in decreased sexual activity have been well studied¹⁻⁶. However, relatively little is known about how sensory loss impacts sexuality in older adults, despite the high prevalence of sensory loss with aging⁷ and the central role the classical senses play in sexuality⁸⁻¹².

We previously reported that global sensory impairment (a measurement of dysfunction across the five classical senses: vision, hearing, smell, taste, and touch) in older adults was associated with a decrease in sexual activity but no change in sexual motivation or sexual satisfaction¹³. This suggests that global sensory impairment presents a barrier to engaging in sex but does not necessarily decrease the importance of sexual expression and satisfaction in the lives of older adults. These data characterized a key connection between age-related impairment of sensory function and sexual activity in older adults. However, it is likely that different senses contribute to sexuality in different ways. For example, in one study both men and women reported smell as one of the most important stimuli when selecting a romantic partner, particularly among young women¹². Indeed, olfaction has a strong, evolutionarily-conserved connection to the limbic system, which plays a critical role in processing emotions and sexual motivation¹⁴⁻¹⁹. Neurons in the olfactory bulb also project directly to the hypothalamus, another key mediator of sexual motivation^{20,21}.

Olfactory loss has severe consequences for the quality of life of older adults. For example, smell loss is associated with social isolation and anhedonia, which are also major

contributors to sexual dysfunction^{22,23}. Thus, we hypothesized that olfactory impairment and sexual dysfunction are related in a manner that goes beyond difficulty initiating sex. Considering the tight neurological coupling of olfaction with emotional processing, we hypothesized that olfaction may play an important role in sexual satisfaction and motivation. To explore this important relationship, we tested the role of olfactory specifically as a sensory modality associated with sexual function.

In this study, we investigated the relationship between sexuality and olfactory function using data from the National Social Life, Health, and Aging Project (NSHAP), a nationally representative study of older U.S. adults²⁴. Respondents answered survey questions about various facets of sexual behavior and motivation, and olfactory function was tested. Our previous work on global sensory impairment included only assessment of odor identification, which is the ability to associate a smell with a picture or word and requires central cognitive processing, memory, and language. Here we also measure olfactory threshold, which more directly probes peripheral and subcortical odor detection. These tests in tandem provide a robust assessment of both components of olfaction and an insight into the balance of different brain systems involved. We also use extensive data on physical, mental, and social well-being which were collected by in-home interview. These data allow us to probe the link between olfaction and sexual function.

METHODS

The National Social Life, Health, and Aging Project (NSHAP)

NSHAP is an omnibus, nationally representative survey of older U.S. adults living at home, who were born between 1920 and 1947²⁵. In 2010–2011, interviewers from the National Opinion Research Center (NORC) conducted in-home interviews with adults who had been interviewed 5 years previously along with their cohabitating partners²⁴. Interviews included assessment of demographic, social, psychological, and biological measures, including olfaction and sexuality as described below. Here, we included respondents who had complete olfactory testing and sexuality measures in 2010–11, a timepoint when the most comprehensive information was collected. Further details regarding NSHAP study design, data collection, and baseline characteristics of respondents are available elsewhere^{25–27}. The study was approved by the Institutional Review Boards of the University of Chicago and NORC. All respondents provided written, informed consent.

Olfaction

Odor sensitivity to n-butanol and odor identification ability were measured in a randomly selected subset (approximately 2/3) of subjects in 2010–11 using the Olfactory Function Field Exam, as previously described^{28–30}. The odor sensitivity task measures the ability to physically detect an odor, while the odor identification task includes the more cognitively challenging task of recognizing a common smell and identifying the correct name from a list. We include both measures of olfaction because physical detection and central processing and recognition involve separate neurological pathways, which can be decoupled with aging but are both necessary for a functional sense of smell²⁸.

Briefly, for odor sensitivity, respondents were asked to detect different concentrations of n-butanol presented via Sniffin' Stick odor pens, a validated measure^{28,29}. Respondents who were able to detect 5 or 6 n-butanol concentrations were classified as normosmic, whereas respondents who detected 4 or fewer pens were classified as having olfactory dysfunction. The number of errors (range 0–6) was used in the model fitting. For odor identification, respondents were asked to identify each of 5 common odors presented using Sniffin' Stick odor pens by choosing from a set of four word/picture choices; refusals were coded as incorrect. Respondents who identified 4–5 odors correctly were classified as normosmic, whereas respondents who identified 3 or fewer odors correctly were classified as having olfactory dysfunction, as in prior work³⁰. The number of errors (range 0–5) was used in the analysis. Pens were obtained from Burghart Messtechnik (Wedel, Germany) and utilized according to the manufacturer's instructions.

Sexuality

Sex or sexual activity was defined in the NSHAP survey as “any mutually voluntary activity with another person that involves sexual contact, whether or not intercourse or orgasm occurs”¹. Multiple components of sexual motivation and behavior were measured as previously described³¹. Sexual motivation was assessed by asking respondents to rate the frequency of sexual thoughts with the responses “never,” “less than once a month,” “one to a few times a month,” “one to a few times a week,” “every day,” or “several times a day.” Respondents also rated their emotional satisfaction with their most recent sexual relationship with the responses: “not at all,” “slightly,” “moderately,” “very,” or “extremely.” Sexual behavior was measured by the frequency of sexual activity. Respondents answered how often they had had sex with their most recent partner with the responses: “none at all,” “once a month or less,” “2 to 3 times a month,” “once or twice a week,” “3 to 6 times a week,” or “once a day or more.” A second measure was how physically pleasurable they found their most recent sexual relationship with the responses: “not at all,” “slightly,” “moderately,” “very,” or “extremely.”

Demographic, Health, and Social Information

Our analyses adjusted for numerous potential factors that could influence the relationship between olfaction and sexuality, including age, gender, race/ethnicity, education, cognitive function, and depression. Age and gender have previously been associated with both olfactory function^{32,33} and sexual behavior³⁴. Race (which affects olfactory function³⁵) and Hispanic ethnicity were measured via self-report according to standard NIH questions, and respondents were classified as White, African American, or Hispanic (those who reported their race as “Black/African American” and answered “Yes” to Hispanic ethnicity were classified as African American). Those reporting their race as “American Indian or Alaskan Native,” “Asian,” or “Other” were combined into a single “Other” category due to low numbers. Socioeconomic status was measured by highest educational degree or certification earned. Cognitive function was measured using a validated version of the Montreal Cognitive Assessment (MoCA) adapted for survey administration (MoCA-SA)^{36–38}. Burden of medical comorbidity was quantified with an adaptation of the validated Charlson index³⁹ using the medical history data that were collected in NSHAP⁴⁰, scored from 0 to 11. This index includes key diseases that affect sexuality including diabetes,

cancer, neurodegenerative disease, and incontinence^{41–44}. Depression has been previously shown to be associated with olfactory dysfunction and sexuality⁴⁵, and was measured with a version of the Center for the Epidemiologic Studies Depression Scale modified for NSHAP⁴⁶ (scored from 0 to 21; a score of 9 or more indicates frequent depressive symptoms).

Statistical analysis

NSHAP had a 74% weighted response rate in 2010–11, excellent for a probability sample. 1,981 older adults had complete data collected on odor sensitivity and sexuality measures, and 1,605 older adults had complete data collected on odor identification and sexuality measures. Analyses were performed using person-level weights, accounting for differential non-response and differential probability of selection. Design-based standard errors were calculated using the linearization method together with the strata and Primary Sampling Unit indicators provided with the dataset. Multivariable ordinal logistic regression models were used to evaluate the relationship of sexual parameters with olfactory function, adjusting for relevant covariates. Results are presented as odds ratios and 95% confidence intervals (CI). Wald tests were used to determine *p*-values. Statistical significance was set at *p*<0.05. All statistical analyses were conducted using Stata Version 14.0 (StataCorp LP, College Station, TX).

RESULTS

In a nationally-representative sample of 2,084 U.S. older adults, 71.5% had impaired n-butanol sensitivity and 22.4% had impaired odor identification ability (Table 1). Self-reports of sexual behavior, motivation, and satisfaction are presented in Table 2 and described in more detail elsewhere³¹

Older adults with worse odor sensitivity (greater number of errors) had less sexual motivation, indicated by less frequent thoughts about sex (OR 0.93, 95% CI 0.87–0.99) (Table 3). Women thought about sex less frequently than men (OR 0.15, 95% CI 0.12–0.18), as did respondents who were older, less educated, and had lower cognition scores. Nonetheless, the association between olfactory sensitivity and sexual motivation remained statistically significant after adjusting for these factors. We also asked whether these associations were stronger in older women (as they are in younger women¹²). Such a gender difference was not evident here among older adults (*p*=0.60 for the gender by olfactory sensitivity interaction).

A similar result was found with the more cognitively-demanding task of odor identification. Older adults with worse odor identification scores reported less emotional satisfaction with their most recent sexual partner (OR 0.89, 95% CI 0.81–0.99) (Table 4). Women reported less emotional satisfaction than men (OR 0.57, 95% CI 0.45–0.73), and respondents with frequent depressive symptoms reported less emotional satisfaction (OR 0.44, 95% CI 0.30–0.69). However, neither of these factors accounted for the association between odor identification and finding sex emotionally satisfying. The relationship also did not vary by gender (*p*=0.44 for the gender by odor identification interaction).

Interestingly, neither measure of sexual behavior was associated with olfactory function as measured by either odor identification or sensitivity. Specifically, the frequency of sex with the most recent partner was not associated with either odor sensitivity or odor identification ability ($p=0.53$ and $p=0.80$, respectively) in adjusted models. Women, white respondents, and those who were older reported less frequent sex in these models. Similarly, physical pleasure of the most recent sexual relationship was not significantly associated with either odor sensitivity ($p=0.23$) or odor identification ($p=0.81$).

DISCUSSION

Our data suggest that olfactory dysfunction affects sexual motivation and emotional satisfaction with sex, in contrast to global sensory impairment. Global sensory impairment, which encompasses dysfunction of multiple senses, has been associated with decreased frequency of sex but not change in frequency of thinking about sex or satisfaction with sexual relationships¹³. However, when we focus on olfaction exclusively, we find the exact opposite result: respondents with olfactory dysfunction were able to have sex with the same frequency and achieve physical satisfaction, but they thought about sex less and were less emotionally satisfied by it. This striking contrast suggests that while the other senses included in global sensory impairment may be more important for initiating and performing sexual acts, olfaction - perhaps due to its strong evolutionarily-conserved link with the limbic system and hypothalamus - is critical for the thoughts and feelings that drive it.

Herz and Cahill surveyed adults about the stimuli that affect their sexual responsivity, and showed that for both men and women, olfactory information is central to sexual attraction¹². Our data support this finding and demonstrate that with increasing age, availability of these olfactory data may continue to drive sexual desire and quality of sexual experience. However, Herz and Cahill also found that olfaction is particularly salient to sexual attraction in young women compared to men, and this finding has been replicated for young women across different cultures⁴⁷. We find that this gender difference is not present in older adults. One possibility that could explain this difference is that olfaction becomes relatively less important for women as they age (perhaps due to hormonal changes), or that it increases in importance for men as they age. This remains an open question to be investigated in future work.

Gudziol and colleagues showed that olfactory dysfunction was associated with decreased sexual appetite, but suggested that depression caused by the olfactory dysfunction was the reason for the decreased interest in sex⁴⁵. In our analyses, we clarified this relationship by controlling for presence of depressive symptoms. While depression is related to both olfactory dysfunction²² and decreased interest in sex^{1,48}, it does not mediate their association.

In this study, we also expand on previous work by including olfactory sensitivity, a measurement which requires less higher-order integration of executive function and memory than odor identification. The finding that both measurements are associated with sexual motivation and emotional satisfaction suggests that the strong connection between olfaction and sexuality may also exist at a subcortical level, not only in the realm of cognition and

memory. This supports our hypothesis regarding the unique way in which evolutionarily-conserved olfactory connections to the limbic system shape sexual drives and responses.

Several limitations of this study should be taken into consideration. While our findings were statistically significant, the magnitude of the observed relationships was not overwhelming. There are likely a variety of factors that contribute to sexuality in older adults, and each may have a small effect, consistent with our results. The lower strength of our association may reflect the difficulty of teasing out all of inputs on sexuality; thus, chemosensory function may play a demonstrable but small effect. Future studies may address these possibilities. In this study we only examined olfactory function rather than the other classical senses. To test the hypothesis that olfaction affects sexuality in a manner that is unique among the senses, future work will be needed to directly compare how olfaction is related to sexuality versus the other individual classical senses. Additionally, our data are cross-sectional; longitudinal analyses would provide insights into mechanisms and causality. If the relationship between olfaction and sexual experience is not causal, an alternative explanation would be that good olfactory and sexual function indicates that their shared neuroanatomic connections remain resilient in aging. Indeed, olfaction is now viewed as a sensitive indicator of other domains of health, especially in the nervous system^{49,50}. In this case, impaired olfaction may be a measurable sign of underlying neurological or cognitive decline, particularly in the brain regions that contribute to sexuality.

Given the demographic changes in our society, the consequences of both impaired olfaction and sexual dysfunction on quality of life are likely to grow. Currently, age-related olfactory dysfunction affects approximately 15 million older Americans and age-related sexual dysfunction affects over 40% of women and 30% of men^{33,51,52}. Further investigation into how these systems are connected and whether treating olfactory loss may improve sexual function has great promise to enhance the quality of life of older adults.

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Table 1.

Demographic characteristics of the population

Characteristic	N (%)	
Odor identification – number of errors	0	896 (45)
	1	661 (32)
	2	254 (11)
	3	146 (6)
	4	63 (3)
	5	64 (3)
Odor sensitivity – number of errors	0	152 (8)
	1	388 (20)
	2	540 (25)
	3	386 (18)
	4	237 (12)
	5	185 (8)
Gender	Men	985 (47)
	Women	1099 (53)
Age (years, mean \pm SD)	72.4 \pm 7.5	
Race/ethnicity	White	1493 (81)
	Black	323 (10)
	Hispanic, non-Black	212 (6)
	Other	48 (2)
Education	<High school	412(16)
	High school graduate or equivalent	534 (26)
	Some college	608 (30)
	Bachelors or higher	530 (27)
Cognition (MoCA-SA, mean \pm SD)	14.0 \pm 3.9	
Comorbidity index (NSHAP-modified Charlson index, mean \pm SD)	1.2 \pm 1.5	
Frequent depressive symptoms (NSHAP-modified CESD, mean \pm SD)	4.7 \pm 4.3	

* Weighted % unless otherwise specified

Table 2:

Distribution of sexuality measures, overall and by gender

	Overall (%)	Men (%)	Women (%)
How often do you think about sex? (Sexual motivation)			
Never	480 (15)	91 (6)	398 (22)
Less than once a month	742 (23)	193 (13)	549 (31)
One to a few times a month	836 (26)	376 (26)	460 (26)
One to a few times a week	707 (22)	430 (29)	277 (16)
Every day	336 (11)	279 (19)	57 (3)
Several times a day	112 (4)	93 (6)	19 (1)
How often did you have sex with your most recent partner? (Sexual behavior)			
None at all	917 (38)	450 (35)	467 (40)
Once a month or less	548 (23)	297 (23)	251 (22)
2–3 times a month	467 (19)	258 (20)	209 (18)
Once or twice a week	372 (15)	199 (16)	173 (15)
3–6 times a week	94 (4)	53 (4)	41 (4)
Once a day or more	31 (1)	15 (1)	16 (1)
How physically pleasurable did/do you find your relationship with your most recent partner to be? (Sexual behavior)			
Not at all	130 (5)	50 (4)	80 (7)
Slightly	129 (5)	54 (4)	75 (6)
Moderately	473(19)	197 (15)	276 (23)
Very	975 (38)	536 (40)	439 (36)
Extremely	850 (33)	505 (38)	345 (28)
How emotionally satisfying did/do you find your relationship with your most recent partner to be? (Emotional cognition)			
Not at all	79 (3)	36 (3)	43 (3)
Slightly	131 (5)	54 (4)	77 (6)
Moderately	473(18)	194 (14)	279 (23)
Very	1069 (41)	580 (42)	489 (39)
Extremely	864 (33)	512 (37)	352 (28)
How important a part of your life would you say that sex is?			
Not at all	932 (33)	256 (20)	676 (44)
Somewhat	566 (20)	249 (20)	317 (21)
Moderately	649 (23)	348 (27)	301 (20)
Very	497 (18)	316 (25)	181 (12)
Extremely	158 (6)	107 (8)	51 (3)

Table 3:

Worse odor sensitivity is associated with decreased sexual motivation (frequency of thinking about sex) (multivariable ordinal logistic regression, n=1,981).

	Odds Ratio (95% CI)	p-value
Odor sensitivity errors	0.93 (0.87–0.99)	0.03
Gender	(reference)	<0.001
Men	0.15 (0.12–0.18)	
Women		
Age	(reference)	<0.001
62 to 69 years old	0.61 (0.48–0.77)	
70 to 79 years old	0.40 (0.29–0.56)	
80 to 90 years old		
Race/Ethnicity	(reference)	0.08
White	0.86 (0.63–1.15)	
Black	0.82 (0.56–1.20)	
Hispanic, non-Black	0.43 (0.20–0.93)	
Others		
Education Level	(reference)	<0.01
Less than high school	1.67 (1.10–2.56)	
High school graduate	1.51 (1.02–2.25)	
Some college	2.22 (1.39–3.56)	
Bachelors or higher		
Cognition	1.06 (1.03–1.10)	<0.001
Comorbidity Index	0.95 (0.89–1.02)	0.13
Frequent Depressive Symptoms	(reference)	0.25
Negative	1.18 (0.92–1.51)	
Positive		

Table 4:

Worse odor identification ability is associated with decreased emotional satisfaction with most recent sexual relationship (multivariable ordinal logistic regression, n=1,605)

	Odds Ratio (95% CI)	p-value
Odor identification errors	0.89 (0.81–0.99)	0.04
Gender	(reference)	<0.001
Men	0.57 (0.45–0.73)	
Women		
Age	(reference)	0.66
62 to 69 years old	0.88 (0.69–1.13)	
70 to 79 years old	0.89 (0.63–1.24)	
80 to 90 years old		
Race/Ethnicity	(reference)	0.09
White	0.91 (0.62–1.35)	
Black	0.46 (0.25–0.84)	
Hispanic, non-Black	1.03 (0.56–1.91)	
Others		
Education Level	(reference)	0.83
Less than high school	0.94 (0.55–1.63)	
High school graduate	1.06 (0.69–1.62)	
Some college	0.97 (0.59–1.60)	
Bachelors or higher		
Cognition	1.04 (0.99–1.09)	0.13
Comorbidity Index	1.04 (0.95–1.14)	0.43
Frequent Depressive Symptoms	(reference)	<0.001
Negative	0.44 (0.30–0.69)	
Positive		