

## **Understanding Overall and Sexual Health in Older Women Using Saliva Sex Hormone Measurements**

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### **Abstract:**

The aim of this study was to explore the associations of the levels of sex hormones (testosterone, progesterone, estradiol and DHEA) with global self-reported health and characteristics of sexual performance and sexual dysfunction in a population-based sample of older women. We used data on salivary hormone measurements collected by The National Social Life, Health and Aging Project (NSHAP). The likelihood of reporting very good or excellent health were significantly and positively associated with higher levels of salivary DHEA. Although reported sexual activity and attitude did not show any associations with sex hormone levels, specific measures of sexual performance and problems revealed such relations. For example, low levels of estradiol and DHEA were associated with difficulty lubricating and women with normal levels (2<sup>nd</sup> tertile) of testosterone were more likely to express interest in sex. Salivary sex hormone measurements contribute to better understanding of women's health and sexual performance at older ages.

The first wave of NSHAP, conducted between July 2005 and March 2006, included collection of a self-collected salivary specimen from all willing respondents.

Sex hormones (estrogen, progesterone, testosterone, DHEA), produced from cholesterol in a human body (Greenspan and Gardner 2001), play an important role in human physiology throughout the lifecourse. An abrupt decrease in ovarian estrogen production occurs in natural menopause; surgical menopause due to removal of the ovaries additionally results in an abrupt drop in androgen production. In men, the decline of androgens is more gradual. Age-related decline in sex hormone production has been linked in men and women to common chronic health problems such as osteoporosis (Ettinger, Pressman et al. 1998; Barrett-Connor, Mueller et al. 2000; Carlsen, Soerensen et al. 2000), cognitive decline (Barrett-Connor, Goodman-Gruen et al. 1999; Manly, Merchant et al. 2000; Cunningham, Sinnott et al. 2001) and cardiovascular disease (Alexandersen, Haarbo et al. 1996).

The National Social Life, Health and Aging Project (NSHAP) was designed, in part, to identify biological mechanisms through which social, including intimate and sexual, relationships affect health as women and men age. Salivary sex hormone measurements conducted by the NSHAP study are important for better understanding of biosocial mechanisms related to sexuality, health and well-being at older ages.

Details of the NSHAP sample design and participant characteristics have been previously described (Lindau, Schumm et al. 2007). The survey yielded 3,005 respondents (1,455 men and 1,550 women) aged 57-84 years. The weighted sample response rate was 75.5%. Here, we describe the collection of saliva samples and details of sex hormone assays.

### **Sample Demographic Characteristics and Variables Used**

We used three categories of age: 57-64, 65-74 and 75-84. Marital status categories included married, divorced, separated, widowed, or never married. Race and ethnicity were categorized as White, Black, non-black Hispanic, and others. Education level was dichotomized as "high school and below" and "some college and higher." In the NSHAP study respondents were asked to rate their physical health using the standard 5-point scale with responses "excellent," "very good," "good," "fair," or "poor." Here we used three self-rated health categories: "very good/excellent," "good," and "fair/poor."

Ovarian surgery in women was estimated on the basis of self-reports. Usage of hormones included reported hormone replacement therapy and oral contraceptives.

Sexual activity was measured as having sex over the last 12 months. Positive sexual attitude was measured as response "" to the question "Was your sex physically pleasurable?" Sexual performance and sexual problems included: Feeling of tingling of vagina during sex, lack of interest in sex, difficulty lubricating, inability to climax and pain during intercourse.

## Statistical Analysis

All analyses were performed using the Stata statistical software package, release 9 (StataCorp 2005). Logistic regression (Hosmer and Lemeshow 1989) was used to model the likelihood of participating in the saliva collection. This model included age group (57-64, 65-74, and 75-85), race (white, African American, Hispanic/non-black and other), education (high school and below, some college and higher) and self-rated health (excellent/very good, good, and fair/poor) as covariates. Hormone measurements were split into tertiles and used the lowest tertile as a reference level. Results are presented as odds ratios together with 95% confidence intervals. To account for the unequal probabilities of selection, we performed weighted analyses using the probability weights with a post-stratification adjustment based on age and urbanicity. Inference was conducted using design-based variance estimates, obtained via the linearization method (Binder 1983) as implemented in Stata (StataCorp 2005). All p-values reported are two-sided.

## RESULTS

Mean values of hormone measurements for older women together with standard deviations and 95% confidence intervals are presented in Table 1.

Table 1 About Here

380 women in the sample reported both ovaries removed, so one might expect significantly lower salivary testosterone levels in ovariectomized women. However it turned out that testosterone levels were very similar in ovariectomized ( $44.23 \pm 1.33$  pg/ml) and non-ovariectomized ( $47.03 \pm 0.94$  pg/ml) women and the difference was not statistically significant. Only tiny proportions of ovariectomized women (6 out of 380) used androgen replacement therapy. Ovariectomized women taking androgen supplementation had only slightly higher levels of testosterone compared to their counterparts not using androgen supplementation ( $50.80 \pm 6.08$  vs  $44.11 \pm 1.31$  pg/ml respectively) and this difference was not statistically significant. Thus, ovariectomized women do not have significantly reduced levels of free testosterone. Overall, with the exception of estradiol in women, sex hormone supplementation has very limited effect on the levels of salivary sex hormones in the NSHAP sample.

The likelihood of reporting very good or excellent health were significantly and positively associated with higher levels of salivary DHEA (Table 2). Although reported sexual activity and attitude did not show any associations with sex hormone levels, specific measures of sexual performance and problems revealed such relations. For example, low levels of estradiol were associated with difficulties lubricating and lack of tingling in vagina. Women with normal levels of DHEA (2<sup>nd</sup> tertile) were less likely to have difficulty lubricating and women with normal levels of testosterone were more likely to express interest in sex. These

data demonstrate that in addition to testosterone and estradiol, DHEA may be an important indicator of overall health and sexual performance in older women.

To the best of our knowledge, NSHAP is the only population-based study, which measures salivary sex hormones in a large sample of older individuals. These unique data help to reveal new, unknown before, associations with overall and sexual health.

Table 1. Mean values of four sex hormones in saliva of older women.

	Women N=1550	
	Mean value (SD), pg/ml	CI (95%)
Estradiol	10.02 (0.57)	8.88 - 11.16
Testosterone	46.31 (0.77)	44.76 - 47.87
Progesterone	60.53 (15.08)	30.24 - 90.83
DHEA	45.89 (1.64)	52.39 - 71.15

**Table 2. Statistically significant associations with self-reported health, sexual activity and measures of sexual health.**

<b>Characteristic</b>	<b>Odds Ratio</b>	<b>P&gt; t </b>	<b>[95% Conf. Interval]</b>	
<i>Self-reported health</i>				
Race				
Whites (reference)				
Non-Hispanic blacks	.3246218	0.000	.2228205	.4729336
Hispanic	.860578	0.700	.3946766	1.876459
Other	.3581719	0.007	.1727639	.7425574
Education				
Some college or higher	2.645599	0.000	1.894136	3.69519
Hormone levels				
Progesterone-2 <sup>nd</sup> tertile	1.382379	0.029	1.034611	1.847045
Progesterone-3rd tertile	1.348117	0.103	.9396157	1.934214
DHEA 2 <sup>nd</sup> tertile	1.501451	0.055	.9908094	2.275265
DHEA 3rd tertile	1.666048	0.048	1.004352	2.763688
<i>Sexual activity last 12mo</i>				
Age				
65-74	.3527585	0.000	.2288329	.5437968
75-84	.1753343	0.000	.0832952	.369074
Education				
Some college or higher	1.48736	0.054	.9927169	2.228469
<i>Finding sex physically pleasurable</i>				
Age				
65-74	.6755517	0.080	.4342826	1.05086
75-84	.4914585	0.009	.290354	.8318515
<i>Tingling of vagina during sex</i>				
Non-Hispanic blacks	.422665	0.084	.1581709	1.129448
Hispanic	.0764539	0.029	.007702	.7589153
65-74	1.105217	0.733	.6132284	1.991925
75-84	.4037041	0.024	.1849996	.8809584
Estradiol 2 <sup>nd</sup> tertile	1.257635	0.437	.6975369	2.267474
Estradiol 3rd tertile	1.714263	0.022	1.084802	2.708971
<i>Lack of interest in sex</i>				
Testosterone 2 <sup>nd</sup> tertile	.572568	0.099	.2936252	1.116505
Testosterone 3rd tertile	.8589571	0.681	.4093659	1.802317
<i>Difficulty lubricating</i>				
Estradiol 2 <sup>nd</sup> tertile	.6948661	0.488	.238925	2.02088
Estradiol 3rd tertile	.4054192	0.082	.1454785	1.129822
DHEA 2 <sup>nd</sup> tertile	.4007843	0.047	.1630463	.9851682
DHEA 3rd tertile	.9835406	0.969	.4136411	2.338627
<i>Inability to climax</i>				
Some college or higher	1.825573	0.033	1.051189	3.170427
Progesterone-2 <sup>nd</sup> tertile	.5845315	0.079	.3202219	1.067001
Progesterone-3rd tertile	.9050459	0.723	.5151459	1.590051
<i>Pain during intercourse</i>				
Non-Hispanic blacks	.4319492	0.168	.1290496	1.445802
Hispanic	6.601621	0.016	1.449945	30.05728
Other	1.753917	0.183	.7595095	4.050277