

Male and Female Testosterone Levels in Blood, Saliva, Hair, and Nails

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Abstract

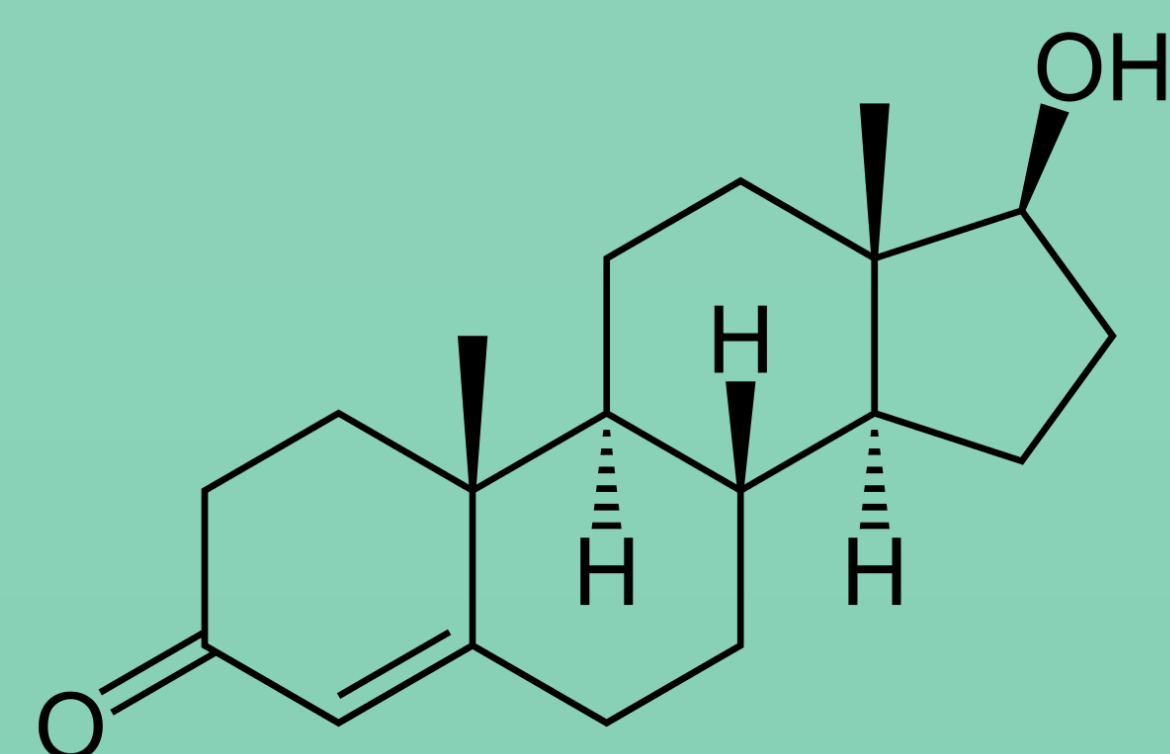
Our overarching goal is to determine the relationship between sexual behaviors and testosterone levels. Blood, hair, nails, and saliva testosterone concentrations were measured in 40 males and 20 females. SIS/SES surveys to measure sexual behaviors were collected, and a hand scan was taken to measure 2D:4D ratios. Testosterone levels in males and females in all matrices were consistent with the literature. Associations between testosterone levels in the different matrices were done by calculating p-values and Spearman's coefficients. Additionally, a set of questions were answered to confirm the validity of our procedures.

Background

- Steroid hormone that is synthesized in males in higher quantities and in females in lower quantities.
- Concentration in blood and saliva follow a diurnal cycle, reaching a maximum at ~8 AM and a minimum ~12 AM.
- Commonly measured and known to be highly correlated in blood and saliva.
- We extended it to measure testosterone in hair and nails to determine if there are relationships between the four matrices
- New literature shows:
 - hair testosterone level and saliva testosterone levels are significantly correlated ($r=0.467-0.515$, $p<0.01$; $r=0.67$, $p=0.034$; $r=0.48$, $p<0.001$; $r=0.454$, $p<0.001$)
 - there is no significant correlation for testosterone concentrations between hair and nails

Method

- Serum was extracted using diethyl ether followed by the back-extraction using deionized water and analyzed using Enzo ELISA.
- Hair and nail samples were extracted using a series of alternating methanol and acetone extractions and analyzed using Salimetrics ELISA.
- Saliva samples were centrifuged and analyzed using Salimetrics ELISA.



Results

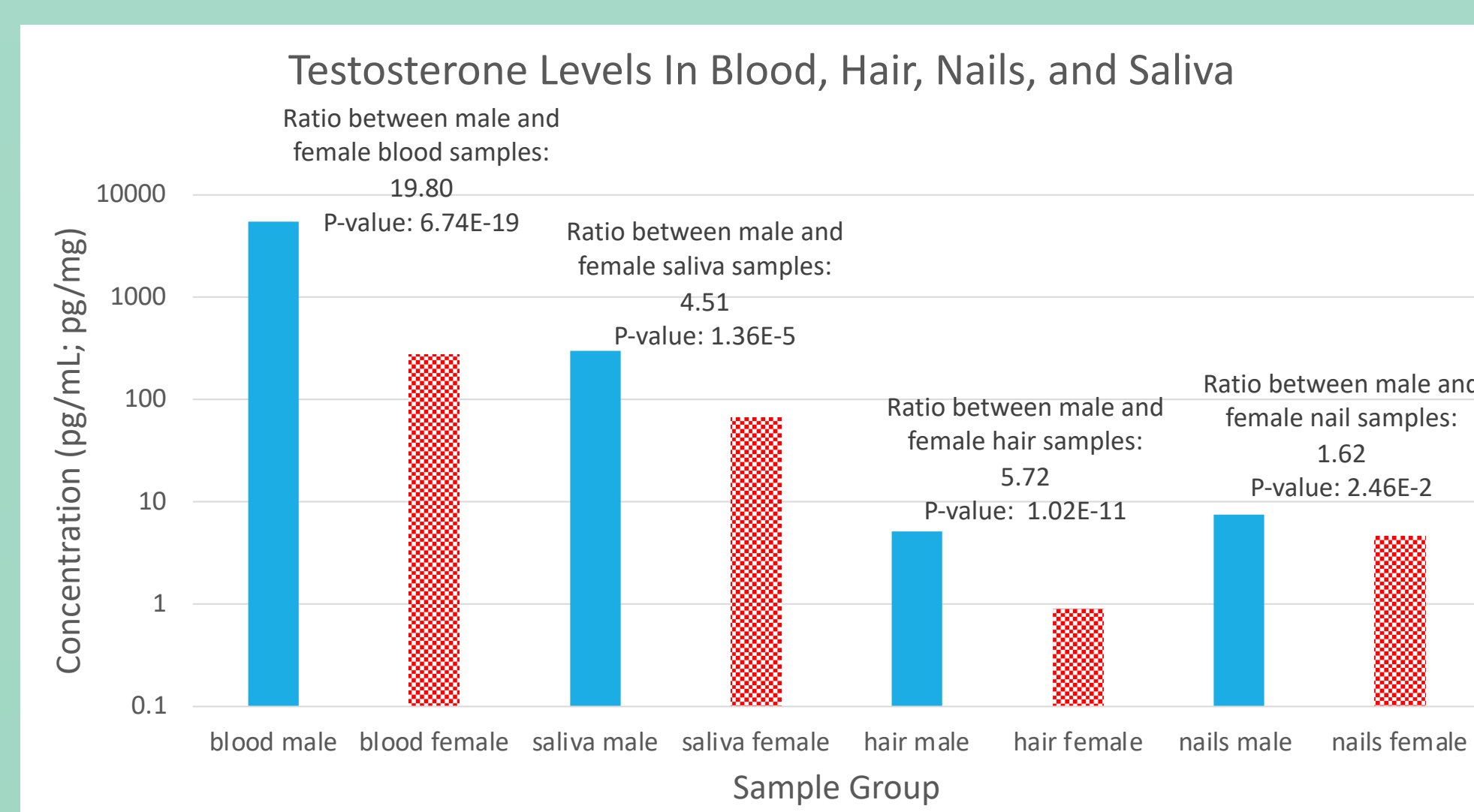


Figure 1. Testosterone levels in blood and saliva are given in units pg/mL; testosterone levels in hair and nails are given in units pg/mg. Standard deviations are omitted due to log scale.

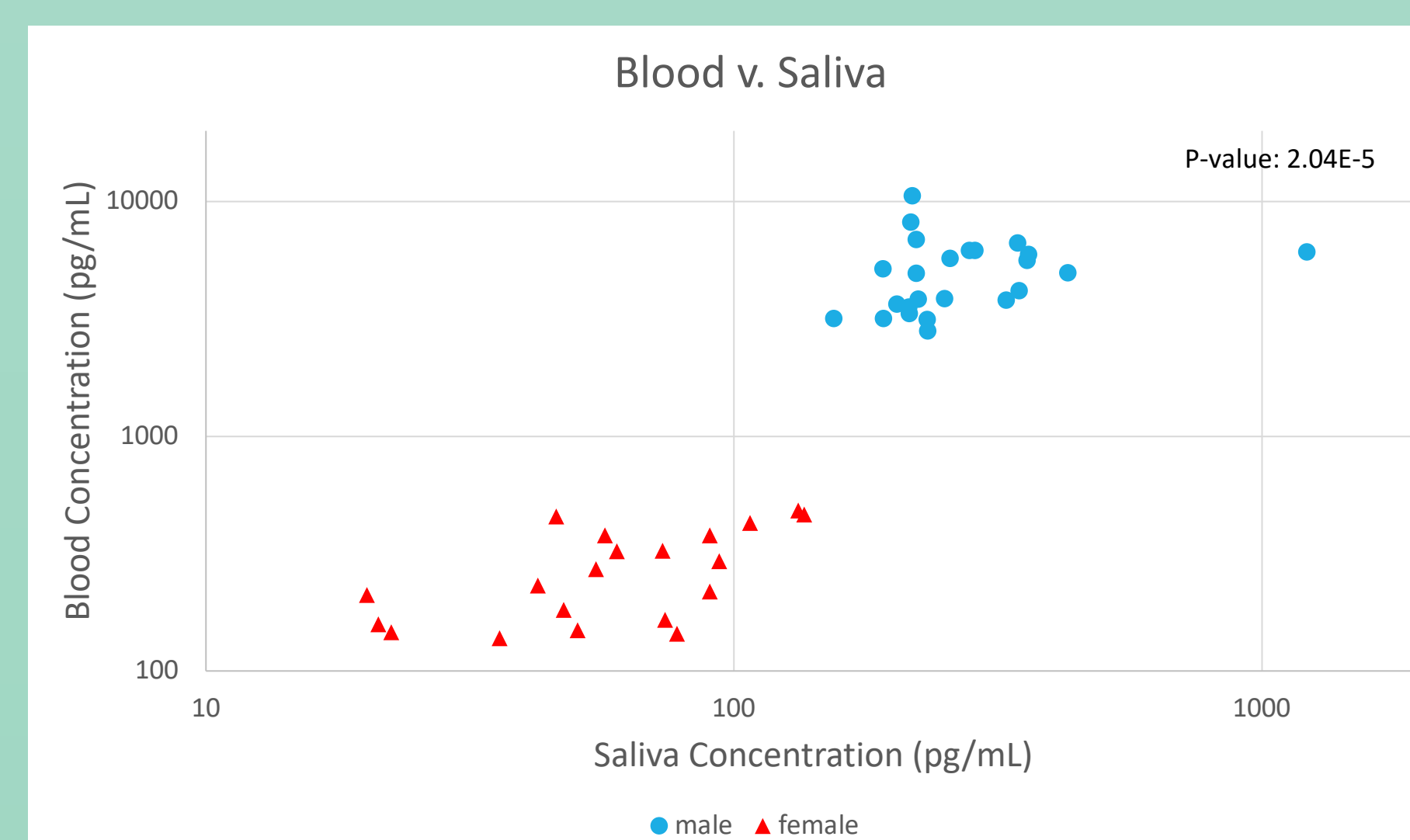


Figure 2. Comparison of blood concentrations and saliva concentrations for male and female samples. P-value lower than 0.05 shows linear relationship between the two groups. This is an example of the comparisons made in Table 1.

Table 1. P-values (Obtained From Linear Regression Test) to measure associations between testosterone levels ($p<0.05$).

	Blood v. Saliva	Blood v. Hair	Blood v. Nails	Saliva v. Hair	Saliva v. Nails	Hair v. Nails
Male	4.52×10^{-1}	8.59×10^{-1}	8.00×10^{-1}	4.63×10^{-1}	4.57×10^{-1}	6.02×10^{-1}
Female	1.73×10^{-3}	3.41×10^{-3}	3.52×10^{-1}	1.32×10^{-3}	8.68×10^{-4}	2.89×10^{-2}
Both	2.04×10^{-5}	1.72×10^{-6}	6.24×10^{-2}	3.32×10^{-10}	1.37×10^{-1}	3.18×10^{-1}

Table 2. Spearman's coefficient to measure associations between testosterone levels (*:significant to 0.1; **:significant to <0.025)

	Blood v. Saliva	Blood v. Hair	Blood v. Nails	Saliva v. Hair	Saliva v. Nails	Hair v. Nails
Male	0.327*	0.033	0.088	0.045	0.117	0.066
Female	0.580**	0.538**	0.254	0.514**	0.737**	0.198
Both	0.814**	0.710**	0.368**	0.790**	0.428**	0.349**

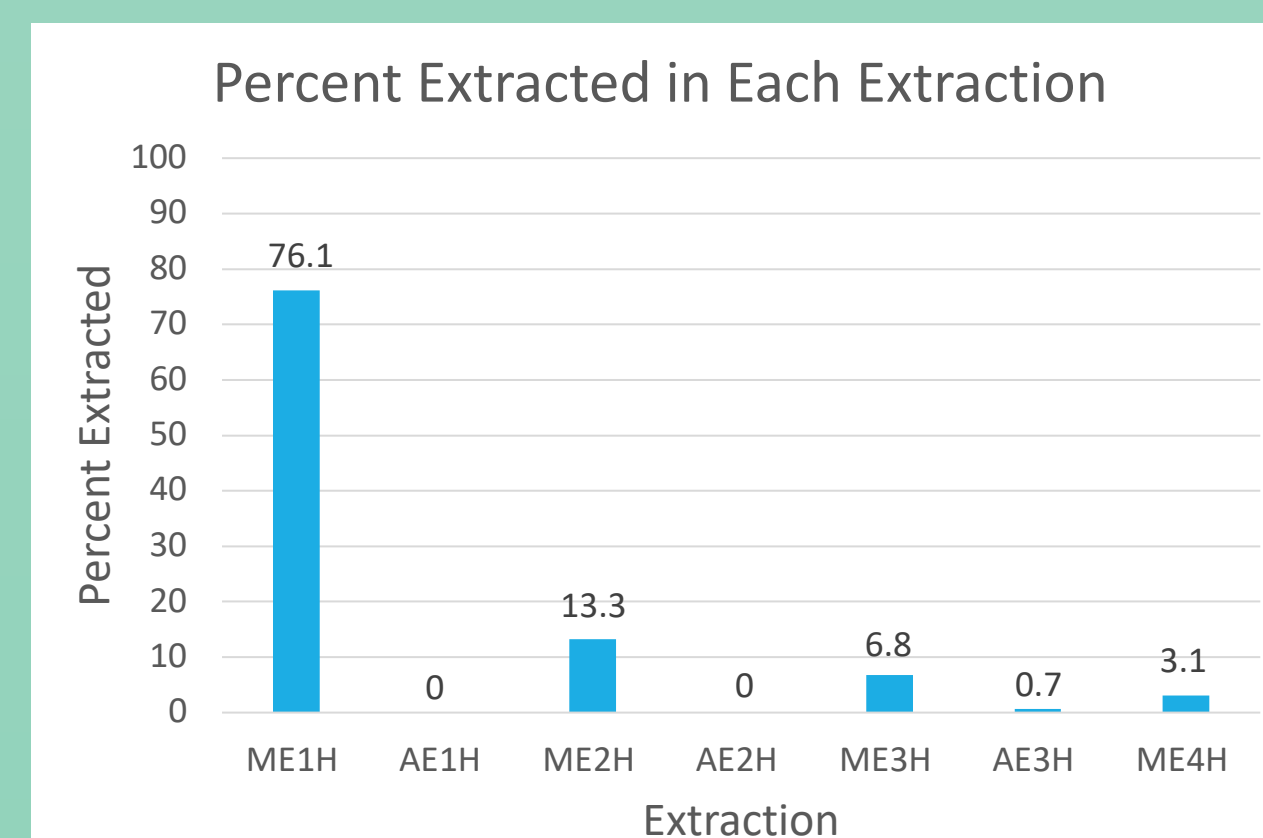


Figure 3. Supernatant were analyzed separately. Testosterone extracted assumed to be total testosterone. Percentage of testosterone extracted per extraction is shown.

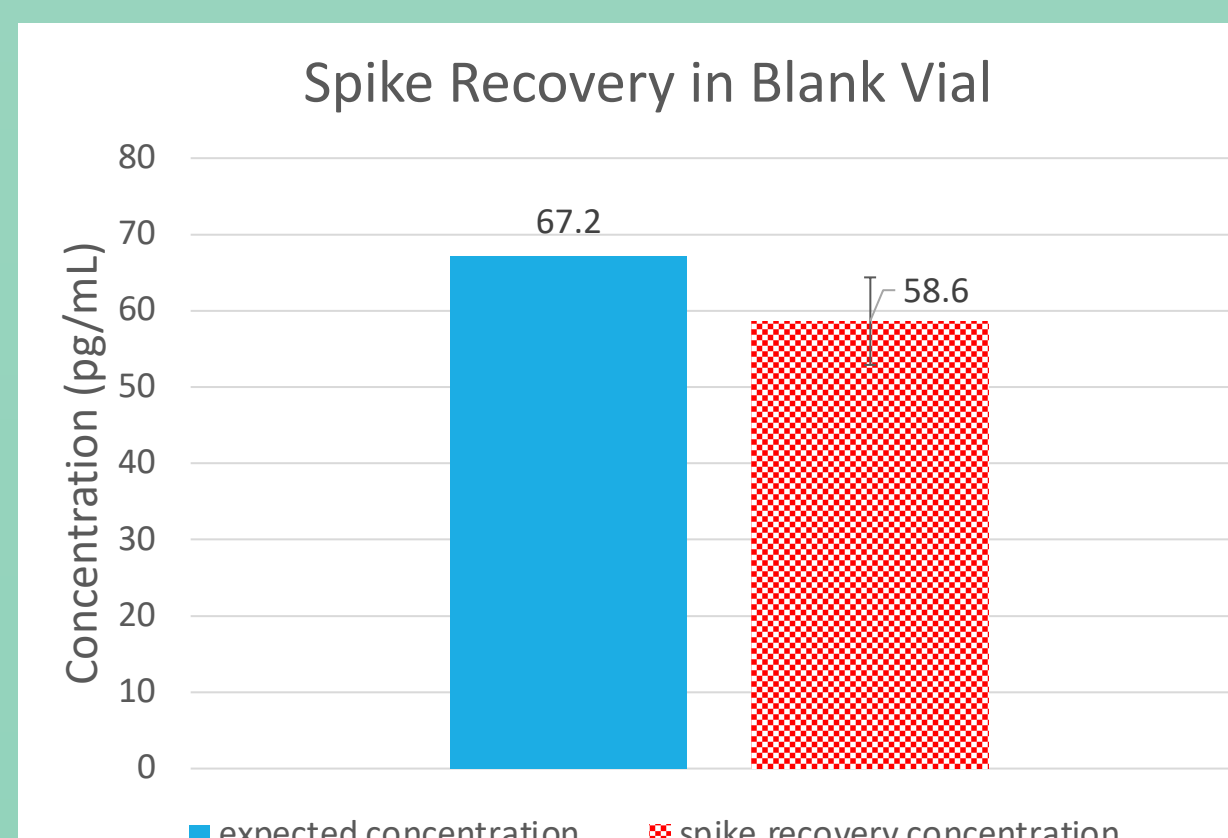


Figure 4. Concentration recovered using current extraction methods in an empty glass vial spiked with 67.2 pg/mL standard.

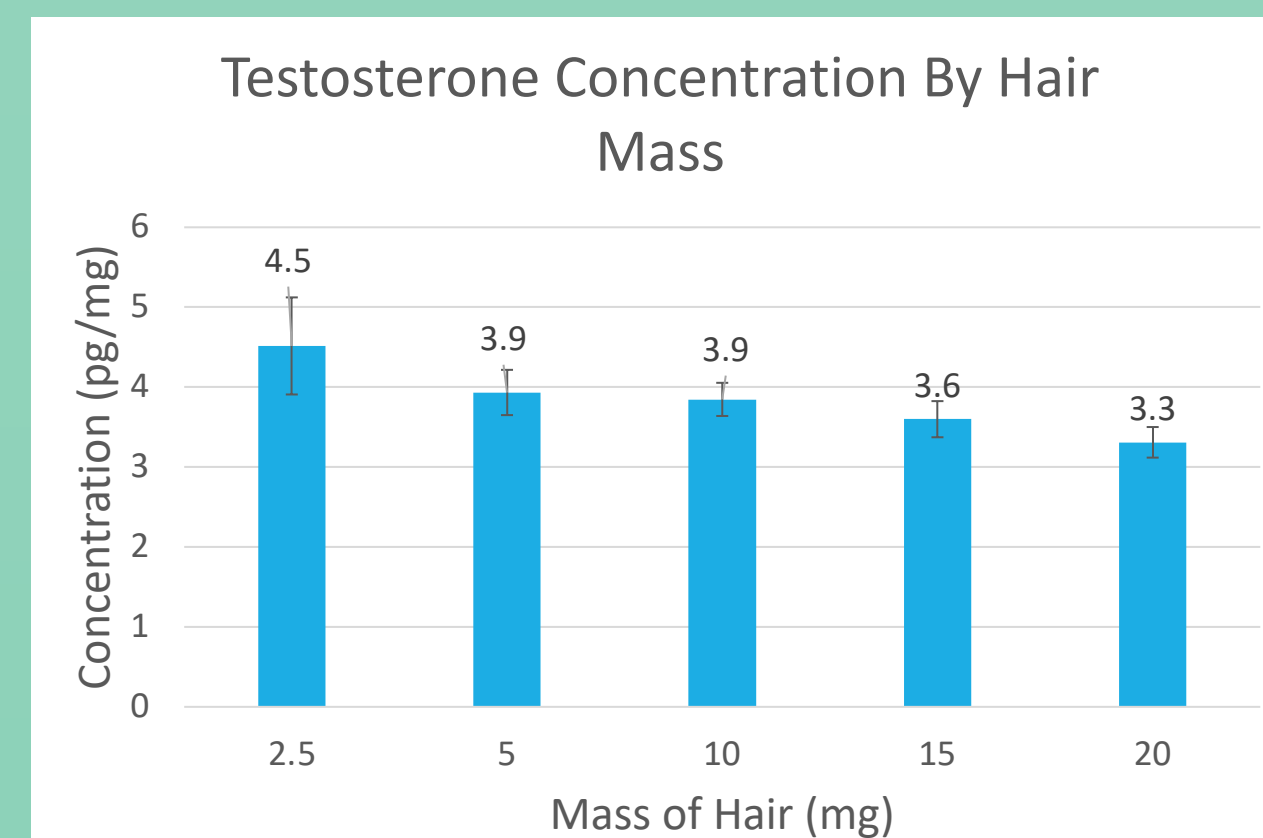


Figure 5. Testosterone levels measured at various masses to determine at what masses it can be measured accurately.

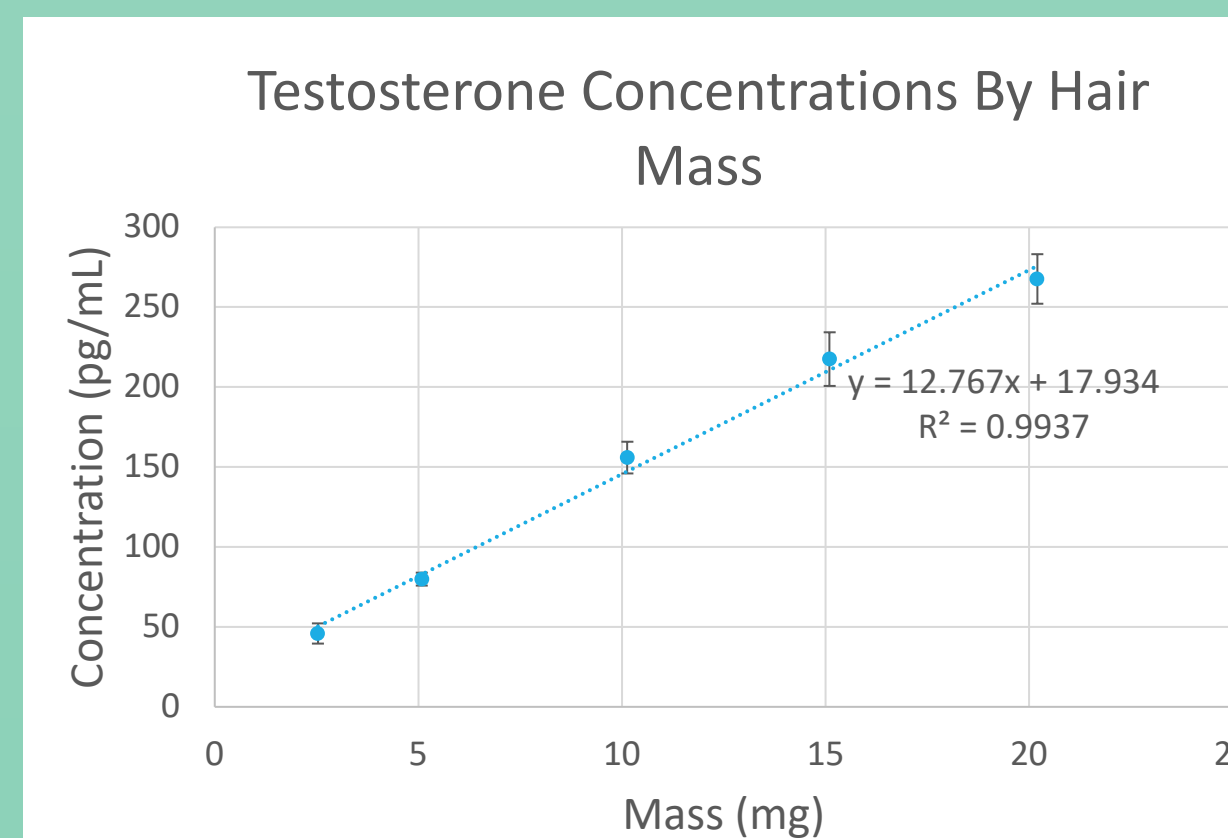


Figure 6. Linearity of testosterone levels at various masses ranging from 2.5 mg to 20 mg.

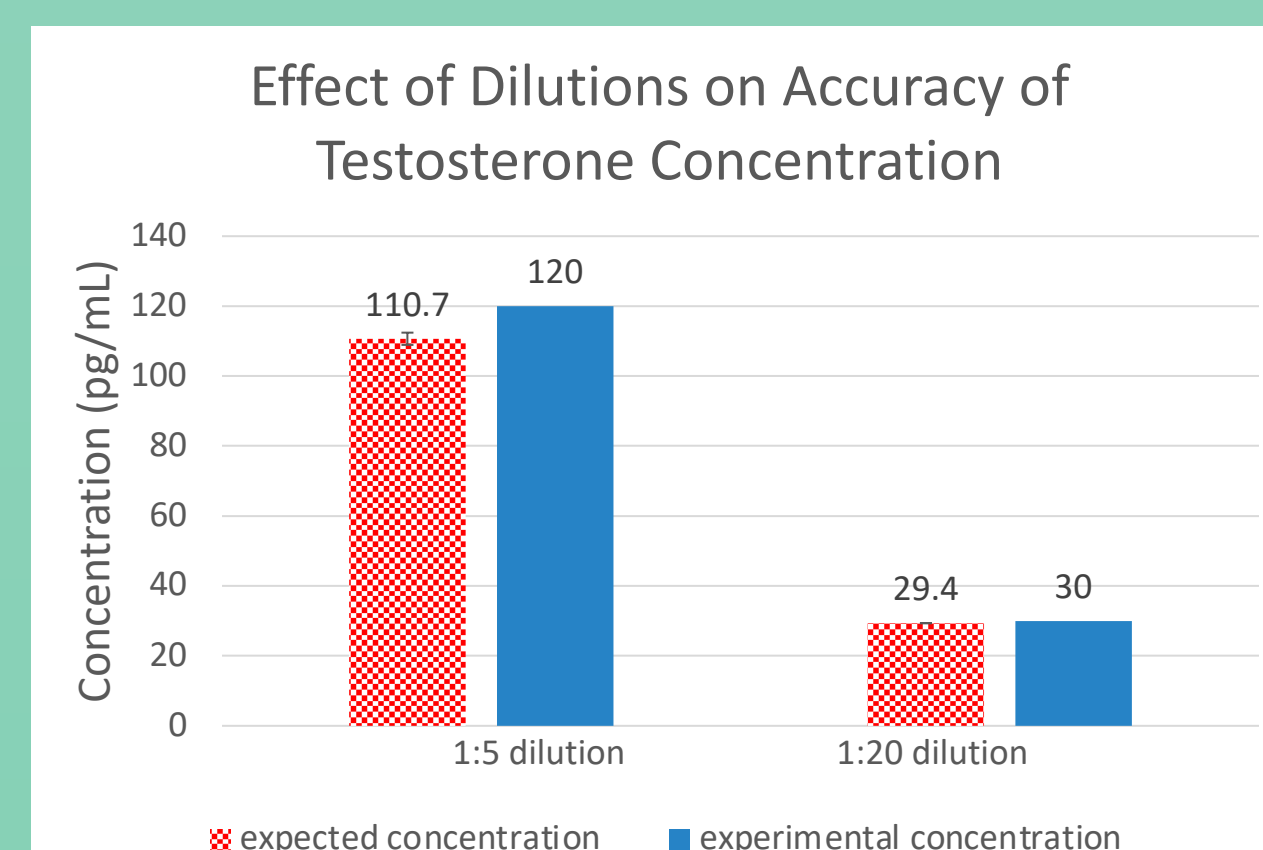


Figure 7. 600 pg/mL standard was diluted 5-fold and 20-fold, then analyzed using ELISA to determine effect of dilutions.

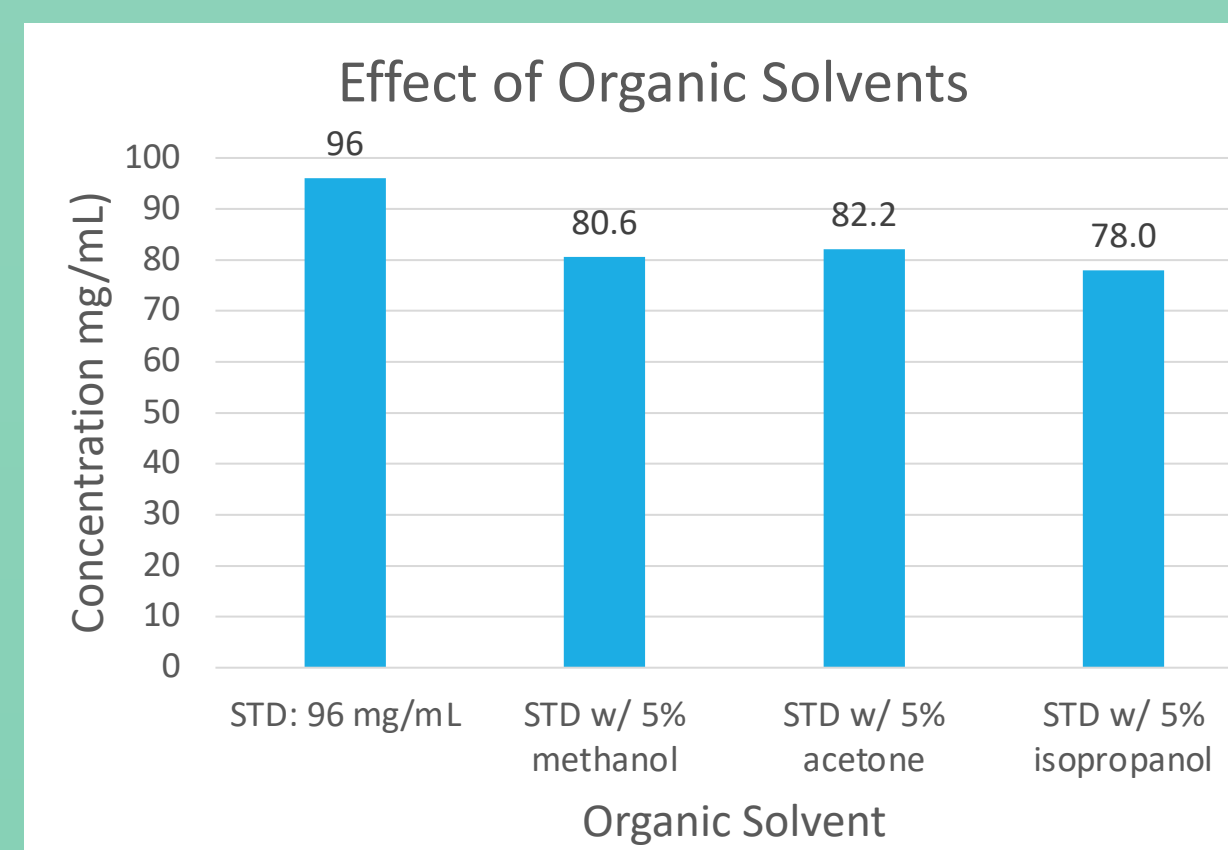


Figure 8. 5% by volume of the given organic solvent was added to 96 pg/mL standard to see the effects on ELISA.

Conclusions

- There are significant differences between male and female testosterone levels in blood, saliva, hair, and nails; p-values <0.05 (Figure 1).
- P-value comparing different matrices show that the following are statistically significant and changing linearly (Figure 2 and Table 1):
 - Male:** none;
 - Female:** blood v. saliva, blood v. hair, saliva v. hair, saliva v. nails, and hair v. nails;
 - Male and female:** blood v. saliva, blood v. hair, and saliva v. hair.
- Spearman's coefficient comparing different matrices show the following are statistically significant:
 - Male:** blood v. saliva;
 - Female:** blood v. saliva, blood v. hair, saliva v. hair, saliva v. nails
 - Male and female:** all

Future Work

Psychology department will compare testosterone levels to 2D:4D ratio and to sexual behaviors documented in SIS/SES surveys.

Acknowledgements

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