

# Is There a Correlation between In-utero Exposure to Sex Hormones, Age of First Menstruation, Sexual Orientation and Prevalence of PCOS?

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## INTRODUCTION

Studies have shown that in-utero exposure to sex hormones, specifically androgens, have a marked influence on the physical and mental development of men and women. The second digit (2D, or index finger) in males is usually shorter than the fourth digit (4D, or ring finger). For females the index finger is generally equal to or longer than the ring finger. Therefore, the 2D:4D ratio for most men is well below 1.0, while women have a higher ratio. There have been several recent studies that point to a possible link between sex hormone levels at the end of the first trimester and sexual orientation, differences of 2D:4D ratio and the onset of menarche, as well as a possible correlation with 2D:4D ratio and the risk of developing of Polycystic Ovary Syndrome (PCOS). We are reporting on the results of a survey that looked into a possible correlation of 2D:4D ratio to age of first menstruation, sexual orientation and prevalence of PCOS.

## METHODS

In Spring 2015 students enrolled in Anatomy & Physiology I and II were asked to volunteer for participation in a 2D:4D Ratio and Anthropometric and Physiological Differences study. The study collected personal data (e.g. age, gender, race/ethnicity) as well as anthropometric data, e.g., body weight, height, waist circumference, and physiologic parameters (vital lung capacity). The survey posed several questions about the participants' personal lives, such as sexual orientation, age at menarche, if they were diagnosed with PCOS in addition to other questions about family history. The survey was completed after the research team measured the anatomical and physiologic parameters of the volunteers. The right and left hands of participants were photocopied and the copies attached to their survey. The length of index (2D) and ring (4D) fingers were measured (in mm) using digital Vernier calipers. 2D:4D ratio was calculated by dividing the length of the index finger by the length of the ring finger. Each hand received two independent measurements that were averaged.

## RESULTS

### 2D:4D Ratio and Age at First Menstruation

Overall 258 students participated in the survey, of those 195 were female students. The question "At which age did you experience your first monthly period?" was answered by 193 participants. The average age of the first period (menarche) was 12.76 years with a low value of 8 years and a high value of 17 years (SD 1.56 years). Looking at the 2D:4D ratio for the left hand (Diagram 1) there is no difference between the age at menarche for participants with a low, i.e., more masculine ratio and participants with a high, i.e., more feminine ratio. The results for the 2D:4D ratio of the right hand were similar (Diagram 2), although the trendline seems to indicate that participants with a high ratio have their first period slightly earlier. However, the sample size was too small to test for statistical significance.

Diagram 1. Correlation of Age at 1. Period and 2D:4D Ratio of the Left Hand

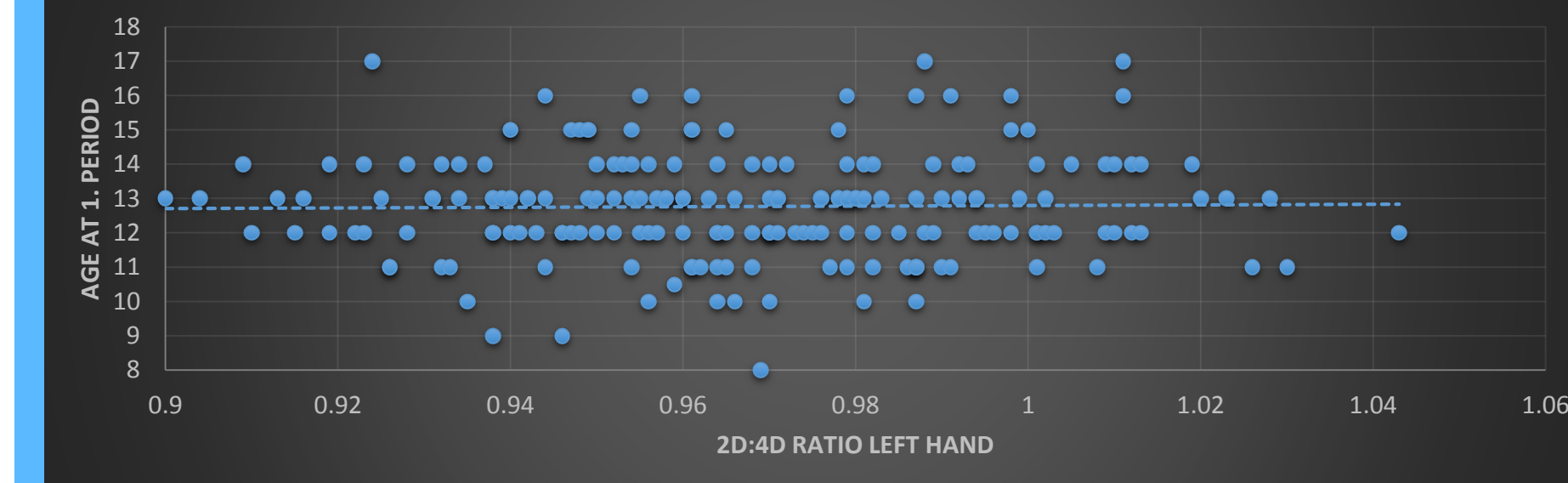
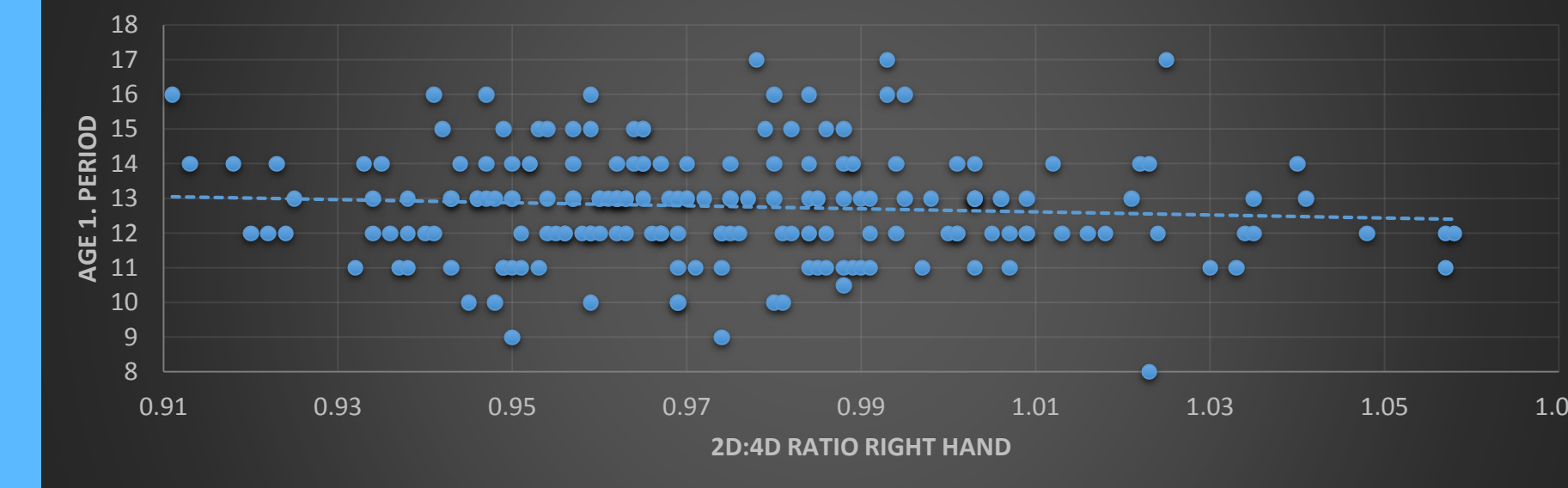


Diagram 2. Correlation of Age at 1. Period and 2D:4D Ratio of the Right Hand



The results are different, however, when we look at the three main ethnicities (Caucasian, African American, Hispanic) in our study (Table 1) individually. African American women experienced menarche earlier (12.32 years) than Caucasian women (12.94 years) and Hispanic women (12.55 years). When we look at the age range for the African American participants compared to Hispanic and Caucasian participants, the range was much more restricted ranging from 10-14 years versus 8-17 years.

Table 1. Average age at menarche, earliest and latest age at menarche, and standard deviation

	Average age at menarche	Earliest age at menarche	Latest age at menarche	SD
All (n = 192)	12.76	8	17	1.56
Caucasians (n = 118)	12.94	8	17	1.60
Hispanic (n = 33)	12.55	9	17	1.74
African American (n = 22)	12.32	10	14	1.02

For Caucasian participants (n = 118), the left hand did not show a correlation between a more male or female ratio and an earlier or later onset of menarche (Diagram 3), whereas the trendline for the right hand seems to indicate that with a more female ratio the onset of menarche was earlier (Diagram 4).

Diagram 3. Age at Menarche and 2D:4D Ratio of the Left Hand Caucasian Females

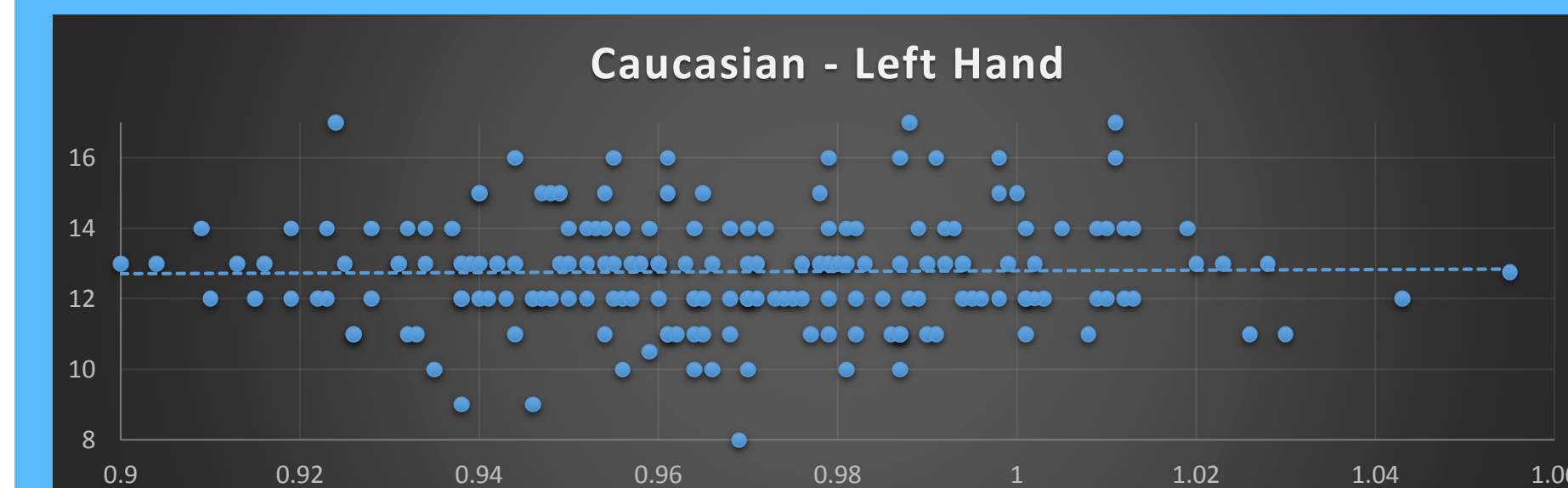
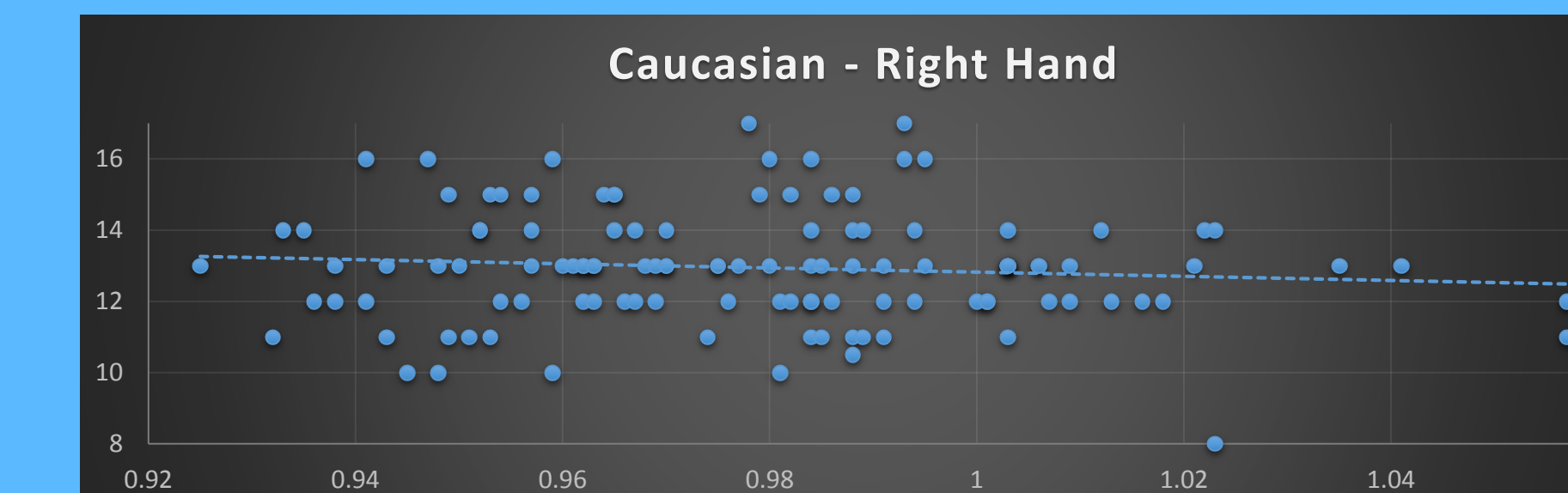


Diagram 4. Age at Menarche and 2D:4D Ratio of the Right Hand Caucasian Females



As for African American participants (n = 22), there is a marked difference in the trendlines for the two hands. The left hand ratio shows a trendline with a more male ratio having an earlier onset of menstruation (Diagram 5), while the trendline for the right hand indicates an earlier menarche for a more female 2D:4D ratio (Diagram 6).

Diagram 5. Age at Menarche and 2D:4D Ratio of the Left Hand African American Females

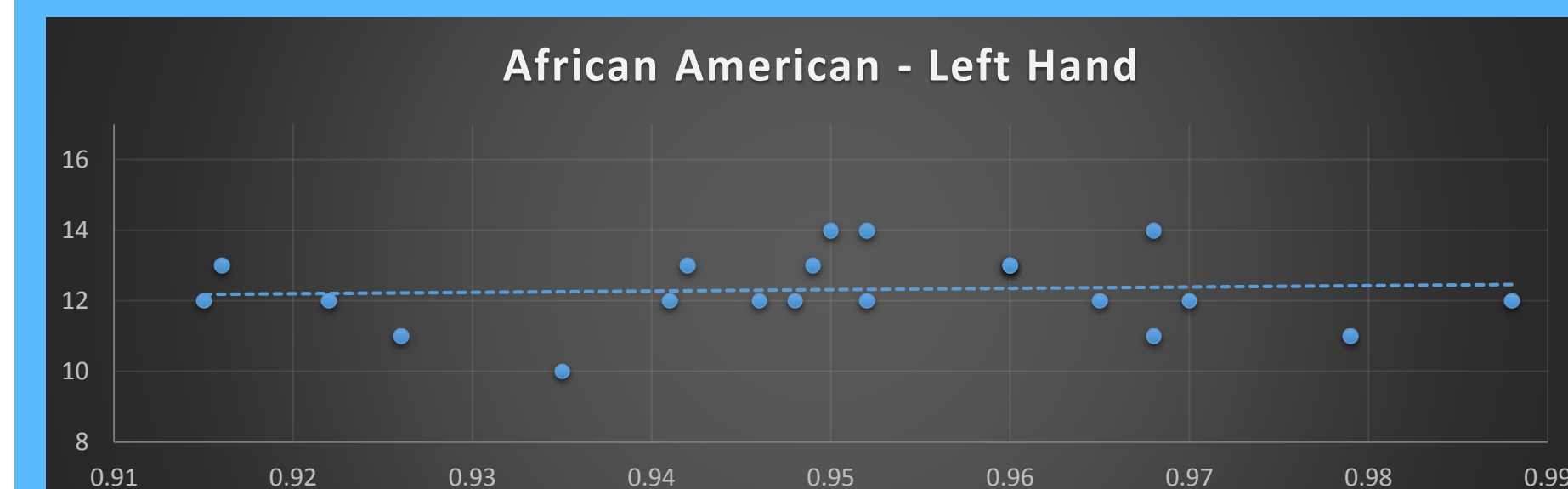
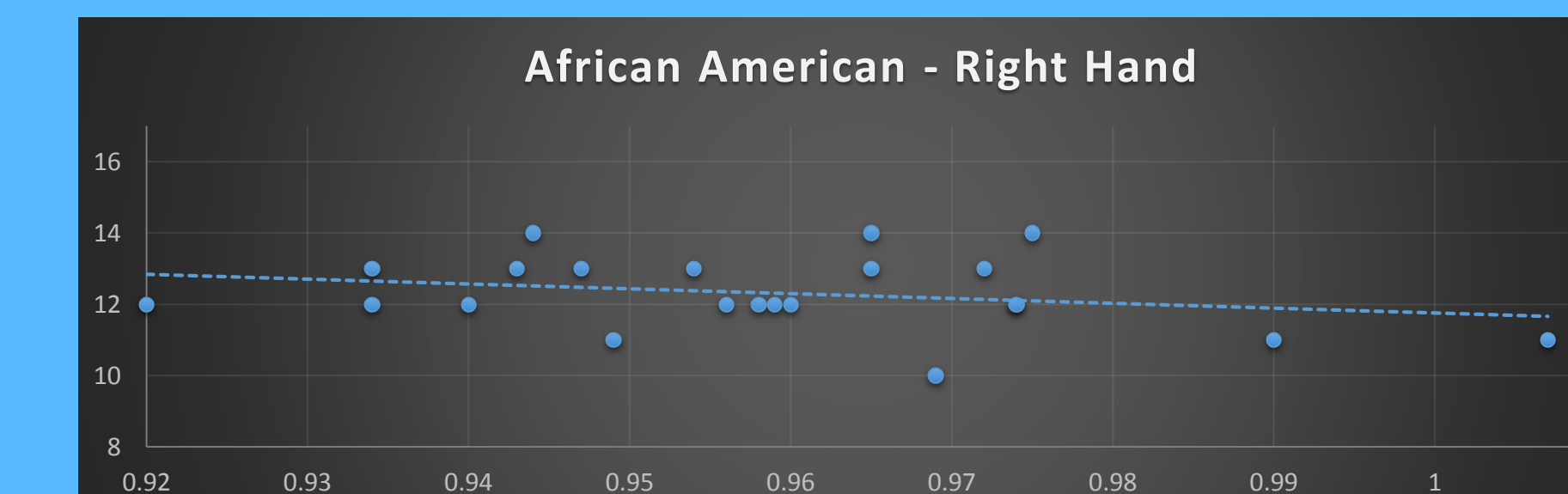


Diagram 6. Age at Menarche and 2D:4D Ratio of the Right Hand African American Females



The trendlines for the left and right hands of Hispanic participants points to an early onset of menstruation for women with a more female ratio (Diagrams 7-8).

Diagram 7. Age at Menarche and 2D:4D Ratio of the Left Hand Hispanic Females

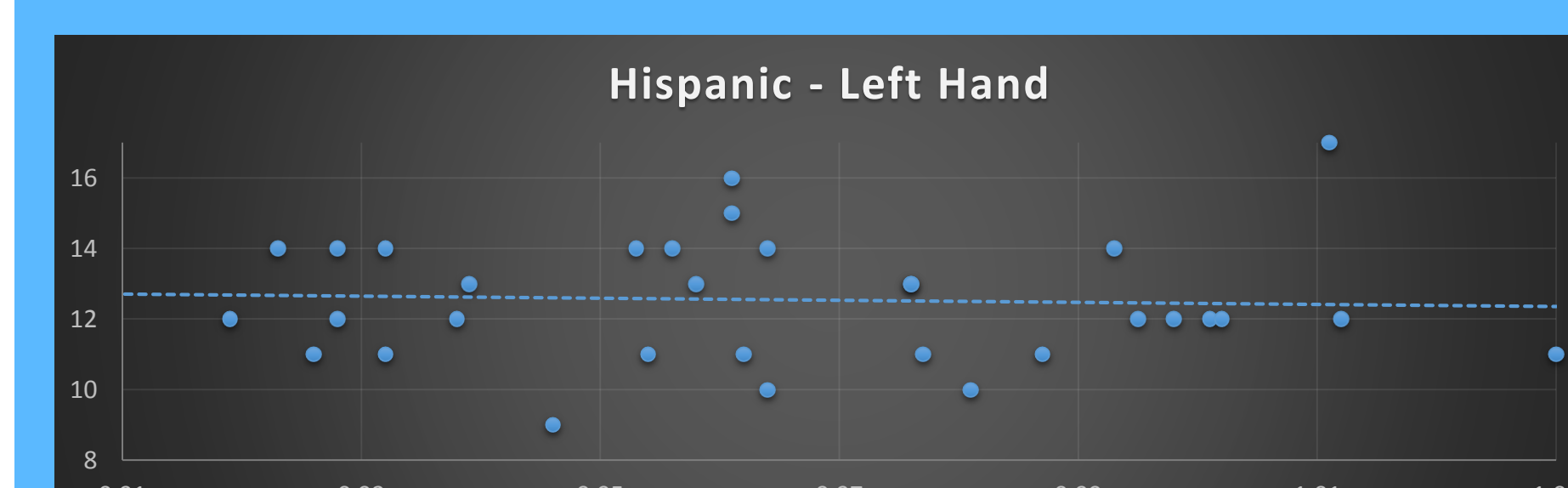
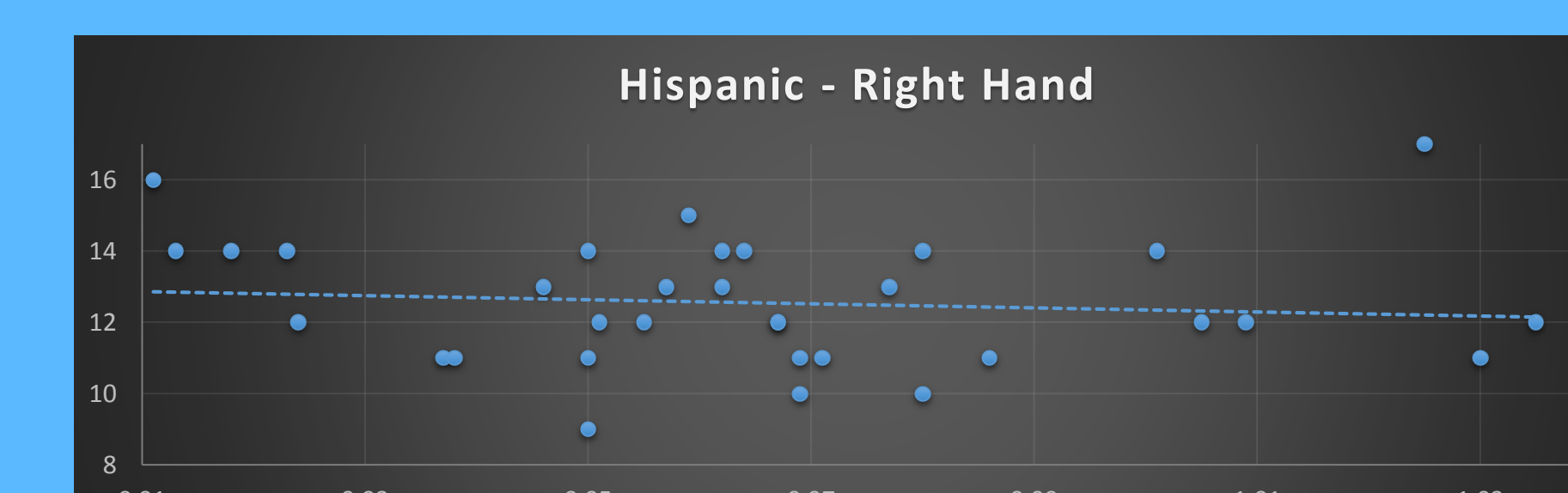


Diagram 8. Age at Menarche and 2D:4D Ratio of the Right Hand Hispanic Females



### 2D:4D ratio and Sexual Orientation

Only three of female participants of 195 indicated that their sexual orientation was either homosexual (n = 1) or bisexual (n = 2). Therefore, we were unable to see if there is a correlation in 2D:4D ratio and sexual orientation.

### 2D:4D Ratio and Polycystic Ovary Syndrome (PCOS)

Only 9 of 184 participants indicated they had been diagnosed with PCOS, i.e., the prevalence of PCOS in our sample was 4.9%. According to national data about 5-10% of women of childbearing age are affected by PCOS, so even though we have a small sample it is reasonably reflective of the general population. There are a few studies that either state that there is a relationship between the 2D:4D ratio of the right hand and PCOS or there is no difference in the ratio of participants with PCOS and without PCOS. As for our study, it seems as if there is a higher than average ratio for the right hand for those that have PCOS (2D:4D 1.007) than those that do not have PCOS (2D:4D 0.974).

Survey participants with PCOS had an average BMI of 22.97%, which is in the normal weight range (20 – 25). This is contrary to most studies which indicate that there is a correlation between a higher BMI and great risk of PCOS. None of the participants indicated that they suffered from diabetes and only one participant had a female relative with diabetes.

Only 44.5% (4 out of 9) of participants with PCOS indicated that they suffered from acne, which was lower than the percentage for all participants (50.8%) and participants without acne (51.4%). They also reported a higher rate of breast cancer on their maternal side than those without PCOS at 50% versus 41.5%. However, our sample size was too small to test for statistical significance of those differences.

Table 2. Comparison of participants with and without PCOS

	Participants with PCOS	Participants without PCOS
Average age of menarche	11.9	12.8
Average 2D:4D Ratio Right Hand	1.007	0.974
Average 2D:4D Ratio Left Hand	0.970	0.968
Self-diagnosis of Acne	44.5%	51.4%
History of maternal cancer incl. breast cancer	50%	41.5%
History of maternal cancer other than breast cancer	50%	25.6%
Average BMI	22.97	22.60

## DISCUSSION

The results of our study were similar to other studies that a median age of menarche for women living in the United States of 12.43 years. We found that woman with a more female 2D:4D ratio of  $\geq 1$  had an earlier menarche than women with a more male ratio. This finding was independent of the ethnicity of the women, although it seemed to be more pronounced in Hispanic participants.

Due to the lack of participants being either homosexual or bisexual we cannot either agree or disagree with previous studies done that found a correlation between 2D:4D ratio and sexual preference.

Based on the results of our study future studies with a larger sample size of female participants diagnosed with and without PCOS should be surveyed to see if there is a trend for a more female right handed ratio, a significant difference in acne or not, and whether there is a connection between PCOS diagnose, maternal breast cancer and a more feminine right handed ratio.