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Changes in Male Testosterone Levels over the Last Century As Reflected In Facial Width-Height Ratios

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Abstract

Purported changes in male fertility and testosterone levels over the last 50 years remain controversial. The present study addressed this issue indirectly via a facial metric, the bizygomatic width-to-height (FWH) ratio, which has been shown to be reflective of testosterone levels. FWH ratios were assessed from photographs of Major League Baseball (MLB) players dating back to 1870. There was a progressive increase in FWH ratios over the past 120 years which was independent of height. FWH ratios, weight and BMI increased more after WWII than before. The results do not support an inference, based on declining sperm counts, that testosterone levels have declined.

Introduction

Testosterone, the primary male sex hormone, is produced and secreted by the testes, and significantly influences spermatogenesis [1]. Several European studies have reported declines in sperm counts over the last 50 years (e.g., [2,3], which indirectly imply changes in testosterone levels, but the reports have lacked consistency, with other studies from the same countries reporting no changes [4] or increases in sperm counts [5]. Studies in the United States have been slightly more consistent, reporting either no changes [6] or increasing sperm counts [7] which in turn imply no changes or increasing levels of serum testosterone levels in American men. This inference, however, is contradicted by a study in American men reporting a decrease in men's testosterone levels of 1.2% per year [8]. These latter findings do not necessarily contradict the inference drawn from the previously mentioned sperm studies because the youngest males in the testosterone study were 45 years old and the oldest was 79, with a median of 58 years of age [8]. While the data indicate a decline in testosterone levels for these older men, that conclusion needs to be tempered with the fact that the men in this study were mainly beyond the typical reproductive age, and may in fact have not experienced such declines during their peak reproductive years. One way of addressing this possibility is to sample testosterone levels in men at a much earlier age. As yet no such study has been undertaken nor to our knowledge, planned as yet. The studies of sperm counts represent an indirect method for testing the hypothesis of decreased testosterone levels but as previously noted, the results are far from consistent. The present study is reported as an alternative method for indirectly examining changes in testosterone levels in American men of reproductive age, using the facial width-to-height (FWH) ratio.

The FWH ratio is a face's bizygomatic width (the distance between right and left cheekbones) divided by upper facial height (the distance between the upper lip and upper eye lid. This ratio is positively correlated with testosterone levels in men [9] and with testosterone-related behaviors such as aggressiveness [10,11; cf., however, 12,13], willingness to exploit competitiveness in a trust game [14] cheating for financial reward [15] and most recently, with player performance in baseball [16].

The feasibility of charting changes in the FWH ratios of American men of reproductive age over decades is only possible because of the existence of a unique photographic data source dating back to 1870 for major league baseball (MLB) players, which is now available on the internet. MLB has a long history of systematic data collection documenting performance and biographical information dating back to the mid-19th century [17] and has been used to test many different hypotheses, e.g., precocity effects on performance [18], handedness on longevity [19] seasonality effects on longevity [20].

Historical changes in anthropometric data such as height, weight and body mass are widely used as indices of population health [e.g., 21-23] and provide valuable insights into various influences on health over time [23, 24]. A classic example is the Dutch Famine study [25], which documented not only the immediate effects of acute famine on mortality, but also its long-term consequences on reproductive outcomes and medical and behavioral anomalies of children born to women who survived the famine. To our knowledge, the present study is the first to use facial morphology to test changes in population health.

Material and Methods

Photographs of MLB players were obtained from several sources including Honig [26-28] and the "out of the park baseball" website (www.ootpdevelopments.com/board/ootp-mods-rosters-photos-quick-starts/184046-gambo-t_wil1-photopack-477.html). Only players facing forward with both ears clearly visible and with no facial expression were used. Based on studies by Stirrat & Perett [14], the distance between the right and left zygion (bizygomatic width) and the distance between the vermilion of the upper lip and the upper eye lid, were measured using a digital vernier caliper with accuracy of 0.01 mm. Only photographs with bizygotic widths measuring 20.0 cm or more were used because a pilot study indicated that with smaller widths measurements were unreliable (more than 10% variability). Only photographs in which there was less than 5% variation in right-left presentation were used. This was determined by measuring the distance from each ex-canthus to a vertical line drawn

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from the zygion. The difference in these distances was divided by the bizygomatic distance to determine percent differences. Inter-rater reliability between the senior author and a trained research assistant of the FWH ratios of a sample of players was high (r(20)=0.90, p<.001). Birth data were obtained from the website "Baseballreference.com." To reduce the influence of ethnicity only Caucasian players were included in the analysis. This was an important consideration in examining trends over the last 100 plus years because African American players were not permitted to play in the major leagues until 1947. Forward stepwise multiple regressions examined the relationship between FWH ratio and year of birth, height, weight and BMI. A second regression analysis examined FWH ratio controlling for height, debut age and decade, to determine if the increase in FWH ratio was independent of height. A third analysis compared each of the four dependent measures for players born prior to WWII (1942) and after, in terms of changes in these measures. All tests had an alpha = 0.05 and a maximum beta = 0.2.

Results

Descriptive summary data for the entire study period are shown in Table 1. The number of players per decade ranged from 19 to 112. The mean FWH ratio was 2.0. Mean height was 183.6 cm; mean weight was 85.2 kg; mean BMI was 25.2. The average age at debut was 23 years. Less than 13% of the players were 20 years or less when they debuted; only 1.7% were over 30.

Ordinary least squares regression models predicted the increase of FWH ratio, height, weight, BMI, per decade, controlling for age of debut. The model accounted for 27% (R^2= 0.27) of the variance in FWH ratio (F(2,754)=138.2, p<.001); the ratio of facial width- to-length increased by 0.03 for every decade (See Figure 1), i.e., facial width increased relative to length. The model also accounted for 26% (R^2=0.26) of the variance in height (F (2,756)=130.8, p<.001) with heights increasing by 0.9 cm for every decade of birth; for 32% (R^2=0.32) of the variance in weight (F(2,752)=179.5, p<.001), with weights increasing 1.6 kg for every decade; and for 14 % (R^2=0.14) of the variance in BMI, with BMI increasing by 0.21 for every decade (F(2,752)=62.0, p<.001).

Controlling for height, debut age and decade did not affect the relationship for FWH (R^2 =0.27; F(3,758)=94.7, p<.001). A similar analysis with BMI instead of height as a controlling variable did not markedly influence the variance estimate (R^2=0.30; F(3,756)=107.1, p<.001).

FWH ratio increased by a ratio of 0.02 per decade prior to WWI, and by 0.04 after the war. Heights by contrast, did not increase after the war by decade (0.41 cm) as much as before (1.25 cm by decade). Weight and BMI both increased more after the war than before. The weight gain before the war was 1.07 kg by decade whereas after the war it was 3.15 kg after. The corresponding change in BMI was -0.02 before the war and 0.78 after.

Table 1: Descriptive statistics, Major League Baseball players, U.S. 1865-1989 (N=801).

	Mean	Median	SD	Min	Max
Height (in)	72.3	72.0	2.5	65.0	81.0
Weight (lb)	187.9	185.0	21.3	125.0	290.0
BMI ratio	25.2	25.1	2.0	18.5	37.2
FWH ratio	2.0	2.0	0.2	1.5	2.9
Year of birth	1925	1915	35.5	1865	1989
Year of debut	1947	1938	35.1	1888	2011
Age of debut (yr.)	23	23	3	15	34

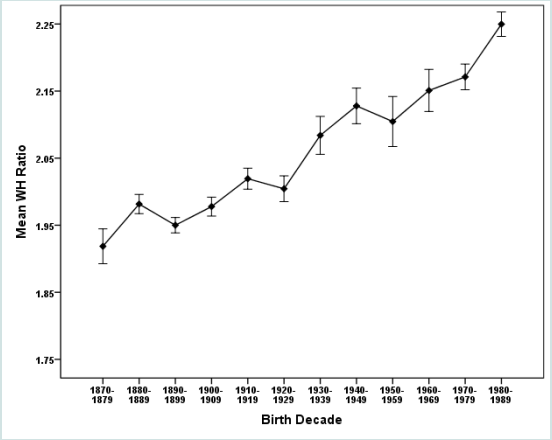

Figure 1: Changes in Mean Facial (± S.E.) Width-to-Height Ratios of Major League Baseball Players Active 1870-1989.

Discussion

The FWH ratio is correlated with circulating testosterone levels [9] and with testosterone-related behaviors and skills [10, 11, 14-16, cf., however, 12, 13]. Other studies using only facial width as an independent variable have found that it is related to increased testosterone levels beginning at puberty [29-31].

Our findings for Major League Baseball Players with respect to height, weight and BMI, are in agreement (although slightly higher) with Saint Onge et al. [32]. Like those researchers, we also found that heights of players born after WWII increased at a slower rate than those born before the war. By contrast, FWH ratios, body weights and BMI increased at a faster rate after the war than before. This implies that the changes in FWH ratio and height are not influenced by the exact same mechanisms.

One inference from the increase in FWH ratios is that testosterone levels have increased in American men over the last 120 years. These findings are in agreement with those studies reporting on increased sperm counts [5,7] and are not necessarily in conflict with a previous study that directly measured testosterone levels in males beginning at 45 years of age [8]. While the data from that study support the conclusion that testosterone levels have declined, that conclusion needs to be tempered with the fact that the men in that study were mainly beyond typical reproductive age, and may in fact have not experienced such declines from their peak reproductive years by the time they were tested. Besides complete differences in methods, the males in the baseball study were about on average 30 years younger, and belonged to a group of much more physically fit occupational group, which would also have had the effect of greater uniformity in the subject population.

To our knowledge the present study is the first to trace changes in facial morphology over a relatively long time period and by implication, to trace changes in testosterone levels. As noted previously, the reason this was possible is that MLB is unique in that

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no comparable extensive photographic data base for an occupational group exists, to our knowledge, for as long a period as that for baseball. By the same token, because this was a selective sample, there was the possibility of selective bias in such a data base which could undermine the generality of these findings.

Although steroid use may have contributed to the increase in FWH ratios in the last decades studied [33], as evident from Figure 1, the increases in FWH ratios began to occur in the 1880s and early 1900s and the trend has been progressively higher in almost every decade. While there is a possibility of a confounding of external steroid use with changes in the latter decades no such confound is likely for the early years.

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