Testosterone and Occupational Achievement*

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Abstract

Men with higher levels of serum testosterone have lower-status occupations, as indicated by archival data from 4,462 military veterans in six U.S. census occupational groups. This finding supports a structural equation model in which higher testosterone, mediated through lower intellectual ability, higher antisocial behavior, and lower education, leads away from white-collar occupations. The model is plausible because testosterone levels are heritable and available early enough to affect a number of paths leading to occupational achievement. Prior research has related testosterone to aggression in animals and men, and high levels of testosterone presumably evolved in association with dominance in individual and small-group settings. It appears an irony of androgens that testosterone, which evolved in support of a primitive kind of status, now conflicts with the achievement of occupational status.

Occupations are cultural creations, and cultural forces lead us toward or away from them. The choice of an occupation depends upon skill, experience, and the work available in a particular society. Biological factors are not usually considered, beyond those so potent as to be of little psychological interest: sumo wrestlers are large, airline pilots have good vision, and most professors are mentally competent. But on a subtle level, biological factors act through small and continuing effects on thoughts, feelings, and behavior. Arvey et al. (1989) found job satisfaction to be heritable, though they did not indicate the biological factors that are important or the pathways through which these factors operate.

The hormone testosterone may be one such factor. Testosterone has been associated with dominance (Mazur 1985), aggression (Bernstein, Rose & Gordon 1974; Rose 1978), antisocial behavior (Dabbs & Morris 1990), sensation seeking (Daitzman & Zuckerman 1980), automaticity and perseverant responding (Broverman et al. 1964; van Hest, van Haaren & van de Poll 1989), libido (Morris et al. 1987; Sherwin, Gelfand & Brender 1985), low verbal intelligence

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(Dabbs, Jurkovic & Frady 1991), and lower verbal than spatial intelligence (Christiansen & Knussmann 1987). Testosterone in utero leads to sexual differentiation and development of the right side of the brain, possibly related to increased spatial ability and decreased verbal ability (Geschwind & Behan 1984). Receptors in the amygdala, hypothalamus, and preoptic areas (Rees, Bonsall & Michael 1986) could allow testosterone to affect on-going functioning of the brain.

Three studies have related testosterone to occupation. Schindler (1979), studying 64 women, found salivary testosterone higher in attorneys than in athletes, nurses, or teachers. Purifoy and Koopmans (1979), studying 55 women, found serum testosterone higher in women who were students or professional and technical workers than in those who were clerical workers or housewives. Dabbs, de La Rue & Williams (1990), studying 67 actors, ministers, professors, physicians, firemen, salesmen, and football players, found salivary testosterone higher among actors and football players than among ministers; they replicated the actor-minister difference among 48 subjects in two additional studies.

Individual differences in testosterone are heritable (Meikle et al. 1987) and thus could enter into causal chains leading to occupational choice. Because testosterone is an archaic hormone, present in many animals and even plants, there is no reason to expect it to be closely related to modern human occupations. However, behavioral and cognitive correlates of testosterone might make a person better suited to one occupation or another. In particular, antisocial and violent tendencies (Dabbs & Morris 1990) could lead to behavior and educational levels that are more appropriate for some occupations than others.

The occupational studies have involved small samples and a limited range of occupations. More information is needed, including information on mediating variables. The present study examined testosterone, antisocial behavior, education, intelligence, and occupation in a large sample of former military servicemen. Structural equation models tested the hypothesis that a relationship between testosterone and occupational choice is mediated by antisocial behavior, intellectual ability, and education.

Method

THE DATA SET

Archival data were available from a study conducted in 1985-1986 to assess physical and psychological effects of the Vietnam military experience (Centers for Disease Control [CDC] 1988, 1989). Subjects were 4,462 former enlisted military servicemen, half of whom had served in Vietnam during 1965-1971. Their mean age was 38 (Std. dev. = 2.5) years, and they were representative of the U.S. population in race, education, income, and occupation. They had been interviewed by telephone and brought to Albuquerque for five days of medical, physical, psychological, neuropsychological, and clinical laboratory testing. This article focuses upon their testosterone concentration, antisocial behavior, intelligence, education, and occupation.

Testosterone concentrations were assayed from single serum samples collected at 8:00 A.M., before breakfast. A standard double-antibody radioimmunoassay was employed, and the coefficient of variation among quality control samples was less than 10% (CDC 1989). It is desirable to have several measurements per subject, but single measurements are adequate. Work with salivary testosterone (which is highly correlated with serum testosterone; Vittek et al. 1985) has shown reliability of single samples to be about r=.64 (Dabbs 1990). This is higher than any likely correlations between testosterone and behavior, and lack of perfect reliability will attenuate correlations with behavior only by a factor equal to the square root of .64, or 0.8 (Ghiselli, Campbell & Zedech 1981).

Antisocial behavior was assessed with a modified Diagnostic Interview Schedule, which provides information for use in DSM-III psychiatric diagnoses (American Psychiatric Association 1980). Scores in the present study were as defined in the CDC data set. Antisocial behavior included childhood conduct disorders (poor grades, trouble in school, being expelled or suspended, running away from home, starting fights, lying, stealing, vandalism, being drunk or using drugs, and being arrested before age 18) and adult antisocial behavior (assaultive marital or relationship problems, negligence toward children, job trouble, trouble with debts, traffic offenses, nontraffic arrests, lying, violence, and vagrancy since age 18).

Education was scored in terms of years of schooling (0-18). Intelligence was defined by performance on the General Technical subscale of the Armed Forces Qualification Test, administered when the other measures were collected.

Occupation was recorded as a 30-character description and coded as one of 504 job titles, following the 1980 census system (U.S. Department of Commerce 1982).[1] Of the original 4,462 subjects, 4,419 were grouped into seven census occupational categories as follows: 956 in managerial and professional work (census codes 3-199); 765 in technical, sales, and administrative support (codes 203-389); 304 in service (codes 403-469); 103 in farming, forestry, and fishing (codes 473-499, mostly farmers in the present sample); 1,030 in precision production, craft, and repair (codes 503-699); 891 operators, fabricators, and laborers (codes 703-789); and 400 unemployed. Forty-three subjects had missing data or job titles that could not be scored. In order to provide a measure of occupational status, the socioeconomic status rating of Stevens and Cho (1985) was attached to the occupation code for each subject.[2]

Results

GROUP DIFFERENCES

Mean testosterone concentration was 680 ng/dl (Std. dev. = 235). Figure 1 shows occupational groups ordered from lowest to highest in testosterone. Differences among the groups were significant (F[6,4412]=11.49, p<.001). Professional and technical workers, along with farmers, were low in testosterone, and industrial workers and unemployed men were high. Following the old distinction between white-collar office and blue-collar industrial

workers, testosterone was higher in blue-collar than in white-collar workers (Means = 699 vs. 649 ng/dl; $t[3914]=6.80$, $p<.001$).

Age and race were examined as possible confounding variables. Testosterone decreased with age ($r=-.19$, $p<.001$) and was slightly lower in whites than nonwhites (Means = 676 vs. 696 ng/dl; $t[4417]=2.16$, $p<.05$). However, analysis of covariance controlling for age and race produced essentially the same results as above ($F[6,4410]=11.84$, $p<.001$), and age and race will not be treated further in this article.

Figure 1 suggests that higher testosterone levels of subjects were associated with lower occupational status, and indeed the testosterone level of employed subjects was negatively correlated with the Stevens and Cho (1985) occupational status score ($r=-.11$, df=4,018, $p=.001$). Delinquency, intelligence, and education could all be mediating variables in the testosterone-status relationship. Testosterone level was correlated $r=.11$ with childhood conduct disorders, $r=.18$ with adult antisocial behavior, $r=-.07$ with intelligence, and $r=-.11$ with years of education. All these correlations were significant at $p<.001$.

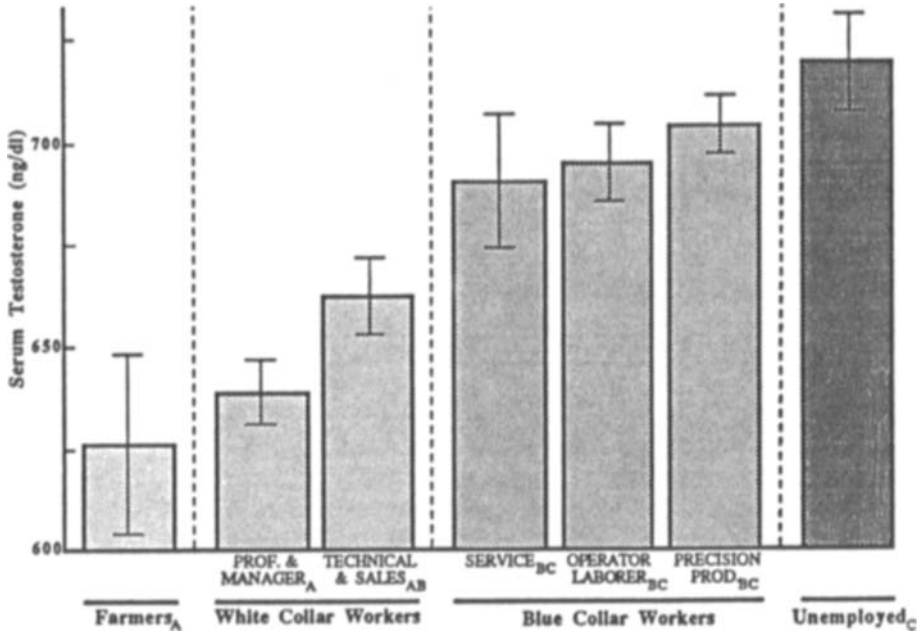
CAUSAL MODELS

The findings were brought together and explored using LISREL-7 and the structural equation procedures of Jöreskog & Sörbom (1984). A plausible sequence of events begins with testosterone level in childhood, through antisocial behavior, education, and intelligence, to occupation in adulthood. In the LISREL analyses, antisocial behavior was treated as a latent variable with two indicators, childhood conduct disorders and adult antisocial behavior. Education was defined by years of formal education. Intelligence was defined by the Technical Subscale score on the Armed Forces Qualification Test. Occupational status was defined by the socioeconomic index score of Stevens and Cho (1985). Unemployed men were excluded, leaving a total of 4,019.

Figure 2 shows three models of the testosterone-status relationship. The first model includes only antisocial behavior as a mediator, arising from testosterone level and leading to low status. The second adds lower education, arising from testosterone level and antisocial behavior and leading to low status. The third adds low intelligence, arising from testosterone level and leading to lower education and low status. All paths in the models are significant at $p<.05$. The numbers are standardized path coefficients, indicating the proportion of the standard deviation of a variable at the end of an arrow that would be removed by eliminating variation at the beginning of the arrow.

With LISREL it is possible to test goodness of fit, the degree to which a model reproduces the observed covariance structure. Hoelter's (1983) critical *N* statistic should be used with chi square to test goodness of fit with large samples, because with very large samples any model will be rejected as inadequate. Critical *N* indicates how many subjects would be needed to reject a model in a particular case. Better models require larger *N*'s to be rejected. Critical *N* greater than 200 is generally taken to mean that the fit is satisfactory (Hoelter 1983). According to this criterion, all the models in Figure 2 fit the data well. The bottom model is preferable because it provides the most complete picture of mediating variables.

FIGURE 1: Mean Testosterone Concentrations (Standard Error of the Mean [± SEM]) in Seven Occupational Groups[a]

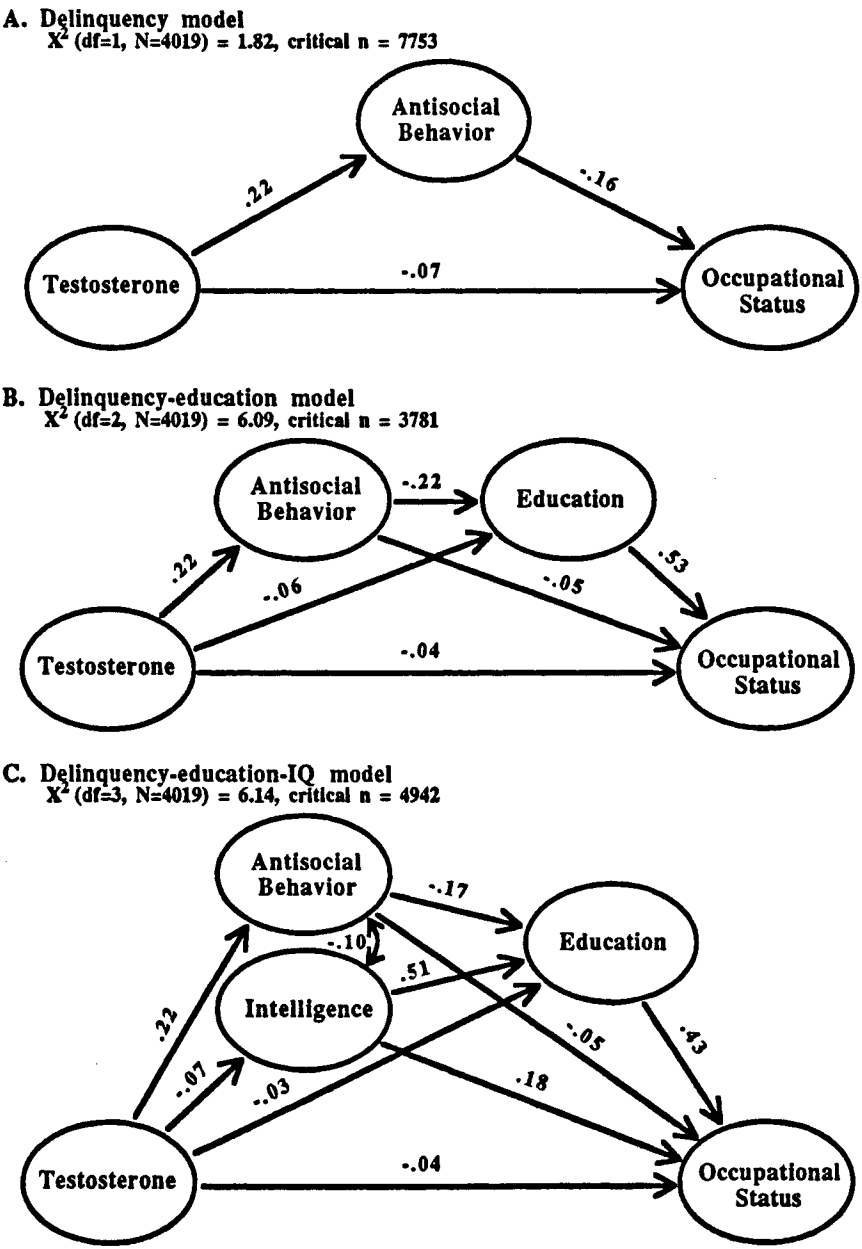


[a] Subjects were 4,419 former military servicemen, with a median age of 38 years, representing U.S. census occupational groups and unemployed men. Groups without a common subscript differ significantly from one another, according to the Newman-Keuls test ($p<.05$).

MEDIATING VARIABLES

Testosterone, intelligence, and education all have significant mediating effects ($p<.05$), according to the test for mediation presented by Baron and Kenny (1986). Antisocial behavior and education together reduced the direct testosterone-status path from -.11 to -.04. Antisocial behavior and intelligence together reduced the direct testosterone-education path from -.11 (the simple testosterone-education correlation) to -.03. Antisocial behavior is mentioned more than intelligence in the literature on testosterone, but the effects of testosterone on education were mediated similarly by high antisocial behavior (.22 x .17 = .0037) and low intelligence (.07 x .52 = .0036).

FIGURE 2: Three LISREL Models Relating Testosterone to Occupational Status[a]



[a] Subjects were 4,019 former military servicemen, representing all U.S. census occupational groups. Effects of testosterone are mediated by antisocial behavior, intellectual ability, and educational attainment. All path coefficients are significant at $p<.05$.

TABLE 1: Binomial Effect Size Display for Testosterone and Occupation[a]

	Occupational Status	
Testosterone	Low	High
High	55	45
Low	45	55

[a] Rosenthal and Rubin's (1982) binomial effect size display, showing the practical effect of $r = .10$ between testosterone and occupation, with testosterone dichotomized at the median and equal numbers of subjects entering high and low status occupations. Entries show expected percentages in each cell.

EFFECT SIZES

With a correlation of r=-.11 between testosterone level and status, the effect size for testosterone level is about .01. This is small for effects in psychological research (Cohen 1988), though not for effects in medical research (Rosenthal 1990). Rosenthal and Rubin's (1982) binomial effect size display provides a way of showing the practical magnitude of an effect. This display in Table 1 indicates that, when the odds are even that a person will enter a high- or low-status occupation, for 100 individuals above the median in testosterone level, there will be 10 more in low- than in high-status occupations. Extending the display to more extreme levels of testosterone would show that, for 100 individuals in the top 1% in testosterone level, there will be 24 more in low- than in high-status occupations. For practical purposes, the effect is large enough to be taken seriously.

Discussion

High-testosterone subjects tended to have low status occupations. The effect was small, but not small enough to be irrelevant. The findings are consistent with a model in which a high testosterone level, through antisocial behavior, low intelligence, and low education, leads to low occupational status. The model follows a plausible sequence of events, in which testosterone concentrations are heritable and to a large extent fixed at birth, antisocial behavior and education are evident in youth, and occupations appear in adulthood. Other model builders might reach different conclusions, however, and other possibilities need to be considered.

Two challenges to the model appear likely. The first is that it is basically wrong, that differences in testosterone levels are the result rather than the cause of occupational differences. Testosterone levels rise with success and fall with failure in competition among animals (Bernstein et al. 1974) and in people following laboratory games (Gladue, Boechler & McCaul 1989), tennis matches (Booth et al. 1989; Mazur & Lamb 1980), and escape from captivity as hostages (Rahe et al. 1990). These changes have only been observed for short periods of hours or days, although they may last longer if associated with other lasting physiological or psychological changes. Kemper (1990) describes how blue-collar

workers are involved in more physical confrontation and challenge from co-workers and managers than are white-collar workers. It seems unlikely, however, that blue-collar workers and unemployed men experience enough success to raise and maintain their testosterone levels above the levels of white-collar workers.

Furthermore, testosterone levels have a genetic component. Testosterone is produced continuously, and its level within an individual is determined by production, conversion, and clearance rates. Heritability of testosterone, based upon studies of monozygotic and dizygotic twins and computed from the formula $H = 2(r_{MZ}-r_{DZ})$, is about .8 for production rate, .1 for clearance rate, and .3 for the resultant individual level (Meikle et al. 1987, 1988). The individual level is probably most relevant to the present study, because it reflects the amount of testosterone available to reach receptors in the brain. The heritable component of individual levels is continuously available to affect behaviors related to occupational achievement.

Physiological factors associated with an occupation might affect testosterone levels. Testosterone in men is produced largely by the gonads and cleared through peripheral conversion and catabolism in the liver, and conversion and clearance rates vary with environmental factors (Meikle et al. 1988). Diet appears to be important, with greater fat and protein intake associated with lower testosterone (Bishop et al. 1988). Bishop et al. report that individuals who are heavier or have higher body-mass index scores (weight/height^2) are lower in testosterone, and there was a negative correlation between testosterone level and the body-mass scores in the present CDC data set (r=-.34, p<.001). But, as with experiences of success and failure, it seems unlikely that occupational differences in physiological or dietary factors would be large enough to produce the observed differences in testosterone levels. Mean body-mass index scores were not significantly different between white- and blue-collar workers (t[3,913]=1.68, n.s.)

The second likely challenge to the model is that it is wrong in details regarding links between testosterone level and occupational achievement. Details of the model are sketchy. We do not know all the motivational and cognitive factors that link testosterone level to behavior. High-testosterone individuals may be more antisocial because they tend toward wild and excessive behavior (Dabbs & Morris 1990) or because they react negatively to frustration and challenges (Olweus, Mattsson & Low 1988). High-testosterone individuals may be lower in intelligence because they have had less exposure to schooling. Readers may wish to reject the notion that higher testosterone levels lead to lower intelligence. However, other investigators have reported negative correlations between aggression, which is related to testosterone level, and intelligence (Huesmann, Eron & Yarmel 1987). Among the veterans, even those with postgraduate education showed a negative correlation between testosterone level and the General Technical subscale of the Armed Forces Qualification Test (r=-.26, df=352, p<.001). Characteristic interests could also lead high-testosterone individuals away from school and toward a world of action. Other research has shown testosterone related to simple perseverant responding (Broverman et al.

1964; van Hest et al. 1989), and high-testosterone individuals may find little satisfaction spending hours sitting in classrooms and considering ideas.

Effects shown in the models are undoubtedly mediated by additional elements not yet identified, elements that could involve cognitive or physiological factors. Testosterone affects development of the brain, and Geschwind & Behan (1984) argue that high levels of testosterone in utero bias development toward the right side of the brain and thereby increase spatial ability and decrease verbal ability. It is plausible, though not established, that high prenatal testosterone levels are correlated with high levels in adulthood, and high testosterone levels in adulthood have been related to high spatial ability relative to verbal ability (Christiansen & Knussmann 1987).

The dependent variable of status provides a convenient vehicle for placing diverse occupations on a single dimension. Other dimensions of occupations might be considered, perhaps some more closely related to the violent and antisocial behavior that prior research has identified with testosterone. For example, the three previously published occupational studies could be interpreted as showing less benevolence in the occupations of higher-testosterone subjects. England and Kilbourne (1989) provide a way of linking Department of Labor scores describing each occupation (U.S. Department of Labor 1977) to 1980 census categories via 1970 census categories (National Academy of Sciences 1971), but these scores emphasize job-related characteristics. If comparably detailed information were available on the personality characteristics of people in different occupations, it would be possible to explore correlates of testosterone other than status.

The finding that farm workers are low in testosterone presents a puzzle. Farmers are neither white-collar nor blue-collar workers, and they do not fit neatly into any socioeconomic class (Mooney 1988). Their occupational status is low (Stevens & Cho 1985), and in the present study they were lower than other veterans in education ($t[4415]=3.23$, $p< .01$) and in total (childhood plus adult) antisocial behavior ($t[4417]=3.59$, $p< .001$). It is conceivable that evolution has contributed to the characteristics of farmers. Wilson (1975) points out that few persons, even biologists, appreciate the speed with which selection pressures can affect a population, and he notes that 10 generations are often sufficient to produce perceptible changes. In the U.S. there has been migration from farm to city for five to ten generations, since well before the Civil War (Fite 1981). People seldom move into farming from outside. Children of farmers most suited to farming grow up and stay on the farm, and those who do leave are different from those who stay in that they are driven by financial need and desire for a more urban life. Those who stay subordinate themselves to the seasons and the vagaries of weather, crops, livestock, and the economy. Willa Cather wrote, "On the farm the weather was the great fact, and men's affairs went on underneath it, as the streams creep under the ice" ([1918] 1976). This is a poor climate for the restlessly aggressive and dominant behavior of high-testosterone individuals.

Subjects in the present study were men, but other studies have focused on women. Two such studies have found occupational differences in testosterone levels (Purifoy & Koopmans 1979; Schindler 1979), but the samples were small and did not include blue-collar occupations. Testosterone could have similar

effects on both sexes, or, alternatively, the testosterone-behavior relationships could differ at the low levels of the testosterone characteristic of women. The effects of testosterone on occupation among women will remain unclear until more data are available.

The purpose of the present article has been to point to a relationship, suggest that testosterone affects occupational achievement, and stimulate thought on how this might come about. Underlying the whole set of findings is an oddity, a contrast between the apparent role of testosterone in human beings and other animals. Among animals, testosterone is associated with aggression that serves to establish dominance (Svare 1983). Aggression has costly side effects, including risk of injury and death from fighting, but it apparently brings enough reproductive success to support the evolution of relatively high levels of testosterone in males. Among humans, the testosterone-dominance relationship is complicated because dominance often depends more upon mastery of cultural rules and skills than upon aggression. An orientation toward aggression could interfere with the intelligent handling of cultural power, causing high-testosterone individuals to gravitate toward low-status occupations or unemployment.

This is not to denigrate high-testosterone individuals. Testosterone was high among precision production workers: welders, ironworkers, miners, people who build things. These skills are critical to modern life, though they carry less prestige than occupations requiring more education. Testosterone was also high among unemployed men. Testosterone brings high status to nonhuman primates, but it often does not bring high status to people. It is an irony of evolution that testosterone, once associated with dominance and status, is now associated with low socioeconomic status.

Notes

1. In the original CDC data there were a number of errors in which subjects in identical occupational categories had been assigned different occupational codes. This became apparent when the data set was sorted and printed alphabetically by job title. An assistant, blind to subjects' testosterone scores, verified and corrected the occupational codes. A data set containing the original and the corrected code for each subject is available from the author.

2. Individual occupations are not examined in this article because the aim is to provide an overview of testosterone's role. A detailed listing showing the mean testosterone score for each occupation in which there were more than ten veterans is available from the author.

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