



## Adrenal androgen and gonadal hormone levels in adolescent girls with conduct disorder

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**Summary** There are few data on the biological correlates of female antisocial behavior. This study compared adrenal androgen and gonadal hormone levels in adolescent girls with conduct disorder (CD) to girls without any psychiatric disorder (NC). We studied 87 girls, (47 CD; 36 NC), ages 15–17 years, obtaining three blood samples, drawn 20 min apart between 8 and 9 AM in the first 72 h of the onset of menstrual flow. Plasma was assayed for testosterone, estradiol, androstenedione, dehydroepiandrosterone (DHEA), dehydroepiandrosterone-sulfate (DHEA-S), sex hormone binding globulin (SHBG), and cortisol; area under the curve (AUC) for each of the three samples was used in the data analysis. We also calculated the Free Testosterone Index, Free Estrogen Index, Index of Hyperandrogenism and cortisol to DHEA ratio. In addition to receiving a full psychiatric interview, each girl completed a self-report questionnaire on general aggression. Main hormone analyses controlled for potentially confounding variables such as psychiatric comorbidity and race. Girls with CD had significantly lower cortisol to DHEA ratios, but did not differ from NC girls on any other hormone variable. Girls with symptoms of aggressive CD had significantly higher mean free testosterone indexes, lower SHBG levels, and lower cortisol to DHEA ratios than girls with non-aggressive CD. Girls with CD scored higher on the aggression questionnaire, but there was no association between general aggression and any hormone variable for the sample. Our data suggest that girls with CD, particularly aggressive CD, have lower cortisol to DHEA ratios, higher levels of free testosterone, and lower levels of SHBG. Clinical and research implications of these findings are discussed.  
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## 1. Introduction

Antisocial behavior in adolescent girls is increasingly prevalent, whether defined as delinquency or conduct disorder CD, a pervasive and persistent pattern of violating the rights of others and noncompliance with rules. Between 1980 and 2003, arrest rates for assaults by girls increased 269% in the US. In 2003, girls accounted for 24% of arrests for aggravated assault, 35% of forgery arrests, and 40% of embezzlement charges for American delinquents (Synder, 2005). Epidemiologic studies show that as many as 10% of 15–17 year-old girls in the general US population meet DSM-III, DSM-III-R, or DSM-IV criteria for CD (Cohen et al., 1993; Costello et al., 2003; Kashani et al., 1989). In the UK, a population study of over 10,000 5–15 year-olds (90.8% Caucasian) reported that 3.5% of 15-year-old girls met criteria for DSM-IV criteria (5.5% of the boys the same age met criteria for CD) (Maughan et al., 2004). Two Canadian studies reported that 2.9–3.6% of 15 to 17-year-old girls met DSM-III-R criteria for CD (Breton et al., 1999; Romano et al., 2001). A large cohort study of New Zealand children followed from birth reported that 8% of the girls met DSM-IV criteria for CD at age 15 (Moffitt et al., 2001). CD is the second most common psychiatric disorder in epidemiologic studies of adolescent girls in the US, UK, and New Zealand (Cohen et al., 1987; Graham and Rutter, 1973; Kashani et al., 1987; McGee et al., 1990; Rutter et al., 1970).

Adolescent antisocial behavior exacts high societal costs and causes significant suffering to families and individuals (Jones et al., 2002; Scott et al., 2001). Furthermore, such behavior in girls is not confined to adolescence; it is associated with a 40-fold increase in adult criminality, an increased rate of early mortality, depression and substance use, poor physical health, and a high rate of intergenerational transmission of antisocial behavior (Pajer, 1998).

Unfortunately, treatment for CD in girls is not very successful. This may be partially due to our limited understanding of the mechanisms underlying female antisocial behavior. This gap is particularly evident with biological factors, such as possible effects of adrenal androgen or gonadal hormone levels. These hormones have been studied in male antisocial behavior because of a hypothesized role for androgens in the etiology of violence, but only two studies have examined this question in girls. Maras et al. (2003) measured plasma testosterone, 5- $\alpha$ -dihydrotestosterone (DHT) levels, and externalizing behavior in 87 14-year-old boys and girls in Germany. Groups were assigned according to

behavioral scores on the Child Behavioral Checklist (CBCL) and the Teacher Report Form (TRF). There were no significant correlations between hormone levels and behavior for girls. Granger and colleagues studied 107 girls and 106 boys (mean age of 13 years) to assess the relationship between diurnal variation in salivary testosterone levels and problem behavior (Granger et al., 2003). Problem behavior was defined as high externalizing behavior scores and DSM-IV symptoms of CD or oppositional defiant disorder (ODD). A steeper decline in testosterone levels throughout the day was associated with problem behavior in girls.

Research on hormone levels in women with antisocial behavior is also meager. Dabbs et al. (Dabbs and Hargrove, 1997) measured salivary testosterone levels and behavior in 87 women, 17–60 years old, in a maximum security prison in the US. Testosterone levels were not associated with criminal violence, but were associated with aggressive-dominant behavior in prison. However, this was only the case in the younger women. His group also measured salivary testosterone concentrations in 29 young men and women (mean age was 25 years) living in an “area frequented by young people of a rebellious nature ...” (Banks and Dabbs, 1996). They were compared to age- and sex-matched local college students. There was no significant correlation between the number of antisocial acts and testosterone in the women in the “delinquent” group.

It is difficult to draw any conclusions from these studies for three reasons. First, there are too few studies and the samples are not representative of the population of females with antisocial behavior. Second, testosterone was the only hormone studied; there are no data about any other hormones. Even if we focus on the broader issue of general aggression (e.g., aggression in sports), as is often done with males, aggression in females has been less often associated with testosterone than with androstenedione, DHEA, or DHEA-S levels (Albert et al., 1990, 1991, 1992; Fishbein, 1992; Inoff-Germain et al., 1988; Kapusta, 1998; Mazur, 1995; Susman et al., 1987a,b). Third, gonadal and adrenal hormone levels are affected by variables such as menstrual cycle phase (Abraham, 1974; Bloch et al., 1998; Couchman and Hammond, 1999), body mass index, race, and social class (Ukkola et al., 2001). None of the studies controlled for these factors, making the results difficult to interpret.

Although we do not know if females with antisocial behavior are similar to males, data from males can be used to generate hypotheses about hormone—antisocial behavior associations.

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