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Do circulating androgen levels predict competitiveness in female athletes?

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Abstract

Objective: In males a correlation between competitiveness and testosterone have been reported. As no such data is available in females we aimed at investigating the possible association between competitiveness and androgen levels in a sample of female top athletes.

Method: Thirty one Norwegian female top athletes completed the competitiveness subscale of the Sport Orientation Questionnaire (SOQ), underwent a maximal oxygen consumption (VO_2max) test with a following lactate measurement and had blood samples drawn to measure androstendione and dehydroepiandrosterone sulphate (DHEAS)and compute free testosterone index (FTI). Regression analyses were used to investigate the correlation between competitiveness and hormone levels.

Results: No androgens were directly correlated to competitiveness. However**,** when controlling for age, body mass index, VO_2max, lactate and sports category, androstendione had a significant positive correlation and free testosterone index (FTI) a significant negative correlation to competitiveness.

Conclusion: In female top athletes androstenedione may be positively and FTI negatively associated with SOQ measured competitiveness. Further research into to possible association between androgens and competitiveness in females are needed to confirm or reject our findings.

Contents

Abbreviations and terms

2D:4D digit ratio: The ratio between the length of the 2nd (index) finger and the 4th (ring) finger.

AIS: Androgen insensitivity syndrome.

Androgen: Any synthetic or natural compound that produces or stimulates the development of male sex characteristics.

Androgen metabolite: Metabolite of an androgen that have no or markedly reduced ability to bind to the androgen receptor and thereby exert androgenic effects.

Androgen receptor: A receptor in the cell that androgens can bind to.

Androstanediol: A testosterone metabolite.

Androstenedione: A weak androgen, it binds less well than testosterone does to the androgen receptor.

BMI: Body mass index. Calculated as body weight in kg / (Height in meters) x (Height in meters).

CET: Cognitive evaluation theory.

Competitiveness: A disposition to strive for satisfaction when making comparison with some standard of excellence in the presence of evaluative others in sport

CAH: Congenital adrenal hyperplasisa. An inheritable defect in the steroid hormone synthesis in the adrenal cortex. Untreated women with the condition have elevated levels of androgens.

DFD: Sexual differentiation disorders.

DHEAS: Dehydroepiandrosterone sulphate. A preandrogen that is taken up in the cells where it can be converted to androgens as well as estrogens.

Eugonadal: Normal sex hormone levels

FTI: Free testosterone index. Calculated as (testosterone/SHBG) × 10. Considered a measure of biologically active testosterone.

Gonadotrophic hormones: Hormones with a gonadotrophic effect, i.e. stimulating the gonads to sex hormone synthesis and/or sex cell production.

Gonads: Organs producing sex cells and sex hormones, i.e. testicles in men and ovaries in women.

Respiratory exchange ratio: The ratio between amount of CO_2 exhaled and O_2 inhaled in one breath.

Hyperandrogenism: Usually increased circulating androgen levels.

Hypogonadal: Low sex hormone levels.

Hypogonadotrophic hypogonadism: Reduced gonadal function (i.e. low levels of sex hormones, in females oestrogen) secondary to reduced pituitary function with low levels of gonadotrophic hormones.

Oligomenorrhea: Experiencing few or no menstruations (menses > 35 days apart or < 10 menses per year, but less than six months since the last menstruation).

Organic endocrinopathies: Endocrine disease caused by an inherited or acquired defect in an endocrine organ, i.e. high or low levels or increased or decreased biological effect of a hormone.

PCOS: Polycystic ovary syndrome.

Pseudohermaphroditic: Genetic female with ambiguous or male external genitalia.

SHBG: Sex hormone-binding globulin.

SOQ: Sports Orientation Questionnaire.

Sublingual testosterone: testosterone administered and absorbed from under the tongue

Testosterone metabolite: Some metabolite of testosterone with markedly reduced or no androgen effect, i.e. low or no ability to bind to the androgen receptor.

VO_2max: Maximal oxygen consumption.

1. INTRODUCTION

1.1 Competitiveness

Competition and competitiveness are important factors in many aspects of social life and the arrangement of human societies in general. It is also an important premise, and incentive, for participating in competitions and competitive behaviour in general and perhaps the most important motivation to participate in sports. Competitiveness has been defined as "a trait that is characterized by the enjoyment of interpersonal competition and the desire to win and be better than others" (Mowen, 2004). That is a general definition. In connection with sports Martens (1976) (referred in Gill & Deeter, 1988, p. 191) states that "competitiveness is defined as a disposition to strive for satisfaction when making comparison with some standard of excellence in the presence of evaluative others in sport".

Literature surrounding this topic generally concludes that men are more competitive than women (Dreber & Hoffman, in press). This is true within several areas of human societies. Often mentioned examples are different economic decisions. The fact that males are more competitive is considered one of the reasons for the existing wage gap between men and women (Buser, 2009). Recent experimental economics research concludes that "women tend to dislike competition while men actively seek it" (Buser, 2009, p. 2). Why this difference exists has yet to be explained, but scientists have hypothesised that there is a possible biological basis and that at least part of this biological gender difference may be caused by androgens (Gómez-Gil et al., 2008). As stated by Dreber and Hoffman (in press) there is strong evidence suggesting that androgens mediate a range of sex differences across animal species.

Androgens affect primary as well as secondary sex differences in animals (Dreber & Hoffman, in press). This is true for animals without genetically determined sexes like the snapping turtle. More importantly, it is also true for our close relative the rhesus monkey who has genetically determined sexes (Dreber & Hoffman, in press).

1.2 Short introduction to hormones

Hormones do not only create the difference in appearance between males and females. It is well established that hormones also have major influence on some aspects of human behaviour. In both genders major changes in sex hormone levels occur around puberty. In males a major rise in testosterone is seen. However, testosterone is only one out of more hormones that binds to the androgen receptor and thereby exert androgenic effects at the cellular level. All together those hormones are called androgens (Fredberg, 2006).

Females also have androgens present in their body and blood stream. In females the androgen levels are much lower. Even if it is not common, androgens can still create an effect on appearance in females. The most important female sex hormone is oestrogen. Oestrogen in women acts in many ways as testosterone in men, but with the opposite effect, turning girls into women through puberty. However, hormones do not only affect appearance, but also behaviour and vice versa. Physical and mental activities, i.e. human behaviour, may also affect hormone levels. The present study looks into the possibility that competitiveness in women associate with circulating androgen levels.

1.3 Prenatal androgen exposure

As already mentioned researches have suggested that the markedly higher testosterone levels in men may partially explain the difference in men and women's level of competitiveness (Buser, 2009; Apicella et al., 2008). Apicella et al. (2008) found that higher levels of circulating testosterone are associated with a higher level of financial risk taking in men. Equally, Sapienza, Zingales & Maestripieri (2009) found that testosterone levels positively correlate with financial risk taking. Interestingly, they also found that when controlling for current and prenatal testosterone levels the gender gap in seeking a career within finance disappeared.

Controlling for prenatal testosterone is not uncommon. One quite easy way of controlling for prenatal testosterone exposure in adults is to look at the 2D:4D digit ratio. The 2D:4D digit ratio is the ratio between the length of the 2nd (index) and the 4th (ring) finger.

Since the bones in the fingers have sex steroid hormone receptors the length of the fingers is affected by hormone exposure as a fetus. Especially the 2D:4D digit ratio has been found to be negatively associated with prenatal testosterone exposure. The 2D:4D digit ratio is lower in men than in women (Manning, Scutt, Wilson & Lewis-Jones, 1998; McIntyre, 2006). This fact supports the view that androgens are involved.

Together with the 2D:4D digit ratio Sapienza et al. (2009) used another measure to control prenatal testosterone levels even better. Since prenatal testosterone exposure also has been found to affect sociability and the ability to empathize with other individuals, testing for that could help determining the prenatal testosterone exposure. To test this the "Reading Mind in the Eyes" test developed by Baron-Cohen was used. In the Baron-Cohen test participants are shown 34 pairs of eyes and told to guess the feeling that is expressed. Low prenatal testosterone exposure is associated with higher performance on the test, and men normally score lower than women (Sapienza et al., 2009).

Only studies investigating the effect of active intervention that decreases or increases testosterone levels can reveal if a cause and effect relationship exists. In females such studies with testosterone are ethically challenging. However, sometimes nature itself makes the experiments for us. An example is congenital adrenal hyperplasia (CAH), an organic endocrinopathy with an inherited defect in the synthesis of steroid hormones in the adrenal cortex. In women it results in elevated circulating levels of androgens during fetal life. These women are generally diagnosed and treated soon after birth. However, some with a mild defect may be diagnosed after menarche or go through life undiscovered. When treated they have normal androgen levels. Accordingly, women with CAH can be used as a model to investigate long term effects of increased androgen exposure during fetal life. Women with CAH tend to be lonelier than their female counterparts and more uncertain about their gender identity (Beltz, Swanson & Berenbaum, 2011; Berenbaum, Bryk & Beltz, 2012; Meyer-Bahlburg, 2011; Pasterski et al., 2011). This indicates that androgens have important lasting effects on important aspects of human life.

In animals as well as humans, too high prenatal testosterone levels will cause genetic females to show male forms while too low levels of prenatal testosterone will cause males to

show female forms. This will be discussed further in a later section as it may be an advantage for females to have male characteristics when competing on a high level in sports.

1.4 Testosterone and cognitive function

According to Stanton et al. (2011) a number of studies have shown a link between male risk-taking behaviour like committing crime, participating in high-risk sports and physical aggression and androgen levels. Men do on average have approximately ten times higher androgen levels than women. Androgens cause some of the gender differences in muscle mass as well as performance on different non-physical tasks like spatial ability, mazes and reading maps (Dreber & Hoffman, in press; Voyer, Voyer & Bryden, 1995).

It has been hypothesized that not only organisational effects sex hormones has in the brain contribute to the sex differences seen in cognition between males and females. Studies looking at the relationship between cognitive function and testosterone levels have found a correlation between the two that indicates as role in sex differences in cognition (Durdiakova, Ostatnikova, & Celec, 2011). Therefore, not only organizational, but also activational effects of testosterone and other androgens may play an important role in explaining the sex differences.

1.4.1 Testosterone and cognitive function in men

Studying testosterones effect on cognitive function most studies seem to only include males while comparing two or more groups. Examples are age groups, comparing younger and older groups, or eugonadal (i.e. normal sex hormone levels) and hypogonadal (i.e. low sex hormone levels) groups. Experimental studies on men have, as mentioned, suggested beneficial changes in cognitive function when supplying testosterone (Aleman, Bronk, Kessels, Koppeschaar & van Honk, 2004).

Comparing older and younger groups is another way of trying to understand how hormones like testosterone and oestrogen affect humans without using hormones as a

treatment since hormone levels tend to change with age in both genders (Dorgan et al., 1995). However, with such a study design it may be difficult to sort out the effect of aging itself.

Several researchers have found associations between testosterone levels and visuospatial abilities in elderly individuals as well as young adults, although mostly in male subjects (Aleman et al., 2004; Gómez-Gil et al., 2008).

1.4.2 Testosterone and cognitive function in women

In women, research suggests that higher testosterone levels are related to better performance on mental rotation tasks and improved visouspatial abilities, like in men. Aleman et al. (2004) aimed to investigate if a single dose of testosterone would enhance female's performance on a task that has been associated with male superiority. Twenty-six females took part in their study on mental rotation demonstrating that a single administration of 0.5 mg of sublingual testosterone (testosterone administered and absorbed from under the tongue) improved visuospatial abilities in young women 4-5 hours after intake. This indicates that testosterone, in addition to long term effects from intrauterine exposure, have more immediate effects, i. e. activational effects on brain functions in women also.

According to Postma et al. (2000) in their sample of fifteen females a single administration of 0.5 mg testosterone had an effect on some aspects of spatial memory. The conclusion was that testosterone may have some activational effect on certain aspects of spatial memory, but they are small and in need of further research.

However, results are inconclusive in women as well as in men (Gómez-Gil et al., 2008). Halari et al. (2005) found no sex differences in cognitive performance between men (n = 42) and women (n = 42) that were related to a variety of hormones (testosterone, oestradiol, progesterone, luteinizing hormone, follicle-stimulating hormone, and sex hormone binding globulin, as well as among women during the follicular phase of the menstrual cycle). Men were better at spatial tasks like mental rotation and judgement of line orientation, as well as an inhibition task. Women on the other hand were better at the verbal tasks (represented by category fluency in the study). No significant relationship between any of the hormones and cognitive performance was found. That suggests that there are few, or no, substantial

relationships between endogenous, nonfluctuating levels of gonadal hormones or gonadotropins and the cognitive tasks used in the study (Halari et al., 2005).

1.5 Testosterone effects on behaviour

Testosterone is widely studied and has been linked to several real-world domains since it was isolated and identified in the 1930s (Mazur & Booth, 1998). According to Mazur and Booth (1998) it was early hypothesised that testosterone and aggression was correlated as Allee, Collias and Lutherman in 1939 gave testosterone to low ranked hens. The hens became aggressive, rose in the hierarchy and showed an increase in male characteristics. Later it has become clear that testosterone has major behavioural effects on human males prenatally (in the uterus and shortly after birth) as well as during puberty and in adulthood (Mazur & Booth, 1998).

In a study done by Cashdan (1995) it was reported that testosterone was negatively correlated with status judged high by their college peers. The female′s self-assessed high status was positively correlated to testosterone. Testosterone also had a negative correlation with smiling frequency which can be an indicator of dominance (Cashdan, 1995).

Stanton et al. (2011) studied the relationship between testosterone and economic decision making. They included a large number of males (n = 142) and females (n = 156) in their study and found that women were more risk averse and more ambiguous than men. They also reported that individuals with high or low testosterone levels were risk and ambiguity neutral, and individuals with intermediate levels were risk and ambiguity adverse. The relationship between testosterone and risk preference was similar for women alone.

1.5.1 Testosterone and aggression

Dominant behaviour and aggression, which may be important factors in sports and competition, have been linked to testosterone (Archer, 2006; Hermans, Ramsey & van Honk,

2008; Mazur & Booth, 1998). Androgens seem to act on specific substrates and areas in the brain increasing aggression and motivation for competition (Gleason, Fuxjager, Oyegbile & Marler, 2009; Hermans et al., 2008). One interesting example is found in humans' close relative the rhesus monkey. Normally young males participate in more and rougher tumble play and threatening behaviour than young females. When pregnant monkeys are treated with high doses of testosterone the female offspring tend to become pseudohermaphroditic (genetic females with ambiguous or male external genitalia) and show typical male play behaviour. Treating pregnant rhesus monkeys in the later part of gestation, instead of the early part, gives female offspring with the same typical male-type playing patterns, but normal female genitals. This illustrates organizational effects of testosterone also in female foetuses with lasting effects on behaviour. Further, this shows that genital and behavioural masculinisation is independent from one and other and that different effects occur during specific time windows during intrauterine life (Mazur & Booth, 1998). Researchers think that several prenatal hormone effects are organizing the architecture of the body and brain. Later in life the same hormones are thought to activate structures in the body and brain (Durdiakova et al., 2011).

Testosterone levels increase in males during puberty and causes male characteristics to appear. When puberty is passed, the boy is changed into a man from a physical standpoint. Normal male testosterone levels do not further influence behaviour by major reorganization of the body (Mazur & Booth, 1998). However, fluctuating levels of circulating testosterone in the blood stream may activate receptors in different organs and the nervous system to, maybe, affect domination and aggressive behaviour. For ethical reasons aggression in humans are mostly measured with different types of personality questionnaires. Although a few researchers have found positive correlations between aggression and testosterone "it seems clear that testosterone is not related in any consistent way to aggression as measured on common personality scales" (Mazur & Booth, 1998, p. 365). Both Mazur and Booth (1998) and Archer (1991) agree upon the fact that studies using self-assessed aggressive predispositions and traits are of limited relevance and that the focus should be more towards concrete indicators of behaviour. That testosterone is associated with both aggressive and dominating behaviour, as well as the willingness to take risks could be an indication that an increase in testosterone levels lead to a decrease in risk aversion (Stanton et al., 2011).

Testosterone has also been positively linked to the willingness to take risks in social domains in both men and women (Stanton et al., 2011).

1.5.2 Testosterone and aggression in women

Researchers have speculated that testosterone may be associated with aggression and status in women as well as men. However, literature on the topic is sparse and the few studies that are found have been conducted in very different ways. Accordingly, the results are hard to compare. Despite that, Purifoy and Koopmans (1979) found that serum androstenedione, testosterone, testosterone-binding globulin (SHBG) and free testosterone levels correlated with the status of the occupation when including fifty-five normal females in their study. Androstendione and free testosterone levels also correlated positively with the job complexity.

Dabbs, Ruback, Frady, Hopper and Sgoutas (1988) found no difference in mean testosterone between eighty-four female prisoners and fifteen college students. However, they did find that testosterone differed among groups of prisoners according to the crime they had been convicted of. Women convicted of unprovoked violence had higher testosterone levels than the other prisoners. Further, Dabbs and Hargrove (1997) included eighty-seven female prisoners in a new study but were unable to find any significant correlation between salivary testosterone levels and criminal violence. Instead they found that aggressive dominant behaviour in prison and salivary testosterone was significantly correlated. However, it should be noted that salivary testosterone associate poorly to testosterone levels in blood (Broadbent, 2002; Granger, Shirtcliff, Booth, Kivlighan and Schwartz, 2004).

It has also been reported that aggressive female patients in a neurological clinic had higher testosterone levels than the non-aggressive patients. However, the patients also suffered from different diagnosis so comparing them could be discussed (Mazur & Booth, 1998).

1.6 Behavioural effects on testosterone levels

It is well established that males' testosterone levels react to competition. Studies in male athletes show that testosterone variation before and after sports competition relates to the outcome of the competitions. Male athletes' testosterone is slightly elevated before the competition, as in anticipation. Winning a competition elevates testosterone levels one or two hours after the match compared to testosterone levels of the losers (Booth, Shelly, Mazur, Tharp & Kittok, 1989). The same pattern of change in testosterone levels is seen in response to symbolic challenges and status change among men and is true for physical as well as non-physical competition (Mazur, Susman & Edelbrock, 1997). These data indicates that psychological mechanisms are involves in the regulation of human circulating testosterone levels, at least in men. The physiological mechanism is essentially unknown. However, the sympathetic nervous system may be involved (Fry, Schilling, Fleck & Kraemer, 2011).

To study if the same pattern was true for females Mazur et al. (1997) used data from twenty-eight males and thirty-two females. Salivary testosterone levels were measured before, during and after competing against a same sex individual in a video game. In males the normal pre competition elevation in testosterone was present, but not in females. Further, males did not have the expected rise in testosterone when winning. This was explained by the fact that winning or losing did not create a mood difference in the males. The mood difference was found in the females, but was not accompanied by a change in testosterone levels (Mazur et al., 1997). Also in soccer games winning or losing have been observed to induce the same changes in salivary testosterone levels (Edwards, Wtzel & Wyner, 2006). However, in a well designed study salivary testosterone levels in female soccer player responded differently to winning or losing (Oliveira, Gouveia & Oliveira, 2009). In winners it was positive and in losers negative. Furthermore, the changes in mood and anxiety found between winners and losers paralleled the changes in salivary testosterone levels. The authors hypothesised that contest induced mood changes may influence the testosterone response.

In 2010 Carney, Cuddy and Yap found that imagining being in a power position for a short while can increase the testosterone levels when including twenty-six females and sixteen males in their study. Testosterone (and other hormones) was measured through saliva samples before and after the participants did the high-and low-power poses. High-power poses caused

increased testosterone compared with low-power poses, which caused a decrease in testosterone. Men and women were not analysed as separate groups.

In oral contraceptive users a decrease in salivary testosterone was observed. However, the changes associated with competitions were conserved (Edwards & O'Neil, 2009). All together this indicates that the physiological testosterone response to winning a competition is not gender specific.

Testosterone levels vary both between individuals as well as within one individual depending on outside stimuli and events (Wood & Stanton, 2012). According to Wood and Stanton (2012) there is a possibility that individuals with higher testosterone values have an increased motivation and desire to compete in sports due to testosterones positive influence on power motivation. High testosterone concentrations are positively linked to seeking into power-laden careers like trial law etc. Power motivation in males is positively correlated to testosterone while in females it is positively correlated to the female sex hormone oestradiol (Schultheiss, Dargel & Rohde, 2003; Schultheiss et al., 2005; Stanton & Schultheiss, 2007; Stanton & Edelstein, 2009). Power-motivated individuals find dominance experiences rewarding and are therefore motivated to pursue dominance. It is thus likely that high testosterone individuals of both sexes may be more motivated to pursue athletic competition and sports than other normal or low testosterone individuals (Wood & Stanton, 2012).

1.7 Females, competitiveness and hormones

When preparing for this research project it became clear that only a few studies have looked at the relationship between competitiveness and hormones in women, and rarely so in a sports setting. Most studies in the field of female competitiveness seems to be comparing women with men and whether or not the competitive gender differences found within the economical field are caused by hormones, in particular testosterone.

However, a study by Metha, Wuehrmann and Josephs (2009) investigated the effect testosterone has on general competitive performance depends on if it is an individual competition among individuals or an intergroup competition amongst teams. Included in the study were an equal number of men and women gave saliva samples before completing an

analytical reasoning test, either in same sex pairs or separately. Interestingly, there was a positive relationship between performance and testosterone in the individual competition and a negative relationship between performance and testosterone in the cooperation setting. This was true for both genders.

Buser (2009) points out that female sex hormones also may play an important role in explaining the gender differences in competitiveness. This assumption is based on the observation that women are significantly less competitive while taking contraceptives containing oestrogen and/or progesterone or during parts of the menstrual cycle when oestrogen and in particular progesterone levels are especially high. Buser (2009) measured competitiveness through letting the participants chose between a tournament and non-tournament reward system when solving math questions. He assumed that the less competitive individuals would chose the non-tournament reward system, while the competitive ones would chose the tournament reward system. He found that progesterone had a negative impact on competitiveness and that women were more competitive during the pill break than when taking the pill. The conclusion was that women's behaviour shifts more towards men's behaviour when female hormone concentrations are low. Buser (2009) also stated that testosterone levels may have an effect on competitiveness and that further research into the mechanisms underlying hormonal effects on competitiveness is needed. In conclusion, endocrine factors and in particular sex hormones, seem to play an important role in explaining the gender differences in competitiveness. Rickenlund et al. (2003) found that girls with higher androgen levels in general had the highest maximal oxygen consumption (VO_2max) values and the highest general performance values.

Finding statistical associations between different behaviours and personal traits and hormone levels does not prove a cause and effect relationship. Interestingly, Zethraeus et al. (2009) conducted a large randomised double blind placebo controlled study. Two hundred post menopausal women between 50-65 years of age were treated with testosterone, oestrogen or placebo for four weeks. At the end of the study there were no differences in altruism, reciprocal fairness, trust, trustworthiness, and risk attitudes (Zethraeus et al., 2009).

1.8 Hormones and menstruation in female athletes

1.8.1 Menstrual disturbances

High performance sports may reduce the ovarian function by suppression of the gonadotrophin releasing hormone (GnRH) at the hypothalamic level (Aebersold-Schütz, 1997; Warren & Perlroth, 2001). The traditional presumption is that female athletes' loss of normal menstrual cycles is a result of an insufficient dietary intake leading to caloric deficit. This deficit initiates a cascade of effects at the hypothalamic, pituitary and ovarian level eventually leading to oligo- or amenorrhea (having a few or no menstruations) and eventually reduced circulating oestrogen levels (hypogonadotrophic hypogonadism). Contrary to the common belief that hypogonadotrophic hypogonadism was the dominating cause of oligoamenorrhea in female athletes Hagmar, Berglund, Brismar and Hirschberg (2009) and Rickenlund et al. (2003) found increased proportions of women with hyperandrogenism and PCOS among female athletes.

1.8.2 Polycystic ovary syndrome

Polycystic ovary syndrome (PCOS) is a metabolic and endocrine disorder affecting as much as 15-20 percent of women in reproductive age (Badawy & Elnashar, 2011). It is a syndrome characterised by menstrual disturbances and hyperandrogenism. In particular testosterone tends to be elevated in most of the women affected by the syndrome. To get the diagnosis of PCOS at least two out of three criteria have to be fulfilled: 1) Oligo- or amenorrhea, 2) Hyperandrogenism, clinically or biochemically, and 3) Polycystic ovaries (Rotterdam ESHRE/ASRM-Sponsored PCOS consensus workshop group, 2004). PCOS is closely linked to insulin resistance and the metabolic syndrome. Accordingly, women affected by PCOS have an increased likelihood of adiposity, impaired glucose tolerance (IGT) and diabetes type 2 (DM2). Genetic studies have so far failed to identify any gene that substantially increases the risk of having PCOS (Badawy & Elnashar, 2011).

Over the last two decades scientists have studied the fetuses intrauterine environmental exposures (both hormones and nutrition) and linked them to long term health

effects as a child, teenager and adult (Swanson, Entringer, Buss & Wadhwa, 2009). Animal studies in monkeys and sheep amongst others have shown that female fetuses exposed to elevated testosterone levels during intrauterine life, develop a condition when they reach fertile age that is very similar to human PCOS (Xita & Tsatsoulis, 2006). Accordingly, it is hypothesised that increased androgen exposure during fetal life predispose to PCOS and hyperandrogenism as an adult. One hypothesis is that a placental dysfunction may cause the increase in placental androgen secretion that in turn affects the fetus.

Interestingly, PCOS women tend to have more minor psychiatric problems than non-PCOS women. Women with facial hirsutism, a clinical manifestation of hyperandrogenism, have a high prevalence of eating disorders and eating disorders were linked to PCOS (Morgan, Scholtz, Lacey & Conway, 2008). In bulimic women an increased prevalence of PCOS was found (Naessén, Carlström, Garoff, Glant & Hirschberg, 2006). The hirsutism score and indices of biological testosterone effects associated with bulimia. This is in accordance with an earlier study that found that one third of women with PCOS had abnormal eating patterns and 6% had scores suggestive of bulimia compared to only 1% of women with organic endocrinopathies (McCluskey, Evans, Lacey, Pearce & Jacobs, 1991). However, others have failed to link eating disorders to PCOS (Michelmore, Balen & Dunger, 2001).

In hyperandrogenic patients with bulimia nervosa treatment with an oral contraceptive (OC) with antiandrogenic properties reduced binge eating behaviour (Naessén, Carlström, Byström, Pierre & Hirschberg, 2007). An adverse effect of testosterone on eating behaviour was proposed.

1.8.3 Androgen insensitivity syndrome

Androgen insensitivity syndrome (AIS) is another, more rare, syndrome that may affect and improve physical performance. AIS is a syndrome where individuals are genetically males, i.e. have a male chromosomal sex, but phenotypically have a typical female appearance and a strong female gender identity (Freberg, 2006). However, subjects with AIS are not completely phenotypically females as some parts of the female sexual features (ovaries and uterus) are underdeveloped. Despite normal circulating androgen levels the tissue does not develop

normally to a male phenotype due to an absent intracellular androgen effect. In short, individuals with AIS end up having male chromosomes while looking like women. Normally this happens in 1 of 60 000 male births. However, in sports 1 in 500 women competing in international sports levels may have AIS (Fredberg, 2006). These seemingly advantages effect of AIS is suspected to be secondary to the insufficient development of the ovaries which are essential in synthesising female hormones. Female hormones may play an important role in differentiating between males and females when it comes to sport achievements.

Also disorders of sexual differentiation (DSD) other than AIS may cause elevated concentrations of endogenous androgens, potentially creating a competitive advantage for females competing in sports (Wood & Stanton, 2012).

1.9 Motivation and competitiveness

As mentioned above competitiveness is defined as a trait that is characterized by the enjoyment of interpersonal competition and the desire to win and be better than others. Competitiveness is an important premise for taking part in competitive sports. The motivation for participating in competition in general and sports competition in particular is not the same for all individuals even if the goal is to win and be better than others. Sports are so much more than just fun and games, there is a lot behind it. From running around the schoolyard to old boys' soccer, world championships and Olympic Games in different sports, it is all motivated by something. To become a top athlete takes a lot of work and a whole lot of training. To go through with a lot of work and a lot of training an individual has to be motivated for the task at hand.

1.9.1 The self-determination theory

One specific theoretical perspective attempting to explain the relationship between competition and motivation is self-determination theory (Deci & Ryan, 1985). The self-determination theory is not sport specific, but here it will be explained in a sports setting. Self-determination assumes that human beings and our behaviour are motivated of three

psychological needs being autonomy, competence and relatedness with others. The need for autonomy is fulfilled when individuals participate in an activity, in this context sports, of their own free choice. Challenging an individual's skill level, at the right amount, will cause the individual to develop its abilities and build confidence. Seeing its own increased competence and self-determination then creates intrinsic motivation. Intrinsic motivation is according to Deci and Ryan (1985) a key outcome of self-determination. Seen from a sports perspective self-determination theory focuses on how intrinsic motivation influences individuals to develop, persist and compete in sports (Frederick & Ryan, 1993). When an individual engages in sports by its own free will and is challenged at the right level, when the task at hand does not feel too easy or too difficult, it feels challenged but still capable of overcoming the challenge. The competence and autonomy the athlete gains may motivate him or her to train for hours and hours to improve and become as perfect as possible, all with no apparent reward. The individual's intrinsic motivation level reflects self-determination and can be influenced by the athlete's participation environment in the form of received performance feedback or the reward structure of the competition or activity.

Not all sports activities are intrinsically motivated. Extrinsically motivated sports activities are not freely chosen by the individual, or not challenging or too challenging. One example everyone can relate to is gym classes at school. A lot of human behaviour starts with extrinsic motivation and moves towards greater self-regulation with time. Parents' pushing their kids into different types of after school activities and sports programs is just one example. Sometimes the kids then quit when given the opportunity to make their own choice, while others chose to stick with it. Extrinsically motivated sports activities can go though three levels of internalization as the individuals' self-determination increases (Deci & Ryan, 1985). The first one is external regulation where the behaviour is controlled and forced directly by an external source. Introjected regulation is the next level where the former external control is internalized so that the behaviour is motivated by a desire to avoid social disapproval and gain approval. In the third level the individual is finally motivated by its own interest, ability and desire to achieve self-initiated goals. Identified regulation, as it is called, is therefore characterized by a high level of self-determination and internalization (Frederick-Recascino & Schuster-Smith, 2003).

When it comes to sports, intrinsic motivation correlates positively with training hours and days per week. The same is true for the activities levels of perceived satisfaction and competence the athlete feels. Extrinsic motivation has a positive correlation with anxiety, and a negative correlation to self-esteem (Frederick and Ryan, 1993). According to Hodgins, Yacko, Gottlieb, Goodwin and Rath (2002) (referred in Frederick-Recascino & Schuster-Smith, 2003) athletes motivated by autonomous motivational states performed better than those motivated by extrinsic states. Deci and Ryan (1985) and Frederick-Recascino and Schuster-Smith (2003) supports the fundamental assumption of the self-determination theory which sees motivation as the driving force of psychological as well as behavioural outcome within real-life domains. That again suggests that differences in motivation lead to differential levels of participation and/or psychological outcomes for athletes and not the other way around (Frederick-Recascino & Schuster-Smith, 2003).

1.9.2 The cognitive evaluation theory

When using self-determination theory in a sport setting it is normally done on the background of the cognitive evaluation theory (CET), a sub-theory of self-determination theory (Deci & Ryan, 1985). It addresses how external factors like feedback, reward, choice and competition are interpreted within sports and predicts how the same factors enhances or undermines intrinsic motivation. CET says that athletes can interpret sport and exercise performance informationally or in a controlling way. A competition, or other event, having many rules, rigid structure and even punishment, it is considered to be a highly controlling competition and limit the athletes autonomy. That again makes the athlete perceive the competition as facilitating external causality and result in lower intrinsic motivation. A competition, or event, being the complete opposite with less external control and only a few rules, no rigid structure and no punishment would demand high intrinsic motivation and give an increased likelihood of adherence to the activity. Sources of motivation being outside the individual may lead to increased extrinsic motivation, unachievable goals or even quitting the sport completely (Frederick-Recascino & Schuster-Smith, 2003).

When athletes interpret the competition, or event, as a way of gaining information it is referred to as an informational perspective. Reviewing competitions personally gives the

athlete positive or negative feedback about the results. Incompetence is often interoperated from a negative perspective, while a positive interoperation promotes competence. Also here it depends on the competition/event and how controlling it is. Positive information taken from a controlling competition strengthens extrinsic motivation letting the controlling surroundings be more important than the positive feedback and therefore the athlete is no longer autonomous in initiating the decision making. Once again extrinsic motivation is reinforced by nonself-determining surroundings. Negative feedback in the same setting would suggest incompetence and result in learned helplessness as it undermines intrinsic and extrinsic motivation (Ryan, Vallerand & Deci, 1984).

Fortier, Vallerand, Briere & Provencher (1995) found that competitive athletes had lower intrinsic motivation and higher identified regulation and amotivation, than recreation athletes. Amotivation is a state of unwillingness where the athlete lacks the intention to act. It is often a result of not feeling competent enough or not believing that it will produce the desired result (Ryan & Deci, 2000). Competition has a possibility of harming intrinsic motivation. When the focus of the competition becomes winning, as Fortier et al. claimed was the case for athletes, the extrinsic motivation takes over. In other words, the more serious the athlete takes the sport and competitions the more likely is it that he or she is mainly motivated by extrinsic factors. Recreational athletes are more likely to be intrinsically motivated and participate in sports for the fun of the sport itself. It is important to add that, as Fortier et al. (1995) states, most athletes are likely to at some point have started his or her sport due to intrinsic motivation, but as the competitions get more and more serious, winning becomes more important and for many ends up being the main objective.

Fortier et al. (1995) interpreted the results as a support to CET saying that the competitive environment can affect intrinsic motivation. For competitive athletes the goal and focus is winning, and success is measured after that standard giving them a personally controlling environment and external causality. Other studies confirm this finding (Frederick-Recascino & Schuster-Smith, 2003).

The athletes own perceived competitiveness is important within CET. In sports situations athletes judge how they perceive the competition, competitive environment, their own thoughts and behaviour. Athletes being task-oriented find it easier to maintain their

intrinsic motivation as they focus on the challenge at hand and process of the competition. They find the experience and feelings the sport give them important no matter if they win or lose. Outcome-oriented athletes focus on the result of the competition, in other words if they win or lose and compare themselves to others. They are more extrinsically motivated (Frederick-Recascino & Schuster-Smith, 2003). In their own study Frederick-Recascino & Schuster-Smith (2003) found that sport specific competitiveness (measured with the Sport Competition Trait Inventory) was positively correlated with intrinsic motivation while general competitiveness was related to lower levels of intrinsic motivation in cyclists. The results were interoperated as supping CET saying that the competitive environment can have great influence on the athlete motivation style.

White and Duda (1994) used the Task and Ego Orientation Questionnaire and found that males were significantly higher in ego-orientation than females. The group consisting of athletes was more ego-oriented than the other groups (consisting of youth, high school kids, intercollegiate and individuals using sports for recreational reasons). High ego-oriented individuals were more likely to participate in sports for the competition, potential recognition and status, and less likely to emphasize team membership. The task-oriented individuals related positively to the importance of skill development and fitness as reasons to participate in sports.

1.10 Gender and competitiveness

Using SOQ (Sports Orientation Questionnaire) difference in the level of competitiveness has been found between students entered in competitive and non-competitive activity classes (Gill & Deeter, 1988; Gill & Dzwaltowski, 1988). Martin, Eklund and Smith (1994) claim that male runners are more competitive than their female counterparts but when checking the reference given no such information is available in the cited paper (Martin & Gill, 1991). Gill (1993) did however study gender differences on competitiveness and found that males participate more in competitive sports and score higher on competitiveness than females do.

Cashdan (1998) used competition diaries among university students and found that men talked more about competition within the same sex than females and competed more in

sports than females. Males also used physical, but not verbal, aggression more often. Females competed more about looking attractive compared to other women. When measuring the strength of competition with a questionnaire Cashdan found that males and females over all felt the same degree of competitiveness. Males felt more competitive than females about sports and sexual attention, while females felt more competitive about looking attractive. Cashdan (1998) also reports that young males were more competitive than older males, as well as more aggressive (physically and verbally). No age difference in competitiveness was found in women.

1.11 A lack in research

Despite indirect data indicating that there might be a relationship between circulating androgens and competitiveness we did not find any research looking at the possible relationship in female athletes through the extensive literature search for this project. And no data are available on the possibility that differences in competitiveness between athletes and non-athletes may be explained by differences in androgen levels. Yet, researchers have pointed out that women with PCOS and AIS are both overrepresented in sports competitions and that these syndromes might be an advantage when competing (Fredberg, 2006; Hagmar et al., 2009; Rickenlund et al. 2003). It has been pointed out that males, who on average have approximately ten times higher testosterone levels than women, are more competitive and stated that more research into the field is needed. However, close to nothing has been published on female athletes, competitiveness and androgens.

1.12 Aim of the study

The aims of the study was to investigate in females athletes the possible association between self esteemed competitiveness measured with the Sport Orientation Questionnaire's competitiveness subscale and circulating androgens represented by serum testosterone, androstenedione and dehydroepiandrosterone sulphate (DHEAS). Our hypothesis was that:

among female top athletes competitiveness is positively associated with circulating androgen levels.

2. METHODS

2.1 Literature search

The databases PsycINFO, Scopus, Web of Science and Embase were searched by the use of the search terms competition or competitive ability combined with human sex differences or hormones or endocrinology or sex hormones/ or adrenal cortex hormones or athletic performance or athletes or athletic participation or sports or sport psychology. The last search date was 18th of April 2012. Only human studies were included. After searching the abstracts we were left with 55 papers of possible interest. The reference lists of these papers were also screened.

In addition to that, as the paper grew in extent sources were needed to help explain how hormones work in general, what and how VO2max, lactate, BMI and age are related to competitiveness. That was found by looking through the reference list of the articles that were already found as well as special searches designed to find specific explanations

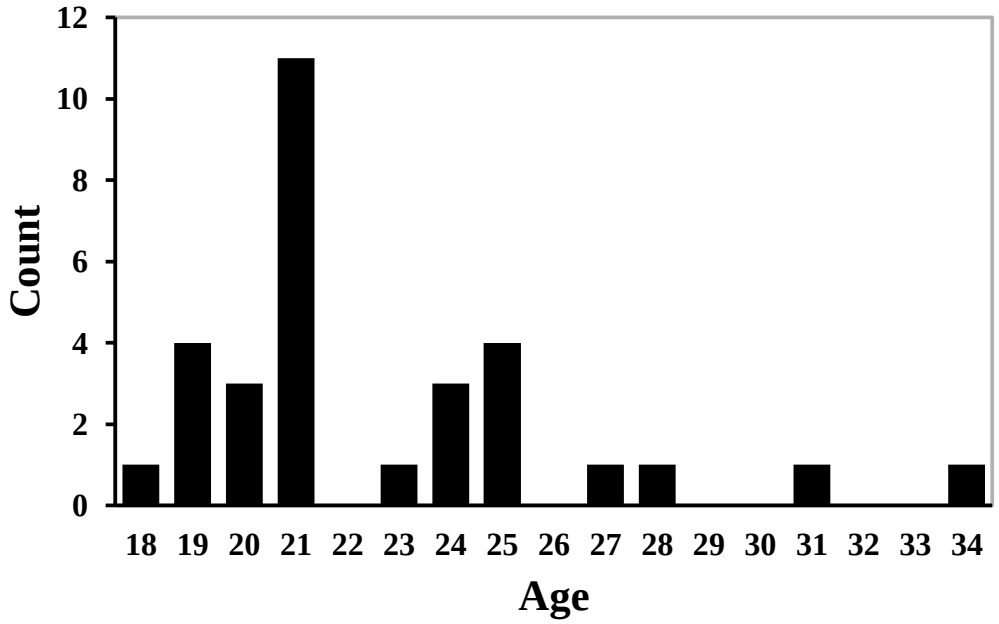
2.2 Participants

The participants were 36 female athletes supported by Olympiatoppen Midt-Norge, an organisation supporting top athletes in Mid-Norway. Four of the 36 had to be excluded due to missing blood samples and one due to a lack of VO_2max data, leaving 31 participants for the data analysis.

The athletes were between 18 and 34 (M = 22.6 ± 3.6, Mdn = 21) years old. In Figure 1 a graphical picture of participants' age distribution is given. This is done because neither mean age nor median gives a good picture to describe the age distribution in the group. Out of

the 31 participants 22 practiced soccer and 9 cross country skiing, all competing on international or national levels.

Figure 1. Age distribution of the participants.



2.3 Measures

2.3.1 Questionnaires

Sport Orientation Questionnaire (SOQ). SOQ was developed by Gill and Deeter in 1988. The goal was to develop an instrument that was appropriate to use on athletes, non-athletes, males and females and individuals who participated in different competitive and non-competitive sport activities. SOQ has three subscales; competitiveness, win orientation and goal orientation which can be seen as separate factors. The competitive subscale has 13 items, the goal orientation subscale has 6 items and the win orientation subscale has 6 items. Only the 13 competitiveness subscale items were included in our questionnaire (Appendix 1). Gill and Deeter (1988) found that the competitiveness score differentiated between students enrolled in competitive classes and those in non-competitive classes. It also differentiated between individuals participating in competitive sports while other more general

competitiveness measures failed to demonstrate the same differences. SOQ is a 5-point Likert-type scale with 25 statements describing reactions to different sport situations. Gill (1993) stated that in females SOQ represented the strive for success and satisfaction, in other words, competitiveness.

Internal consistency was estimated by Gill and Deeter (1988) to be 0.94 and construct and concurrent validity have been adequately demonstrated (Houston, McIntire, Kinnie & Terry, 2002). The questions were translated to Norwegian by one subject and the translation validated by translation back to English by another subject unaware of the original English questions.

The competitiveness subscale consists of 13 questions, each with 5 possible answer ranging from strongly agree (score = 5), slightly agree (score = 4), neither agree nor disagree (score = 3), slightly disagree (score = 2) and strongly disagree (score = 1). The scores on all the questions are summarized representing the competitiveness score. This gives a possible over all competitiveness score ranging from 13 in the least competitive subjects to 65 in the most competitive subjects.

2.3.2 Hormones

Blood samples were drawn from an antecubital vein between 08 and 10 am after an overnight fast. Serum was stored at -20 degrees centigrade for a maximum of 14 days before transferred to a -80 degrees centigrade freezer.

For serum testosterone and androstenedione analyses, organic solvent extraction (dichloromethane for testosterone and ethyl ether for androstenedione) was used before quantification. Androstenedione was measured with a competitive immunoassay based on the use of antibody-coated tubes, the Coat-A-Count® Direct Androstenedione procedure, using reagents and calibrators supplied by the manufacturer Siemens Medical Solutions Diagnostics (Los Angeles, CA, USA). 17-hydroxy-progesterone, sex hormone-binding globulin (SHBG), testosterone, and dehydroepiandrosterone sulphate (DHEAS) were all measured using an enzyme-linked immunosorbent assay (ELISA) for quantitative determination in serum. Intra-

assay coefficients of variation were 1.8 % for 17-hydoxy-progesterone, 5.6 % for androstenedione, 2.8 % for DHEAS, 6.6 % for SHBG, and 9.5 % for testosterone. All samples were measured in duplicates and the mean of the two measurements were used in all estimations. The free testosterone index (FTI) was calculated as (testosterone/SHBG) × 10.

In the present study androstenedione and testosterone were analysed after a precipitation of the serum to be analysed. This procedure was undertaking to separate out water soluble androgen metabolites that tend to interfere with the androgen analyses and lead to an overestimation of the levels of the hormone measured. From previous unpublished data from the same laboratory that performed the analyses for this study we know that this procedure reduces the hormone levels measured by 20-40 percent in females.

17-hydroxyprogesterone was measured to exclude that some of the participants suffered from congenital adrenal hyperplasisa and never thought to be included in the model.

2.3.3 Physical performance

Aerobic capacity was measured by a VO_2max (relative = ml/kg/min) test. VO_2 was measured through pulmonary gas exchange a treadmill using Oxycon Pro (Jaeger GmbH, Hoechberg, Germany) throughout the test with a sample frequency of 0.1 Hz. In addition heart rate was continuously measured. The participants had a ~15 minutes warm up on the treadmill (unless they requested another method) on approximately 60 % of their maximal heart rate. The test started with a 10.5 % incline with the speed increased stepwise by 1km/h every minute. The oxygen uptake was continuously measured and an average of the six latest 10-s consecutive measurements, in other words measurements from the last minute of the test, determined the VO_2max. Maximal effort was considered when at least two of three following criteria were met: a plateau in VO_2 was reached despite increased intensity/speed, a respiratory exchange ratio (the ratio between amount of CO_2 exhaled and O_2 inhaled in one breath) > 1.10 or blood lactate concentration > 8 mmol/L. To determine peak lactate blood samples were drawn 1 minute after the test was finished and analysed consecutively on site (Lactate Pro LT-1710, ArkRay Inc, Kyoto, Japan). To be able to determine BMI height and weight was also recorded.

2.3.4 Other instruments

This study is a part of a larger study where several other measurements were used and investigations performed. These were questionnaires determining handedness (The Edinburgh Handedness Inventory), examining eating behaviour (Eating Disorder Inventory, EDI 2), assessing anxiety and depression (Hospital Anxiety and Depression Scale, HADS) and sensation seeking (The Sensation Seeking Scale) were included as well as questionnaires about sexual orientation, their menstrual cycle, bodily hair growth (Ferriman-Gallwey score), sport history and goals, and living arrangements.

Additional physical tests included maximal muscular power in the lower body measured by an explosive power squat jump on an AMTI BP6001200 Biomechanics Force Platform (Advanced Mechanical Technology, Inc., Massachusetts, USA) and maximal upper body effect tested by measuring acceleration in standard bench press with 50 % of body weight. A gynaecological examination (assessment by a gynaecologist in order to determine if the participants had PCOS) and full body Dual Energy X-ray Absortiometry (DEXA) scan using Hologic Discovery. The scan was performed to determine body composition and bone density. These results are reported elsewhere.

2.4 Procedure

The participants were recruited through their engagement with Olympiatoppen Midt-Norge. The participants were tested during the daytime of their choice. When they arrived at our physical test laboratory they were taken into a quiet room where they were given extensive information about the test (Appendix 2). They read an information sheet and signed the consent sheet (Appendix 3). Next, they were handed a package including all the questionnaires mentioned above. Filling out the questionnaires took from 35-60 min depending on the individual. After the questionnaires were finished they were taken to the laboratory to perform the physical test. First they were given about 15 minutes to warm up, before starting with the power squat jump, continuing with the bench press and ending with

the VO_2max test and lactate tests. After having finished the questionnaires' and tests the participants were told to visit the local hospital and have the blood drawn within 2-3 days, if possible. Gynaecological examination and DEXA scan was conducted on a different day at our local hospital (St. Olavs Hospital, Trondheim University Hospital).

2.5 Ethics

The study was approved by the Regional Committee for Research Ethics in Health Region IV in Norway. Participation was voluntary and an informed consent was signed by all women before inclusion in the study. The Helsinki Declaration was followed throughout the study.

2.6 Statistics

Values are given as means and standard deviation (*SD*). *t* test for independent samples was used to compare groups. To investigate the association between competitiveness and hormones multivariate linear regression analyses were used. In regression analyses variables suspected to associate with competitiveness and hormone levels were entered into the model. In addition a stepwise linear regression with the same variables was performed. All analyses were performed with the software IBM SPSS Statistics, version 19.0. *P* values less than .05 were considered significant; no adjustment for multiple testing was performed.

FTI, and not testosterone itself, was included in the regression model because it associates better to biological testosterone effect than total serum testosterone. SHBG was measured only to be able to compute the FTI in each participant.

DHEAS, a precursor to androgens and estrogens, were also entered into the model. DHEAS and its de-sulphated form DHEA can be taken up in cells and converted to both androgens and estrogens (Labrie, 2004). Accordingly, we measured DHEAS to be able to adjust for this possible effect on competitiveness in the regression analyses.

BMI and age both affect hormone levels and should therefore be controlled for in the analyses (Dorgan et al., 1995; Ecochard, Marret, Barbato & Boehringer, 2000).

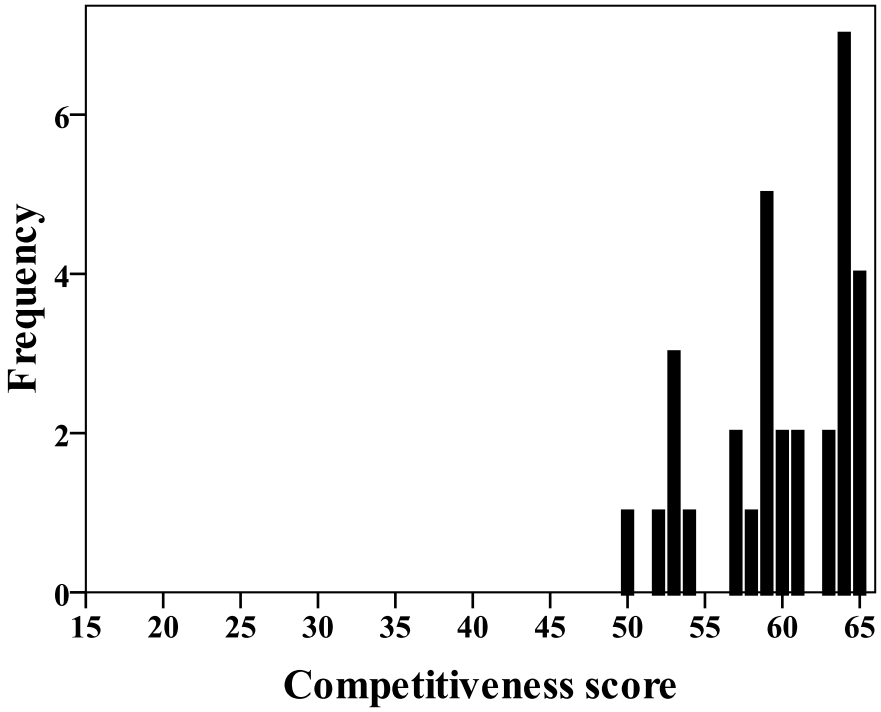
VO_2max and lactate were included in the analyses because it might be associated with competitiveness. At the top level in sports the goal is to win. To win and become better than the rest athletes have to train and be in a better physical condition than their competitors. VO_2max and lactate are both well known measures expressing how good a shape someone is in and is widely used endurance in sports (as both soccer and cross country skiing are). As seen from the questions in SOQ competitiveness as well as the definition of competitiveness it has a lot to do with wanting to be the best and pushing yourself (Appendix 1). Since both VO_2max and lactate is a measure of how well trained an individual is it could give information about how competitive they were. Being at the highest possible lactate and VO_2max hurts, therefore we hypothesised that the more competitive individuals, those who want it the most, will also be the most competitive.

3. RESULTS

3.1 Competitiveness scores

Figure 2 shows the distribution of participants competitiveness score. As seen in the Figure 2 there were no major differences in competitiveness in our sample. The possible score ranged from 13 to 65, but in our sample all participants scored in the upper third of the competitiveness scale.

Figure 2. Distribution of the competitiveness score



3.2 Participant characteristics

The average BMI for all participants combined was 21.7 ± 1.7 kg/m^2, the cross country skiers did in average have a lower BMI (20.5 ± 1.0 kg/m^2) compared to the soccer players (22.2 ± 1.8 kg/m^2). The difference between the two groups was significant (t = 2.69, p <.05). The cross country skiers also ended up with a significantly lower lactate with an average of 9.9 ± 1.7 mmol/L compared to the soccer players 11.5 ± 1.7 mmol/L(t = 2.32 p <.05). For the two groups combined the average lactate was 11.1 ± 1.9 mmol/L. For the entire group VO_2max was measured to 54.3 ± 6.9 mL × min^{-1} × kg^{-1}, while the soccer players had an average of 52.8 ± 6.8 mL × min^{-1} × kg^{-1} and cross country skiers 57.8 ± 6.4 mL × min^{-1} × kg^{-1}. (t = -1.88, p 0.070).

For DHEAS the values were 4.2 ± 1.6 μmol/L for the whole group, for the soccer players 4.4 ± 1.7 μmol/L and 3.5 ± 1.1 μmol/L for the cross country skiers. For androstendione the group average was 9.6 ± 2.9 nmol/L, the average was 9.9 ± 2.9 nmol/L for the soccer players and 8.8 ± 2.9 nmol/L for the cross country skiers. The FTI group average

was .148 ± .109, .166 ± .120 was the soccer players average and .104 ± .059 was the cross country skiers average. An overview is given in Table 1.

Table 1. Participant characteristics.

	All participants* (N = 31)	Soccer* (n = 22)	Cross country skiing* (n = 9)	P value**
Age (years)	22.6 ± 3.6	22.6 ± 4.0	22.7 ± 3.0	.935
BMI (kg/m^2)	21.7 ± 1.7	22.2 ± 1.8	20.5 ± 1.0	.012***
Competitive index	59.9 ± 4.5	59.7 ± 4.1	60.6 ± 5.5	.631
VO_2max ($mL \times min^{-1} \times kg^{-1}$)	54.3 ± 6.9	52.8 ± 6.8	57.8 ± 6.4	.070
Lactate (mmol/L)	11.1 ± 1.9	11.5 ± 1.7	9.9 ± 1.7	.028***
DHEAS (μmol/L)	4.2 ± 1.6	4.4 ± 1.7	3.5 ± 1.1	.164
Androstenedione (nmol/L)	9.6 ± 2.9	9.9 ± 2.9	8.8 ± 2.9	.375
FTI	.148 ± .109	.166 ± .120	.104 ± .059	.150

*Values are given as mean ± *SD*.

***P* value for *t* test for independent samples for difference between skiers and soccer players.

*** p <.05

3.3 Regression analyses

In a multivariate linear regression model controlling for age, BMI, sports category, VO_2max and DHEAS, FTI, androstenedione and lactate were found to be significantly associated with

competitiveness. The model explained almost 25 % of the variation in competitiveness with an adjusted R squared of .232 (*SE* 3.938).

As seen in Table 2 androstenedione and lactate associate positively with competitiveness which is in accordance with our hypothesis. This means that women with the higher androstenedione levels and women that were able to go on exercising until they reached the higher lactate levels also were the women who scored the highest on the competitiveness scale. However, FTI has a significant negative correlation meaning that women with the higher FTI values were the least competitive ones.

Table 2. Multivariate linear regression analyses of hormones and competitiveness.

	Standardized Coefficients Beta	*t*	*P* value
(Constant)		1.207	.240
Age (years)	-.021	-.124	.903
BMI (kg/m^2)	-.063	-.338	.738
VO_2max ($ml \times min^{-1} \times kg^{-1}$)	.553	1.953	.064
Lactate (mmol/L)	.520	2.702	.013*
Sports category (Soccer = 1, Cross country skiing = 2)	-.232	-.807	.428
Androstenedione (nmol/L)	.675	2.539	.019*
FTI	-.626	-2.178	.040*
DHEAS (μmol/L)	-.012	-.052	.959

Dependent Variable: Competitiveness

* $p < .05$

4. DISCUSSION

To the best of our knowledge this is the first study investigating the possible association between competitiveness and androgens in females. In a multivariate regression analyses in a group of female soccer and cross country skiing athletes we found that competitiveness was positively associated to androstenedione levels (p = .019) and maximum lactate levels achieved during an exercise test (p = .013), and negatively with associated with FTI (p = .040). The positive association between androstenedione and competitiveness was as anticipated. Androstenedione is a weak androgen; it binds less well than testosterone to the androgen receptor. However, when united with the receptor the cellular effects are as for testosterone. Perhaps more importantly, both DHEAS and androstenedione can be converted to testosterone within the cell. The newly converted testosterone may bind to the androgen receptor without being traceable in samples from circulating blood (Labrie, 2004).

The negative correlation between FTI, a measure of free biologically active testosterone, and competitiveness was unexpected. A possible explanation could be that testosterone may exert its effects by binding to other receptors than the known androgen receptors, or have non-receptor mediated effects. One other possibility is that it is not testosterone itself, that exert the effects, but its metabolites.

4.1 Competitiveness and physical performance

Lactate levels associated positively to competitiveness (p <. 05) as anticipated. We included lactate levels in the multivariate regression analyses because of the suspicion that it would be associated to competitiveness. We hypothesised that he most competitive individuals are more likely to have pushed themselves harder during all exercise and training for years and in every type of competition, both against themselves as well as against others. Accumulation of lactate in the blood stream during physical activity is a sign that the individual is pushing itself. High-intensity exercise gives an accumulation of lactic acid within the muscles being used. This causes a lowering in the muscles pH and onset of muscle fatigue and muscle pain (Hoffman, 2002). Training that stresses the anaerobe energy systems, like sprinting etc. improves the buffering capacity within the muscles and improves the muscles ability to

tolerate high concentrations of lactic acid. Individuals that are more competitive and therefore views every training session as a competition giving it their all will have higher intensity in training and therefore increase the amount of lactate the muscle can handle before the onset of fatigue.

In addition, they probably train their tolerance to pain during exercise. Because of that they can handle higher lactate levels than less competitive individuals who do not have the will and competitive instinct to keep on working when the muscles are fatigued. Our findings are in line with the observation of Martin et al. (1994) who investigated competitiveness, using the SOQ, and personal best times for distance runners and found a positive correlation. Individuals with the faster personal best times scored highest on competitiveness indicating that the fastest runners were indeed more competitive than the slower runners in the study by Martin et al. (1994).

Our results are also in line with Rickenlund et al. (2003) who found that among female athletes a subgroup of girls with the highest androgen levels (total and free testosterone, androstendione, LH-FSH ratio) also had the highest VO_2max values and the highest general performance values. Accordingly, our findings of a positive association between competitiveness and lactate and androstenedione levels are in line with the results from the Rickenlund et al (2003) study. However, in our study VO_2max which is another measure of performance did not show a significant correlation with competitiveness. Though, it should be noted that there was a borderline positive association also between competitiveness and VO_2max which further support the view that competitiveness is an important factor driving the female athletes towards performance and victory in competitions and it supports the rationale for studying the possible association between competitiveness and androgen levels in females.

The borderline association between VO_2max and competitiveness makes it difficult to draw conclusions. The borderline significance may be due to a small sample, but it may also be of other reasons. Some individuals have better physical predisposition for achieving high VO_2max values than others. There are mainly two types of muscle fibres, slow-twitch fibres and fast-twitch fibres. The slow-twitch fibres are better for endurance performance since that is their primary responsibility while the fast-twitch fibres are better for performing rapid

movements (Fredberg, 2006). In other words, individuals with more slow-twitch fibres have better chances at achieving a high VO_2max and thereby success in their sport activity. As mentioned in the introduction behaviour and success may affect androgen levels (Booth et al, 1989; Carney, Cuddy and Yap, 2010; Mazur et al., 1997). With that in mind, in later studies it might be vice to use lactate as a test of how far the athletes can push themselves and not VO_2max.

4.2 Competitiveness and hormones

The negative association between competitiveness and biological testosterone activity measured as FTI was contrary to our hypothesis and very surprising. Why one androgenic hormone, i.e. androstenedione show a positive correlation and FTI a negative correlation with competitiveness is hard to explain. Especially since all androgens bind to the androgen receptor to exert their biological effects. One possible explanation may be that androgens might exert effects by binding to other receptors or have non-receptor mediated effects. Another possibility is that it is not the hormones themselves, androstenedione or testosterone, which exerts the effects, but perhaps their metabolites (Edinger & Frye, 2007). Actually, in rats the testosterone metabolite androstanediol exerts effects on mating behaviour (Sánchez Montoya, Hernández, Barreto-Estrada, Ortiz & Jorge, 2010). Noteworthy, in the present study we performed precipitation procedures before testosterone and androstenedione analyses to avoid co-estimation of androgen metabolites.

In women estrogens have been associated with drive and competition. Buser (2009) found that females were less competitive when oestrogen and progesterone levels were especially high due to birth control medication or natural differences. When the female sex hormones oestrogen and/or progesterone were low Buser found females to be more competitive and act more similar to males compared to when the concentration of oestrogen and/or progesterone were high. Buser found progesterone to have a negative impact on females' competitiveness. He concluded that endocrine factors, and sex hormones in particular, seem to play an important role in explaining the gender difference in

competitiveness. Interestingly, in animal models androgen metabolites seems to interact with cerebral oestrogen receptors to exert their cerebral effects (Edinger & Frye, 2007).

As mentioned in the introduction a substantial part of female athletes have PCOS (Fredberg, 2006; Hagmar et al., 2009; Rickenlund et al. 2003). Women with PCOS have increased androgen levels while oestrogen levels tend to be decreased. Accordingly, in female athletes elevated FTI may be a marker of low oestrogen levels. Then the inverse association between competitiveness and FTI may actually depend on low oestrogen levels and a possible biological oestrogen effect on competitiveness and not an effect of testosterone *per see*. This is in line with previous data showing that power motivation in females are positively correlated to oestradiol, the major female sex hormone, while in males power motivation is related to testosterone, the major male sex hormone (Schultheiss et al., 2003; Schultheiss et al., 2005; Stanton & Schultheiss, 2007; Stanton & Edelstein, 2009). However, Wood and Stanton (2012) stated that it is likely that high testosterone individuals of both sexes may be more motivated to pursue athletic competition and sports than normal or low testosterone individuals.

4.3 Competitiveness, age and body mass index

Age was included in the analyses because hormone levels change with age. Since the hypotheses was that hormones plays an important role in determining competitiveness controlling for factors associated with hormone levels was important (Dorgan et al., 1995). Controlling for body mass index (BMI) was done for the same reason.

Martin et al. (1994) examined the relationship between competitiveness and age in distance runners between the age of 10-61 (58 male, 22 female). They found that competitiveness and age was negatively related meaning that competitiveness declined with age. On the contrary Cashdan (1998) did not find an age related difference in competitiveness in women, but did so in men. In men competitiveness declined with age, like Martin et al. (1994) also found. However, as seen in Table 2 we did not find an association between age and competitiveness in our study. This goes against Martin et al. (1994) but is in support of Cashdan (1998). One explanation to why we did not find a correlation between age and

competitiveness may be the relative narrow age span. Even if the age of the participants ranged from 18 to 34 years the mean of all participants age was 22.6 ± 3.6 years (*Mdn* = 21) (see Table 1). However, as seen in Figure 1, around one third of the participants were at the age of 21 and only four participants were between 27 and 34 years of age. A wider age span and more equal age distribution among the athletes might have given different results.

Another possible explanation for the fact that Martin et al. (1994) found age differences in competitiveness and we did not could be that Martin et al. did not control for BMI, lactate, VO_2max like it was done in the present study. It is also possible that only the most competitive females' keeps competing at the highest level for years while the less competitive ones retire as athletes at an earlier age. In this way the average competitiveness of active female top athletes would not decline with increasing age of the active participants even when the competitiveness of each individual athlete decline with age. However, our results of no age/competitiveness correlation are supported by Cashdan (1998).

BMI and competitiveness are not correlated as seen in Table 2. It was still important to use in the analysis since it has been reported that women's hormone levels change with BMI (Ecochard et al., 2000). In future studies it may be wise to adjust for BMI or perhaps even better the subjects' body composition as muscle is metabolically more active compared to fat tissue.

4.4 A weakness in the competitiveness score?

As mentioned earlier both Mazur and Booth (1998) and Archer (1991) agree upon the fact that studies using self-assessed aggressive predispositions and traits may be of limited relevance and the focus should be more towards concrete indicators of behaviour. If that is true for aggression, it could also be the case for other self-assessed predispositions and traits like for example competitiveness. On the other hand, competitiveness may be considered a more acceptable trait than aggressiveness. If so, one might expect that self-rated competitiveness should be more reliable than self-rated aggression.

All the participants included in this study were athletes on a top level. Some of them may think of them themselves as more competitive than they really are, or maybe even feel

that they should be more competitive and answer accordingly. It might be that if we could have asked their trainers or peers to evaluate the team members' competitiveness the outcome would have been different (Archer, 1991; Mazur & Booth, 1998). In her study, Cashdan (1995) also found that self-rated and peer-rated levels of status differed from one and other. High self-rated status was positively correlated with testosterone. It cannot be excluded that the same could be the case for competitiveness, and that the SOQ score gives a wrong image of competitiveness in our group.

4.5 Individual versus team sport

The fact that most of the participants were soccer players might influence our results. Besides being a competitive sport it is soccer is also a team sport. Previously it has been shown that the correlation between testosterone and performance differs for tasks that are performed alone and tasks performed in pairs (Mehta et al, 2009). Mehta et al. found that testosterone had a positive effect on performance in individual competition, as cross country skiing is, and a negative effect on performance when being forced to cooperate with others as is done (or at least should be done) in team sports as soccer. For soccer players team competence is important and may be more important than being ultimately competitive. The most competitive individuals might find it unsatisfying to work according to a team plan and turn to another sport. However, as seen in Table 1 we found no difference in competitiveness between soccer players and cross country skiers.

4.6 Focus on females

Most competitiveness research has been conducted on male athletes and to a large extent applied to both sexes, this it is not optimal. Males and females are biologically different and everything from training plans, competition strategies and meal plans should probably be adjusted according to gender. By taking a closer look at female competitiveness and what drives women to be competitive we can also hopefully better understand what drives them in other domains. This is important not only in a sports setting, but also in several other life

aspects. Understanding how, why and when females act and react different from men is key to help female athletes to improve their performance. It would be helpful for the trainers in their coaching of athletes as well as improving our understanding of gender differences in general. It might improve our general understanding of female athletes and possibly make us aware of what can be done to make female athletes stay in sports for a longer part of their life.

Acknowledging the sex difference in cognition is also important to more than just athletes and how to accomplish the best performance. So many things in life are built on competition. Everything from early childhood play to getting the dream job and being better than the rest is a lifelong competition.

4.7 Strengths and weaknesses of the study

One strength of this study is that competitiveness was measured with a questionnaire and factors that could influence competitiveness were added in the regression analyses. According to our view adjustment for factors that might affect hormone levels might be essential when assessing the possible association between hormone levels and psychological traits in females. In the present study competitiveness, hormones and physical measures are combined to create an overview of the factors that might affect competitiveness. Another major strength of our study is that the hormones were measured in blood samples and analysed in doubles which decreases measurement inaccuracy. In many other studies with testosterone as a factor the testosterone is sampled from the participants' saliva. It is easier to do, but not as accurate. According to Granger et al. (2004) estimating total or free testosterone in the blood stream based on saliva levels has low accuracy for males, and even lower for females. They found the correlation between free testosterone and saliva testosterone in females to be poor (r = .37). Broadbent (2002) reports the same findings. An important aspect of our study is also the precipitation procedure to eliminate androgen metabolites before androgen analyses.

The fact that the participants only represent two different sports, cross country skiing and soccer, and that both sports depend on high capacity in endurance and power, is also an

advantage. This makes the study group more homogenous while still having both an individual and a team sport represented.

A weakness of the study is the low number of participants and the somewhat skewed relationship between the two sports with 9 cross country skiers and 22 soccer players. With a larger number of participants VO_2max could have become significantly related to competitiveness provided that the trend seen in our data was not coincidental.

Another weakness may be the number of questionnaires for the participants to fill out. All in all the participants answered 7 questionnaires after one another. The SOQ was the 5th questionnaire to be answered. The participants may have been tired when answering the SOQ considering that some of the questionnaires before were quite extensive.

Another weakness of the study is that estrogens were not measured. Studies indicate that estrogens might influence competitiveness in women (Buser, 2009).

5. CONCLUTION

When adjusting for age, BMI, VO_2max, lactate and sports category, we found that androstendione correlated positively and FTI negatively to competitiveness as measured by the sports orientation questionnaire. Why one androgen correlates positively to competitiveness while another correlates negatively is hard to explain, but one possible explanation is that androgens might have non-receptor mediated effects or exert their effect by binding to other receptors. Another possibility is that it is the androgen metabolites, and not the hormones, androstenedione or testosterone that exerts the effects.

It might also be that we have been looking at the wrong hormones. Research has indicated that oestrogen and progesterone may influence competitiveness. When female hormone concentrations were low females' behaviour has been more like men's behaviour and the females were more competitive. A support for that theory might be the link between PCOS and top athletes. PCOS causes decreased oestrogen and increased androgens. Maybe research has focused on the wrong hormones, the androgens, while estrogens might possibly be more important in female athletes.

It has previously been found that competitiveness declines with age. In this study however, no correlation between age and competitiveness was found.

Lactate levels were associated with competitiveness. The most likely explanation being that the most competitive individuals are the individuals pushing themselves the hardest before they give up in any sport setting. As a result their metabolism would be more used to handling lactate and endure higher levels before having to slow down.

As seen through the literature referred in this paper more focus is needed on the possible association, or even the possible cause and effect relationship between competitiveness and sex hormones, in particular in females. Studies combining competitiveness measured by different instruments and both androgens and estrogens measurements would help us understand the complex interaction between hormone effects and competitiveness. In women, taking a closer look at oestrogen and competitiveness has been suggested by several researchers and is needed as it may seem like the two are closely linked together.

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APPENDIX I

Initialer: ☐☐☐ Studiedeltager nr. ☐☐☐

The Female Competitiveness Study:

SPORT ORIENTATION QUESTIONNAIRE (SOQ)

De følgende utsagnene beskriver reaksjoner på idrettssituasjoner. Vi vil vite hva du vanligvis føler angående idrett og konkurranse. Les hvert utsagn og kryss av i boksen som indikerer hvor enig eller uenig du er med utsagnet på skalaen: a, b, c, d eller e. Det er ingen riktige eller gale svar, bare svar ærlig det du føler. Ikke bruk for lang tid på noen av utsagnene. Husk å svare det du vanligvis føler.

	A Veldig enig	B Litt enig	C Verken enig eller uenig	D Litt uenig	E Veldig uenig
1. Jeg er en bestemt konkurrent.	☐	☐	☐	☐	☐
2. Jeg er en konkurrerende person.	☐	☐	☐	☐	☐
3. Jeg prøver på det hardeste å vinne.	☐	☐	☐	☐	☐
4. Jeg ser frem til å konkurrere.	☐	☐	☐	☐	☐
5. Jeg liker å konkurrere mot andre.	☐	☐	☐	☐	☐
6. Jeg vokser på konkurranse.	☐	☐	☐	☐	☐
7. Målet mitt er å være den best mulige atleten.	☐	☐	☐	☐	☐
8. Jeg vil være suksessfull i sport.	☐	☐	☐	☐	☐
9. Jeg jobber hardt for å bli suksessfull i sport.	☐	☐	☐	☐	☐
10. Den beste testen på mine evner er konkurranse mot andre.	☐	☐	☐	☐	☐
11. Jeg ser frem til muligheten til å teste mine ferdigheter i konkurranse.	☐	☐	☐	☐	☐
12. Jeg presterer mitt beste når jeg konkurrerer mot en motstander.	☐	☐	☐	☐	☐
13. Jeg vil være den beste hver gang jeg konkurrerer.	☐	☐	☐	☐	☐

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APPENDIX II

Forespørsel om deltagelse i forskningsprosjekt:

"The Female Competitiveness Study" – er det sammenheng mellom hormonnivåer og konkurranseinstinkt hos kvinnelige toppidrettsutøvere?

Bakgrunn og hensikt

Toppidrettsutøvere presser sin fysiske og psykiske kapasitet til det ytterste. De fysiske og psykiske aspektene og sammenhengen med hormonnivåer har vært studert tidligere, spesielt hos menn. Sammenhengen mellom hormonnivåer, fysisk kapasitet og mentale faktorer hos kvinner er derimot lite studert.

Nivået av androgene hormoner (hormoner med testosteronvirkning) og spesielt testosteron er noe forhøyet hos kvinner med polycystisk ovarialsyndrom (PCOS). Kvinner med PCOS utgjør 10-15 % av kvinner i fruktbar alder, de synes å ha høyere konkurranseinstinkt og delta mer i idrett enn kvinner uten PCOS. Det synes også å være en svak sammenheng mellom PCOS, humørsvingninger og spiseadferd. Vi tror mye av dette kan ha sammenheng med de noe økte nivåene av hormoner med testosteronvirkning og at kvinner med økte testosteronnivå i spesiell grad trekkes mot idrett generelt og toppidrett spesielt.

Vi henvender oss til deg fordi du er en kvinnelig toppidrettsutøver for å be om ditt samtykke til deltakelse i dette forskningsprosjektet. Formålet med studien er å få økt kunnskap om sammenhengen mellom hormonnivåer hos kvinnelige toppidrettsutøvere og konkurranseinstinkt, muskelmasse, fysisk kapasitet, beintetthet, mentale forhold inkludert seksuell orientering og forekomsten av PCOS. Studien er et samarbeidsprosjekt mellom Avdeling for endokrinologi, St. Olavs hospital, Institutt for Bevegelsesvitenskap og Psykologisk Institutt, Norges teknisk- naturvitenskaplige universitet (NTNU) og Olympiatoppen Midt-Norge. Denne forespørselen går til toppidrettskvinner mellom 18 og 40.

Hva innebærer deltagelse i studien?

Den enkelte deltager vil få utført en DEXA-scan og taking av fastende blodprøve ved Avdeling for endokrinologi, St. Olavs hospital. Ved DEXA-scan ligger man stille i truse på ryggen i 10 minutter og det hele er helt smertefritt. Ved denne undersøkelsen bestemmes fettmasse, muskelmasse, beinmasse og beintetthet. I tillegg besvares spørreskjema om konkurranseinstinkt, spenningssøking, spiseadferd, mental helse og seksuell orientering. Vi

vil også registrere resultatene fra fysiske tester (VO_2 max, laktat, maksimal muskelkraft ved spensthopp og benkpress). Medisinbruk, spesielt hormonpreparater (p-pille, p-stav, p-sprøyte, hormonspiral etc.) vil bli registrert.

I tillegg håper vi å kunne tilby en gynekologisk undersøkelse for deltagerne i studien.

Mulige fordeler og ulemper

Som deltager har du mulighet til å bidra til ny kunnskap om sammenhengen mellom forhold knyttet til idrettsprestasjoner og toppidrettskvinners helse. Deltagelse i prosjektet medfører testing og analyse av blant annet beintetthet og muskelmasse. Lav beintetthet og menstruasjonsforstyrrelser kan være et problem hos kvinner som trener mye. Dersom dette påvises kan fagpersonene i prosjektgruppen vurdere spesielle tiltak dersom du ønsker det.

Opplever du noen av spørsmålene som ubehagelige er det greit å unnlate å besvare dem. Data vil uansett ikke kunne spores tilbake til enkeltpersoner etter at de er registrert i en database. Vi har dessverre ikke anledning til å gi deltagerne økonomisk kompensasjon så deltagere i prosjektet må selv dekke eventuelle reiseutgifter.

Den fysiske testingen vil bli gjennomført etter standard prosedyrer for slik fysiologisk testing og risikoen for at noe kan skje er minimal. VO_2 max kan oppleves som anstrengende, men gi nyttig informasjon som kan brukes til videre treningsplanlegging. Prestasjonstester vil også være standard og gjennomføres i tråd med trening du som utøver gjennomfører til daglig. Den eneste reelle forskjellen fra den daglige trening og testing er at dataene fra testene vil bli systematisert og lagret for brukt i prosjektet.

Viktig! Dine forberedelser

Blodprøvene vil bli tatt om morgenen, og du må faste 8 timer (dvs. fra midnatt) i forkant (inkludert røyk/snus-avhold). Dersom du er veldig tørst kan du evt. drikke et halvt glass vann morgenen før prøvene tas.

Hva skjer med testene og informasjonen om deg?

Dine resultater fra undersøkelsene vil bli behandlet i ikke identifiserbar form, dvs. uten navn, fødselsnummer eller andre identifiserende opplysninger. En kode knytter deg til dine opplysninger og prøver, gjennom en navneliste. Denne koden oppbevares uavhengig av selve databasen med alle opplysningene fra studien. Det er kun autorisert helsepersonell knyttet til prosjektet som har adgang til navnelisten og som eventuelt kan finne tilbake til deg. Det vil

ikke være mulig å identifisere deg i resultatene av studien når disse publiseres. Når prosjektet er avsluttet vil også koden som knytter deg til enkeltdata i databasen slettes.

Dersom du ønsker det kan vi gi deg tilbakemelding på testresultatene (som for eksempel kroppssammensetning, VO_2 max, styrketestene, og evt. gynekologisk undersøkelse). Vi kan eventuelt også informere om eventuelle andre helseproblemer vi måtte påvise ved de undersøkelsene du gjennomgår. Dette vil foregå ved studiemedarbeiderne (kroppssammensetning, VO_2 max, styrketestene) eller lege (gynekologisk undersøkelse, beintetthet, evt. andre forhold). Olympiatoppen, trenere eller andre vil ikke på noe tidspunkt få tilgang til informasjon om enkeltpersoner utover resultater fra de fysiske testene Olympiatoppen får tilgang på slik de gjør ved tilsvarende rutinetesting av utøvere.

Studien er vurdert og godkjent av Regional komité for medisinsk forskningsetikk, Midt-Norge og vil bli gjennomført etter de regler og retningslinjer som er nedfelt i Helsinkideklarasjonen. Når studien er avsluttet vil resultatene bli publisert i et engelskspråklig internasjonalt medisinsk tidsskrift.

Frivillig deltakelse

Studien er frivillig, du kan på hvilken som helst tidspunkt trekke deg uten nærmere begrunnelse eller uten at det får noen negative konsekvenser for deg. Dette gjelder selvfølgelig også videre oppfølging fra Olympiatoppen. Dersom du trekker deg fra studien har du rett til innsyn i data registrert om deg. Du kan også trekke tilbake samtykket. Da vil alle innsamlede opplysninger om deg bli slettet og frosne blodprøver vil bli destruert med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskaplige publikasjoner.

Vi ber også om tillatelse til eventuelt å kontakte deg senere for oppfølgning. Dette er kun en forespørsel om vi får lov å ta kontakt med deg senere og ikke noe løfte fra deg om at du vil stille opp. Dette er ingen forutsetning for å delta i studien. Hvis du samtykker i å delta i studien må du undertegne en samtykkeerklæring lik den som er vedlagt før du deltar. Personopplysninger som knytter deg til data vil bli oppbevart til utgangen av 2014 og deretter slettet.

Personvern

Opplysninger som registreres om deg er:

Helseopplysninger som du selv gir oss

Opplysninger om din aktuelle medisinbruk

Resultater av blodprøveanalyser som tas

Opplysninger om de tester og undersøkelser du gjennomgår

Svar på de spørreskjema du besvarer

Enkle kliniske data (høyde, vekt, blodtrykk etc.)

Opplysningene legges inn i en database ved Enhet for anvendt klinisk forskning, NTNU i avidentifisert form, dvs. ikke med ditt navn eller fødselsnummer men kun med ditt deltagernummer.

Alt personell som er involvert i studien og behandlingen av innsamlede data har taushetsplikt.

Representanter for kontrollmyndigheter kan få utlevert studieopplysninger og gis innsyn i relevante deler av din journal. Dette er lovpålagt. Formålet er å kontrollere at studieopplysningene stemmer overens med tilsvarende opplysninger i din journal. Alle som får innsyn i informasjon om deg har taushetsplikt.

Forskningsbiobank

Blodprøvene som blir tatt og informasjonen utledet av dette materialet vil bli lagret i en forskningsbiobank som professor Sven M. Carlsen er ansvarlig for. De vil bli lagret i ikke personidentifiserbar stand, dvs. bare identifisert med deltagernummer.

Utlevering av materiale og opplysninger til andre

Hvis du sier ja til å delta i studien, gir du også ditt samtykke til at prøver og avidentifiserte opplysninger kan utleveres til våre samarbeidspartnere i forskning.

Innsynsrett og oppbevaring av materiale

Hvis du sier ja til å delta i studien, har du rett til å få innsyn i hvilke opplysninger som er registrert om deg. Du har videre rett til å få korrigert eventuelle feil i de opplysningene vi har registrert. Dersom du trekker deg fra studien, vil det ikke samles inn flere opplysninger eller mer materiale. Opplysninger som allerede er innsamlet fra deg vil ikke bli slettet.

Finansiering

Studien og biobanken er søkt finansiert av forskningsmidler fra Olympiatoppen og forskningsmidler som professor Sven M. Carlsen har innestående ved Unimed Innovation.

Sponsor (ansvarlig myndighet for studien) er Institutt for kreftforskning og molekylærmedisin, NTNU.

Forsikring

Du er forsikret gjennom Pasientskadeerstatningsordningen.

Med vennlig hilsen

_____

Sven M. Carlsen

Professor dr. med. Prosjektleder

Prosjektledelse:

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APPENDIX III

SAMTYKKEERKLÆRING

For deltakeren:
Jeg bekrefter med dette at jeg har fått den informasjon jeg ønsker om og er villig til å delta i ***"The Female Competitiveness Study"***. Jeg vet at jeg uten nærmere begrunnelse kan trekke med fra studien på et hvert tidspunkt dersom jeg skulle ønske det uten at det vil ha konsekvenser for meg. Jeg er klar over at de innsamlede data brukes utelukkende til forskning og eventuell egen nytte ved økt kunnskap om meg selv.

Jeg samtykker i å delta i prosjektet som innebærer følgende:

- Testing av fysisk kapasitet (maksimal muskelkraft og VO_2max)
- Dexa-scan av kroppssammensetning
- Blodprøvetaking for hormonanalyser
- Spørreskjema angående konkurranseinstinkt, spenningssøking, spisevaner, mental helse og seksuell orientering
- Gynekologisk undersøkelse (ingen betingelse for å delta i resten av studien)
- Enkel klinisk undersøkelse (høyde, vekt, blodtrykk etc.)
- Fotokopi av hendene

Dersom du godkjenner at vi kontakter deg for eventuell oppfølgende forskning på et senere tidspunkt, vennligst kryss av her: ☐

Dersom du ønsker å bli kontaktet dersom blodprøver eller andre av undersøkelsene gir mistanke om spesielle medisinske problemer hos deg, vennligst kryss av her: ☐

Sted:_____ Dato:___/___- 2011

Navn:_____
(Deltakers fulle navn med BLOKKBOKSTAVER)

_____
Deltagers underskrift

Jeg bekrefter med dette at deltageren har fått muntlig og skriftlig informasjon om studien, har fått svar på de muntlige spørsmål hun hadde og har underskrevet på denne deltagerformasjonen:

Sted: _____ Dato:___/___- 2011

Studiemedarbeider: _____

Ansvarlige lege for undersøkelsen:
Sven M. Carlsen, Professor, Enhet for anvendt klinisk forskning, NTNU
Overlege, Avdeling for endokrinologi, St. Olavs hospital