UiA Universitetet i Agder

Disordered Eating in Adolescent Elite Athletes and Non-athletes

Prevalence, longitudinal development and association with body composition, health parameters and diet

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Contents

ABBRIVATIONS

BEDA-Q	The Brief Eating Disorder in Athletes Questionnaire
BMD	Bone mineral density (g/cm^2)
BMI	Body mass index [weight (kg) divided by height squared (m^2)]
DALY	Disability-adjusted life years
DE	Disordered eating
DLS	The Drive for Leanness Scale
DSM	The Diagnostic and Statistical Manual of Mental Disorders
DXA	Dual-energy x-ray absorptiometry
EA	Energy availability
ED	Eating disorder
EDE	The Eating Disorder Examination
EDE-Q	The Eating Disorder Examination Questionnaire
FFM	Fat-free mass
HR	Heart rate
IOC	The International Olympic Committee
Kcal	Kilo calorie
L1-L4	Lumbar vertebrae 1 to 4
LEA	Low energy availability
M1-M3	Measuring point 1 to 3
RED-S	Relative energy deficiency in sport
RMR	Resting metabolic rate
RMR_{ratio}	The ratio between measured and predicted RMR
SD	Standard deviation
Triad	The female athlete triad
VO_{2max}	Maximal oxygen uptake (L·min-1 or mL·kg-1 ·min-1)

ABSTRACT

INTRODUCTION: Adolescence is a vulnerable time for developing disordered eating. The literature is inconclusive on whether adolescent athletes present higher or lower prevalence of disordered eating compared to adolescent non-athletes. The purpose of the master thesis was to examine the prevalence of disordered eating among adolescent elite athletes and age-matched controls, and to assess the one-year development of disordered eating among the athletes. Furthermore, associations between disordered eating and body composition, dietary intakes and health parameters related to relative energy deficiency in sport (RED-S) were examined.

METHODS: A total of 36 athletes from endurance and ball-game sports, and 16 controls participated in the study. Disordered eating was assessed by the Eating Disorder Examination Questionnaire (EDE-Q), the Brief Eating Disorder in Athletes Questionnaire (BEDA-Q), and the Drive for Leanness Scale (DLS). Dietary information was self-reported and obtained from semi-structured interviews. Body composition, bone mineral density and resting metabolic rate were obtained objectively through DXA scans and indirect calorimetry.

RESULTS: The degree of disordered eating was greater in non-athletes. Correlation analyses showed associations between disordered eating and higher body mass, lower amount fat-free mass, and lower dietary intakes in both groups. Longitudinal data found consistent levels of disordered eating among the athletes during a year.

CONCLUSION: Self-reported disordered eating was more prevalent in adolescent non-athletes compared to adolescent elite athletes, and appeared in association with higher body mass and lower self-reported dietary intakes. The prevalence of DE among adolescent athletes did not significantly change through one year of high school.

KEYWORDS: Disordered eating, Adolescent athletes, Relative energy deficiency in sport, Athlete health

SAMMENDRAG

INTRODUKSJON: Under ungdomstiden er man sårbar for å utvikle forstyrret spiseatferd. Det er uklart om unge idrettsutøvere er mer eller mindre utsatt for forstyrret spiseatferd sammenlignet med unge ikke-utøvere. Hensikten med denne masteroppgaven var å undersøke forekomsten av forstyrret spiseatferd i unge elite utøvere og ikke-utøvere, og undersøke om forekomsten forandret seg hos utøverne i løpet av et år. I tillegg ble det sett på assosiasjoner mellom forstyrret spiseatferd og kroppssammensetning, kosthold, og helseparametere relatert til relativ energimangel i sport.

METODE: Totalt deltok 36 utøvere og 16 kontroller i studien. Forstyrret spiseatferd ble undersøkt gjennom spørreskjemaene «Eating Disorder Examination Questionnaire» (EDE-Q), «Brief Eating Disorder in Athletes Questionnaire» (BEDA-Q), og «Drive for Leanness Scale» (DLS). Kostholdsinformasjon ble innhentet gjennom et kostintervju. Kroppssammensetning, beinmineraltetthet og hvilemetabolisme ble objektivt målt gjennom DXA og indirekte kalorimetri.

RESULTATER: Kontrollene viste høyere grad av forstyrret spiseatferd. Korrelasjonsanalyser viste assosiasjoner mellom forstyrret spiseatferd og høyere kroppsmasse, lavere fettfri masse og lavere næringsinntak i begge gruppene. Longitudinelle data viste ingen signifikant endring i grad av forstyrret spiseatferd over et år hos utøverne.

KONKLUSJON: Selvrapportert forstyrret spiseatferd forekom oftere hos unge ikke-utøvere sammenlignet med unge elite utøvere, og var assosiert med høyere kroppsmasse og lavere selvrapportert næringsinntak. Forekomsten blant unge utøvere viste ingen signifikant forandring i løpet av et år.

NØKKELORD: Forstyrret spiseatferd, unge idrettsutøvere, relative energimangel i sport, idrettshelse

Part 1:

Introduction, theoretical background and methods, including methodical discussion

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1. Introduction

Disordered eating (DE) is a subclinical condition referring to a wide range of abnormal eating behaviors like dieting, restriction of certain foods, fasting, binging and purging, as well as body dissatisfaction and preoccupation with weight (Russell-Mayhew, 2007; Torstveit, Rosenvinge, & Sundgot-Borgen, 2008). These symptoms can also be found in patients with clinically diagnosed eating disorders (ED). What separates DE from EDs are the severity of the condition and frequency of behaviors (Shisslak, Crago, & Estes, 1995). EDs are clinical conditions diagnosed through specific criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders (DSM) (Joy, Kussman, & Nattiv, 2016). Even though a person with DE may not fulfill the criteria for an ED, DE can still be the first symptom of a more serious condition (Affenito, Dohm, Crawford, Daniels, & Striegel-Moore, 2002). DE behavior can harm physiological functions of the body, and cause psychological stress and disturbances in body image, emotions and social relations, thus, negatively impact quality of life (Nattiv et al., 2007).

There is inconsistency in the literature regarding the prevalence of DE in adolescent athletes and non-athletes, and which group is most at risk (Rice et al., 2016; Werner et al., 2013). However, in youth populations, the prevalence of DE has been reported to be around 20-26% in females and 7-15% in males (Fortes, Kakeshita, Almeida, Gomes, & Ferreira, 2014; Yannakoulia et al., 2004). Western countries have the highest prevalence of EDs, and the highest number of Disability-Adjusted Life Years (DALY) from EDs per 100 000 of the population (Hoek, 2016). Out of all psychiatric disorders, EDs have the most impact on the disease burden (Moessner & Bauer, 2017). In Norway, the prevalence of DE has been found to be approximately 20% in adolescent endurance athletes, and 55% in adolescent non-athletes (Pettersen, Hernaes, & Skarderud, 2016; Torstveit, Aagedal-Mortensen, & Stea, 2015). There are several mediating factors describing the mechanisms involved in the development of DE. Risk factors may include social pressure, perceived beauty standards and body ideals, body dissatisfaction, low self-esteem and dieting (Francisco, Narciso, & Alarcão, 2013). Body dissatisfaction (i.e. negative thoughts about one's body including weight and shape) can lead to unhealthy weight-loss methods (Goltz, Stenzel, & Schneider, 2013), and are often facilitated by unattainable and unhealthy beauty standards (Robinson et al., 2017). Unhealthy weight-loss methods like vomiting, dehydration, laxatives, diuretics, and extreme energy restrictions can cause serious negative consequences for health and overall quality of life (Bašková, Holubčíková, & Baška, 2017; Werner et al., 2013).

Societal beauty standards and body ideals can influence body dissatisfaction and DE (Prichard, McLachlan, Lavis, & Tiggemann, 2018; Werner et al., 2013). In recent years, a new "fit" ideal has emerged alongside the still prominent thin ideal (Prichard et al., 2018). This so-called "fitspiration" is a rising movement on social media, expressed through both text and imagery, reaching a large number of adolescents every day (Prichard et al., 2018; Robinson et al., 2017). Posts often feature idealizing fitness images, promoting healthy eating, exercise, and well-being. Despite the apparently "healthy" focus, images often encourage weight loss and highlight the importance of appearance, where the lean and toned body type is predominantly pictured. Viewing photographs of thin, athletic women has been shown to increase body dissatisfaction (Prichard et al., 2018). In comparison, exposure to images of average weight women who appear athletic does not seem to result in greater body dissatisfaction, suggesting that the thinness of typical "fitspiration" significantly impacts body image (Prichard et al., 2018). A majority of screening instruments focus on the thin ideal (Wagner, Erickson, Tierney, Houston, & Welch Bacon, 2016). However, with the raising fitness trends, these tools may not discover DE and body dissatisfaction related to having more muscular and lean bodies as effectively (Smolak & Murnen, 2008), especially in males (Strother, Lemberg, Stanford, & Turberville, 2012).

DE typically manifest during adolescence, and athletes and adolescents have been referred to as the most at-risk populations for EDs, with females usually presenting more DE compared to males (Bratland-Sanda & Sundgot-Borgen, 2013; Domine, Dadoumont, & Bourguignon, 2012; Kirkcaldy, Siefen, Kandel, & Merrick, 2007). Athletes may feel pressure to lose weight in order to perform in their sport, either for aesthetic purposes, weight classes or endurance, agility and speed (Rodriguez et al., 2009). However, to the authors knowledge, few studies have investigated the longitudinal development of DE in adolescent athletes (Krentz & Warschburger, 2013). In young adult females, both attitudinal and behavioral features of ED psychopathology have been found to decrease with increasing age (Mond, Hay, Rodgers, & Owen, 2006).

Low energy availability (LEA) represents a state of mismatch between energy intake and energy expenditure, causing inadequate energy to support optimal health and bodily functions (Mountjoy et al., 2018). LEA can be present in subjects with DE due to intentional restriction of foods and/or excessive exercise, but also in athletes without DE or dietary restriction (Loucks, Kiens, & Wright, 2011). Given high training volume, athletes can have increased energy availability (EA), and restriction of energy can further impair athletic performance

(Mountjoy et al., 2018). LEA has been documented to cause the syndrome of relative energy deficiency in sport (RED-S) (Mountjoy et al., 2018). One of the measured consequences of LEA is decreased resting metabolic rate (RMR) (Melin et al., 2015). RMR is the minimum amount of energy (kcal) the body requires to maintain basic physiological functions (e.g. growth, reproduction, thermoregulation and cellular maintenance). When the body is exposed to low energy intake over time, metabolism adapts by decreasing as an attempt to conserve energy (Müller & Bosy-Westphal, 2013). Therefore, low RMR has been used as a surrogate marker for LEA (Staal, Sjödin, Fahrenholtz, Bonnesen, & Melin, 2018).

Body composition refers to the ratio between fat-free mass (FFM), mainly consisting of muscle mass, and fat mass. A higher amount of muscle mass and lower amount of fat mass has been related to increased athletic performance (Rodriguez et al., 2009), which could be a reason why athletes, especially in leanness dependent sports, have shown high levels of DE behavior and weight-loss methods (Joy et al., 2016). Low bone mineral density (BMD) has been observed in subjects with LEA (Yeager, Agostini, Nattiv, & Drinkwater, 1993), and DE (Barrack, Rauh, Barkai, & Nichols, 2008). Even though there is strong evidence that exercise benefits bone health and is a critical factor in osteoporosis prevention and treatment, low BMD appear frequently in female athletes (Lambrinoudaki & Papadimitriou, 2010). Low BMD can lead to osteoporosis and stress fractures, which may have consequences for an athletic career (Keen & Drinkwater, 1997; Lambrinoudaki & Papadimitriou, 2010).

A diet adequate in both macro- and micronutrients is important for maintaining and promoting health and physical performance (McClung, Gaffney-Stomberg, & Lee, 2014). Athletes' diets do not need to be substantially different from the general nutrition recommendations, though daily energy requirements can be considerably higher given increased exercise energy expenditure (Kreider et al., 2010; Nordic Council of Ministers, 2014; Rodriguez et al., 2009). Low energy intakes can lead to LEA and impair health and performance (figure 2 and 3). In a sample of male and female endurance athletes, estimated energy requirement was found to be 4287.2 (± 949.6) kcal/day, while measured energy intake was inadequate to cover this energy expenditure (Baranauskas et al., 2015). The need for carbohydrate and protein in athletes can also exceed the general recommendations because of increased demand to maintain glycogen- and protein synthesis within muscles (Kerksick et al., 2018). Sufficient dietary fat is crucial in order to maintain hormone balance and attain adequate amounts of fatty acids and fat-soluble vitamins (Nordic Council of Ministers, 2014; Rodriguez et al., 2009). Low fat intakes have been found as a risk factor for low lumbar spine BMD (Barron et al., 2016). In other words, having sufficient intakes of energy and macronutrients are important for both health and athletic performance, however athletes do not seem to always fulfill their energy requirement, putting them at risk for LEA and RED-S.

The present master thesis is part of a larger ongoing Ph.D. project named "*Energy availability and sports performance: Incidence and development of relative energy deficiency among young female and male athletes in southern Norway".* The purpose of the Ph.D. project is to examine RED-S, DE, laboratory-based health parameters, daily physical activity, training volume, diet, sleep, and athletic performance in elite athletes and controls. The present master thesis focuses on DE, body composition, health parameters and diet in elite adolescent athletes and controls, and is divided into two parts. The purpose of part 1 is to present a theoretical framework of DE, RED-S related health parameters, and dietary variables. This part also includes a comprehensive method chapter explaining the full test protocol, and a chapter where the methods are discussed. Part 2 consists of the research paper including results, result discussion, and conclusion. The research paper is written after standards of the "European Journal of Sport Science" (https://www.tandfonline.com/toc/tejs20/current).

1.1 Aim of the present study

The main aim of the master thesis was to investigate the degree of DE among adolescent elite athletes and controls, and study whether DE levels changed over 12 months among the athletes. Furthermore, associations between DE and body composition, RED-S related health parameters, and intakes of energy and macronutrients were explored.

Research questions

The following research questions were: Does adolescent elite athletes show higher degree of DE compared to adolescent non-athletes? Increases the level of DE among adolescent athletes during a 12 month period? Is DE associated with body mass index (BMI), fat percentage, BMD, RMR_{ratio}, and energy- and macronutrient intake?

Hypotheses

Hypothesis: Adolescent elite athletes have higher levels of DE compared to adolescent non-athletes.

Hypothesis: The level of DE increases in adolescent athletes during a 12 month period.

Hypothesis: Higher DE-score is negatively associated with BMI, fat percentage, BMD, RMR_{ratio}, and energy- and macronutrient intake.

1.2 Delimitations of the thesis

Due to the word-limitations, and guidelines for layout and setup of the master thesis, results, discussion and conclusion of the present study are only included in part 2.

Furthermore, due to limitations of space and word count, other RED-S related variables including gastrointestinal function, illnesses, injuries, athletic performance, and possible risk-factors and treatment-strategies for DE were not covered in the thesis.

2. Theoretical background

2.1 Prevalence and epidemiology of disordered eating

Norwegian female adolescent athletes have shown higher prevalence of clinical EDs compared to non-athletic peers (Martinsen & Sundgot-Borgen, 2013). However, when self-report methods are used, adolescent non-athletes report more DE behavior compared to athletes (Martinsen, Bratland-Sanda, Eriksson, & Sundgot-Borgen, 2010), causing the prevalence of DE to be similar or higher in non-athlete adolescents (Fogelholm & Hiilloskorpi, 1999; Fulkerson, Keel, Leon, & Dorr, 1999; Martinsen et al., 2010; Rosendahl, Bormann, Aschenbrenner, Aschenbrenner, & Strauss, 2009; Smolak, Murnen, & Ruble, 2000). However, a resent review concluded that athletes present higher prevalence of DE compared to non-athletes, illustrating the divergence of the literature (Joy et al., 2016).

The majority of studies on DE are conducted on female samples, mainly because females are usually more at-risk compared to males (Limbers, Cohen, & Gray, 2018; Murray et al., 2017). However, reviews have found 30-67% of adolescent males to report body dissatisfaction and/or unhealthy weight control behaviors (Limbers et al., 2018; Murray et al., 2017). Moreover, male athletes have presented DE more frequently compared to male non-athletes (Sundgot-Borgen & Torstveit, 2004; Sykora, Grilo, Wilfley, & Brownell, 1993). In view of these findings, it no longer seems reasonable to assume that DE is uncommon among males, nor that males account for only a small percentage of the health burden of EDs (Murray et al., 2017). In contrast to females, males report less shape and weight concern or drive for thinness (Murray et al., 2017). Males usually display a drive for muscularity, leanness, and a “bigger” physique (Limbers et al., 2018). This drive can lead to another collection of DE behaviors classified under muscle dysmorphic disorder, like excessive weight lifting, and use of supplements and steroid drugs.

The prevalence of DE differs between sports (Glazer, 2008; Kong & Harris, 2015; Reinking & Alexander, 2005; Sundgot-Borgen, 1993b; Sundgot-Borgen & Torstveit, 2004). The highest prevalence has been observed within leanness-sports including aesthetic-, antigravitation- and weight-class sports, followed by endurance sports, and lastly non-leanness sport like ball-game and technical sports (Glazer, 2008; Kong & Harris, 2015; Reinking & Alexander, 2005; Sundgot-Borgen, 1993b; Sundgot-Borgen & Torstveit, 2004). In Norway, the prevalence of EDs in leanness-sports has been found to be 24-42% in aesthetic sports, 24% in endurance sports and 17% in technical sports (Sundgot-Borgen, 1993b; Sundgot-Borgen & Torstveit, 2004). Whether pathogenic weight-loss methods are more prevalent in elite athletes compared to non-athletes is not clear. However, athletes from leanness-sports show higher levels of this behavior compared to controls, and pathogenic weight-loss methods are especially common among weight-class athletes in preparation for competition (Werner et al., 2013).

To ensure early detection and sufficient treatment, screening for signs and symptoms of DE behaviors, and predisposing factors, should be performed regularly (Bonci, Bonci, & Granger, 2008). In Norway, there are no established routines for screening adolescents or athletes for DE (Bjørnelv, 2014). Detection of EDs in adolescents rely mainly on the initiative from the individual to seek help and guidance. Further treatment of EDs begins with the involvement of the general practitioner (Bjørnelv, 2014). Nonetheless, general practitioners have shown inadequate knowledge of EDs, and only half of the patients with EDs are diagnosed in primary care (Bjørnelv, 2014). For athletes, the coach can play a significant role in the prevention and detection of DE, and should therefore be educated on the topic (Martinsen, Sherman, Thompson, & Sundgot-Borgen, 2015).

2.2 The female athlete triad and relative energy deficiency in sport

LEA can occur if DE causes low energy intakes (Mountjoy et al., 2018). This makes athletes a vulnerable group given their usually high exercise energy expenditure and dependence on physical performance. Optimal EA is important for supporting a wide range of physiological factors (Mountjoy et al., 2014), and is achieved when the energy from dietary intakes, after subtracting energy spent on activity (exercise energy expenditure), expressed relative to FFM leaves adequate energy for bodily functions (Committee on Adolescent Health Care, 2017; Mountjoy et al., 2018). This can be expressed as (Loucks & Thuma, 2003):

$$\text{Energy availability} = \frac{\text{energy intake (kcal)} - \text{exercise energy expenditure (kcal)}}{\text{FFM (kg)}}$$

Optimal EA is often set at 45 kcal/kg FFM a day (Loucks & Thuma, 2003). A threshold for LEA is often set at <30 kcal/kg FFM a day, which usually reflects the average RMR of an individual.

During the 1980s, female athletes were discovered to have correlating menstrual dysfunction and low BMD that did not substantially improve even after returning to normal menstrual function (Cann, Martin, Genant, & Jaffe, 1984; Drinkwater et al., 1984; Drinkwater, Nilson, Ott, & Chesnut, 1986). In 1992 the American College of Sports Medicine defined this phenomenon as the Female Athlete Triad (Triad) (Yeager et al., 1993). In 2007 the Triad was re-defined as the *"interrelationship among energy availability, menstrual function, and bone mineral density, which may have clinical manifestations including eating disorders, functional hypothalamic amenorrhea, and osteoporosis"* (Nattiv et al., 2007, p. 1867).

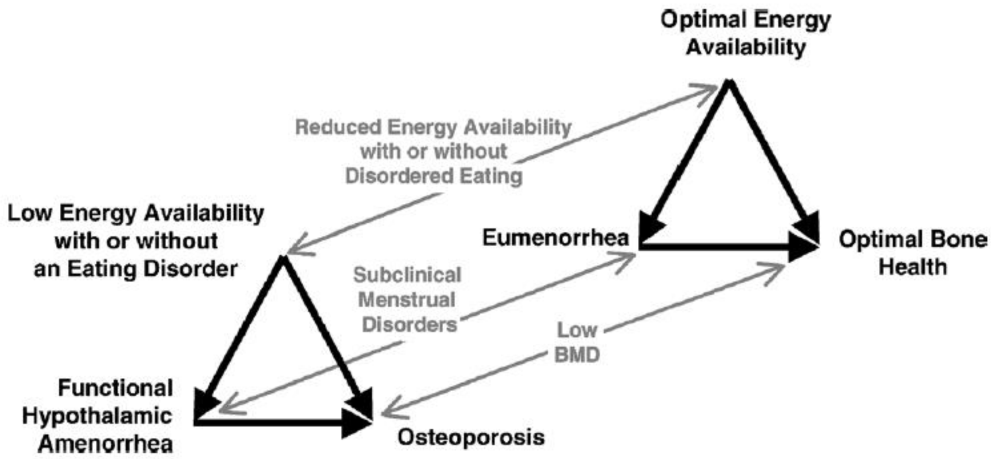

Figure 1. *The female athlete triad can be seen as a continuum where the athlete can move up and down between optimal energy availability, optimal bone health and normal menstrual function, and low energy availability, osteoporosis, and amenorrhea (Nattiv et al., 2007).*

In 2014, the IOC released a position stand stating that LEA had more consequences beyond those described by the Triad, also in males (Mountjoy et al., 2014). Hence, the Triad was no longer confined to only female athletes. This further led to the term RED-S which was intended to describe all health- and performance consequences of LEA in both male and female athletes more accurately (figure 2 and 3). The position stand stated that *"The syndrome of RED-S refers to impaired physiological function including, but not limited to, metabolic rate, menstrual function, bone health, immunity, protein synthesis, cardiovascular health caused by relative energy deficiency"* (Mountjoy et al., 2014, p. 1).

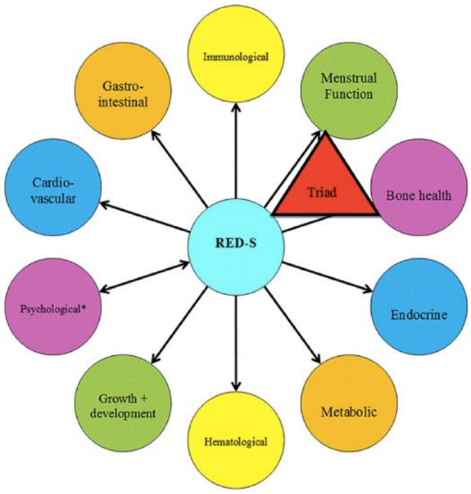

Figure 2*. Health consequences from Relative Energy Deficiency in Sport (Mountjoy et al., 2014). The former female athlete triad is shown in red.*

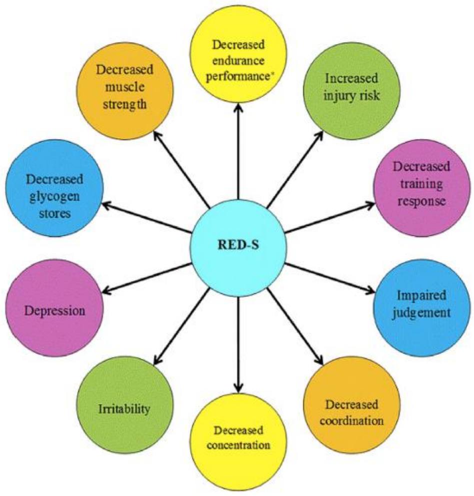

Figure 3. *Performance consequences from Relative Energy Deficiency in Sport (Mountjoy et al., 2014).*

2.3 Resting metabolic rate

RMR can be predicted, estimated and measured using many different methods. The simplest tools to predict RMR are equations such as the Harris Benedict (Harris & Benedict, 1918), Mifflin's equation (Mifflin et al., 1990), or the Cunningham equation (Cunningham, 1980). More accurate methods for measuring RMR are double labeled water and indirect calorimetry (Wooley, 2006). RMR_{ratio} refers to the difference between predicted RMR and measured RMR (Melin et al., 2015). When RMR is reduced, measured RMR will decrease below predicted RMR, further reflected in the RMR_{ratio}. LEA has been found to significantly reduce RMR (Woods, Garvican-Lewis, Lundy, Rice, & Thompson, 2017), with female endurance athletes being especially at-risk (Melin et al., 2015). RMR_{ratio} has therefore been suggested as a surrogate marker for LEA (De Souza et al., 2007; Melin et al., 2015). There is still much unknown about the adaptation of RMR, but it may explain why restrictive diets are not effective long term approaches to weight loss, and often result in weight gain when subjects go back to previous eating habits (Müller & Bosy-Westphal, 2013). After a couple of weeks in a calorie deficit the body can compensate for up to 25% of a given energy deficit, which will diminish further weight reduction (Müller & Bosy-Westphal, 2013).

2.4 Body composition and bone health

The pressure to achieve a body composition that optimizes performance can put athletes at great risk for EDs (Joy et al., 2016; Rodriguez et al., 2009). In weight-class and aesthetic sports like body building, participation and placing is directly linked to weight and appearance. In endurance sports, the right body composition can have impact on stamina, agility and speed (Rodriguez et al., 2009).

DE can be present in both underweight and overweight individuals (Babio, Canals, Pietrobelli, Pérez, & Arija, 2009; Costa, Schtscherbyna, Soares, & Ribeiro, 2013; Gibson, Mitchell, Harries, & Reeve, 2004; Rouzitalab et al., 2015; Torres-McGehee et al., 2009). Societal beauty standards can cause DE behaviors in individuals considering themselves as overweight or otherwise not fitting into these standards (Robinson et al., 2017; Werner et al., 2013). In other ways, DE can cause overweight through binge eating where control over eating is lost and large amounts of food are consumed in a short period of time (E. Stice, Killen, Hayward, & Taylor, 1998).

BMD can increase through weight-bearing activity, and higher BMD has been found in young healthy athletes compared to non-athletes (Committee on Adolescent Health Care, 2017). However, impaired bone health has been found in 45% of female endurance athletes, where 33% of these also presented DE (Melin et al., 2015). Low BMD has also been found in male endurance athletes (Hetland, Haarbo, & Christiansen, 1993; Nichols, Palmer, & Levy, 2003; Stewart & Hannan, 2000). In male adolescents with EDs, low BMD has been correlated with low BMI, higher activity level and low calcium intake (Castro, Toro, LÁZaro, Pons, & Halperin, 2002). Consequences of low BMD can be osteoporosis and stress fractures, further leading to reduced training volume and possibly a discontinued athletic career (Goolsby & Boniquit, 2016). Low BMD is not easily discovered and may go unrecognized until an injury occurs (Manore, 2002).

2.5 Dietary intakes

RED-S have illustrated how low dietary intakes can have negative consequences for health and performance. Need for carbohydrates increases in athletes based on training volume (Kreider et al., 2010). For the general population, dietary recommendations state to limit products with high sugar content as well as sugary drinks like sodas and juices (Nordic Council of Ministers, 2014). Elite athletes, on the other hand, can struggle to consume the required amount of daily carbohydrates, especially during intense training (Kreider et al., 2010). Therefore, competitive athletes are recommended to consume concentrated carbohydrate from juices/fluids or consume high carbohydrate supplements, like gels, to satisfy carbohydrate requirements, especially during long demanding training sessions (Kreider et al., 2010).

Protein has a non-specific role as energy source, but is important in enzymatic- and antibody activity, as well as muscle work, repair processes, transportation of various substances, and building of cellular structural elements (Nordic Council of Ministers, 2014). Low protein intakes have been found in adolescent athletes with DE (Costa et al., 2013; Dwyer et al., 2012). Athletes may require more protein compared to the general recommendations (Kreider et al., 2010; Rodriguez et al., 2009). Special consideration should be given athletes with restrictive diets, vegetarians, or those who avoid other animal products (Hector & Phillips, 2018; Manore, 2002; Nordic Council of Ministers, 2014).

Adequate dietary fat is crucial in order to maintain hormone balance and attain sufficient amounts of fatty acids and fat-soluble vitamins (Nordic Council of Ministers, 2014; Rodriguez et al., 2009). Evidence have pointed to low fat intake being a risk factor for low lumbar spine BMD (Barron et al., 2016). Fat intakes are almost always low in active women who are restricting energy intakes (Manore, 2002). Athletes with LEA have presented 26% lower relative fat intakes compared to athletes with optimal EA (Melin et al., 2016). Athletes competing in aesthetic and endurance sports often avoid foods such as butter and margarine (Sundgot-Borgen, 1993a). Similar traits have also been observed in male non-athletes with DE (Rocks, Pelly, Slater, & Martin, 2016).

3. Materials and methods

3.1 Design and recruitment

This master thesis was part of a larger collaboration project between the University of Agder, “Faculty of Health- and Sport Science, Department of Public Health, Sport and Nutrition” and “Olympiatoppen, Region South”. The whole study period is to last three years, while data in the present study were collected at baseline (M1), M2 and M3 (figure 4).

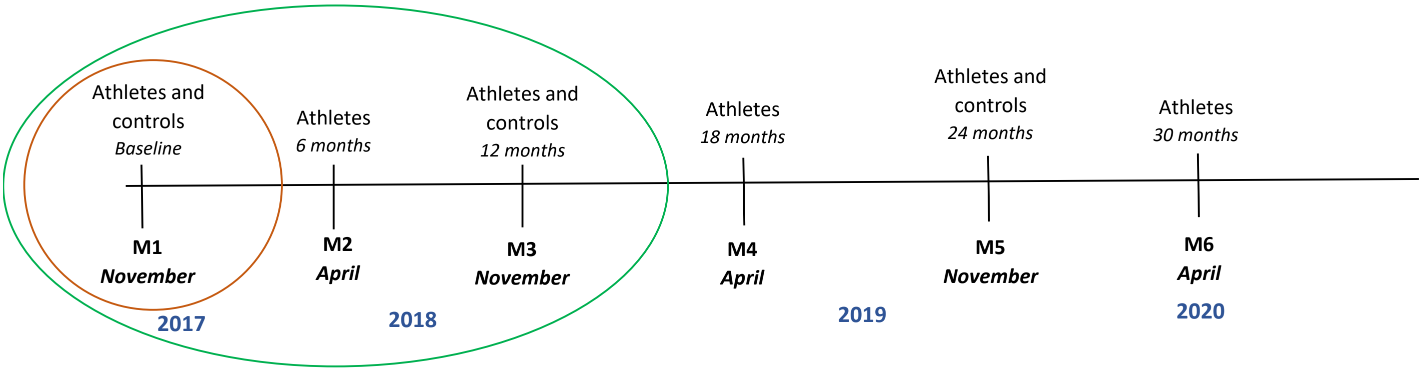

Figure 4. *Overview of all measuring points throughout the whole project. The present study includes cross-sectional data from baseline (M1, small circle), and longitudinal data on DE from M1-M3 (large circle). Athletes were tested twice a year, while controls were tested once a year. There was approximately six months between each measuring point.*

Correlation analyses included cross-sectional data from baseline, while the development of DE over 12 months were longitudinal data from M1-M3 (figure 4). Only athletes who completed all three measuring points were included in the analyses of longitudinal data. Athletes were tested twice a year, while controls were tested once a year (figure 4). For all participants, baseline data were collected during first semester of high school. M2 and M3 were conducted during second and third semester of high school, respectively. The present sample was recruited through convenience sampling. Given few elite sport high schools in the region of southern Norway this was necessary in order to assemble enough eligible participants.

3.2 Subjects

A total of 52 subjects, 36 athletes (23 males, 13 females) and 16 controls (8 males, 8 females), were recruited from four different high schools in the south of Norway. The athletes attended sport specific study programs, while the controls attended general studies. The athletes were competing at regional or national level in endurance sports (cross-country skiing, biathlon, orienteering and triathlon) categorized as leanness sports, or ball-game sports (soccer and hand ball) categorized as non-leanness sports, after standards by Torstveit and Sundgot-Borgen (2005).

In order to be included in the present study participants had to fulfill a set of inclusion criteria:

Inclusion criteria athletes:

- First year high school student, attending a sport specific study program
- Regularly competing at regional and/or national level

Inclusion criteria controls:

- First year high school student attending general studies

Exclusion criteria:

- Illnesses or injuries that prevented participation in the tests

Data on all measures were not obtained for every participant. To illustrate missing data the number of subjects (n) completing each test is included in the tables (Appendix 6). Data on anthropometry and health parameters were obtained for all participants. Dietary information was missing from two athletes and three controls due to not remembering complete intakes for the past three days. Reasons for not completing questionnaires were unknown. Athlete drop-outs from baseline to M3 is presented in figure 5. Of the 19 remaining athletes at M3, all completed the EDE-Q, 17 the BEDA-Q and 16 the DLS at both M1, M2 and M3.

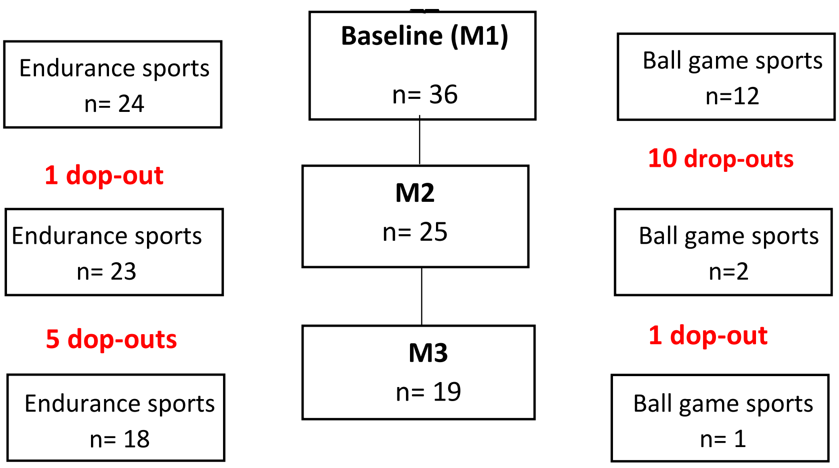

Figure 5. *Overview of the number of athlete participants and drop-outs at each measuring point and within each sport.*

3.3 Test procedure and measurements

The full test protocol included RMR test, immediately followed by measurement of resting blood pressure, DXA scan, work efficiency test on a bike, reaction test on a laptop, leg-press power test, and dietary interview. VO_{2max} tests were performed by athletes only, either three hours after fasted tests, or on a different day. Thus, controls completed all tests in one day at each measuring point. Prior to test-day, participants wore an activity tracker (Sensewear, Bodymedia, Inc., Pittsburgh, PA 175 USA) measuring activity and sleep continuously for seven days, while athletes also wore a heart rate (HR) sensor and watch (Polar, M400) during training for seven day. All devices were returned at test day together with completed questionnaires.

Athletes from the nearby high schools were usually tested on two non-consecutive days given the close location of the schools and the university. All tests, except the VO_{2max} test were performed the first day, while the VO_{2max} was performed on one of the following days. Athletes from the other high schools had a long commute to the university. Therefore, they spent the night at the university campus in order to complete all tests and interviews during 24 hours. Dietary interviews were completed in the evening at the time of arrival, while all other tests were performed the day after, with the VO_{2max} test at least three hours after fasted tests.

All tests, except dietary interview and VO_{2max} tests, were performed fasted, meaning at least nine hours without foods or fluids. No alcohol or tobacco were allowed for a minimum of 12 hours prior to testing, whereas training was restricted to a maximum of 60 minutes low intensity the day before testing. All subjects were to perform minimal physical activity the morning of the test-day, and were instructed to use motorized transportation to the university campus.

In the present study, data from the questionnaires, RMR tests, DXA scans, and dietary interviews were included. The method chapter will further describe these tools and tests.

3.3.1 Questionnaires

Three different self-report questionnaires were used to measure DE and DE related behaviour (Appendix 4). The Eating Disorder Examination Questionnaire (EDE-Q) is a 28-items questionnaire including four subscales: Restraint, Eating concern, Shape concern and Weight concern (Eating Disorder Examination Questionnaire (EDE-Q 6.0), Bohn, K. & Fairburn, C., 2008, Ullevål, Oslo). Global score represents the overall score on the questionnaire. EDE-Q is developed from the clinical interview Eating Disorder Examination (EDE) (Fairburn & Beglin, 1994). Of the 28 questions, 22 are categorized into the four different subscales, while the remaining six questions assess pathogenic weight-control methods such as binging, self-induced vomiting, and use of laxatives, diuretics and diet pills. Participants were classified with DE if they had mean Global scores of ≥2.6, or ≥2.6 on Restraint, ≥1.5 on Eating concern, ≥3.4 on Shape concern, or ≥3 on Weight concern (Regional avdeling for spiseforstyrrelser (RASP)).

The Brief Eating Disorder in Athletes Questionnaire (BEDA-Q) and the Drive for Leanness Scale (DLS) are shorter questionnaires constituting of six-items each. The answers are scored 1 to 6 on a Likert scale, where higher scores indicate higher level of DE or DE related behaviour and attitudes. No cut-off, dividing subjects with and without DE, has been developed for the

DLS, nor the six-point format of the BEDA-Q scored from 1 to 6 (Martinsen et al., 2014; Smolak & Murnen, 2008). Therefore, these questionnaires were used to describe the degree of DE. Possible scores ranged from six to 36, and scores above 21, representing the 50 percentiles of possible scores, were referred to as high.

The BEDA-Q is validated in adolescent female athletes, and has shown acceptable sensitivity and specificity in a wide range of sports (Wagner et al., 2016). The DLS was developed to discover the degree of drive for leanness, defined as *"a motivating interest in having relatively low body fat and toned, physically fit muscles"*, in both males and females (Smolak & Murnen, 2008, p. 251). The questionnaire has shown adequate internal consistency in mixed gender samples (Smolak & Murnen, 2008).

3.3.2 Resting metabolic rate

RMR was measured by indirect calorimetry using an open hood canopy system (Oxycon Pro, Eric Jeager, Germany), calibrated before every test. Total estimated time for the test was 40 minutes. Before the test, subjects rested for 10 minutes in the supine position, in order to obtain resting HR and adjust to the environment (Compher, Frankenfield, Keim, & Roth-Yousey, 2006). RMR was then assessed by measuring oxygen consumption and carbon dioxide production for 30 minutes. RMR calculation included the last 20 minutes of the test and followed the protocol of Compher et al. (2016). During the test, subjects were not allowed to move, talk or fall asleep. Test personnel checked up on the subjects several times throughout the test by quietly asking if they were awake. Subjects could open their eyes as a sign of not sleeping. A HR monitor (Polar, V800/M400) was used to record the lowest resting HR during the test. After the test, the canopy hood was removed, and resting blood pressure was measured by an electronic device. Blood pressure was measured three times, and mean values were calculated. RMR_{ratio} was defined as measured RMR divided by predicted RMR. Predicted RMR was calculated using the Cunningham equation (Cunningham, 1980), and suppressed RMR was defined as RMR_{ratio} <0.90.

3.3.3 Anthropometry, body composition and bone health

Body weight was measured without shoes, and in light clothing, to the nearest 0.1 kg using a weight scale (*Seca 1; model 861, Germany*). Height was measured without shoes to the nearest 0.1 cm using a wall-affixed centimetre scale (Seca Optimera, Seca, UK). BMI was calculated as body weight in kg divided by height squared in m (kg/m^2). BMI < 18.5 was defined as underweight, while fat percentage <5% and <12% was defined as low for males and females, respectively (Meyer et al., 2013). DXA (Dual energy x-ray absorption; GE-Lunar Prodigy, Madison, WI, USA) was used to measure fat mass, FFM and BMD in the whole-body, lumbar spine (L1-L4) and hip, and procedures followed a standardized protocol (Nana, Slater, Hopkins, & Burke, 2012). Before the scan, subjects were told to wear light clothing without metal and remove jewellery.

In the present thesis, z-scores from lumbar BMD (L1-L4) were used in the analyses. BMD was classified as recommended in previous position statements of athletes (Mountjoy et al., 2014; Nattiv et al., 2007). Z-scores ≥ -1 were seen as normal BMD, z-scores between -1 and -2 were seen as low BMD, while z-scores ≤ -2 were seen as osteoporosis (Nattiv et al., 2007). All DXA scans were performed on the same scanner and assessed by the same technician. Calibration was performed daily, using a phantom provided by the manufacturer.

3.3.4 Dietary interview

Dietary intakes were reported during a semi-structured dietary interview where participants were asked to recall all foods and fluids consumed the past seven days. In the analyses, dietary recall information from the previous three days were used in order to limit recall bias. The test personnel were trained in performing thorough dietary interviews with an ethical consideration following an interview protocol (Appendix 5). Mean intakes of energy (kcal), and grams of protein, carbohydrate and fat were calculated for each participant, as well as median intakes per kg FFM. Relevant images of portion sizes were shown to the participants if this was difficult to define. The interviewer could later correlate the image with a given weight for that particular portion size. Dietary records were registered by the interviewer in a digital program that could estimate total daily intakes (Dietist Net, Kost och Näringsdata, Bromma, Sweden). Dietist Net has access to the "Norwegian food table" (Matvaretabellen, 2014), "open Norwegian nutritional information database" (MILLUM PBD) and "the U.S. national nutrient database" (US department of Agriculture).

3.4 Statistical analyses

Statistical analyses were performed using SPSS software for Windows, version 25 (v. 25; IMB Corp., Armonk, NY, USA). Figures and tables were made using Microsoft Excel (2018). All correlation analyses were performed using the Spearman's rho, due to small sample size and low level of normal distribution in DE scores. Correlations of (±) 0.90-1.0 were considered very strong, 0.7-0.9 strong, 0.5-0.7 moderate, 0.3-0.5 weak and 0.0-0.3 negligible (Hinkle, Wiersma, & Jurs, 2003). Significance was established when p-value was ≤0.05. The dataset was controlled for missing data and signs of non-normality by visual confirmation of histograms and comparisons of means and medians. Non-normally distributed data are presented as medians (25, 75 percentile) as well as means ± standard deviations (SD), while normally distributed data are presented as means ±SD. Differences in data between athletes and controls were analysed using independent samples t-tests for normally distributed data and Mann-Whitney U-tests for non-normally distributed data. Chi square test was used to investigate the differences in the male to female ratio between groups, while Kruskal-Wallis was used to examine differences in DE scores from baseline to M3. Because of small sample size and significant difference in the male to female ratio between athletes and controls, subgroup comparisons are not presented.

Data on anthropometry and health parameters were obtained for all participants (athletes n=36, controls n=16). Dietary information was missing from two athletes and three controls due to not remembering complete intakes for the past three days. Reasons for not completing questionnaires were unknown. In the longitudinal data of the development of DE in athletes, only athletes that completed questionnaires at all three measuring points were included. Drop-outs are presented in figure 2.

3.5 Ethical considerations

Permission to undertake this study was provided by the Norwegian Centre for Research Data (NSD), and permission to undertake this particular master thesis was provided by the ethics committee for the Faculty of Health and Sports Science at the University of Agder (Appendix 1). The Regional Committees for Medical and Health Research Ethics (REK) found the present study to fall outside of their domain, permission from REK was therefore not necessary in order to conduct the study. Before inclusion, all participants were informed orally and in writing of study procedures explaining that participation involved fasting before tests, measurement of body composition, use of the ventilation hood, and testing to exhaustion, all of which could cause some discomfort (Appendix 2). All participants completed a consent form (Appendix 3), and could at any moment, without stating a reason, withdraw from the study.

All data were anonymized and stored in a safe-deposit box under ID number only authorized research personnel could access. Thus, subject information could not be linked to participant's identity. By agreeing to terms of the written consent, anonymized data could be used for publication in journals, lectures and congresses. All participants had right to insight into their own data. Participants received their test results after analyzing. Given the sensitive nature of some of the information (e.g. high DE scores and body composition) the results were communicated in a considerate way. If findings were significantly higher or lower than population-based reference values, subjects were advised to contact medical personnel for follow up. Participants scoring above cut-off for DE on the EDE-Q were given the opportunity to talk to a professional.

4. Method discussion

4.1 Design

The present study used a cross-sectional design describing the prevalence of, and associations between, certain variables at a specific point in time. The cross-sectional design is a frequently used method that are cost effective and time saving (Setia, 2016). However, cross-sectional studies and correlations analyses cannot establish causal relationships (Setia, 2016). Associations between DE and higher body mass, and lower dietary intakes observed in the present study (Appendix 6) cannot specify which variable led to the other. Furthermore, a different result could have appeared at another point in time. Changes in DE behavior were studied through longitudinal data on DE levels in athletes from three measuring points over a 12-month period. Longer study periods may be necessary to identify whether the level of DE changes during adolescence in athletes. If DE behavior in athletes are affected by performance pressure, it is likely that the level of DE differs around competitive season. The present study took this into account, by measuring athletes both before and after their competitive season.

4.2 Study sample

The present sample consisted of 52 first year high school students. Among the athletes, 24 represented endurance sports and 10 ball-game sports. Endurance athletes, which are classified as leanness athletes, have presented higher levels of DE compared to ball-game athletes (Joy et al., 2016; Sundgot-Borgen & Torstveit, 2007). The inclusion of ball-game athletes may have lowered the overall prevalence in the athletic group (subgroup comparisons not presented). However, including more sports makes the sample more representative in regards to adolescent athletes in general, though other leanness sports showing high levels of DE, like weight-class sports, were not represented. The relatively small sample size was, to some degree, accounted for by using non-parametric tests when analyzing differences and correlations. In order to account for the high activity level in athletes in relation to energy intakes, dietary intakes were calculated relative to FFM. Athletes had significantly higher FFM compared to controls (Appendix 6), which might also indicate higher EA (Klausen, Toubro, & Astrup, 1997).

The present sample consisted of both males and females, and the gender ratio was significantly different between the athletes and controls with 63.8% males and 36.1% females among the athletes, and 50% males and females among the controls. Females have shown higher levels of DE compared to males (Blair et al., 2017), suggesting that the significantly higher DE scores on the EDE-Q and BEDA-Q among controls may have been a result of having significantly more females. Sub-group comparisons were not included in the results as low number of participants made it difficult to gain statistical power (Thomas, Nelson, & Silverman, 2011).

The number of drop-outs from baseline to M3 was quite high (figure 5), with 44.4% male athletes and 38.4% female athletes dropping out. More ball-game athletes dropped out compared to endurance athletes, possibly because the study tests appealed more to endurance athletes. Moreover, most of these athletes attended high schools further away, traveled together to the University, spent the night at the university campus and went through all tests together the next day. These athletes may have experienced more of a community and motivation from their peers, leading to less drop-out. There was no significant difference in baseline DE scores between drop-out athletes and athletes who completed all three measurements, suggesting that DE was not a reason for dropping out, or for further participation.

4.3 Measurements

Self-report measures

Several methods have been developed to examine DE or EDs (Cooper & Fairburn, 1987; Melin et al., 2014; Mond et al., 2006; Wagner et al., 2016; Wear & Pratz, 1987). In the present study, DE and diet were self-reported.

Self-report questionnaires and semi-structured interviews are frequently used methods for assessing DE. There are currently no “gold standard” method for examining EDs in athletes (Wagner et al., 2016), although, the clinical interview has been recommended as a favorable method (Martinsen & Sundgot-Borgen, 2013; Sundgot-Borgen & Torstveit, 2004). Clinical interviews show high accuracy, however, they are time-consuming and require trained personnel (Sundgot-Borgen & Torstveit, 2004). Questionnaires, on the other hand, are easier to distribute, more time- and cost-effective, and do not require trained personnel. The present study used three different questionnaires to assess DE, which had slightly different approaches to the aspects of DE. All were validated and had shown adequate specificity (Fairburn & Beglin, 1994; Martinsen, Holme, Pensgaard, Torstveit, & Sundgot-Borgen, 2014; Mond et al., 2006; Smolak & Murnen, 2008).

The EDE-Q was the most comprehensive questionnaire (Appendix 4) and included questions meant to assess symptoms of EDs, which are diagnosed through more strict criteria compared to DE. Assessment of more severe symptoms may be why the EDE-Q found the lowest prevalence of DE in both groups. The BEDA-Q has been validated in an athletic population (Martinsen et al., 2014), and included questions regarding perfectionism; a personality trait often observed in both patients with ED and athletes (Forsberg & Lock, 2007). Presumably, this made the BEDA-Q a reliable and well suited for the present sample. The version of BEDA-Q in the present study was a six-items questionnaire, while the original version is nine-items including three more questions regarding weight loss (Martinsen et al., 2014; Wagner et al., 2016). This may have led to a less comprehensive description of DE symptoms, however, the six-items questionnaire has previously been used in athletic populations (Peric, Zenic, Sekulic, Kondric, & Zaletel, 2016).

When comparing results from self-report questionnaires with clinical interviews, athletes have been found to underreport symptoms of DE, causing more athletes to be classified as false-negative (Martinsen & Sundgot-Borgen, 2013). Athletes may underreport symptoms in fear of embarrassment or removal from training and competition (Sundgot-Borgen & Torstveit, 2010). Stigmatization of DE in sport must be avoided and should be a topic athletes and coaches can openly talk about. This would make it easier for an affected athlete to come forward and seek treatment. As an attempt to limit underreporting, participants in the present study were informed that no results would be communicated to coaches, teachers or others, without consent from the participant.

The DLS was developed to discover DE related behavior and attitudes, regardless of gender, by assessing desire for a lean body ideal (Holland & Tiggemann, 2017; Raggatt et al., 2018; Smolak & Murnen, 2008). Feeling unable to attain this ideal may cause body dissatisfaction and use of unhealthy weight-loss methods (Prichard et al., 2018; Robinson et al., 2017). DLS has shown adequate internal consistency in mixed gender samples (Smolak & Murnen, 2008), further supported by the results from the present study which found high scores in both females and males (Appendix 6). The BEDA-Q also includes questions about body image and ideals, but is more focused on thinness, which is not necessarily related to drive for leanness, muscularity and male body ideals (Klimek, Murray, Brown, Gonzales IV, & Blashill, 2018). High DLS scores in athletes, controls, males and females, suggest that the muscular and lean body type is largely idealized by Norwegian adolescents. Screening tools for detecting DE are mainly focused on females, body weight and shape concerns that are perhaps more common in the female population (Chapman & Woodman, 2016). Inclusion of screening tools also assessing body ideals and behaviors more common in males, like the DLS, are therefore important when studying mixed gender samples.

In analyses of dietary intakes, the last three recalled days were used in order to limit recall bias. Ideally weighted food records should have been used, because of accuracy and less bias (Barrett-Connor, 1991). However, this was considered unethical in the present sample, given negative experiences with weighted food records in the participating high schools. The ethical concern was that students with DE would experience worsening of symptoms if dietary intakes were to be weighted and recorded. As a compromise for the schools' participation, dietary interviews were chosen. Over- and underreporting are possible bias with dietary interviews (Lafay et al., 1997). In order to limit false reporting of intakes in the present study, an interview guide was used by the test-personnel (Appendix 5). Participants were tested on different days; hence, the recalled days could consist of weekends for some, and only weekdays for others. This was an inconvenience with the interviews, considering dietary patterns can vary throughout the week.

There are some bias regarding self-report methods, including carelessness, confusion, lack of efforts, or intentional mischief (Fan et al., 2006). However, there was no reason to believe that any of the participants provided inaccurate responses intentionally. The dietary interviews were always conducted last, with no following test, giving the interviewer enough time to obtain all necessary information.

Objective measurements

The variables RMR, BMD and body composition were objectively measured by well-established tools, with high specificity, following best practice protocols (Compher et al., 2006; Nana et al., 2012). For the objective measurements, the same technicians performed the different tests using the same equipment on all participants in order to limit bias. Every effort was made to ensure optimal condition for testing, calibrations were made before each test, and well informed instructions were given to participants regarding procedures. Hydration status was not accounted for at baseline, which is often recommended to minimize errors in analyses of body composition (Nana et al., 2012). However, all participants were instructed to follow guidelines regarding hydration and fasting and there was no reason to assume any errors with the DXA analyses.

Indirect calorimetry using a canopy hood was chosen to measure RMR due to the proven validity and accuracy (Compher et al., 2006). To minimize errors, instructions from both the manufacturer of Oxycon, and the systematic review of best practice protocol by Compher et al. (2006) were followed. However, in order to ensure more accurate results, the measuring time was extended to a total of 30 minutes, where the last 20 minutes were used to calculate RMR. Thus, adjustment-time and familiarization with the equipment were taken into account. The Oxycon was calibrated at the beginning of every test day, and after every second subject, or when conditions in the room suddenly changed. In some cases, the canopy hood has been shown to cause claustrophobia, while in others it has caused sleepiness (Psota & Chen, 2013). These factors can contribute to variability in the measurements. The test personnel tried to avoid this by making the bed and environment comfortable, talking subjects through the protocol before testing, and asking the participants if they were sleeping during the test. RMR_{ratio} (i.e. the ratio between measured and predicted RMR) is widely used in athletes to establish whether changes in RMR have occurred (De Souza et al., 2007). The Cunningham equation used in this study, have been reported to be precise, and most accurate for predicting RMR in athletes (Cunningham, 1980; Gibbs, Williams, & De Souza, 2013).

4.4 Statistical analyses

Because of skewed questionnaire data and small study sample, non-parametric tests were mainly used given their robustness. The present study did not attempt to create cut-off values for the BEDA-Q and DLS, because of the special skills and demanding statistical procedures involved in methodical developments, which fell outside the scope of this master thesis. The BEDA-Q- and DLS scores were rather viewed as continuous variables describing higher or lower degree of DE.

Given previously observed prevalence of EDs in adolescents (Eric Stice, Marti, Shaw, & Jaconis, 2009), normal distribution of DE scores was not expected. Scores clustered towards the lower end of the scale were believed to be more likely, thus making mean scores lower than median possible score. Therefore, scores at or greater than median possible score (≥ 21) was referred to as high for the BEDA-Q and DLS. This approach has been used in previous publications (Jones, Fortenberry, Sanyer, Knighton, & Van Hala, 2018), and was decided most suited for the present study.

4.5 Practical implications and future research

Given the small study sample, results cannot be generalized to all adolescents. However the outcomes can imply possible associations, risk factors and trends regarding DE in adolescents, thus, further support research and generation of new hypotheses.

Longitudinal studies of DE can help identify if sufficient preventive measures and interventions are present, and whether these are effective or not. The development of DE over longer time periods, favorably years, should be conducted on vulnerable groups like adolescent athletes. High levels of DE should be taken seriously, and procedures for screening adolescents, both athletes and non-athletes should be further developed and implemented in sport federations and the health care system. Moreover, screening tools should take into account body ideals and DE behaviors related to the increasing fitness trends and body ideals including high levels of muscularity and leanness.

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Part 2:

Research paper

Disordered eating in adolescent elite athletes and non-athletes; prevalence, longitudinal development and association with body composition, health parameters and diet

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Disordered eating in adolescent elite athletes and non-athletes; prevalence, longitudinal development and association with health parameters and diet

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Abstract

The purpose of the present study was to investigate the prevalence of disordered eating (DE) among adolescent elite athletes and age-matched controls, and to assess the one-year development of DE scores among the athletes. Furthermore, associations between DE and body composition, bone health, dietary intakes, and resting metabolic rate (RMR) were examined. A total of 36 adolescent elite athletes and 16 adolescent controls participated in the study. DE was examined through the Eating Disorder Examination Questionnaire (EDE-Q), the Brief Eating Disorder in Athletes Questionnaire (BEDA-Q), and the Drive for Leanness Scale (DLS). Dietary information was self-reported and obtained from semi-structured interviews. Body composition, bone mineral density (BMD) and RMR were obtained objectively through DXA scans and indirect calorimetry, respectively. A higher degree of self-reported DE was found in non-athletes compared to athletes, and DE was associated with higher BMI and fat percentage, lower amount fat-free mass, and lower intakes of energy, protein, carbohydrates and fat, in both groups. There was no significant association between DE and RMR and low BMD. DE scores were consistent among the athletes during a 12-month period, based on three measuring points. These results suggest that sport participation may have a protective effect on DE in Norwegian adolescents. Moreover, DE appear in combination with higher body mass and lower self-reported dietary intakes. DE levels among adolescent athletes do not change through first year of elite sport high school.

KEYWORDS: Disordered eating, Adolescent athletes, Relative energy deficiency in sport, Athlete health

Introduction

Disordered eating (DE) is a subclinical condition referring to a wide range of abnormal eating behaviours like dieting, restriction of certain foods, fasting, binging, and purging, as well as body dissatisfaction and preoccupation with weight (1). These symptoms can also be found in patients with clinically diagnosed eating disorders (ED). What separates DE from EDs are the severity of the condition and frequency of behaviours (2). EDs are clinical conditions diagnosed through specific criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders (DSM) (3). Western countries have the highest prevalence, and EDs are the psychiatric disorder with the most impact on the disease burden (4). The prevalence of DE in youth populations has been found around 20-26% in females and 7-15% in males (5, 6). In Norway, the prevalence of DE has been found to be around 20% in adolescent endurance athletes, and 55% in adolescent non-athletes (7, 8). However, there is still inconsistency in the literature regarding the prevalence of DE, and whether athletes are more or less at risk compared to non-athlete populations (9, 10). Among athletes have the prevalence of DE been found to differs between sports (11). The highest prevalence has been observed within leanness-sports including aesthetic-, antigravitation- and weight-class sports, followed by endurance sports, and ball-game- and technical sports (11). The literature on DE are focused on females (12). Even though males tend to show lower levels of DE compared to females, male athletes have presented DE more frequently compared to male non-athletes (11). Studies find 25-67% of adolescent males to present body dissatisfaction, abnormal eating behaviours or unhealthy weight-control methods, implying that DE are not uncommon among males (12).

Low energy availability (LEA) is a state of mismatch between energy intake and energy expenditure, which means inadequate energy to support optimal health and bodily functions (13). LEA can occur in subjects with DE due to intentional dietary restriction and/or excessive exercise, but also in athletes without DE or dietary restriction (14). Optimal Energy Availability (EA) is achieved when the energy from dietary intakes, after subtracting energy spent on activity, expressed relative to fat-free mass (FFM), leaves adequate energy for bodily functions (13). Optimal EA is often set at 45 kcal/kg FFM a day, while LEA is often found at approximately 30 kcal/kg FFM a day (13). Resting metabolic rate (RMR) is the minimum amount of energy (kcal) the body requires to maintain basic physiological functions (e.g. growth, reproduction, thermoregulation and cellular maintenance). One of the measured consequences of LEA is decreased RMR (13). When the body is exposed to low energy intakes over time, metabolism adapts by decreasing as an attempt to conserve energy. RMR_{ratio} refers to the difference between predicted RMR and measured RMR (15). When RMR is reduced, measured RMR will be lower than predicted RMR, which has led to RMR_{ratio} being used as a surrogate marker for LEA (15).

The term relative energy deficiency in sport (RED-S) was introduced in 2014 by the International Olympic Committee (IOC), as LEA was proven to impair health and a wide range of physiological processes (13). RED-S was intended to describe all health- and performance consequences of LEA in both males and females, including impaired bone health and metabolic function (13). Bone health often refers to bone mineral density (BMD), and low BMD has been observed in subjects with LEA and DE (13, 16). Even though there is strong evidence that exercise benefits bone health and is a critical factor in osteoporosis prevention and treatment, low BMD has been frequently found in female athletes (17). Low BMD can lead to osteoporosis and stress fractures, which may have consequences for an athletic career (17). Low fat intakes have been found as a risk factor for low lumbar spine BMD (18). A diet adequate in both macro- and micronutrients is important for maintaining and promoting health and physical performance (19). Athletes' diets do not need to be substantially different from the general nutrition recommendations, though daily energy requirements may be considerably higher given increased exercise energy expenditure (20). The need for carbohydrate and protein can also exceed the general recommendations because of increased demand to maintain glycogen- and protein synthesis within muscles (21). Sufficient dietary fat is crucial in order to maintain hormone balance and attain adequate amounts of fatty acids and fat soluble vitamins (20).

The main aim of the present study was to investigate the prevalence of DE among adolescent elite athletes and controls, and study whether this prevalence changed over a 12 month period. Furthermore, associations between DE, body composition, RED-S related health parameters, and intakes of energy and macronutrients were analysed.

Materials and methods

Design and recruitment

The present study includes both cross-sectional and longitudinal data. The correlation analyses were based on cross-sectional data from baseline, while longitudinal development of DE scores was based on three measuring points; baseline (M1), six months after baseline (M2) and 12 months after baseline (M3). Given few elite sport high schools in the region of southern Norway, the present sample was recruited through convenience sampling in order to assemble enough eligible participants.

Baseline data were collected during first semester of high school for all participants, while M2 and M3 were conducted during second and third semester of high school, respectively. Athletes were tested twice a year, while controls were tested once a year. Only athletes who completed all three measuring points were included in the analyses of longitudinal data.

Subjects

A total of 52 subjects, 36 athletes (23 males, 13 females) and 16 controls (8 males, 8 females), were recruited from high schools in the south of Norway, and found eligible for participation in the study. All participants were first year students, where the athletes attended sport specific study programs, and the controls attended general studies. The athletes were competing at regional or national level in endurance sports (cross-country skiing, biathlon, orienteering and triathlon) categorized as leanness sports, or ball-game sports (soccer and hand ball) categorized as non-leanness sports, after standards by Torstveit and Sundgot-Borgen (22). Inclusion required absence of illnesses or injuries that prevented participation in the tests. In the longitudinal data of DE scores in athletes, only athletes who completed questionnaires at all three measuring points were included. They were all endurance athletes, except for one ball-game athlete.

Testing procedures and measurements

Data from the present study were based on questionnaires, RMR tests, DXA scans and dietary interviews. RMR and DXA scans were performed fasted, i.e. at least nine hours without foods or fluids. No alcohol or tobacco was allowed for a minimum of 12 hours prior to testing. Training was restricted to a maximum of 60 minutes low intensity the day before testing, and all subjects were to perform minimal physical activity the morning of the tests.

Questionnaires

Three different self-report questionnaires, were used to measure DE and DE-related behaviour. The Eating Disorder Examination Questionnaire (EDE-Q) is a 28-item questionnaire including four subscales: Restraint, Eating concern, Shape concern and Weight concern (23). Participants were categorised with DE if they had mean Global scores of ≥2.6, referring to the overall score on the questionnaire, or ≥2.6 on Restraint, ≥1.5 on Eating concern, ≥3.4 on Shape concern, or ≥3 on Weight concern (24).

The Brief Eating Disorder in Athletes Questionnaire (BEDA-Q) and the Drive for Leanness Scale (DLS) are shorter questionnaires constituting of six-items each (25, 26). The answers are scored 1 to 6 on a Likert scale, where higher scores indicate higher level of DE or DE related behaviour and attitudes. No cut-off, dividing subjects with and without DE, has been developed for the DLS, nor the six-point format of the BEDA-Q scored from 1 to 6 (Martinsen et al., 2014; Smolak & Murnen, 2008). Possible scores ranged from six to 36, and scores above 21, representing the 50 percentile of possible scores, were referred to as high.

The BEDA-Q is validated in adolescent female athletes, and has shown acceptable sensitivity and specificity in a wide range of sports (27). The DLS was developed to discover the degree of drive for leanness, defined as *"a motivating interest in having relatively low body fat and toned, physically fit muscles"* in both males and females, and has shown adequate internal consistency in mixed gender samples (25).

Resting metabolic rate

RMR was measured by indirect calorimetry using an open hood canopy system (Oxycon Pro, Eric Jeager, Germany), calibrated before every test. Total estimated time for the test was 40 minutes. Before the test, subjects rested for 10 minutes in a supine position in order to obtain resting heart rate and adjust to the environment (28). RMR was then assessed by measuring oxygen consumption and carbon dioxide production for 30 minutes. The last 20 minutes of the test were used to calculate RMR, following the protocol of Compher et al. (2016). RMR_{ratio} was defined as measured RMR divided by predicted RMR, and suppressed RMR was defined as RMR_{ratio} <0.90. Predicted RMR was calculated using the Cunningham equation (29).

Anthropometry, body composition and bone health

Body weight was measured without shoes, and in light clothing, to the nearest 0.1 kg on a weight scale (Seca 1; model 861, Germany). Height was measured without shoes to the nearest 0.1 cm using a wall-affixed centimetre scale (Seca Optimera, Seca, UK). BMI was calculated as body weight in kg divided by height squared in m (kg/m^2). BMI < 18.5 was defined as underweight, while fat percentage <5% and <12% was defined as low for males and females, respectively (30). DXA (Dual energy x-ray absorption; GE-Lunar Prodigy, Madison, WI, USA) was used to measure fat mass, FFM and lumbar spine BMD (L1-L4), with procedures following a standardized protocol (31). BMD was classified as recommended in previous position statements of athletes (32). Z-scores ≥ -1 were seen as normal BMD, z-scores between -1 and -2 were seen as low BMD, while z-scores ≤ -2 were seen as osteoporosis (32). All scans were performed on the same scanner, and assessed by the same technician, while calibration of the DXA scanner was performed daily using a phantom provided by the manufacturer.

Dietary interview

Dietary intakes were reported during a semi-structured dietary interview where participants were asked to recall complete food and fluid intakes from the past seven days. In the analyses, dietary recall information from the previous three days were used in order to limit recall bias. The test personnel were trained in performing thorough dietary interviews with an ethical consideration, and followed an interview protocol. Mean intakes of energy (kcal), and grams of protein, carbohydrate and fat were calculated for each participant and for the two groups to, along with median intakes per kg FFM. Relevant images of portion sizes were shown to the participants if this was difficult to define. The interviewer could later correlate the image with a given weight for the different portions. Dietary records were registered by the interviewer in a digital program that could estimate total daily intakes (Dietist Net, Kost och Näringsdata, Bromma, Sweden). Dietist Net has access to the "Norwegian food table" (Matvaretabellen, 2014), "open Norwegian nutritional information database" (MILLUM PBD) and "the U.S. national nutrient database" (US department of Agriculture).

Statistical analyses

Statistical analyses were performed using SPSS software for Windows, version 25 (v. 25; IMB Corp., Armonk, NY, USA). Figures and tables were made using Microsoft Excel (2018). All correlation analyses were performed using the Spearman's rho, due to small sample size and low level of normal distribution of DE scores. Correlations of (±) 0.90 - 1.0 were considered very strong, 0.7- 0.9 strong, 0.5 - 0.7 moderate, 0.3 - 0.5 weak and 0.0 - 0.3 negligible (33). Significance were established if p-values were ≤ 0.05. The dataset was controlled for missing data and signs of non-normality using histograms and comparisons of means and medians. Not normally distributed data are presented as medians (25, 75 percentile) as well as means ± standard deviations (SD), while normally distributed data are presented as means ±SD. Differences in normally distributed data between athletes and controls were analysed using independent samples t-tests, while non-normally distributed data were compared using Mann-Whitney U-tests. Chi square test was used to study the difference in the male to female ratio between groups, while Kruskal-Wallis tests were used to study differences in DE scores on the three measuring point. Because of small sample size and significant difference in the male to female ratio between athletes and controls, subgroup comparisons are not presented.

To illustrate missing data, the number of subjects (n) completing each test was included in the tables. Data on anthropometry and health parameters were obtained for all participants. Dietary information were missing from two athletes and three controls due to not remembering complete intakes. Reasons for not completing questionnaires were unknown.

Ethical considerations

Permission to undertake this study was provided by the Norwegian Centre for Research Data (NSD), and the Ethics Committee for the Faculty of Health and Sports Science (FEK) at the University of Agder. All procedures followed the guidelines laid out by the Declaration of Helsinki.

Results

Characteristics

Athletes had significantly lower fat percentage, higher FFM and higher absolute and relative dietary intakes compared to controls (table 1). There was no significant difference in RMR_{ratio} or BMD between athletes and controls. A significant difference in the male to female ratio between athletes and controls was found ($p<0.001$). Among athletes, the gender distribution was 63.8% males and 36.1% females, while amongst controls, it was 50% males and females. Among the athletes, three males and none of the females were underweight, while none low fat percentage or RMR_{ratio}. Two underweight and four normal weight male athletes, as well as three normal weight female athletes, had low spine BMD z-scores. Among controls, two males and none of the females were underweight. None of the controls had low fat percentage. One underweight male control had low RMR_{ratio} and low BMD z-score, while one female control had low BMD z-score. Athletes had significantly higher absolute mean intakes of energy, protein, carbohydrate and fat compared to controls ($p <0.01$), as well as significantly higher median intakes per kg/FFM ($p<0.05$ and <0.01) (table 1).

(insert Table 1 here)

Disordered eating scores

In the total sample, none of the athletes and five controls (31.2%, 2 males, 3 females) were categorized with DE based on the EDE-Q. Median Global scores were significantly lower in athletes compared to controls ($p<0.01$) (table 2). All EDE-Q subscale scores were also significantly higher among controls compared to athletes ($p<0.01$).

Three out of 34 athletes (8.8%, 0 males and 3 females) and six out of 15 controls (40.0%, 1 male and 5 females) had high scores on the BEDA-Q. Median BEDA-Q scores were significantly lower in athletes compared to controls ($p<0.01$) (table 2).

A total of 17 out of 32 athletes (53.1%, 11 males and 6 females) and 10 out of 15 controls (66.7%, 6 males and 4 females) had high scores on the DLS. There was no difference in median DLS scores between athletes and controls ($p=0.19$), and median scores in both groups were above the 50 percentile of possible scores (table 2). In both groups, more males than females had high DLS scores, in contrast to scores on the EDE-Q and BEDA-Q where females scored highest.

(insert Table 2 here)

Longitudinal development of disordered eating scores

DE scores did not change significantly in the athletes from baseline (M1) to M2 and M3 over the course of 12 months on neither of the questionnaires. Median scores on the EDE-Q were 0.1 at M1, 0.1 at M2 and 0.2 at M3 ($p=0.75$). Median scores on the BEDA-Q were 10.0 at M1, 11.0 at M2 and 10.0 at M3 ($p=0.78$). Median DLS scores were 22.0 at M1, 20.5 at M2 and 23.5 at M3 ($p=0.78$). Figure 1 illustrates the differences in DE scores, and the variation in direction and degree of change among the individuals.

No significant differences in baseline scores were observed between athletes who completed all three measuring points and athletes who dropped out (data not shown). Of the athletes included in the longitudinal analyses, none scored above cut-off on EDE-Q for either of the measuring points. On the BEDA-Q, three athletes had high scores at baseline, two at M2, and none at M3. On the DLS, nine had high scores at baseline, eight at M2, and 10 at M3.

(insert Figure 1 here)

Disordered eating and associated factors

Among the athletes, Restraint was significantly associated with higher BMI ($r_s=0.40$, $p<0.05$) and fat percentage ($r_s=0.35$, $p<0.05$) (table 3). Shape concern was significantly associated with lower FFM (r_s= -0.35, p<0.05), while BEDA-Q score was significantly associated with higher fat percentage (r_s=0.42, p<0.05) and lower relative dietary intakes of energy (r_s= -0.47, p<0.01), protein (r_s= -0.47, p<0.01) , carbohydrate (r_s= -0.53, p<0.01) and fat (r_s= -0.35, p<0.05) (table 3).

Among controls, Global score (r_s=0.58, p<0.05), Shape concern (r_s=0.66, p<0.01) and Weight concern (r_s=0.52, p<0.05) were significantly associated with higher fat percentage (table 3). Global score (r_s= -0.62, p<0.05), Eating concern (r_s= -0.57, p<0.05), Shape concern 8 r_s= -0.69, p<0.01), and Weight concern (r_s= -0.57, p<0.05) were all significantly associated with lower FFM. Global score (r_s= -0.68, p<0.05), Restraint (r_s= -0.62, p<0.05), Shape concern (r_s= -0.78, p<0.01) , and Weight concern (r_s= -0.82, p<0.01) were significantly associated with lower relative protein intakes. Weight concern (r_s= -0.63, p<0.05) and Shape concern (r_s= -0.70, p<0.05) were significantly associated with lower relative fat intakes, while Weight concern (r_s= -0.59, p<0.05) was also associated with lower relative energy intakes. BEDA-Q score was significantly associated with higher fat percentage (r_s=0.80, p<0.01). BEDA-Q was also significantly associated with lower relative intakes of energy (r_s= -0.70, p<0.05), protein (r_s= -0.89, p<0.01), carbohydrate (r_s= -0.66, p<0.05) and fat (r_s= -0.65, p<0.05). Significant correlations were absent for the DLS (table 3). Significant associations with DE was more pronounced among controls compared to the athletes.

(insert Table 3 here)

Discussion

The present study found higher degree of DE in adolescent non-athletes compared to adolescent elite athletes. The level of DE stayed consistent in athletes over a 12 month period. DE was associated with higher body mass, lower FFM and lower dietary intakes of energy, protein, carbohydrate and fat. Low BMD and RMR_{ratio} were not associated with DE in this sample.

Disordered eating scores

The prevalence of DE based on the EDE-Q was 0% among the athletes and 31.2% among the controls (p<0.01). On the BEDA-Q, 8.8% athletes and 40.0% controls had high scores (p<0.01), whereas on the DLS, 53.1% athletes and 66.7% controls had high scores, and there was no significant difference in scores between the groups (p=0.189). Similarly, in their meta-analysis, Smolak, Murnen (34) found athletic participation to be protective against eating problems, especially in high school athletes. In the present study, median EDE-Q Global score in athletes (0.3) was lower compared to a previous study of female adolescent endurance athletes (1.0) (16). In the present study, the athlete group mainly consisted of males, and given the lower prevalence of DE observed in males compared to females (35), this may have affected the results. However, none of the female athletes in the present study scored above cut-off on the EDE-Q.

A study comparing EDE-Q scores across different levels of athleticism and physical activity levels, found active non-athlete males and females to be more at risk of DE compared to inactive participants and competitive athletes (36). These results suggest that serious sport participation might protect against DE, while being an active non-athlete might increase the risk of DE, similarly to the results of the present study. However, activity level was not assessed in the present study. Future studies should examine the relationship between activity level and DE in non-athletes, as well as comparing results to athletes.

The EDE-Q was the longest and most comprehensive questionnaire, including questions meant to assess more severe symptoms related to clinical EDs (23). This may explain why the EDE-Q found lower levels of DE compared to the BEDA-Q and DLS that assess less severe symptoms of DE (25, 26). Nevertheless, this could also mean that the cut-off score on the EDE-Q are too high, and categorizes more subjects as false-negative. The BEDA-Q was the only questionnaire validated in an athletic population, though validated in females, not males (26). Less is known about the accuracy of BEDA-Q discovering DE in males. Presumably, this made the BEDA-Q a reliable and suitable tool for discovering DE among the female athletes. High BEDA-Q scores were found in both female athletes and non-athletes, compared to males.

In recent years, a new “fit” ideal has emerged alongside the still prominent thin ideal (37). This so called “fitspiration” is a rising movement on social media, expressed through both text and imagery, reaching a large number of adolescents every day. “Fitspiration” often includes pictures of lean and toned bodies, and despite the apparently “healthy” focus, images often encourage weight loss and highlight the importance of appearance (37). In females, viewing photographs of thin and athletic women has been shown to increase body dissatisfaction (37). The DLS describes the drive for a lean body ideal (38, 39). Feeling unable to attain this ideal can cause body dissatisfaction and use of unhealthy weight-loss methods (37, 40). The DLS, which is validated for both males and females, found the highest degree of DE in the present sample. High scores in both athletes, controls, males and females, suggest that the lean body type is largely idealized by Norwegian adolescents. Compared to females, males scored higher on the DLS, and the greater number of males scoring high on the DLS compared to the EDE-Q and BEDA-Q, may illustrate that males relate more to the attributes featured in the DLS. This was also observed in the study by Smolak and Murnen (41) who found higher DLS scores in males (24.5) compared to females (22.6). The BEDA-Q also includes questions about body image and body ideals, but focuses more on thinness which is not necessarily related to leanness, muscularity and male body ideals (42). Using three different questionnaires with different approaches to the aspects of DE makes the results of the present study more nuanced, and can help discover traits and risk factors liked to certain populations, e.g. higher drive for leanness in males.

Similarly to the present study, a Norwegian study of first year students (n= 682) from Norwegian elite sport high schools and adolescent controls, documented higher levels of self-reported DE in non-athletes (50.7%) compared to athletes (25.0%) (43). In contrast to the majority of previous research (11), Martinsen et al. (2010) found no difference in DE between leanness and non-leanness sports (43). However, when clinical interviews were used to control the self-report results, athletes were found to underreport symptoms of DE (44). In the end, the prevalence of clinical EDs was found to be higher among the athletes (7.0%) compared to the controls (2.3%). The underreporting of symptoms in athletes can have several explanations; one may be a concern for exclusion from further sport participation if DE is revealed. In the present study, self-report data were not controlled by clinical interviews. Therefore, underreporting of symptoms in athletes, as well as overreporting in controls, may have occurred and affected the results, causing lower prevalence of DE among the athletes. In Norwegian non-athlete high school students, the prevalence of DE has been found highest in vocational study programs, followed by general study programs and lastly sport programs (7). Similar to the present study, Torstveit, Aagedal-Mortensen (7) found higher level of DE in association with overweight and weight regulation, suggesting that overweight may be a risk factor for DE.

Longitudinal development of disordered eating

DE scores were consistent over a 12 month period, and there were no significant differences in scores from the three measuring points on neither the EDE-Q, BEDA-Q or DLS. These findings are in accordance with results from other studies documenting stable DE scores in adolescent athletes over the course of a year (45), and in non-athletic adolescents over the course of up to three years (46, 47). Despite stable group variables, intraindividual differences may have occurred, however this was not analyses due to small sample size. The wide range of scores between the athletes in the longitudinal study could explain why no significant difference in group score was found from baseline to M3. Figure 1 shows a large variation in the direction of DE development between athletes, and also tendencies of some outliers. Especially scores on the EDE-Q varied a lot among the athletes. Even though there was no difference in scores from baseline to M3 on the BEDA-Q, this questionnaire went from finding three athletes with high scores at baseline, to none at M3, which could be viewed as a favourable development.

The consistent level of DE raises the question whether enough focus is put on healthy attitudes towards body image, eating for performance, and DE prevention. Information on the longitudinal development of DE in adolescent athletes may further clarify if there is sufficient preventive measures present, and whether these measures are effective. Longitudinal studies should be further conducted on this population, preferably in larger samples and over even longer timespan.

Disordered eating and associated factors

In the present study, DE was associated with higher body mass in both groups. Among the athletes, higher fat percentage was associated with Restraint, however the athletes had significantly lower fat percentage compared to the controls, meaning dietary restraint could have further negative consequences for their health, and possibly cause RED-S (13). In controls, Global score, Shape concern and Weight concern were associated with higher fat percentage. Thus, indicating that controls with a higher amount of fat mass also felt a higher concern about their appearance and weight. Associations between DE and higher body mass have been observed in previous studies (5, 48-51). Whether DE is caused by higher body mass, or if having DE leads to higher body mass cannot be established through correlations analyses. Both scenarios could be possible; higher body mass can be related to increased body dissatisfaction, a risk factor for DE, but DE can involve overeating and binging, causing a calorie surplus and weight gain (52).

EDE-Q scores were further associated with having lower amount of FFM. FFM consists mainly of muscle mass, which again is related to the lean body ideal, suggesting that subjects with less muscle mass had more body dissatisfaction. In contrast, DLS scores were not associated with body composition. DLS examines drive for leanness, which is related to wanting a muscular, lean body, however, this drive was neither positively nor negatively associated with fat percentage or FFM. The lack of associations between DLS and body composition, health parameters and dietary intakes in the present study, may be a result of the overall high DLS scores in both groups.

RMR_{ratio} and low BMD was not associated with DE in the present study, most likely given the fact that DE was not associated with reduced body mass, further related to decreased RMR and low BMD (53, 54). Individual data in study participants showed lower RMR_{ratio} and BMD in underweight individuals, however, these subjects did not report DE behaviour.

Moreover, DE was associated with lower dietary intakes. Only BEDA-Q scores were associated with lower intakes in athletes. In controls, on the other hand, there were several associations between low intakes and both EDE-Q- and BEDA-Q scores. Associations were weak to moderate among athletes, and moderate to strong among controls. Controls also presented higher levels of DE. In a large sample of female high school students with DE, dietary intakes were lower compared to healthy students (55). Furthermore, low dietary intakes of energy and fat have been observed in adolescent girls one year pre-onset of anorexia nervosa, suggesting that low dietary intakes can be an early sign of EDs (56). Although DE was related to higher body mass in the present sample, dietary interviews found low intakes in association with DE. One explanation could be that subjects had a restrictive diet but also regularly engaged in binge eating, though not frequently enough to be registered by the dietary interview. Another explanation could be underreporting of foods in subjects with DE, caused by shame or trying to appear "healthier". Underreporting of dietary intakes has been related to poor body image and weight consciousness (57). In the present study, an interview-guide was used in order to attain the most comprehensive dietary information, and there was no other method, considered ethical, to control for possible underreporting. Significantly higher intakes of energy and macronutrients were observed among the athletes compared to controls. Increased energy demand will follow intense physical activity, thus higher dietary intakes in these athletes are favourable. The present study did not estimate EA in the participants, however, took this into account by using dietary intakes per kg FFM, which may reflect EA more than viewing just absolute intakes.

Strength and limitations

Body composition, BMD and RMR was assessed objectively in a physiology lab by high quality equipment following best practice protocols. Given the self-report nature of questionnaires, every effort was made to maximise understanding of the questionnaires and ensure participants of their anonymity. Furthermore, an interview guide was followed during dietary interviews in order to obtain as accurate information as possible. Sufficient time was set aside to conduct the interviews, and the interviewer worked on establishing a safe environment for the subjects where no answers were right or wrong. Despite this, a limitation with self-report data is that some participants may still give inaccurate responses.

Perspectives

While some studies find higher levels of DE in athletes compared to non-athletes, the results of the present study support the hypothesis that sport participation may have a protective effect on eating problems, especially in adolescents. By longitudinally analysing levels of DE in athletes, the present study illustrated that the level of DE did not significantly increase or decrease in adolescent athletes attending first year of elite sport high schools. The results from the correlation analyses further indicated a relationship between DE and higher body mass and lower dietary intakes. Results from the DLS suggested that the muscular, lean body ideal is widely desired by Norwegian adolescents, both athletes and non-athletes. In future studies, it would be interesting to investigate the longitudinal development of DE in larger samples and longer timespans. More studies comparing adolescent athletes and non-athletes should be conducted in order to investigate to which degree adolescent athletes are affected by RED-S. Moreover, the indication that overweight predisposes for DE should be further explored in order to describe possible risk factor.

Conclusion

Adolescent elite athletes reported significantly lower DE scores on the EDE-Q and BEDA-Q compared to adolescent non-athletes ($p<0.01$). On the DLS, there was no significant difference in scores between athletes and non-athletes ($p=0.19$). None of the athletes and 31.2% of the controls were classified with DE based on the EDE-Q, 8.8% of the athletes and 40.0% of the controls had high scores on the BEDA-Q, while 53.1% athletes and 66.7% controls had high scores on the DLS. Among the athletes, DE scores stayed consistent over a 12 month period, and did not significantly change between the three measuring points. DE was associated with higher BMI, higher fat percentage, lower dietary intakes and lower FFM. There were no associations between DE and RMR_{ratio} and low BMD in the present sample.

Disclosure statement

No potential conflict of interest was reported by the authors.

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TABLES

***Table 1**. Baseline data of anthropometry, body composition, health parameters and dietary intakes. Presented as mean ±SD or median (25, 75 percentile).*

	Athletes n= 36	***Controls*** n= 16
Age (years)	16.4 ±0.3	16.3 ±0.4
Height (cm)	**177.6*** ±7.7	171.3 ±10.8
Body weight (kg)	65.7 ±8.1	65.2 ±10.5
BMI	20.8 ±1.8	22.3 ±3.3
Fat %	**17.5**** ±7.7	28.4 ±13.4
Fat%[M]	16.0 (11.0, 24.4)	33.9 (16.2, 38.1)
FFM (kg)	**55.0**** ±8.7	43.2 ±8.9
RMR_{ratio}	1.0 ±0.1	1.1 ±0.1
BMD z-score	-0.3 ±0.9	0.1 ±1
BMD z-score[M]	-0.4 (-1, 0.2)	-0.1 (-0.6, 0.7)

Total mean intakes ±SD	n=34	n=13
Kcal	**3141.8**** ±1183.6	1511.5 ±849.7
Protein (g)	**130.3**** ±55.2	71.4 ±46.8
Carbohydrate (g)	**383.1**** ±132.9	175.3 ±97.9
Fat (g)	**114.0**** ±52.0	54.1 ±34.9

Median intakes per kg/FFM (25, 75 percentile)		
Kcal	**53.6**** (45.0, 69.0)	38.8 (17.5, 53.0)
Protein (g)	**2.2*** (1.6, 2.9)	1.6 (0.8, 2.1)
Carbohydrate (g)	**6.3**** (5.7, 8.1)	5.0 (2.1, 5.5)
Fat (g)	**1.9*** (1.4, 2.6)	1.0 (0.5, 2.2)

* P<0.05 **p<0.01

[M] – non-normally distributed data, also presented as medians

BMD – bone mineral density, BMI – body mass index, Fat % – body fat percentage, FFM – fat-free mass, g – grams, Kcal – kilo calorie, RMR_{ratio} – resting metabolic rate ratio, SD – standard deviation

Table 2. *Scores on the self-report questionnaires: EDE-Q including Global score and the subscales Restraint, Eating concern, Shape concern and Weight concern, BEDA-Q and DLS.*

Athletes			
Questionnaires scores	**Median (25, 75 percentile)**	**Mean ±SD**	n=
EDE-Q Global score	0.1 (0.0, 0.5)**	0.3 ±0.5	36
- Restraint	0.0 (0.0, 0.3)**	0.3 ±0.5	34
- Eating concern	0.0 (0.0, 0.1)**	0.2 ±0.4	34
- Shape concern	0.1 (0.0, 0.6)**	0.5 ±0.9	34
- Weight concern	0.0 (0.0, 03)**	0.4 ±0.8	34
DLS	21.5 (16.0, 25.5)	21.1 ±6.3	32
BEDA-Q	10.0 (9.0, 12.0)**	11.1 ±4.3	34
Controls			n=
EDE-Q Global score	1.2 (0.6, 2.1)	1.7 ±1.6	15
- Restraint	1.4 (0.0, 2.6)	1.6 ±1.8	15
- Eating concern	0.4 (0.0, 1.6)	09 ±1.4	15
- Shape concern	1.6 (0.6, 3.3)	2.1 ±1.8	15
- Weight concern	1.4 (0.2, 2.8)	1.9 ±1.8	15
DLS	25.0 (16.0, 29.0)	23.7 ±7.3	15

Table 3. *Correlations between DE score, body composition, health parameters and dietary intakes.*

Athletes	**BMI**	**Fat %**	**FFM (kg)**	**RMR_{ratio}**	**BMD**	**Kcal/kg FFM**	**Protein/kg FFM**	**CH/kg FFM**	**Fat/kg FFM**
EDE-Q Global score	0,15	0,25	-0,31	0,02	0,09	-0.16	-0.28	-0.16	-0.11
- Restraint	**0,40***	**0,35***	-0,08	-0,04	0,13	-0.17	-0.20	-0.25	-0.94
- Eating concern	0,04	0,15	-0,27	0,01	-0,05	-0.07	-0.21	-0.01	-0.04
- Shape concern	-0,02	0,25	**-0,35***	0,02	-0,00	-0.16	-0.30	-0.19	-0.86
- Weight concern	0,13	0,24	-0,30	0,05	0,04	-0.07	-0.19	-0.11	-0.17
DLS	-0,02	-0,09	0,14	0,12	0,11	-0,14	-0,16	-0,16	-0,01
BEDA-Q	0,28	**0,42***	-0,29	-0,03	0,08	**-0,47****	**-0,47****	**-0,53****	**-0,35***
Controls									
EDE-Q Global score	0,31	**0,58***	**-0,62***	-0,27	0,38	-0,41	**-0,68***	-0,40	-0,57
- Restraint	0,32	0,46	-0,37	-0,08	**0,53***	-0,38	**-0,62***	-0,35	-0,56
- Eating concern	0,15	0,40	**-0,57***	-0,22	0,27	-0,12	-0,41	-0,19	-0,40
- Shape concern	0,31	**0,66****	**-0,69****	-0,26	0,40	-0,51	**-0,78****	-0,46	**-0,63***
- Weight concern	0,24	**0,52***	**-0,57***	-0,38	0,34	**-0,59***	**-0,82****	-0,50	**-0,70***
DLS	-0,07	-0,30	0,42	-0,25	0,20	0,18	0,18	0,30	-0,18
BEDA-Q	0,41	**0,79****	-0,68	-0,08	0,47	**-0,70***	**-0,88****	**-0,66***	**-0,65***

* $p<0.05$ **$p<0.01$

BMI – Body Mass Index, Fat % – Body fat percentage, FFM – Fat-Free Mass, RMR_{ratio} – Resting Metabolic Rate Ratio, BMD – Bone Mineral Density

EDE-Q - Eating Disorder Examination Questionnaire, DLS – Drive for Leanness Scale, BEDA-Q – Brief Eating Disorder in Athletes Questionnaire

FIGURES

Figure 1:

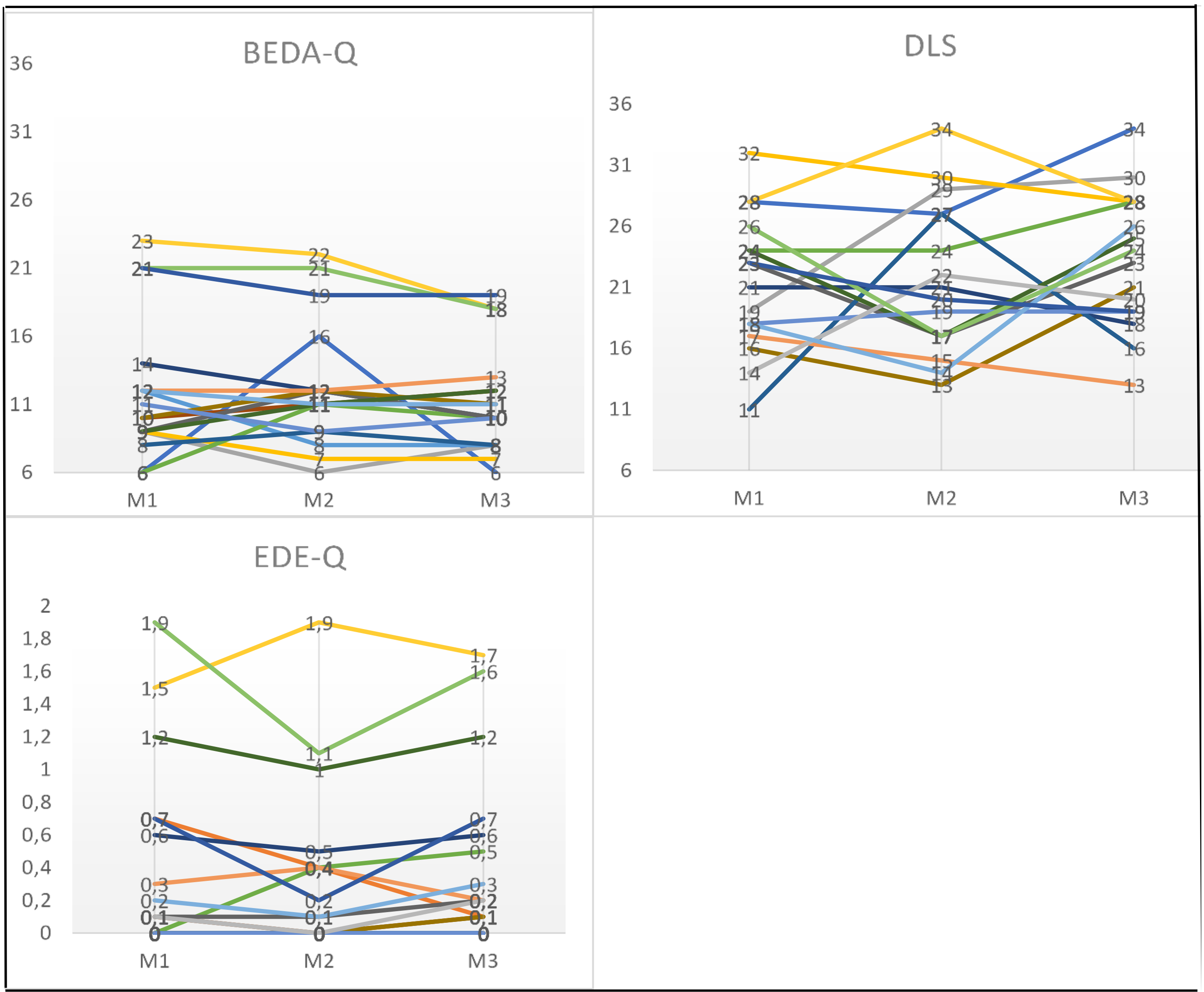


Figure 1: Longitudinal development of DE scores from the Brief Eating Disorder in Athletes Questionnaire (BEDA-Q), the Drive for Leanness Scale (DLS), and Eating Disorder Examination Questionnaire (EDE-Q) in athletes, based on three measuring points over the course of a year.

APPENDIX

CONTENTS

Benedikte Western
University of Agder
May 2019

APPENDIX 1

Monica Klungland Torstveit
Serviceboks 422
4604 KRISTIANSAND S

Vår dato: 16.08.2017	Vår ref: 54496 / 3 / STM	Deres dato:	Deres ref:

Tilbakemelding på melding om behandling av personopplysninger

Vi viser til melding om behandling av personopplysninger, mottatt 22.05.2017. All nødvendig informasjon om prosjektet forelå i sin helhet 16.08.2017. Meldingen gjelder prosjektet:

54496	Energitilgjengelighet og idrettslig prestasjon - Forekomst og utvikling av relativ energimangel og assosierte helse- og prestasjonsvariabler blant unge mannlige og kvinnelige idrettsutøvere i Sør-Norge
Behandlingsansvarlig	Universitetet i Agder, ved institusjonens øverste leder
Daglig ansvarlig	Monica Klungland Torstveit

Personvernombudet har vurdert prosjektet, og finner at behandlingen av personopplysninger vil være regulert av § 7-27 i personopplysningsforskriften. Personvernombudet tilrår at prosjektet gjennomføres.

Personvernombudets tilråding forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, ombudets kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database.

Personvernombudet vil ved prosjektets avslutning, 30.11.2020, rette en henvendelse

angående
status for behandlingen av personopplysninger.

Dersom noe er uklart ta gjerne kontakt over

telefon. Vennlig hilsen

Katrine Utaaker
Segadal

Siri Tenden Myklebust

Kontaktperson: Siri Tenden Myklebust tlf: 55 58 22 68 / Siri.Myklebust@nsd.no

Vedlegg: Prosjektvurdering

Personvernombudet for forskning

Prosjektvurdering - Kommentar

Prosjektnr: 54496

FORMÅL

Formålet med prosjektet er å undersøke sammenhengen mellom energitilgjengelighet (EA) og idrettslige prestasjoner hos unge idrettsutøvere over tid. Tilstrekkelig EA (samsvar mellom inntak og forbruk) er viktig både for helse og god prestasjon for idrettsutøvere. For lav EA har vist seg uhensiktsmessig for helse og prestasjon, og forskningen er mangelfull i forhold til unge talentfulle utøvere. Intens trening i kombinasjon med energimangel kan føre til økt risiko for sykdom og skader, overtrening og nedsatt prestasjon. Man ønsker gjennom prosjektet å få innsyn i og forståelse for hvordan unge utøvere og deres trenere kan sikre grunnlaget for best mulig trening og prestasjon på kort og lang sikt, slik at kroppen tåler den økende treningsmengde over tid for å bli god.

REK har vurdert at prosjektet faller utenfor helseforskningslovens virkeområde (2017/738/REK sør-øst A).

UTVALG OG DATAINNSAMLING

Det skal rekrutteres ca. 100 konkurranseaktive elever fra VG1 på idrettsgymnas. Disse må være konkurranseaktive innen idretten sin på regionalt og/eller nasjonalt nivå. Det skal også inkluderes en kontrollgruppe bestående av elever fra den lokale videregående skolen. Elevene i kontrollgruppen skal ha ulikt aktivitetsnivå, ikke trene spesifikt mot en konkurranse, men trene maksimalt fire timer i uken.

Når prosjektet starter inkluderes kun elever fra VG1, og disse følges longitudinelt gjennom den videregående skole. Er deltaker 15 år ved prosjektstart, involveres foreldre i informasjon og samtykke. Elever mellom 16-18 år samtykker på egen hånd. Personvernombudet er enig i at 16-åringene kan samtykke selv i dette prosjektet. Vi har lagt vekt på at det er nødvendig for prosjektets formål å innhente opplysningene fra ungdommene selv.

Data samles inn ved bruk av elektronisk og papirbasert spørreskjema og medisinske tester. Deltakerne vil gjennomgå idretts-spesifikke fysiologiske tester (maksimalt oksygenopptak, laktat-profiltest, anaerob kapasitet, reaksjonstest og styrketest). I tillegg samles det inn helsevariabler, ved bruk av ergo-spirometri, blodprøver, blodtrykk, høyde, vekt, DXA (beinhelse og kroppssammensetning) samt målinger knyttet til energiomsetning (aktivitetsmåling, pulsmåling samt hvilemetabolisme samt kostholdsregistrering).

INFORMASJON OG SAMTYKKE

Utvalget informeres skriftlig og muntlig om prosjektet og samtykker til deltakelse. Informasjonsskrivet mottatt 16.08.2017 er godt utformet.

SENSITIVE PERSONOPPLYSNINGER

Det behandles sensitive personopplysninger om helseforhold.

INFORMASJONSSIKKERHET
Personvernombudet legger til grunn at forskerne etterfølger Universitetet i Agder sine interne rutiner for datasikkerhet. Siden det skal behandles sensitive personopplysninger, anbefaler vi at disse krypteres.

INNSAMLING AV BIOLOGISK MATERIALE
Ifølge forsker skal biologisk materiale ikke oppbevares i prosjektperioden, men vil destrueres fortløpende. Så lenge biologisk materiale destrueres innen tre måneder er det ikke nødvendig å søke om opprettelse av forskningsspesifikk biobank. Vi viser for øvrig til korrespondanse den 08.08.2017 og den 16.08.2017.

PROSJEKTSLUTT
Forventet prosjektslutt er 30.11.2020. Deretter skal datamaterialet oppbevares avidentifisert i 10 år og koblingsnøkkelen skal oppbevares på UiA i tilsvarende periode for eventuelt longitudinelt studie og/eller oppfølgingsstudier. Innen det er gått 10 år skal datamateriale anonymiseres. Anonymisering innebærer å bearbeide datamaterialet slik at ingen enkeltpersoner kan gjenkjennes. Det gjøres ved å:
- slette direkte personopplysninger (som navn/koblingsnøkkel)
- slette/omskrive indirekte personopplysninger (identifiserende sammenstilling av bakgrunnsopplysninger som f.eks. bosted/arbeidssted, alder og kjønn)

Vi minner om at eventuelle oppfølgingsstudier eller ny forskning på datamaterialet krever ny melding til personvernombudet.

APPENDIX 2

Informasjon og forespørsel om deltakelse i et forskningsprosjekt ved Olympiatoppen Sør og Universitetet i Agder

«Energitilgjengelighet, helse og prestasjon»

Forekomst og utvikling av relativ energimangel og assosierte helse- og prestasjonsvariabler blant unge mannlige og kvinnelige idrettsutøvere i Sør-Norge

UNIVERSITETET I AGDER

OLYMPIATOPPEN
Sør

APPENDIX 2

Kjære unge idrettsutøver!

Vi søker talentfulle unge utøvere innen sykling, langrenn, skiskyting, langdistanseløping, orientering, svømming, fotball og håndball til å bli med på et forskningsprosjekt i forbindelse med en doktorgrad i idrettsvitenskap ved Universitetet i Agder (UIA) og i samarbeid med Olympiatoppen Sør.

Bakgrunn og hensikt

For utøvere i alle aldre kan det være vanskelig å finne den gode balansen mellom trening, kosthold og restitusjon. I dette forskningsprosjektet ønsker vi å kartlegge en rekke variabler som vi antar har en sammenheng med idrettslig prestasjon og helse. Vi har en del kunnskap om disse variablene blant voksne mannlige og kvinnelige utøvere på toppnivå, men vi vet mindre om tilsvarende variabler blant unge utøvere. Vi har spesielt lite kunnskap om hva som skjer i løpet av perioden hvor unge jenter og gutter går på idrettsgymnas. I denne perioden er det mange som opplever økte treningsmengder, mindre tid til restitusjon og utfordringer med å få i seg nok og riktig mat. I dette prosjektet ønsker vi derfor å måle variabler som treningsmengde, fysisk kapasitet (eks. utholdenhet, muskelstyrke og reaksjonstid), kostholdsvaner, kroppssammensetning og andre helsevariabler som blodtrykk, sykdom og skader. Vi ønsker å måle disse variablene to ganger i sesongen over den perioden man er elev ved idrettsgymnaset.

Dette ønskes gjort for å få et større innsyn i, og forståelse for, hvordan utøvere og trenere kan legge til rette for, og sikre grunnlaget for best mulig trening og prestasjon ikke bare på kort sikt, men også sikre at kroppen bygges opp for å tåle den økende treningsmengde som kreves over lang tid for å bli god i sin idrett.

Med bakgrunn i dette er det i kommende forskningsprosjekt ønskelig å kartlegge fysiologiske helse- og prestasjonsvariabler som trenings- og kostholdsvaner, kroppssammensetning, blodtrykk, hvilemetabolisme, fysiologisk kapasitet, sykdom og skader samt psykologiske variabler som motivasjon, velvære samt forhold til mat, trening, kropp og vekt to ganger i sesongen over tre år.

Vi håper at du har lyst til å hjelpe oss med å skaffe slik unik kunnskap og bidra til forskning innen idrettsvitenskap.

Forsøkspersoner

Vi ønsker å rekruttere utøvere som oppfyller følgende inklusjonskriterier:

(1) Elev ved VG1 på idrettsgymnas ved prosjektet begynnelse
(2) Konkurranseaktiv innen idretten sin på regionalt og/eller nasjonalt nivå
(3) Fravær fra sykdom og skader som hindre deltakelse i prosjektet.

Deltakelsen i prosjektet innebærer derfor for deg som deltaker, at du må være villig til å gjennomføre et testbatteri over 1-2 dager (til sammen kun ca. 2 timer), samt svare på spørsmål om kosthold, trening, aktivitetsnivå og vekt to ganger i sesongen over tre år.

APPENDIX 2

Hva innebærer deltakelse i prosjektet?

Dette er en kartleggingsstudie som vil inneholde to målepunkter fordelt over en sesong (før og etter sesong). Prosjektet vil gjennomføres over tre sesonger, hvilket innebærer seks måle- og registreringsperioder (se figur 1 for oversikt). Prosjektet er lagt opp slik at det ikke skal forstyrre treningsopplegget ditt hvis du ønsker å delta.

Testfasen:

Testfasen består av en testdag med spørsmål knyttet til kostholdet ditt (se eget ark). Du ankommer OLT Sør i Kristiansand tidlig på dagen du skal teste.

- Til testen skal du møte fastende i laboratoriet for måling av kroppssammensetning, beinhelse, hvilestoffskiftet, blodtrykk, reaksjonstest, styrketest, og du vil bli spurt om å besvare noen spørreskjemaer om mat, kropp og helse.
- Den siste test du skal gjennomføre er en VO2maks test, men denne utføres på ettermiddagen, og altså ikke på morgenen slik de andre tester gjøres. VO2maks testen er derfor ikke i fastende tilstand.
- Siden du kun kommer til laboratoriet for testing to ganger per år vil du bli bedt om å svare på noen få spørsmål ca. en gang i måneden via et elektronisk spørreskjema. Disse spørsmålene handler hovedsakelig om sykdom, skader og velvære.
- En gang i løpet av perioden vil du bli bedt om å svare på samme spørreskjema med to ukers mellomrom (se figur 1 i vedlegg).
- De siste 7 dager opp testing skal du sove med søvnmåler på armen, gå med aktivitetsmåler på dagen samt loggføre al trening med pulsklokke.

***NB:** De siste 24 timer før testdagen må du ikke utføre intensiv eller utmattende trening/konkurranser eller drikke alkohol. Du har ikke tillatelse til å spise, snuse eller røyke de siste 9 timene før testene (disse gjennomføres tidlig på morgenen). De siste tre timer før testene må du ikke drikke te, kaffe eller annen koffeinholdig drikke. Som forsøksperson vil du bli godt ivaretatt av testledere.*

Mulige fordeler og ulemper:

Mulige fordeler:

- Bidra til å skaffe ytterligere kunnskap rundt energitilgjengelighet blant unge idrettsutøvere og ikke-konkurranseaktive ungdom
- Få mulighet til å teste fysisk kapasitet uten kostnad på UIA/OLT Sør
- Få kartlagt helsevariabler av betydning for idrettslig prestasjon uten kostnad på UIA/OLT Sør
- Få kartlagt kostholdsvaner, søvn og energiforbruk uten kostnad på UIA/OLT Sør.
- Få målt hvilestoffskiftet og kroppssammensetning med gullstandard målemetoder og kunne følge disse over tid

APPENDIX 2

Mulige ulemper:

- Må møte fastende til testing 6 ganger i løpet av 3 år. Slik testing kan ligge i skoletiden, da primært ved å erstatte andre treningsøkter, men forventes ikke å ha varighet på mer enn 1,5 time pr. test. Helsetest må gjennomføres i fastende tilstand
- Kan ikke trene intensive økter dagene før testing
- Må være opplagt til hver test og gjennomføre disse med god innsats
- Måling av hvilestoffskiftet kan oppleves uvant for enkelte
- Risiko for overbelastning ved testing
- Må svare på spørsmål knyttet til kosthold og trening hver 6. måned i tre år.

Hva skjer med informasjon om deg?

Data som blir registrert skal kun brukes slik som beskrevet i hensikten med prosjektet. Opplysningene vil bli behandlet uten navn og fødselsnummer, eller andre direkte gjenkjennende opplysninger. Som deltaker vil du få et ID nummer som representerer ditt navn. Tester som blir gjennomført og data som blir innhentet, vil knyttes til dette ID nummeret. Det er kun autorisert personell knyttet til prosjektet som har adgang til ID nummeret og nøkkelfilen vil oppbevares nedlåst hos prosjektansvarlig. Innsamlet data vil bli benyttet i masterprosjekt og doktorgradsprosjekt, men alltid anonymt. Dataene vil også kunne bli brukt til publisering i tidsskrift, undervisning og kongresser. Som deltaker har du rett til å få innsyn i data som er registrert på deg selv. Data vil oppbevares avidentifisert på prosjektlederes passordbelagte PC. Data vil bli oppbevart i opptil 10 år etter at prosjektet er avsluttet.

Rett til innsyn og sletting av opplysninger om deg

Hvis du sier ja til å delta i prosjektet, 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 prosjektet, kan du kreve å få slettet innsamlede prøver og opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner.

Frivillig deltakelse:

Det er frivillig å delta i prosjektet. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke til å delta i prosjektet. Dersom du ønsker å delta, undertegner du samtykkeerklæringen som medfølger. Om du nå sier ja til å delta, kan du senere trekke tilbake ditt samtykke uten at det påvirker din øvrige deltakelse. Dersom du senere ønsker å trekke deg eller har spørsmål til prosjektet, kan du kontakte prosjektleder/ kontaktperson (se under). Ytterligere detaljert informasjon om prosjektet og de ulike testene kan fås ved å kontakte stipendiat Thomas Birkedal Stenqvist.

Annet:

Datainnsamling forventes avsluttet senest i uke 17, 2019. Datamateriale forventes oppbevart i 10 etter endt datainnsamling.

APPENDIX 2

Hvordan bli med?

Dersom du ønsker å være en del av dette prosjektet kan du sende en mail til thomas.b.stenqvist@uia.no der du beskriver følgende:

- Hvem du er
- Idrettsgren og nivå
- Skole og klasse

Dersom du blir plukket ut til deltakelse må du også signere samtykkeerklæringen på siste side og levere denne til Thomas eller Monica.

Med vennlig hilsen
Thomas Birkedal Stenqvist
PhD stipendiat

Fakultet for helse- og idrettsvitenskap
Institutt for folkehelse, idrett og ernæring
Universitetet i Agder
Tlf: + 47 38142416
Mobil: + 47 45290621
thomas.b.stenqvist@uia.no

Konsulent, Test- og laboratorietjenester
Olympiatoppen Sør

Prosjektansvarlig og veileder
Monica Klungland Torstveit
Førsteamanuensis

Fakultet for helse- og idrettsvitenskap
Institutt for folkehelse, idrett og ernæring
Universitetet i Agder
Tlf: + 47 3814 1831
monica.k.torstveit@uia.no

Fagansvarlig Idrettsernæring og restitusjon,
Olympiatoppen Sør

APPENDIX 2

Vedlegg:

Detaljert beskrivelse av de ulike testene
<u>Testdagen</u>

Ved ankomst til laboratoriet ønsker vi først å måle hvilestoffskiftet ved hjelp av indirekte kaliometri.

Hvilestoffskiftet: Vi vet at det kan være store forskjeller i hvilestoffskiftet mellom individer og de aller færreste vet hvor mye energi de bruker i hvile da målemetodene sjelden er tilgjengelig. Som forsøksperson skal du ligge avslappet på en benk i ca. 30 minutter med en «hette» (som vist på bildet). Målingen medfører ingen smerte eller ubehag. Hvilepulsen vil bli registrert og vi vil se til at du ikke sovner underveis i målingen. Mens dere ligger på benken vil vi også måle **blodtrykket** liggende og deretter i stående posisjon.

Beinhelse og kroppssammensetning: DXA (dobbel røntgen absorpsjonsmetri) er gullstandard måling for vurdering av din kroppssammensetning og beinhelse. Dette måles ved hjelp av lav-dose røntgenstråling (stråledosen du blir utsatt for er svært liten og tilsvarer samme mengde du vanligvis får ved å fly fra Oslo til New York). Ved DXA måling vil du blant annet få målt muskelmasse og din beinmineraltetthet (indikator på hvor sterkt skjelettet ditt er). Du vil få resultater både totalt for hele kroppen, men også i spesielt interessante områder som rygg og hofter. Selve målingen er <u>helt smertefri</u> og gjennomføres påkledd ved å ligge på en benk/seng. Det vil kun ta ca. 15 minutter å gjennomføre målingen.

Arbeidsøkonomi: Vi ønsker å måle hvor effektive dere er til å utføre et stykke arbeide i fastende tilstand, og hvor mye det koster å doble arbeidsmengden. Arbeidet utføres på en stasjonær sykkel, hvor vi måler forbruket av oksygen og produksjonen av karbondioksid. Testen består av 3 blokker av 6 min hver. Belastningen er hhv. 0 watt, 50 watt og 100 watt. Belastningen er derfor meget lav og testen vil føles meget lett.

Reaksjonstest: Reaksjonstiden du bruker måles ved hjelp av en bærbar PC. Reaksjonstiden testes ved å måle tiden du bruker på å trykke mellomroms-tasten ned på tastaturet når PC-skjermen skifter farge.

Maksimal styrke: Her vil vi måle din maksimale muskelstyrke ved hjelp av dertil utvalgt styrkeprotokoll. Det vi ønsker å måle er hhv. utholdende styrke, maksimal styrke og power.

APPENDIX 2

Måltid: Etter styrketesten er vi ferdige med dagens første blokk, og det er tid for skole. Det er nå viktig at dere spiser frokost og mat gjennom dagen slik dere vanligvis gjør, før dere skal testes igjen på ettermiddagen (etter skole).

VO_{2maks}: Under testen måles oksygenopptaket til utmattelse. Du vil bli bedt om å begynne arbeidet på en gitt belastning som vil økes hvert minutt inntil utmattelse inntrer og du ser deg nødsaget til å avslutte testen. De to høyeste målinger du oppnår danner grunnlag for dit maksimale oksygenopptak. Alle utenom syklister testes på tredemølle. Testen begynner på 6 km/t med en konstant stigning på 10,5%. Farten på tredemøllen økes med 1km/t pr. minutt inntil utmattelse inntreffer.

Avslutningsvis bes dere om å besvare noen spørreskjema før dere er ferdige med dagens testbatteri. Spørsmålene omhandler temaer som demografi, treningsmengde, konkurranseerfaring, forhold til trening, mat og kropp, skader/sykdommer og restitusjon/søvn/velvære.

Søvnmåler: De siste 7 dager opp til testing skal du sove med en søvnmåler på armen. Denne påsettes før du legger deg, og tas av igjen når du står opp.

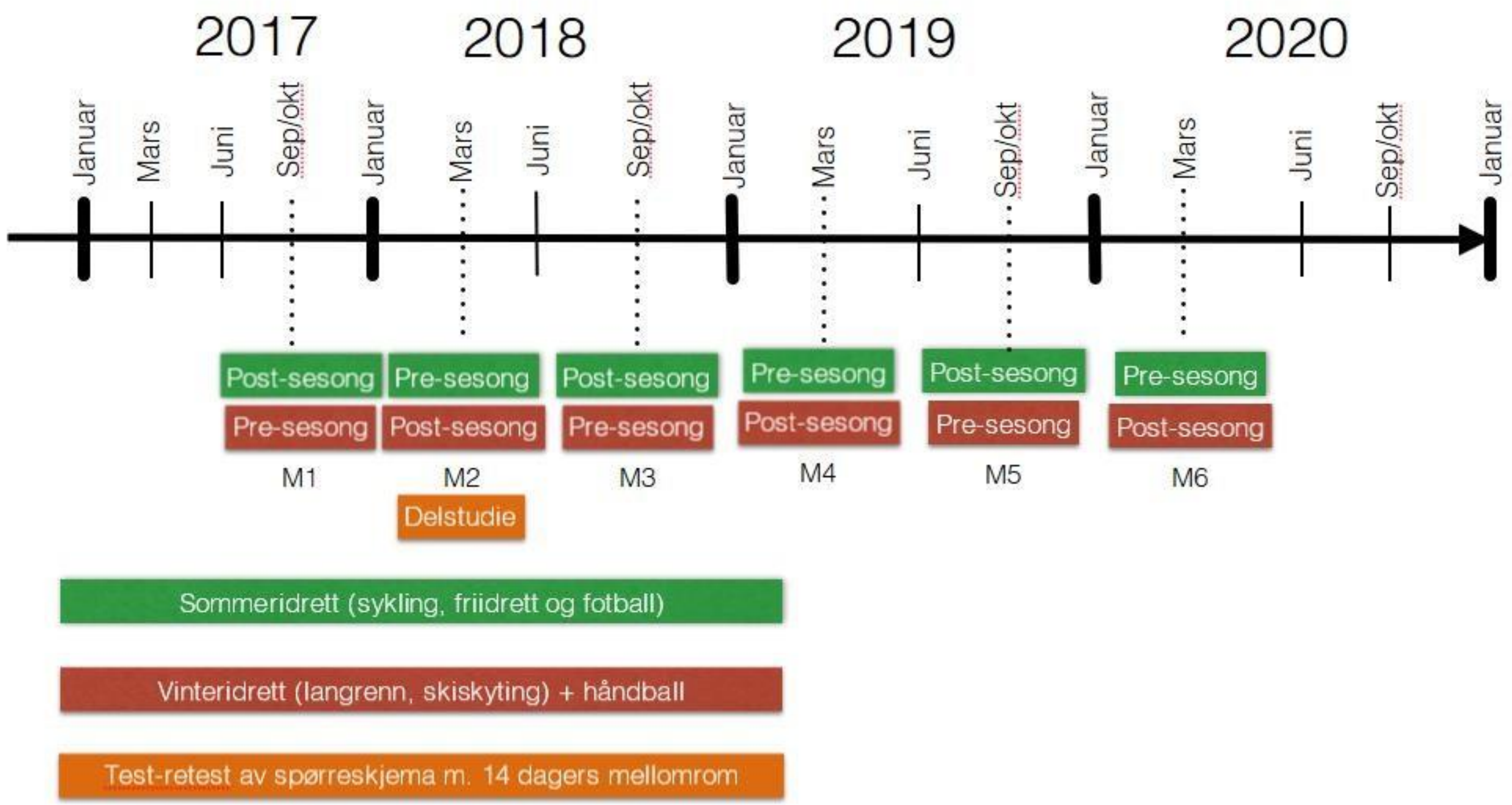
Aktivitetsmåler: De siste 7 dager opp til testing skal gå med en aktivitetsmåler på armen, fra du står opp til du går i seng. Denne skal KUN tas av når du dusjer, svømmer og trener. Viktig at den tas på igjen så raskt som mulig.

Pulsmåling under trening: De siste 7 dager opp til testing skal deltakeren loggføre al s trening med en pulsklokke som lagrer økten. Hvis du ikke selv har enten en Polar (med tilkopling til Polar Flow) eller en Garmin (med tilkopling til Garmins hjemmeside) har du mulighet for å låne en Polarklokke med pulsbelte av oss.

Fingerstikk: Vi ønsker å måle glukosenivå i blodet med et fingerstikk etter hvilemetabolisme-testen og under arbeidsøkonomi-testen (totalt 4 fingerstikk).

APPENDIX 2

Tidslinje for hele prosjektet:



Figur 1: *Oversikt over prosjektet. Prosjektet består av seks målepunkter (M1 – M6) hver 6. måned, samt hvor i sesongen hhv. vinteridrett og sommeridretter befinner seg. En gang i løpet av prosjektet sendes det samme spørreskjema med 14 dagers mellomrom.*

APPENDIX 3

UNIVERSITETET I AGDER

Samtykke til deltakelse i prosjektet

«Energitilgjengelighet og idrettslig prestasjon»

Ved å si ja til å delta i prosjektet, har du rett til å få innsyn i hvilke opplysninger som er registrert på deg. Du har videre rett til å få korrigert eventuelle feil i de opplysningene vi har registrert. Dersom du trekker deg fra prosjektet, kan du kreve å få slettet innsamlede opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner.

Ved å signere samtykkeerklæringen bekrefter du også at du ikke har kjent hjertesykdom eller andre lidelser/sykdom som medfører at din fastlege har frarådet deg å teste intensivt.

Som deltaker i prosjektet er du for øvrig forsikret via at staten er selvassurandør for universitetene.

Jeg er villig til å delta i prosjektet

(Signert av prosjektdeltaker, dato)

Jeg bekrefter å ha gitt informasjon om prosjektet

(Signert, rolle i prosjektet, dato)

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PASTA Physiological Adaptation in Sport, Training and physical Activity

APPENDIX 4

Del 5, DLS, forhold om kropp og kroppsbilde

Nedenfor er det noen meninger om kropp. Hvor ofte stemmer disse for deg?

Aldri = 1
Sjeldent = 2
Noen ganger = 3
Ofte = 4
Nesten alltid= 5
Alltid= 6

6-point scale, ranging from never (1) to always (6). (aldri = 1, sjeldent = 2, noen ganger = 3, ofte = 4, nesten alltid= 5, alltid= 6)

1. Jeg synes de kroppene som ser finest ut er de som er veldefinerte*
2. Personer som har en fast og veldefinert kropp er svært disiplinerte*
3. Målet mitt er å ha veldefinerte muskler*
4. Personer som har en veltrent kropp og ser atletiske ut er de mest attraktive*
5. Det er viktig å ha veldefinerte magemuskler*
6. Klær ser finere ut på personer som har veldefinerte muskler*

Takk for svarene i del 5

Eating Disorder Examination Questionnaire (EDE-Q 6.0)

From *"Cognitive Behavior Therapy and Eating Disorders"*
by Christopher G. Fairburn

Original English version is available online at:
www.psych.ox.ac.uk/credo/cbt_and_eating_disorders

Norsk godkjent oversettelse

v/ D. L. Reas og Ø. Rø ved Regional avdeling for spiseforstyrrelser (RASP),
Oslo universitetssykehus HF, Ullevål.
September 2008

EDE-Q 6.0 DATO: ____________________ ID NUM: _____________

Instruksjoner: Dette spørreskjema handler kun om de siste fire ukene (28 dager). Les hvert spørsmål nøye. Svar på alle spørsmålene.

Spørsmål 1 til 12: Tegn en sirkel rundt det tallet til høyre som du synes passer best. Husk at spørsmålene kun handler om de siste fire ukene (28 dagene).

	På hvor mange av de siste 28 dagene …	**Ingen dager**	**1-5 dager**	**6-12 dager**	**13-15 dager**	**16-22 dager**	**23-27 dager**	**Alle dager**
1	Har du bevisst prøvd å begrense mengden mat du spiser for å påvirke din figur eller vekt (uavhengig av om du har klart det eller ikke)?	0	1	2	3	4	5	6
2	Har du i lengre perioder (8 våkne timer eller mer) ikke spist noe i det hele tatt for å påvirke din figur eller vekt?	0	1	2	3	4	5	6
3	Har du prøvd å utelukke noen typer mat du liker, for å påvirke din figur eller vekt (uavhengig av om du har klart det eller ikke)?	0	1	2	3	4	5	6
4	Har du prøvd å følge bestemte regler for hva eller hvordan du spiser (f.eks. en kalorigrense) for å påvirke din figur eller vekt (uavhengig av om du har klart det eller ikke)?	0	1	2	3	4	5	6
5	Har du hatt et klart ønske om å ha tom mage for å påvirke din figur eller vekt?	0	1	2	3	4	5	6
6	Har du hatt et klart ønske om å ha en helt flat mage?	0	1	2	3	4	5	6
7	Har du opplevd at tanker om mat, spising eller kalorier har gjort det veldig vanskelig å konsentrere deg om ting du er interessert i (f.eks. å arbeide, følge en samtale eller lese)?	0	1	2	3	4	5	6
8	Har du opplevd at tanker om figur eller vekt har gjort det veldig vanskelig å konsentrere deg om ting du er interessert i (f.eks. å arbeide, følge en samtale eller lese)?	0	1	2	3	4	5	6
9	Har du hatt en klar frykt for å miste kontroll over spisingen din?	0	1	2	3	4	5	6
10	Har du hatt en klar frykt for at du kan gå opp i vekt?	0	1	2	3	4	5	6
11	Har du følt deg tykk?	0	1	2	3	4	5	6
12	Har du hatt et sterkt ønske om å gå ned i vekt?	0	1	2	3	4	5	6

Spørsmål 13 til 18: Fyll inn passende antall i boksene til høyre. Husk at spørsmålene kun handler om de siste fire ukene (28 dagene).

	I løpet av de siste fire ukene (28 dagene)…	
13	I løpet av de siste 28 dagene, hvor mange ganger har du spist det andre ville betraktet som en uvanlig stor mengde mat (omstendighetene tatt i betraktning)?	………………..
14	Ved hvor mange av disse episodene hadde du en følelse av å ha mistet kontrollen over spisingen din (mens du spiste)?	………………..
15	I løpet av de siste 28 dagene, hvor mange DAGER har slike episoder med overspising forekommet (dvs. der du har spist uvanlig store mengder mat og hatt en følelse av å miste kontrollen mens du spiste)?	………………..
16	I løpet av de siste 28 dagene, hvor mange ganger har du kastet opp for å kontrollere din figur eller vekt?	………………..
17	I løpet av de siste 28 dagene, hvor mange ganger har du brukt avføringsmidler for å kontrollere din figur eller vekt?	………………..
18	I løpet av de siste 28 dagene, hvor mange ganger har du følt deg drevet eller tvunget til å trene for å kontrollere din vekt, figur eller fettmengde, eller for å forbrenne kalorier?	………………..

Spørsmål 19 til 21: Tegn en sirkel rundt det tallet som du synes passer best. Vær oppmerksom på at i disse spørsmålene brukes begrepet "overspisingsepisode" om å spise det andre ville synes var en uvanlig stor mengde mat i den situasjonen du var i, samtidig med en følelse av å ha mistet kontroll over spisingen.

19	I løpet av de siste 28 dagene, hvor mange dager har du spist i hemmelighet (i skjul)? …tell ikke med overspisingsepisoder.	Ingen dager	1-5 dager	6-12 dager	13-15 dager	16-22 dager	23-27 dager	Alle dager
		0	1	2	3	4	5	6
20	Hvor mange av de gangene du har spist, har du hatt skyldfølelse (følt at du har gjort noe galt) fordi det kan påvirke din figur eller vekt? …tell ikke med overspisingsepisoder.	Ingen av gangene	Noen få ganger	Færre enn halv-parten	Halv-parten	Mer enn halv-parten	De fleste gangene	Hver gang
		0	1	2	3	4	5	6
21	I løpet av de siste 28 dagene, hvor bekymret har du vært for at andre mennesker ser deg spise? …tell ikke med overspisingsepisoder.	Ikke i det hele tatt		Litt		Ganske mye		Veldig mye
		0	1	2	3	4	5	6

Spørsmål 22 til 28: Tegn en sirkel rundt det tallet til høyre som du synes passer best. Husk at spørsmålene kun handler om de siste fire ukene (28 dagene).

	I LØPET AV DE SISTE 28 DAGENE………	**Ikke i de hele tatt**		**Litt**		**Ganske mye**		**Veldig mye**
22	Har vekten din påvirket hvordan du tenker om (bedømmer) deg selv som person?	0	1	2	3	4	5	6
23	Har figuren din påvirket hvordan du tenker om (bedømmer) deg selv som person?	0	1	2	3	4	5	6
24	Hvor opprørt ville du bli hvis du ble bedt om å veie deg en gang i uken (ikke mer, ikke mindre) de neste fire ukene?	0	1	2	3	4	5	6
25	Hvor misfornøyd har du vært med vekten din?	0	1	2	3	4	5	6
26	Hvor misfornøyd har du vært med figuren din?	0	1	2	3	4	5	6
27	Hvor mye ubehag har du følt ved å se kroppen din (f.eks. når du ser figuren din i speilet, reflektert i et butikkvindu, ved klesskift, eller når du bader eller dusjer)?	0	1	2	3	4	5	6
28	Hvor mye ubehag har du følt ved at andre ser figuren din (f.eks. i offentlige omkledningsrom, når du svømmer, eller når du har på deg trange klær)?	0	1	2	3	4	5	6

Hva er din nåværende vekt? (vennligst anslå så godt som mulig) ……………………

Hvor høy er du? (vennligst anslå så godt som mulig) ………….…………

Hvis kvinne: Har noen menstruasjoner uteblitt de siste 3-4 månedene? ……………
Hvis ja, hvor mange? ……………...
Har du brukt p-piller, p-plaster, p-ring, eller lignende? ………

TAKK!

BEDA-Q Introduksjon

I punktene nedenfor spørres det om dine holdninger, følelser og atferd. Noen av punktene handler om mat og spising. Andre punkter dreier seg om dine følelser i forhold til deg selv. Du skal ved hvert punkt bestemme deg for i hvilken grad utsagnet passer på deg: ALLTID, VANLIGVIS, OFTE, IBLANT, SJELDEN eller ALDRI. Hvis du mener at ditt svar på et utsagn er ofte, sett da et kryss i ruten i kolonnen under ofte for det gjeldende utsagn.

Svar på alle punktene idet du forvisser deg om at du setter kryss i den ruten som best gjenspeiler hvordan du føler det nå for tiden.

ID-nummer:

Dato:

SETT KUN ETT KRYSS FOR HVERT SPØRSMÅL

		Alltid	Vanligvis	Ofte	Iblant	Sjelden	Aldri
1	Jeg får dårlig samvittighet når jeg har spist for mye.	☐	☐	☐	☐	☐	☐
2	Jeg er svært opptatt av å bli tynnere.	☐	☐	☐	☐	☐	☐
3	Jeg synes at magen min er for stor.	☐	☐	☐	☐	☐	☐
4	Jeg er fornøyd med figuren min.	☐	☐	☐	☐	☐	☐
5	Foreldrene mine har krevd topp-prestasjoner av meg.	☐	☐	☐	☐	☐	☐
6	Som barn anstrengte jeg meg mye for ikke å skuffe mine foreldre og lærere.	☐	☐	☐	☐	☐	☐

UNIVERSITETET I AGDER

Manual for semistructured dietary interview

Energy availability and sports performance

Incidence and development of relative energy deficiency among young female and male athletes in Southern Norway

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PASTA
Physiological Adaptation in Sport, Training and physical Activity

OLYMPIATOPPEN Sør

APPENDIX 5

1. Introduction and aim

The aim of the semi-structured dietary interview is to assess habitual dietary pattern and to estimate energy intake in adolescent athletes from three different high schools in Southern Norway. Semistructured interviews allow for structure but are not so rigid that they limit the participant from sharing tangential and often relevant information.

For the purpose of this study, the interview aims to assess habitual meal patterns and dietary intake with specification of intake during the last seven days. There are several limitations compromising the validity of this method compared to the prospective weighed food record. Therefore, it is extremely important that the interviews are carried out as standardized as possible. The wording of the questions and how they are presented to the participants are crucial for the quality of the collected data. The language must be open-ended, unbiased, and nonjudgmental.

Be curious and get as much details about the respondent's meal pattern as possible. If he/she has difficulties in remembering, give him/her a little time to think back.
Make the respondent feel important. He/she has very important information we need in our research.

The interviewer must be completely objective. There are no "right" or "wrong" foods and it is important that the interview is reflected by this. Closed questions (where the answer can be "yes" or "no") should be avoided. Instead, questions often begin with "when" or "what". When you ask for details, it is okay to begin with "is this…", e.g. "is this a with or without sugar?"

For many people, talking about their dietary habits can be very intimidating, especially when they are face by health professionals. Maybe they are nervous when coming in to the interview. The interviewer must be natural in his questioning technique and when answers are received by the respondent. It is the interviewer's task to create a comfortable environment, where the respondent feels, he/she can be 100% honest. Nodding and smiling are simple and good ways to manage this. First step is to ask an ice-breaker question for instance: "Hi and welcome. I really appreciate that you want to participate in this study. What are your experiences so far?" or "what a nice weather today – how are you going to enjoy it later today?"

The interview guide serves the interviewer as a help to get the needed information but the order of the questions may depend on how the respondent answers and maybe you need to ask additional questions. Many sports are seasonal; therefor the interview is performed twice for each athlete.
Use the interview guide and write down the respondent's answers in the form.

2. Interview guide

Once again thank you for your participation in this study. Your participation is very valuable to us, and your participation help us with increased knowledge and to help you and other young athletes to optimize performance.

Now I will appriciate to know about you habitual eating habits. Our conversation will take about an hour. It is very important to me that you know, that there are not any "right" or "wrong" foods. Right foods are what you eat and it is important that you are honest. It is important that you tell me everything you eat and drink – also snacks and also if you eat or drink during the night.
What you tell me here is anonymously and will only be used for research purposes.
I will help you, if you are having trouble remembering and here beside me I have a little book with pictures of foods and portion sizes where you can identify which one is most equal to what you eat.

Do you have any questions before we begin?
So let us begin.

I will ask you to think back on what you have eaten during the last week.

1. From midnight; when is the first you eat or drink?
   a. What do you eat?
      i. Do you know the brand of this product?
      ii. Is this with sugar or a light version? (e.g. if the respondet answers youghurt)
      iii. Is this a full fat or a low fat version (e.g. if the respondet answers cheese, youghurt, or butter)
      iv. Is this a regular type or with whole grain? (e.g. if the respondet answers rice, pasta, or bread)
      v. How many slices/pieces do you eat? (e.g. if the respondet answers bread, crackers, or potatoes)
      vi. What size is this portion you eat? (e.g. if the respondet answers oat meal, pasta, rice, stew. Use the pictures)

      If e.g. the participant tells you he/she had 2 dl oat meal 5 times for breakfast during the week and 2 slices of knekkebrød with cheese the other 2 days:
      - *((40g/dl x 2) x 5)/7 =* ***57 g oat***
      - *((11g/slice x 2) x2/7 =* ***6.3 g Knekkebrød***
      - *((35g/slicex2) x2)/7 =* ***20 g cheese***

      What is written in bold should be entered in Dietist Net.

   b. Thank you. And what else do you eat at this time a day? (repeat section a, until the respondent tells you he/she does not eat anything else at this meal)

   c. What do you drink?
      i. Do you know the brand of this product?

ii. Is this with sugar or a light version? (e.g. if the respondet answers drinkingyoughurt, chocolate milk, soda or lemonade. If the respondent tells you he/she drinks self-mixed sportsdrink, remember to ask about the concentration; how many scoops/grams per ½ liter?)

iii. Is this a full fat or a low fat version (e.g. if the respondet answers milk or chocolate milk)

iv. What size is this portion you drink? (small glass, large glass, a can, ½ liter?)

2. When do you eat next? (Repeat section a, b, and c)
   - Repeat untill midnight

3. Regarding you training; what do you eat and drink there?

4. How about weekends; does weekends differ from what you have told me here? In what way?

5. You may need to add questions like «How often do you eat...?», «How often do you drink sports drink during training?», «How often do you eat after a training session?»

6. Thank you very much. Now I will read to you everything I have written of what you have told me so far.

7. Are there anything we have missed? (give the respondent time to think. In general people tend to forget snacks, alcohol and special foods they eat in the weekends. Athletes tend to forget what they drink/eat during training and supplements in general. Therefore, you may help the respondent by asking:

- How about during training sessions – what do you drink/eat during this time?
- Do you take any other supplements? For instance of vitamin/minerals?

After the interview: enter in Dietist Net and safe the filled-out form.
On page 5 you see examples of how to fill out the form. Page 6 contains the form, you need to print and fill out during the interview (you will probably need more than one).

APPENDIX 5

Subject ID:_________________________

Meal-type: Breakfast

Date: _________________________

Time	**Food/beverage item** (Preparation/cooking)	**Brand** (if known)	**Specify** (e.g. fat or fiber content, if known)	**Amount (portion size/grams/slices/pieces)** Use pictures
Monday @6:30	*Oat meal*	*Solgryn*	*10% fiber*	*Medium portion*
6:30	*Milk*	*Tine*	*1,5% fat*	*1 big glass*
6:30	*Biola*	*Tine*		*1 small glass*
Tuesday @6:30	*Bread*	*Kiwi brand*	*Grov*	*3 slices*
6:30	*Spekepølse*	*Gilde jubilæum*		*6 slices*
6:30	*Milk*	*Tine*	*Lett*	*1 medium glas*

APPENDIX 5

Subject ID:________________________

Meal-type: ________________________

Date: ________________________

Time	**Food/beverage item** (Preparation/cooking)	**Brand** (if known)	**Specify** (e.g. fat or fiber content, if known)	**Amount (portion size/grams/slices/pieces)** Use pictures

APPENDIX 6

Supplementary tables

Baseline data of anthropometry, body composition, health parameters and dietary intakes. Presented as mean ±SD or median (25, 75 percentile).

	Athletes n= 36	***Controls*** n= 16
Age (years)	16.4 ±0.3	16.3 ±0.4
Height (cm)	**177.6*** ±7.7	171.3 ±10.8
Body weight (kg)	65.7 ±8.1	65.2 ±10.5
BMI	20.8 ±1.8	22.3 ±3.3
Fat %	**17.5**** ±7.7	28.4 ±13.4
Fat%^{M}	16.0 (11.0, 24.4)	33.9 (16.2, 38.1)
FFM (kg)	**55.0**** ±8.7	43.2 ±8.9
RMR_{ratio}	1.0 ±0.1	1.1 ±0.1
BMD z-score	-0.3 ±0.9	0.1 ±1
BMD z-score^{M}	-0.4 (-1, 0.2)	-0.1 (-0.6, 0.7)
Total mean intakes ±SD	n=34	n=13
Kcal	**3141.8**** ±1183.6	1511.5 ±849.7
Protein (g)	**130.3**** ±55.2	71.4 ±46.8
Carbohydrate (g)	**383.1**** ±132.9	175.3 ±97.9
Fat (g)	**114.0**** ±52.0	54.1 ±34.9
Median intakes per kg/FFM (25, 75 percentile)		
Kcal	**53.6**** (45.0, 69.0)	38.8 (17.5, 53.0)
Protein (g)	**2.2*** (1.6, 2.9)	1.6 (0.8, 2.1)
Carbohydrate (g)	**6.3**** (5.7, 8.1)	5.0 (2.1, 5.5)
Fat (g)	**1.9*** (1.4, 2.6)	1.0 (0.5, 2.2)

* $P<0.05$ ** $p<0.01$

^{M} – non-normally distributed data, also presented as medians

BMD – bone mineral density, BMI – body mass index, Fat % – body fat percentage, FFM – fat-free mass, g – grams, Kcal – kilo calorie, RMR_{ratio} – resting metabolic rate ratio, SD – standard deviation

APPENDIX 6

Correlations between DE score, body composition, health parameters and dietary intakes.

Athletes	**BMI**	**Fat %**	**FFM (kg)**	**RMR$_{ratio}$**	**BMD**	**Kcal/kg FFM**	**Protein/kg FFM**	**CH/kg FFM**	**Fat/kg FFM**
EDE-Q Global score	0,154	0,251	-0,309	0,015	0,087	-0.160	-0.281	-0.157	-0.110
- Restraint	**0,396***	**0,345***	-0,075	-0,039	0,126	-0.174	-0.203	-0.250	-0.940
- Eating concern	0,043	0,153	-0,274	0,010	-0,050	-0.067	-0.209	-0.012	-0.038
- Shape concern	-0,018	0,246	**-0,347***	0,024	-0,004	-0.159	-0.302	-0.189	-0.860
- Weight concern	0,127	0,236	-0,303	0,051	0,036	-0.074	-0.189	-0.111	-0.170
DLS	-0,020	-0,086	0,144	0,120	0,105	-0,143	-0,164	-0,158	-0,011
BEDA-Q	0,275	**0,415***	-0,291	-0,031	0,077	**-0,469****	**-0,468****	**-0,528****	**-0,351***
Controls									
EDE-Q Global score	0,310	**0,583***	**-0,623***	-0,269	0,381	-0,411	**-0,681***	-0,395	-0,568
- Restraint	0,322	0,464	-0,371	-0,080	**0,530***	-0,381	**-0,624***	-0,353	-0,557
- Eating concern	0,154	0,398	**-0,574***	-0,221	0,271	-0,120	-0,408	-0,186	-0,404
- Shape concern	0,307	**0,658****	**-0,691****	-0,262	0,403	-0,511	**-0,778****	-0,460	**-0,634***
- Weight concern	0,243	**0,519***	**-0,569***	-0,376	0,338	**-0,588***	**-0,823****	-0,496	**-0,701***
DLS	-0,071	-0,297	0,419	-0,247	0,195	0,175	0,182	0,297	-0,175
BEDA-Q	0,41	**0,794****	-0,677	-0,082	0,470	**-0,695***	**-0,881****	**-0,659***	**-0,653***

* $p<0.05$ **$p<0.01$

BMI – Body Mass Index, Fat % – Body fat percentage, FFM – Fat-Free Mass, RMR$_{ratio}$ – Resting Metabolic Rate Ratio, BMD – Bone Mineral Density

EDE-Q - Eating Disorder Examination Questionnaire, DLS – Drive for Leanness Scale, BEDA-Q – Brief Eating Disorder in Athletes Questionnaire

APPENDIX 6

Scores on the self-report questionnaires: EDE-Q including Global score and the subscales Restraint, Eating concern, Shape concern and Weight concern, BEDA-Q and DLS.

Athletes

Questionnaires scores	**Median (25, 75 percentile)**	**Mean ±SD**	n=
EDE-Q Global score	0.1 (0.0, 0.5)**	0.3 ±0.5	36
- Restraint	0.0 (0.0, 0.3)**	0.3 ±0.5	34
- Eating concern	0.0 (0.0, 0.1)**	0.2 ±0.4	34
- Shape concern	0.1 (0.0, 0.6)**	0.5 ±0.9	34
- Weight concern	0.0 (0.0, 03)**	0.4 ±0.8	34
DLS	21.5 (16.0, 25.5)	21.1 ±6.3	32
BEDA-Q	10.0 (9.0, 12.0)**	11.1 ±4.3	34

Controls

			n=
EDE-Q Global score	1.2 (0.6, 2.1)	1.7 ±1.6	15
- Restraint	1.4 (0.0, 2.6)	1.6 ±1.8	15
- Eating concern	0.4 (0.0, 1.6)	09 ±1.4	15
- Shape concern	1.6 (0.6, 3.3)	2.1 ±1.8	15
- Weight concern	1.4 (0.2, 2.8)	1.9 ±1.8	15
DLS	25.0 (16.0, 29.0)	23.7 ±7.3	15
BEDA-Q	15.0 (12.0, 22.0)	17.9 ±7.5	15

* $p<0.05$ **$p<0.01$