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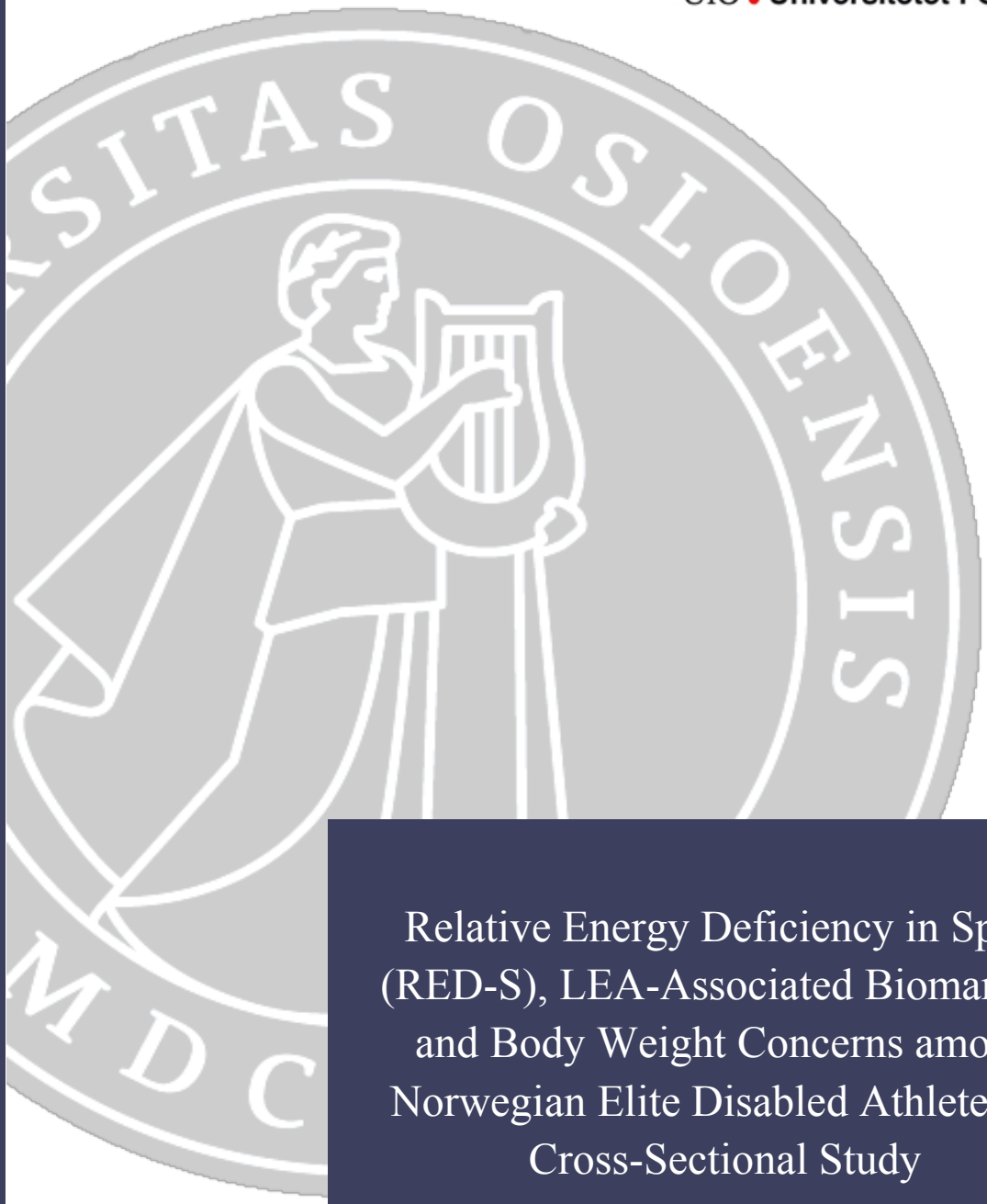

Relative Energy Deficiency in Sport (RED-S), LEA-Associated Biomarkers and Body Weight Concerns among Norwegian Elite Disabled Athletes. A Cross-Sectional Study

Master Thesis by

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Department of Nutrition
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May 2021

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Miriam Gustad

Abstract

Background: Relative energy deficiency in sport (RED-S) due to low energy availability (LEA) is suggested to be prevalent among disabled athletes, however the literature is scarce, and the associated implications are not well understood. The International Olympic Committee is promoting more research on this topic.

Objectives: This master thesis aimed to investigate the risk of RED-S and LEA-associated biomarkers among Norwegian elite disabled athletes, and possible relationships between risk estimates and biomarkers. Furthermore, body weight concerns and its possible relation to risk of RED-S or any LEA biomarkers are explored**.**

Methods: To attain these objectives, the risk of RED-S was assessed through the Low Energy Availability in Female Questionnaire (LEAF-Q) and Low Energy Availability in Male Questionnaire (LEAM-Q) among 11 (5 female, 6 male) elite disabled athletes with various impairments. Bone mineral density (BMD) was evaluated using dual-energy x-ray absorptiometry (DXA); resting metabolic rate (RMR) was measured using indirect calorimetry. Endocrine and metabolic profiles were obtained through blood sampling. Associated factors of body weight concerns were assessed by a medical interview.

Results: High risk of RED-S was displayed in nine (82%) subjects, and BMD Z-score and RMR were reduced compared to cutoff thresholds for five (45%) and six (55%) subjects, respectively. Endocrine and nutritional biomarkers were within reference ranges in all subjects. Menstrual function could not be evaluated due to use of contraceptives, while testosterone levels were low for two (33%) male subjects. Risk estimates did not correlate significantly with any biomarker. Seven (64%) subjects managed body weight intentionally, and current body weight deviated from desired body weight in six subjects (55%).

Conclusion: High risk of RED-S was considerably prevalent among Norwegian elite disabled athletes, although the detection of LEA associated biomarkers was ambiguous. Prevalent body weight related factors suggest possible body weight concerns. Due to the heterogeneity, the small sample size and the absence of a RED-S risk tool which has been validated in the cohort studied, conclusions should be made with caution. Further research for additional quantification of risk estimates and elucidation of LEA implications is warranted.

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Abbreviations

AB	Able-bodied
ACTH	Adrenocorticotropic hormone
BMD	Bone mineral density
BMI	Body mass index
BMR	Basal metabolic rate
BWC	Body weight concerns
BWM	Body weight management
CP	Cerebral palsy
DE	Disordered eating
DXA	Dual-energy X-ray absorptiometry
EA	Energy availability
ED	Eating disorder
EI	Energy intake
fT3	Free triiodothyronine
fT4	Free thyroxine
FFM	Fat free mass
HPA	Hypothalamic pituitary thyroid axis
IQR	Interquartile range
LBM	Lean body mass
LEA	Low energy availability
LEAF-Q	Low Energy Availability in Female Questionnaire
LEAF+M-Q	Low Energy Availability in Female Questionnaire with added sections from Low Energy Availability in Male Questionnaire
LEAF/M-Q	Low Energy Availability in Female Questionnaire and Low Energy Availability in Male Questionnaire combined
LEAM-Q	Low Energy Availability in Male Questionnaire

$_{M}$RMR	Measured resting metabolic rate
PAL	Physical activity level
$_{P}$RMR$_{C}$	Predicted resting metabolic rate using Cunningham equation
$_{P}$RMR$_{HB}$	Predicted resting metabolic rate using Harris-Benedict equation
RED-S	Relative energy deficiency in sport
RMR	Resting metabolic rate
RMR-factor	Ratio between energy intake and resting metabolic rate
RMR-ratio$_{C}$	Ratio between measured resting metabolic rate and predicted metabolic rate using Cunningham equation
RMR-ratio$_{HB}$	Ratio between measured resting metabolic rate and predicted metabolic rate using Harris-Benedict equation
RPE	Rate of perceived exertion
SD	Standard deviation
SOP	Standard operating procedure
TSH	Thyroid-stimulating hormone

1 Background

The nutritional needs of athletes are of great concern considering its pivotal role in athletic performances (1). Although low energy availability (LEA) related to sport performance is a widely recognized issue among able-bodied (AB) athletes, research have regarded little attention to disabled athletes and the possible implications of such relative energy deficient states among this specific population.

1.1 Disabled Athletes

1.1.1 Definition of the Population

Disabled athletes also referred to as para-athletes, are athletes with a physical, visual, or intellectual impairment (2). In the Paralympics Games of Rio 2016, 4328 para-athletes competed, demonstrating a substantial increase of participants since the first Paralympic Games was initiated in 1960 with only 400 participants (3). Along with the international expansion of the para-sports, there is an increased number of Norwegian disabled individuals active in sports, both nationally and internationally. As of 2019, 11 089 disabled individuals were registered active in adaptive sports, in which approximately 70% were above 20 years of age (4). The number of elite disabled athlete is relatively small in Norway, although the exact number is not attainable due to poor documentations of such. However, the population is growing, and the Norwegian Olympic Committee are aiming for a doubling of medal candidates within an eight year period (5). Additionally, as of 2018, increased economic resources are distributed towards the para-sport across ages in Norway, both publicly funded and privately donated considerable amounts of money, for enhancing of the sport (4). Examples of such organizations are *Sparebankstiftelsen* and *Stiftelsen Vi* in which the latter cooperates with the Norwegian Olympic Committee (4). A sport-specific functional classification system known as the International Paralympic Committee classification system, classifies athletes according to the degree of reduced function and performance due to the impairment in each sport (6). To this date, there are 28 internationally recognized Paralympic sports (7).

1.1.2 Disabilities and Associated Implications

There are numerous impairments documented, in which most research in regard to sports are conducted on spinal cord injured (SCI) athletes (8). Other impairments which investigators have studied are cerebral palsy (CP), spina bifida, acquired brain injury, amputations, hearing and visual impairment, and intellectual impairments (8, 9). To the author's knowledge, there is a paucity of published data concerning the prevalence of elite disabled athletes with the respective impairments in Norway. The following section describes the impairments mostly researched in regards to sports, as well as those relevant for this master thesis.

Spinal Cord Injury and Spina Bifida

The loss of function due to spinal cord injury is dependent on the neuroanatomical location of the lesion. Paraplegia and quadriplegia describe loss of function of lower extremities and all four extremities, respectively, including organs innervated below the site of lesion. Incomplete lesions cause impaired functions of limb, while complete lesions forges limb paralysis (1). Spina bifida is a congenital condition resulting in neural tube defects and improper, or failure, of the rostral spinal cord to close, often impacting ambulation which results in inefficient gait or wheelchair reliance (10). Implications with respect to sports are in large the same as of athletes with SCI as described below (11).

Implications of SCI are multiple and are due to an interruption of the central nervous system as a result of the injury (1). Further complications may be encountered by virtue of the autonomic nervous system involvement, or due to wheelchair-reliance or medical side effects following the injury. Commonly reported problems include: reduced bone mineral density (BMD), gastrointestinal dysfunction such as reduced gastric emptying and bowel distention, altered metabolism, muscle atrophy below the level of lesion, pressure ulcers and bladder distention (1). Downstream, gastrointestinal related issues may contribute to reduced appetite and dietary intake both during sports and independent of such activities (1). The prevalence of reduced BMD are reported to be increased among wheelchair-reliant individuals and athletes with little resistance training and a reduced load on skeleton (9). Lower extremities including limbs and hip are frequently reported to be impacted by the injury and ambulation state (11), while the BMD of upper extremities including the spine and radius do not appear to be affected as demonstrated in wheelchair basketball players (11-13). Energy requirements of athletes with SCI are not well understood. Altered metabolism and muscle atrophy may

reduce basal metabolic rate (BMR), however, little is known regarding energy expenditure during daily living activities (1, 8, 9). Furthermore, low testosterone levels have been recorded among males with SCI (14, 15), while menstrual function is in large reported not affected (11).

Cerebral Palsy

Cerebral palsy is a congenital condition derived from an insult on the developing brain in early fetal life, or as a consequence of peri-partum hypoxia. It can also occur as a consequence of stroke or acute head trauma (1). The implications are dependent of the severity and location in which the brain is injured, and individuals with CP are at risk of age-related disabilities (16). Typically, mobility is reduced due to abnormal muscle control and bone deformities resulting in impaired ambulation or wheelchair use (1, 16). Consequently, reduced BMD and early-onset of osteoporosis is frequently recorded and the severity is dependent on the ability to ambulate with or without aids (16). Reduced BMD (Z-score <-1.0) in lumbar spine, total hip as well as total body have been reported among adults with various functional status (16, 17). Furthermore, hypogonadism manifested as testosterone levels below clinical reference ranges have been reported, although literature is scarce (17). Nutrition related implications include dysphagia and reduced ability for grocery shopping and cooking, all in which increases the risk of insufficient energy intake (EI) (9). In individuals with athetosis (involuntary movements) and spasticity due to neurological implications, energy expenditure during sedentary activities increases substantially compared to their AB counterparts (1). Additionally, there is an increased risk of epilepsy among individuals with CP, often requiring medication (1). Anticonvulsant medication use may further cause gastrointestinal related issues and a reduced appetite.

Little is known regarding disabled athletes with CP and nutritional issues. Although athletes with athetosis and spasticity are suggested to have higher energy requirements, reports regarding energy expenditure and BMR are inconsistent and results are largely dependent on ambulation state. Ambulatory individuals may experience increased energy expenditure upon mobilization due to inefficient ambulation (1). Non-ambulatory disabled athletes competing in sports requiring less energy compared to sports such as football, cycling, swimming etc., may however have an increased energy requirement due to spasticity and athetosis compared to AB athletes.

Limb deficiency: Amputees and Dysmelia

Amputations of extremities as a consequence of vascular disease, trauma or other illnesses are classified as loss of limb or limb deficiency according to Paralympic classification system (18). Dysmelia is a congenital limb deficiency forging full or partial absence of bone or joint through amputation (1). Depending on the site and severity of injury, amputation impair ambulation and often results in use of prosthesis or wheelchair (1). Therefore, increased energy expenditure due to inefficient ambulation and pressure ulcers at the site of prosthetic contact are challenges athletes with an amputation may encounter (1, 11). Due to loss of limb, asymmetric BMD has been observed in individuals with unilateral amputations (1, 11). Nutritional requirements of such athletes are yet to be explored, although an increased energy requirement dependent of ambulation state is suggested (1, 11). Further, among athletes with lower limbs amputations, glycogen store capacity is documented to be reduced (8).

Visual and Hearing Impairments

Visual and hearing impairments may be congenital, or acquired due to illness or trauma. Nutrition-related concerns depend largely on the cause of the impairment, as underlying diseases may impact nutritional requirements (1). Athletes with such impairments have not been subject to extensive research regarding sports and nutrition-related issues. Intuitively, grocery shopping and cooking may be of challenge impacting the nutritional intake among athletes with visual impairments. Of the limited research conducted, visual impaired sedentary individuals have been observed with significantly increased risk of hip fractures, although the relationship between the two is unclear (11). Furthermore, they are suggested to hold a higher level of body satisfaction and thus a reduced risk of unhealthy dietary behavior associated to inadequate EI (11). Howbeit, such unhealthy behaviors have been reported among this population (19).

1.2 Relative Energy Deficiency in Sport

1.2.1 Low Energy Availability

Definition and Equation

Energy availability (EA) is defined as energy available beyond energy spent on exercise related activities (9). It is determined by EI minus energy expenditure during exercise divided by kg of fat free mass (FFM). There are existing cutoff thresholds describing the level of EA

for female athletes which is hypothesized to be lower for male athletes: optimal EA (>45kcal·kg FFM^{-1}·day^{-1}), suboptimal (<40kcal·kg FFM^{-1}·day^{-1}) and low (<30kcal·kg FFM^{-1}·day^{-1}) (9). These cutoff thresholds were validated in AB athletes, and whether they are applicable for disabled athletes is unknown. Possibly, the athlete's ambulation state as well as impairment type impact the relevance of this cutoff in disabled athletes (20). Frequently reported reasons of the occurrence of LEA states are intentional body weight management for enhancement of athletic performance forging restrictive dietary behaviour, or unintentional under-eating, often accompanied by a high training load (21). There are no established guidelines for the duration of which an individual must be under restrictive EI compared to requirements for a LEA state to occur. Acute, intermittent and chronic LEA have been described in literature (9). Hormonal and metabolic alterations may arise even from short duration of energy restrictive behavior; Loucks et al. found alterations in blood metabolic parameters after five days of LEA (22). Researchers have suggested identifying disabled athletes at LEA states based on risk estimates and the prevalence of LEA biomarkers rather than LEA calculations (23). A validated screening tool for early identification of female athletes in risk of LEA with associated complications has been developed. The Low Energy Availability in Female Questionnaire (LEAF-Q) is a self-reported questionnaire designed to detect physiological symptoms related to prolonged LEA and contains questions regarding injuries and illness, gastrointestinal and reproductive function (24). Drew et al. concluded the questionnaire to be of high utility in addressing high risk of LEA, as it identifies potential factors closely associated to illness in female athletes (25). A similar questionnaire regarding LEA in male athletes (LEAM-Q) is developed by the same authors as those of LEAF-Q (24).

1.2.2 From the *Triad* to Relative Energy Deficiency in Sport

Relative energy deficiency in sport (RED-S) is a well-recognized term within the athletic sphere and is further developed from the previous recognized Female Athlete Triad (the *Triad*) (11). The components of the *Triad* are functional hypothalamic amenorrhea/oligomenorrhea and reduced bone health/osteoporosis caused by long-term LEA states with or without the presence of disordered eating (DE)/eating disorder (ED) (26). This *Triad* was extended to describe physiological adaptions within male athletes in addition to females, and is now recognized as RED-S (11, 27). The syndrome of RED-S involves implications caused by relative energy deficiency hampering normal physiological processes as a result of short- or long-term LEA, with concurrent high level of exercise energy

expenditure (11). The syndrome of RED-S impairs health and performance and include, but is not limited to, alterations of BMD, reproductive function, metabolism, immunological, haematological, musculoskeletal and gastrointestinal function, and mental health, with or without DE/ED (11) (**Figure 1.1**). Athletes may display one or more of the implications, and the adaptations may occur on a spectrum from healthy at optimal EA to unhealthy with LEA (**Figure 1.2**)**.** Such implications are deleterious for short- and long-term health beyond athletic performance. The phenomenon is mainly explored within AB athletes, and literature is scarce regarding disabled athletes (20). The International Olympic Committee recently published a consensus statement emphasizing the need for investigating the impact LEA imparts on disabled athletes, as this is greatly unknown (21). The authors argued that impaired athletes are particularly vulnerable for RED-S, with emphasis on reduced BMD and increased energy requirements due to the nature of impairments. An early detection of LEA through screening was emphasized as strategy for the prevention of RED-S (21).

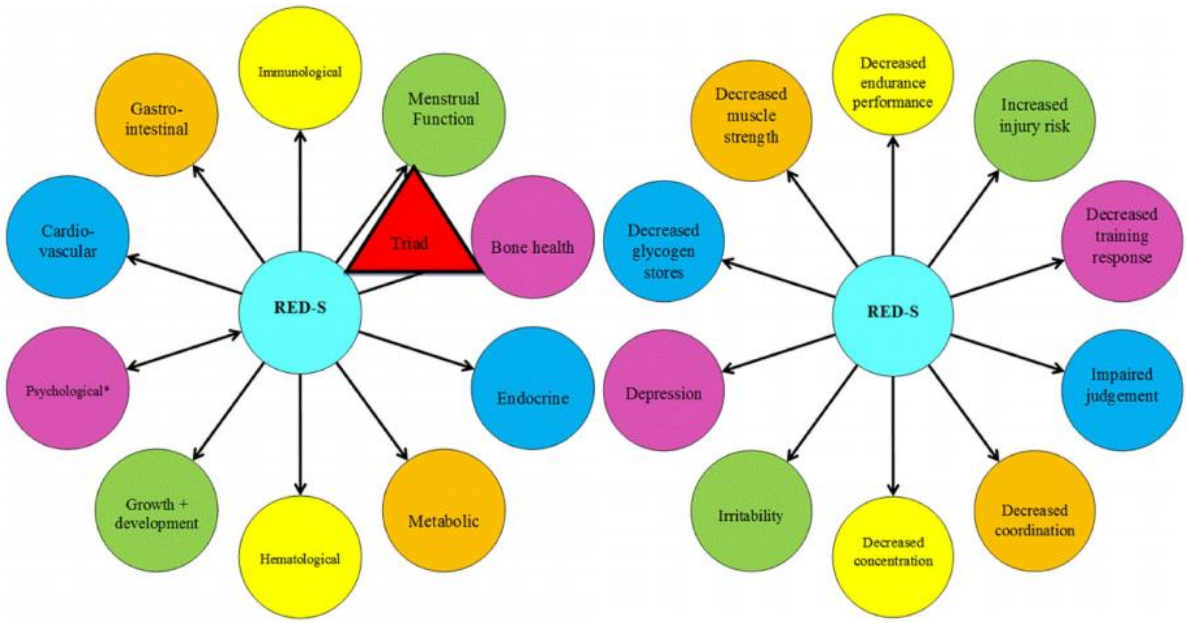

Figure 1.1 Syndrome of RED-S including the female athlete *Triad*
The figure presents symptoms of RED-S as an expansion of the female athlete *Triad* (21). It includes both physical and psychological factors. The *Triad* is demonstrated in red. Reproduced from Mountjoy et al. with permission from BMJ Publishing Group Ltd (21). RED-S=relative energy deficiency in sport.

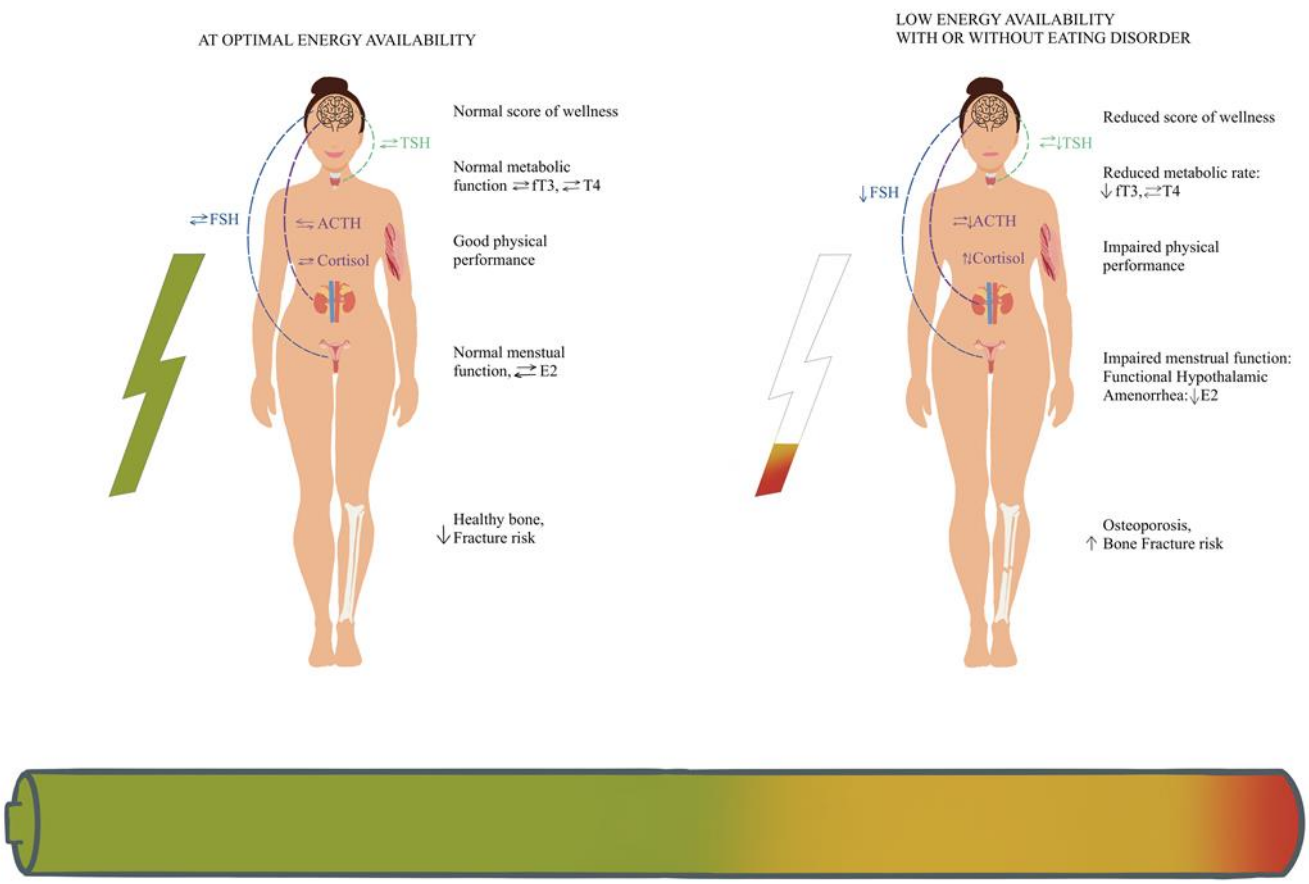

Figure 1.2 Symptoms of RED-S in a female athlete at optimal EA and at LEA state

The figure illustrates how RED-S may present. An athlete with adequate EA ensures physical and physiological health, whereas an unhealthy athlete with a long-term LEA with or without ED/DE may present with RED-S symptoms such as menstrual dysfunction, reduced BMD or osteoporosis, and reduced RMR (21). Athletes may also be found in an intermediate stage where short-term energy deficiency may alter biomarkers while visible RED-S symptoms not yet are developed (21). FSH=follicle-stimulating hormone, TSH=thyroid-stimulating hormone, ACTH= adrenocorticotropic releasing hormone, fT3=free triiodothyronine, fT4=free thyroxine, E2=oestradiol, RED-S= relative energy deficiency in sport, EA = energy availability, LEA= low energy availability. The figure was made by the master student.

1.2.3 Biomarkers of LEA and Components of RED-S

Below a list of biomarkers of LEA and components of RED-S are described. However, due to the scarcity of evidence regarding RED-S among disabled athletes, the following section is derived from studies conducted on AB sedentary and athletic individuals.

Reproductive Function

The mechanisms of which menstrual dysfunction manifest has been described in literature. As the hypothalamus detects LEA, the hypothalamus releases reduced levels of gonadotropic releasing hormone (GnRH) which downstream causes a reduced pituitary release of follicle-

stimulating hormone (FSH) and luteinizing hormone (LH). Hence, a decreased production of oestradiol and progesterone arises giving inadequate folliculogenesis and anovulation (28). Disturbed menstrual function displays as luteal phase defects, anovulation, and oligomenorrhea (29). Oligomenorrhea describes a menstrual cycle interval of more than 35 days, and amenorrhea describes absence of menarche by the age of 15 if primary, and irregular menses for more than six months if secondary (30). Researchers have found a dose-response relationship between relative energy deficiency and frequency of menstrual disturbances (29). However, a specific threshold of EA for menstrual function of all females has not been described (31). Although the duration and severity of LEA necessary to impair menstrual functions are not fully understood (21), menstrual function and oestradiol levels have been reported to be highly sensitive to short-term LEA (32).

Although testosterone has received little attention, it has been proposed as an objective marker of LEA among male athletes (33). Male athletes experiencing LEA may develop hypogonadism due to disruption of the hypothalamic-pituitary-gonadal axis displayed as low testosterone levels; equivalent to the menstrual dysfunction unit of the female *Triad* (30). However, research is inconsistent as testosterone levels are also reported unaffected by LEA (34). Further, studies have reported a significant association between low testosterone levels and low BMD which is an established surrogate marker of LEA (35).

Bone Mineral Density

BMD is an established surrogate marker of long-term LEA (36). A BMD relative to the reference population matched with age and sex (Z-score) below -1.0 increases the fracture risk and is suggested to correspond with LEA states, and a Z-score below -2.0 is considered clinically low with increased risk of osteoporosis (36). Such conditions may impair athletic performance and overall health in both short- and long-term perspective, and thus BMD is an overall health concern (1, 36). Researchers who investigated male and female distance runners suggested low BMD as a valid surrogate marker of long-term LEA (37-39). Female athletes seem to be more predisposed to alterations of bone health as a result of LEA than male athletes (34).

Metabolism Regulating Hormones

Thyroid-stimulating hormone (TSH) and the thyroid hormones triiodothyronine (T3), both free and total, as well as thyroxine (T4) is suggested to be altered by LEA, as the

hypothalamic-pituitary-thyroid axis (HPA) is downregulated as a response to LEA to reduce energy expenditure. These hormones along with the HPA are central in the regulation of energy balance and metabolic rate, especially in relation to EI, energy storage and mobilization (31). T3 is suggested to be an indicative marker of LEA among athletes (22). However, the evidence concerns female athletes predominantly and evidence for a significant reduction of T3 levels are scarce regarding male athletes (34). Research is inconsistent regarding T4 and TSH levels in relation to LEA states (22, 34, 40).

Cortisol is a catabolic hormone released in relation to blood glucose homeostasis, and it plays a pivotal role in the regulation of bone homeostasis (41). It is also related to physiological stress indicators such as illness and injuries. Cortisol affects calcium absorption in the intestines and thus indirectly increase bone resorption (41, 42). Cortisol release is affected by EA, and its release is typically increased during energy deficiency. Cortisol release is affected by cortisol releasing hormone and adrenocorticotropic releasing hormone (ACTH), both indirectly affecting reproductive function (31). Cortisol has been suggested to be associated with the *Triad* condition (43-45). However, various responses of cortisol in LEA states, both baseline cortisol and overnight cortisol release, in both female and male athletes have been documented (31, 46).

Metabolic Rate and Body Composition

Resting metabolic rate (RMR) reflects the amount of energy the body utilizes for basal physiological processes necessary to maintain life (9). There are multiple methods to measure RMR, in which doubled-labeled water and indirect calorimetry are recognized methods of high accuracy (1). Another commonly used method includes predictive equations which are more feasible than clinical measurement methods. There are various predictive equations of estimating RMR, e.g. the Cunningham equation and Harris-Benedict equation (47, 48). As a reduced RMR is reported in LEA states due to metabolic hormonal alterations, the ratio between predicted and measured RMR is an acknowledged surrogate of LEA when seen in relation to other established biomarkers (49). Researchers have described a ratio of less than 0.9 to be reflective of LEA states (50, 51). Studies have predominantly demonstrated a reduction of RMR among athletes with reduced EA (<45 kcal/FFM) as reduced EI compared to estimated energy needs (31, 52). Body mass index (BMI) is also suggested as a possible marker of prolonged LEA, however, literature is inconsistent (53-55).

Nutritional Biomarkers

Iron is a well-recognized parameter of nutritional status and its pivotal role in oxygen transportation is of special concern in athletes (56). An insufficient iron intake has been described as common among disabled athletes. Reasons of this are many, e.g., restrictive dietary pattern, insufficient protein intake, poor quality and quantity of food intake (8). Athletes are claimed to have a greater iron requirement, e.g., due to higher blood cell turnover and training adaptions (erythropoiesis) (8). A low iron status may hamper physical performance as well as reduce overall health, and possibly indicates a LEA state (8, 57).

1.2.4 Disabled Athletes- Are They at Risk of RED-S?

Sports nutritionists are lacking sufficient knowledge concerning nutritional needs of disabled athletes as such has never been thoroughly assessed (8). Consequently, the current nutritional guidelines for disabled athletes are according to the nutritional needs of AB athletes, which might be unsuitable adopting on disabled athletes (8). The nature of impairment may introduce alterations of metabolic processes affecting the energy balance, which potentially results in reduced EA (11). Involvement in sports increases energy requirement compared to sedentary counterparts, however, not all increase the EI accordingly (8, 9). A prolonged LEA state may further magnify implications already introduced by the impairment (11). Although the para-sport includes a variety of disabilities, the majority of the existing research has been conducted on athletes with SCI. Investigators agree upon a high prevalence of LEA and certain associated implications in which reduced BMD is most frequently reported (19, 20, 58, 59). Brook et al. conducted a survey among American elite para-athletes and reported of LEA-associated risk factors such as menstrual dysfunction and reduced BMD of being prevalent across sports, impairment and sex (20). Another study reported a high risk of RED-S and a prevalent low BMD among disabled athletes predominantly with SCI and spina bifida (59). Furthermore, Egger et al. found a high prevalence of LEA among wheelchair-reliant athletes (58).

1.3 Body Weight Concerns

Body weight management (BWM) and other factors associated to body weight concerns (BWC) in athletic environments have been extensively documented (32, 60-62). One worldwide recognized female athlete, Mary Cain, confronted this issue by sharing her story of immense pressure from her coach to maintain a lean and low body weight. As a response, the

hashtag *#fixgirlssport* emerged and is used by female athletes across the world. The high prevalence of a BWC among female and male athletes is undeniable, although the latter population has received less attention (32).

The perception that a certain body composition increases sport performances; social media influence, and the general idolization in society of a certain body composition, may all contribute to an excessive attention to food and training, making the athlete more susceptible to BWC and unhealthy weight regulation (32). A pressure to optimize body composition for athletic performance has been reported to be prevalent. Such pressure may originate from good intentions from coaches and teammates for the sake of achievements, but may also reflect the lack of evidence-based studies supporting such pressure (32). Athletes may use various diets to obtain a body composition and weight perceived as optimal. Subsequently, BWC may display as a notable body weight fluctuation and body dissatisfaction. Such factors are suggested contributors of the development of RED-S (32).

Research has documented perceptions promoting unhealthy behaviour concerning exercise and dietary intake patterns (63). Beliefs commonly reported among athletes favours a lower body weight and a thin appearance in endurance and aesthetic sports, while strength-oriented and explosive sports emphasize leanness and low body fat (61). Concerns specifically described among disabled athletes include fitting into a racing chair, an optimal body weight for prevention of prostheses discomfort as well as enabling of using any prosthesis of choice (59, 64). Furthermore, opposition to overweight and obese body weight, which is commonly reported subsequent of injuries and impairments due to reduced ambulation state has been recorded (64). Compensating for the disabled body parts by growing stronger or thinner of the functional body parts was an indicated concern among sedentary individuals with SCI (65). Thus, disabled athletes potentially experience BWC in two levels.

Most research regarding BWC has been conducted on AB athletes and the prevalence among disabled athletes remains largely unknown. The available literature among disabled athletes is mostly conducted on athletes with SCI (9, 11, 59, 64). A larger study (N=260) reported a relatively high prevalence of BWC in respect to sports performances and pressure to attain perceived optimal body weight among disabled athletes in the USA. More than 50% of both male and female athletes across sports met the criteria of concerns for body weight (20).

Considering such impressions might arise due to pressure from internal bodies in the athletic environment (32), a fundamental and increased understanding of the prevalence and the nature of the concerns in disabled athletes is urgent.

1.3.1 *Sunn Idrett* and Preventive Works

Maintaining a healthy sport environment has been a focus area with the athletic communities in Norway in the last 13 years. Indeed, it is a leading country addressing nutritional issues commonly reported among athletes, and targets both adolescents and adults (66). *Sunn Idrett* is an organization aiming to prevent RED-S and the development of ED/DE among Norwegian athletes, and as of 2020, all sports are included in this nation-wide preventative effort. The organization aims to educate athletes as well as supportive teams regarding sports nutrition, and to promote healthy attitudes towards food, body, health and athletic performances. Thus, unhealthy behaviors and incorrect perceptions regarding body composition and subsequently RED-S are prevented at an early age (66). Hitherto, the prevalence of RED-S and unhealthy dietary behavior among Norwegian disabled athletes are not known. As knowledge is key for preventative works, unveiling this issue among the population in question is of high value for enablement of such efforts among disabled athletes and their supportive teams.

2 Hypothesis and Objectives

This master thesis is a sub-study of the ongoing *ParaNut* study (Optimizing Nutritional Counselling for the Disabled Athlete). The overall aim of the *ParaNut* study is to assess nutritional needs among Norwegian and Dutch disabled athletes and to elucidate potential shortcomings. Furthermore, the study aims to further the understanding of the current health and nutritional status including risk of RED-S in this population. In the current master thesis, attention was specifically paid to the risk of RED-S and the prevalence of LEA-associated risk factors. After reviewing available literature, it was reasonable to hypothesize a prevalent high risk of RED-S, while its associated biomarkers was expected ambiguous. For further emphasis, the primary and secondary objectives were to:

- Investigate the risk of RED-S and its associated biomarkers among Norwegian elite disabled athletes and to explore any possible relationships between the risk estimates and measured biomarkers.
- Explore the prevalence of BWC among disabled athletes and the relation it may impart with risk of RED-S and associated biomarkers.

3 Methods

3.1 Study Design

This observational study held a cross-sectional study design. It was part of the larger *ParaNut* study which is a collaboration of Norwegian School of Sports Sciences (NIH), HAN University of Applied Sciences, and Maastricht University. A pilot study with a smaller study sample (n=2) was conducted prior to study initiation with successful outcome. The study consisted of one test day at the NIH facility in Oslo and a subsequent 15-day home-based test-period. Data included in this sub-study was conducted from November 2020 until February 2021.

Before the test day, subjects were instructed to avoid strenuous training and to consume at least 2 L of water 24h prior to testing. Furthermore, they were to avoid any consumption of alcohol and nicotine/tobacco 12 hours before testing, and to refrain from any food and liquid consumption the morning of testing to ensure a fasted state and a standardized hydration status. For a rested state enablement, subjects were instructed to minimize the activity level the morning of testing, (e.g. avoid unnecessary ambulation and showering). Where possible, subjects were also asked to postpone drug administration until after measurements requiring a fasted state. During the test day at the facility, morning measurements included BMD, RMR and endocrine and nutritional biomarkers which were respectively assessed by DXA scan, indirect calorimetry and blood sampling. The test day also included fulfilment of a questionnaire and a medical interview. The participants were informed concerning the subsequent 15 days including instructions to maintain normal dietary intake pattern and training regimen. A training log was provided to each participant with instructions regarding fulfilment. The subsequent 15 day-period included data collection of nutritional intake and training regimen conducted by 24h recalls and training log fulfillment. The test period is visualized in **Figure 3.1.**

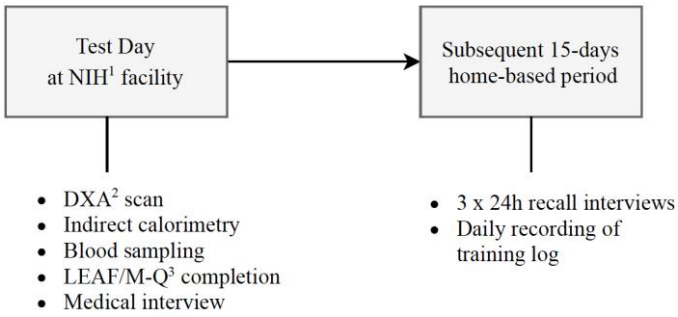

Figure 3.1 Test day and the subsequent 15-day period with respective measurements

Note: [1]Norwegian School of Sports Sciences, [2]Dual-energy X-ray absorptiometry, [3]Low energy availability in female/male questionnaire (24).

3.2 Study Participants and Recruitments

3.2.1 Study Participants

The recruitment of the study participants was done by invitation by the study manager via respective sport federations or coaches, or directly to athletes, continuously through the study period. Where invitation went through a coach, the invitation was forwarded to the respective athletes. All eligible participants were included in the study.

3.2.2 Inclusion and Exclusion Criteria

Requirements for elite disabled athletes to be eligible for study participation were as follows: eligible for participating in para sports and part of the National winter or summer selection of the Norwegian Olympic and Paralympic Committee, or participating in the highest existing level in their sport; age between 16 and 50 years; willingness to comply with all study-related procedures and signing of informed consent. All types of disabilities were eligible. Eligible athletes were required to have a representative and habitual training period for the time of data collection. Ineligible participants were females in or past their menopause and athletes with current injury or illness preventing attainment of the scheduled exercise training regimen.

3.2.3 Test Period

Several factors including the global pandemic COVID-19 as well as structural alterations gave multiple challenges and delays regarding recruitment of participants. Hence, there was a limited test period and a smaller number of subjects for recruitment than initially planned.

3.2.4 Heterogeneity in Study Population

As all sports and disability types were eligible for inclusion in the current study, the population was characterized by a great heterogeneity. The *ParaNut* study aims to include a total of 120 subjects over a 3-year period. In the present thesis, 12 subjects including both male (n=7) and female (n=5) athletes from six and nine different sports and impairments, respectively, were included. This sub-selection represented only a small heterogeneous group, which must be considered when interpreting the data.

3.3 Measurements and Data Collection

3.3.1 Low Energy Availability in Female/Male Questionnaire

To assess the risk of RED-S, the questionnaires LEAF and LEAM, of which the former is validated, and the latter is under current validation (24), were filled in by female and male participants, respectively (**Appendix 1 and 2**) . Where possible, the participants completed a paper-based version of the questionnaire. For whom writing was challenging, the questionnaire was completed electronically. During completion of the questionnaire, they were instructed to fill out the form as thoroughly as possible and clarifications of questions were documented in a separate sheet to ensure identical explanations for all participants.

Cutoff and Scoring Key for LEAF-Q and LEAM-Q

A validated scoring key and a cutoff score for the LEAF-Q were applied to calculate a final score as well as a score for subcategories for each female participant. A LEAF-Q total score ≥ 8 is considered an increased risk of LEA and was thus set as the cutoff score. Within the LEAF-Q, cutoff scores of ≥ 2, ≥ 2, and ≥ 4 were applied for the categories regarding gastrointestinal symptoms, injuries and illness, and menstrual function, respectively (24). As no validated scoring key existed for the LEAM-Q, both scoring key and cutoff score were developed based on the LEAF-Q scoring key set-up: the cutoff score for LEAF-Q accounts for 16.33% of the possible total score; the same percentage was set as cutoff score for LEAM-Q giving a score of 20 as cutoff in LEAM-Q. The same calculation was performed when determining the injury and illness cutoff score, giving ≥ 6. The section concerning gastrointestinal issues was identical to this section in LEAF-Q, thus an identical cutoff score was applied. A wellness and restitution cutoff score was not developed, as no similar section was originally part of the LEAF-Q. Within this section in LEAM-Q, a cutoff score for hours

of habitual sleep was determined based on reports of previous studies (67, 68). Participants documenting habitual sleep of less than 6h received two points; those documenting 6-7h received one point, while participants reporting more than 7h received zero points. Finally, a total score was calculated for each participant. Subjects scoring above or below the cutoff score were defined as having a high or low risk of RED-S, respectively. The same procedure was applied when investigating subcategories within the two questionnaires. The total score was investigated as well as evaluated in relation to surrogate markers of LEA.

The LEAM-Q involved more detailed information regarding injuries and illness, restitution, sleep, energy level, and general well-being as well as libido. These sections were completed by the women as well, as an extension of the LEAF-Q, to eliminate deviations of risk estimates due to sex. Analysis of the LEAF-Q was based on validated methodology (24), which provided basis for the analyses of the LEAM-Q as well as the LEAF-Q with sections from LEAM-Q attached.

3.3.2 Medical Interview

A medical interview was conducted to obtain data regarding the medical condition and factors related to BWC among the participants (**Appendix 3**). The interview was conducted by the same study operator for all participants to limit information bias. Questions regarding sport and disability, ambulation state/use of prosthesis, general medical history and questions regarding body weight and associated concerns were included. The questions were closed-ended with opportunity for elaboration where relevant.

General medical history regarded the onset and nature of the disability; medication use; nutrition-related issues, e.g. gastrointestinal symptoms; issues related to BMD and any previously documented osteoporosis or osteomalacia. For the female participants, menstruation patterns and use of contraceptives were reported. Primary amenorrhea was defined as menarche later than 15 years of age; secondary amenorrhea as absence of menstruation occurring after menarche of more than three months, and oligomenorrhea was defined as menstrual cycles occurring at intervals more than 35 days (36).

Body weight related issues were addressed in the medical interview by exploring the following: intentional BWM and the purpose behind it; yearly body weight fluctuation;

current body weight in relation to desired body weight; relationship to food and body weight and any relevant history concerning unhealthy eating behaviour; history of nutritional issues preventing the subject from sport participation; adherence to a specific diet. For analysis enablement, elaborated answers were categorized where applicable. Yearly body weight fluctuation was considered elevated if ≥ 4.0kg (63).

3.3.3 Dual-Energy X-ray Absorptiometry

BMD was assessed by Dual-energy X-ray absorptiometry (DXA) (Lunar iDXA, GE Healthcare, Madison, USA) in an overnight-fasted and rested state. All measurements were performed between 8 and 10 am by the same two trained study operators. The scans were performed on the same instrument at NIH for all subjects. The DXA scanning modules for lumbar spine and femoral neck were used to determine BMD of the lumbar spine and femoral neck, respectively. Additionally, a whole-body scan was performed. Whole and regional BMD, total bone mass, lean body mass (LBM) (excluding bone mass) and fat mass were analysed by the DXA enCore software (version 18, GE Healthcare, Madison, WI, USA) according to guidelines provided by the manufacturer. Scanning regions with internal metal objects were removed before analysis for elimination of disturbances during analysis. Z-scores for BMD were calculated by the same software and expressed as standard deviations (SD) from the DXA reference base which is based on an able-bodied population matched for age and sex. As there are currently no established normative BMD Z-scores nor related cutoff values available for people with impairments, Z-scores and cutoff values determined for a sedentary able-bodied population were used (36). The results were not for clinical diagnostic purposes, thus cutoff values for BMD were limited to include normal or low BMD. Z-scores >-1.0 for all measurement sites were classified as normal BMD, and Z-score <-1.0 for at least one measurement site was considered low BMD. BMD was expressed as $g \cdot cm^{2-1}$ in addition to Z-scores.

The DXA was calibrated in the mornings of the test days according to the guidelines provided by the manufacturer (Lunar iDXA, GE Healthcare, Madison, USA). Each subject was scanned for approximately 15 minutes. The scan was performed with minimal clothing, with no metal containing clothes. Subjects without a urinary catheter were asked to void the bladder prior to scanning if necessary. The participants were positioned in accordance with the manufacturer's instructions (Lunar iDXA, GE Healthcare, Madison, USA). Adaptations

were made when necessary due to challenges with standard positioning, and were documented. In cases of spasticity or tremor during scanning, the subject was repositioned, and scan repeated. Subject body weight was measured prior to DXA scan wearing limited clothing using a calibrated SECA scale (model 877) if ambulatory, and a wheelchair SECA scale (model 676) if non-ambulatory. Wheelchair weight was measured alone for subjects who were weighted with the wheelchair for subsequent subtraction from wheelchair weight. Height was measured using a fixed stadiometer. If height could not be determined in an upright position, length was measured from top of head to bottom of feet in a supine position.

3.3.4 Collection of Biological Samples

Surrogate markers of LEA included free T3 (fT3), free T4 (fT4) and TSH; hormonal status of circulating oestradiol, testosterone, and cortisol, as well as level of the nutritional parameters ferritin, transferrin saturation, and total iron binding capacity (TIBC). Vitamin D was measured as it is a relevant factor concerning BMD. A venous blood sample was obtained after an overnight fast between 8 and 10 am. Reproductive function was evaluated based on level of oestradiol and testosterone. As no reference levels were developed for either of the surrogate markers for the respective impairments, the applied reference ranges were based on an able-bodied population. In addition to evaluating testosterone according to clinical reference ranges, level of testosterone was considered low for values within the lowest quartile of the clinical reference range (8-35 $nmol \cdot L^{-1}$). This cutoff threshold was determined as although LEA have been reported in male athletes, testosterone levels have remained within clinical reference ranges (69). Consequently, applying a subclinical threshold for testosterone might be more applicable for identifying male athletes with LEA (23). S-Ferritin were considered depleted with values < $20\mu g \cdot L^{-1}$ for both sexes, and transferrin saturation reduced when < 16% (8). Vitamin D were considered reduced with levels below $75nmol \cdot L^{-1}$ (70). For all other markers obtained from blood, the clinical reference ranges provided by the laboratory were applied (71). Available variation coefficient for the respective blood analyses was: 8.5% (fT3), 7.3% (fT4), 19.5% (TSH), 22.8% (oestradiol), 12.0% (testosterone), 14.4% (ferritin) and 4.0% (TIBC) (71).

Plasma and Serum Sampling

Blood sampling was performed by a bioengineer at NIH. One blood sample was collected in a fasted state and treated according to the NIH standard operating procedure (SOP) using serum

vacutainers. The serum vacutainers were incubated at room temperature for a minimum of 30 minutes before centrifugation for 10 minutes at 1800 x g and thereafter temporarily stored at 4 degrees Celsius (C). Thereafter, the vacutainers were shipped to Fürst Medical Laboratory (Fürst Laboratory, Oslo, Norway) for analyses.

Laboratory Analysis

Analyses were carried out at the centre for blood analysis, Fürst Medical Laboratory (Fürst Laboratory, Oslo, Norway). fT3, fT4, TSH, oestradiol, testosterone, cortisol, ferritin, ferritin saturation, TIBC and vitamin D were all analysed in serum.

3.3.5 Indirect Calorimetry

RMR Measurement

RMR was assessed by indirect calorimetry performed in a fasted state using a ventilated hood (Oxycon Pro, Jaeger System, Germany). A hydrometer measured room humidity which had a day-to-day variation between 17 and 30%. Room temperature was approximately 22 degrees C for all test days. The ventilated hood was calibrated accordingly each morning with conditions as stated in SOP provided by the manufacturer. All measurements were conducted between 7:30 and 9:00 am. Subjects rested for 30 minutes upon arrival and prior to testing to ensure a rested state. During the testing, the subjects held a supine, rested position while instructed to avoid talking and perform body movements. Adaptations were made to enable rest according to disabilities requiring a position deviating from a supine position. Data were averaged over 30 second periods throughout the total 30 minutes of testing. The mean of the most stabile minutes from minute 10 to 20 constituted the determined RMR calculated by JLAB software version 5 (Carefusion, Hoechberg, Germany) using the Weir equation (71). Minutes of measurements deviating from protocol were documented.

Evaluation towards RMR

RMR measured (mRMR) by indirect calorimetry was evaluated in relation to predicted RMR based on the Cunningham ($_{P}RMR_{C}$) (47) and the Harris-Benedict ($pRMR_{HB}$) (48) predictive equations. The percentage point differences were evaluated. As there is no equation recommended for a disabled athletic population, equations recommended for a sedentary able-bodied population and athletic population, respectively, were applied (72). For the

Cunningham equation, data concerning LBM (excluding bone mass) was derived from DXA scan.

3.3.6 Assessment of Total Energy Intake

Data from a 24h dietary recall was used to evaluate the average EI (kcal·kg body mass^{-1}·day^{-1}) in relation to energy expenditure. Weighted means of EI was calculated based on the reported activity level according to the training log. Thereafter, weighted means of EI was evaluated in relation to estimated physical activity level (PAL) over the 15-days period in order to evaluate the risk of LEA (further described in section 3.3.7).

The 24h recalls were conducted within the 15-day period following the test day. The validated method gave less participant burden and involved three unannounced video recall days representable for the training period: one rest/easy day, one medium load training day, and one high load training/competition day, selected randomly within the appointed time period based on a training schedule provided by each participant. For subjects with no planned rest days within the appointed time period, a day with lower training load replaced a rest day. The recalls were conducted by one specifically trained dietitian using an adapted version of a validated five-step multiple-pass method developed to reduce bias and to increase accuracy (73, 74). This method consisted of five steps:

1. the time and occasion of foods and beverages consumed throughout the 24-hour period
2. a quick-list uninterruptedly given by the subject
3. a detailed and thorough review of all foods and beverages consumed and the amount of such demonstrated by tableware and household measures
4. screening of a forgotten foods-list with categories of foods documented as frequently forgotten
5. a final probe.

All recalls were checked for completeness and, where possible, recipes were provided by the subjects. The information obtained was processed with the food and nutrient calculation software Kostberegningssystem version 7.4 (KBS, Oslo, Norway) using the database AE-18 by the same trained dietitian.

3.3.7 Exercise Energy Expenditure and Evaluation of Potential LEA

Daily training regimen was documented by each subject using a daily training log provided on the day of testing (**Appendix 4**). Duration of training sessions in minutes, intensity score based on the rating of perceived exertion (RPE) raging 1-10 (75), as well as type of exercise were recorded. Based on the RPE reported for each session, the training days were categorized as rest/easy (RPE 0-3), medium (RPE 4-6) or hard (RPE >7). In case of missing training data, estimated PAL and weighted means of EI were estimated based on subject-specific information concerning training schedule as provided during test day and by teammates.

Calculations

The PAL-value was estimated based on the categorization by FAO/WHO/UNU (76). A PAL of 1.4-1.69, 1.7-1.99 and 2.0-2.40 was set for rest/easy, medium and hard training days, respectively. Using the lower and upper value in each category, two PAL values were calculated for each subject. Finally, PAL-values for each of the 15 days were summarized and an average PAL was calculated representing the whole period. In order to evaluate estimated energy status, the estimated PAL-value was compared to the ratio between EI and $_{M}$RMR (EI:$_{M}$RMR, hereafter referred to as RMR-factor). These calculations were done while assuming the subjects were in weight balance during the 15 days of data collection.

3.4 Storage and Handling of data

The data was collected and stored at the location where the research was conducted. The processing of personal data was performed according to the Norwegian Personal Data Act (Personvernloven), and anonymity of the participants was ensured. All data was made electronic and stored in a protected internal network at NIH.

3.4.1 Feedback To the Participants

Individual feedback was provided to the participants. Data were anonymized with participation numbers before statistical analyses were performed.

3.5 Data Analyses and Statistics

Quantitative data analysis was performed using IBM SPSS Statistics 27 (IBM Corp, Armonk, NY, USA). Prior to statistical analysis, the data were evaluated for normal distribution using histograms, Q-Q plots and Shapiro-Wilk goodness-of-fit test. Parametric data was presented as mean with SD, and non-parametric as median with interquartile range (IQR) (25^{th} and 75^{th} percentiles). Descriptive analyses were performed to evaluate the prevalence of risk of RED-S, altered biomarkers and BWC parameters. Subgroup differences were evaluated using the independent sample t-test (parametric data) and Mann-Whitney U-test (non-parametric data) for continuous data, and χ^2 test for categorical data. Correlation analysis using Pearson's correlation test (parametric data) and Spearman's correlation test (non-parametric data) were performed to demonstrate any possible relationships. Associations were considered weak if $-0.29 \leq r \leq 0.29$, medium if $-0.30 \geq r \geq -0.49$ or $0.30 \leq r \leq 0.49$, and strong if $r \leq -0.50$ or $r \geq 0.50$ (77). Correlation analyses between risk of RED-S as assessed by LEAF-Q and LEAM-Q and surrogate markers of LEA, were performed combining male and female respondents using percentage of total possible score of the questionnaire (hereby referred to as LEAF/M-Q). Wherever relevant (e.g. reproduction hormones), correlation analyses were performed for male and female subjects separately. As the LEAF/M-Q were not validated in this population, correlation analyses were performed between BMD and detected altered surrogate markers. Associations with at least moderate degree with the lowest p-value in each biomarker section (endocrine/metabolic profile and RMR-ratio) were presented. All p-values less than 0.05 were considered statistically significant. Unanswered questions were marked as *missing data* and excluded from analysis.

3.6 Ethics

Following both oral and written information concerning the study, the participants signed an informed consent prior to study initiation, thus agreeing to the terms of the study (**Appendix 5**). The study was approved by the Regional Committee for Medical and Health Research Ethics (REK) (REK # 102284 Optimalisering av kosthold for parautøvere) (**Appendix 6**). The data was handled according to Good Clinical Practice guidelines and conducted in accordance with the Helsinki declaration as revised in 1983 (78). As the number of participants was relatively low, the sport and medical diagnosis of each participant were described in little

detail to ensure anonymity throughout the documentation of this study. There were no conflicts of interest.

3.7 Student Contribution

The following contribution was made by the author: 1) development of the LEAM-Q scoring key and cutoff score; 2) handling of data extracted from LEAF-Q and LEAM-Q, medical interview, DXA scans, and blood samples; 3) responsibility for subject completion of questionnaires; 4) involvement in preparations and assistance prior of and during test days; 5) providing individual feedback to the subjects including nutritional counselling and a written report, 6) all data analysis, and finally 8) the writing of the master thesis. Additionally, the author was involved in collecting and handling of additional data relevant for the *ParaNut* study.

4 Results

4.1 Study Participants

We included 12 eligible participants, which was a lower number than anticipated (20-25) due to the effects of COVID-19. One participant was excluded due to illness on test day, finally giving 11 participants eligible for study participation.

The study participant group consisted of five (45%) female and six (55%) male athletes with ages ranging from 19 to 47. Elite disabled athletes within cross country skiing (n=5), badminton (n=1), shooting (n=1), rugby (n=2), snowboard (n=1) and orienteering (n=1) were represented with disabilities including CP (n=3), SCI (n=1), spina bifida (n=1), dysmelia (n=1), visual impairment (n=1), hearing impairment (n=1), and other physical impairments (n=3). Both congenital (n=8, 73%) and acquired disabilities (n=3, 27%) were represented. The median duration of acquired disability was 12 years with a range of 7-20. Among the study population, five (45%) subjects were wheelchair-reliant, one (9%) subject used a prosthesis, and five (45%) subjects were ambulant independent of wheelchair and prosthesis. Descriptive characteristics of the subjects are presented in **Table 4.1**. Male subjects had statistically significant lower total body fat percentage compared to female subjects (P=0.004). No other differences between male and female subjects were found (P>0.082).

Table 4.1 Descriptive characteristics of study participants

	Mean (SD)	Median (25^{th}, 75th)
Age (years)[1]	29.4 (10.8)	23.0 (21.0, 40.0)
Height (cm)[1]	167.0 (11.3)	166.6 (160.0, 176.7)
Weight (kg)[1]	64.4 (11.9)	60.5 (55.1, 72.5)
BMI ($kg \cdot m^{2-1}$)	23.0 (2.5)	22.4 (20.6, 24.5)
Lean Body Mass (kg)	45.3 (9.4)	44.2 (40.4, 50.2)
Total Fat Percentage (%)	27.0 (10.0)	28.5 (16.7, 36.7)
Years in sport[1]	4.2 (2.5)	4.0 (2.0, 7.0)
Exercise ($h \cdot wk^{-1}$)	12.2 (5.7)	13.7 (8.3, 16.1)

Note: Characteristics shown as mean with SD and median with IQR, [1]Height and length was measured for 8 and 3 subjects, respectively, [2]Body mass index, [1]Skewed distribution.

4.2 Prevalence of Risk Factors of Low Energy Availability

4.2.1 Risk Estimates of Low Energy Availability

Assessment of Risk of Low Energy Availability

The prevalence of high risk of RED-S as identified by LEAF-Q (females) and LEAM-Q (males) among disabled athletes are presented in **Table 4.2**. The total number of people at risk was nine (82%) of which three females and six males. The median score of LEAF-Q and LEAM-Q accounted for 18% and 27% of the maximum possible score, respectively. When counting the sections adapted from the LEAM-Q also for the females, three (60%) of the female subjects were identified as being at high risk of RED-S with a median score of 33.0 (13.5, 55.0). The prevalence of risk of RED-S was not significantly different between wheelchair-reliant and non-wheelchair reliant subjects ($P>0.50$). Gastrointestinal symptoms did not differ between subjects reporting medication use with known gastrointestinal side-effects and subjects independent of such medications ($P=0.121$). Neither did the prevalence of such issues differ between male and female subjects, nor between groups based on ambulation state ($P=0.154$ and $P>0.50$, respectively).

Table 4.2 Results of the LEAF-Q and LEAM-Q indicating participants at risk of RED-S

	Mean (SD)	Median (25^{th},75^{th})	Prevalence Above Cutoff Threshold, n (%)[1]
LEAF-Q[2] (n=5)	10.0 (6.8)	9.0 (4.0, 16.5)	3 (60)
Gastrointestinal symptoms[3]	4.2 (4.4)	3.0 (0.5, 8.5)	3 (60)
Injuries and illness[4]	2.6 (2.4)	4.0 (0.0, 4.5)	3 (60)
Menstrual function[5]	3.2 (0.8)	3.0 (2.5, 4.0)	2 (40)
Wellness and restitution[6]	21.6 (14.0)	19.0 (9.0, 35.5)	Na
LEAM-Q[7] (n=6)	31.7 (9.0)	33.0 (22.3, 38.8)	6 (100)
Gastrointestinal symptoms[3]	0.8 (1.0)	0.5 (0.0, 2.0)	2 (33)
Injuries and illness[8]	5.8 (3.2)	6.5 (3.8, 8.3)	4 (67)
Wellness and restitution[6]	23.0 (5.1)	23.5 (18.8, 27.0)	Na
LEAF/M-Q[9] (%) (N=11)	23.4 (10.6)	25.4 (16.4, 30.3)	9 (82)

Note: data presented as mean with SD and median with IQR. [1]As described by Melin et al. (24) regarding LEAF-Q which were adapted in LEAM-Q, [2]Low Energy Availability in Females Questionnaire with cutoff threshold ≥ 8, [3,4]Cut-off threshold ≥ 2, [5]Cut-off threshold ≥ 4, [6]No cut-off threshold developed, [7] Low Energy Availability in Male Questionnaire with cutoff threshold ≥ 20, [8]Cutoff threshold ≥ 6, [9]LEAF-Q and LEAM-Q combined with score in % of total possible score. LEAF-F= Low Energy Deficiency in Female Questionnaire, LEAM-Q= Low Energy Availability in Male Questionnaire, RED-S= relative energy deficiency in sport.

Assessment of Energy Related Parameters

EI, measured- and predicted RMR, RMR-factor and estimated PAL-value are presented in **Table 4.3**. The mean RMR_{ratio} fell at the border of the cutoff threshold at <0.9. However, the Harris-Benedict and Cunningham predicted RMR values were slightly higher than $_{M}RMR$ with a mean difference of ten percentage points, and six (55%) and five (45%) subjects fell below the cutoff threshold <0.9, respectively (individual data not shown). On visual inspection, the median RMR-factor was lower for subjects at risk compared to all subjects. The high-risk group displayed a higher estimated energy expenditure than EI, as the median estimated PAL-value was higher than the median RMR-factor (**Table 4.3**). Daily EI (kcal/d and MJ/d) was significantly higher among male subjects compared to female subjects (P=0.03) (data not shown). No other differences between males and females showed statistical significance (P>0.07). Nor were any significant differences between wheelchair-reliant and non-wheelchair reliant subjects detected in any of the parameters (P>0.177).

Table 4.3 Energy intake, resting metabolic rate and estimated PAL-value

	All, mean (SD)	All, median (25^{th}, 75^{th}) (N=11)	At risk, Mean (SD)[§] or Median (25^{th}, 75^{th})[ǂ] (n=9)
EI[1], (MJ·d^{-1})	10.61 (3.26)	19.52 (8.53, 11.92)	10.62 (36.06)[§]
EI[1], (kcal·d^{-1})	2537 (777)	2515 (2038, 2849)	2540 (858)[§]
EI[1], (kcal·kg bm^{-1}·d^{-1})	40 (13)	42 (34, 47)	40 (14)[§]
$_{M}$RMR[2,l]	1349 (276)	1341 (1084, 1632)	1472 (1060, 1647)[ǂ]
RMR-factor[3]	1.91 (0.60)	2.03 (1.54, 2.13)	1.87 (0.67)[§]
$_{P}$RMR$_{C}$[4]	1496 (207)	1472 (1390, 1605)	1574 (1314, 1681)[ǂ]
$_{P}$RMR$_{HB}$[5]	1529 (232)	1468 (1344, 1708)	1468 (1307, 1765)[ǂ]
RMR-ratio$_{C}$ [6,*]	0.9 (0.1)	0.9 (0.8, 1.0)	0.9 (0.1)[§]
RMR-ratio$_{HB}$[7,l,*]	0.9 (0.1)	0.9 (0.8, 0.9)	0.9 (0.8, 0.9)[ǂ]
$_{E}$PAL[8,l]	1.91 (0.14)	1.95 (1.84, 2.05)	1.88 (0.15)[§]

Note: Presented as mean with SD and median with IQR. [1]Energy intake, [2]Measured resting metabolic rate in which one subject was measured in a seated position due to spasms, [3]Ratio between EI and $_{m}$RMR, [4]Predicted resting metabolic rate using Cunningham equation (47), [5]Predicted resting metabolic rate using Harris-Benedict equation (48), [6]Ratio between $_{M}$RMR and $_{P}$RMR$_{C}$ with cutoff threshold <0.9 (51), [7]Ratio between $_{M}$RMR and $_{P}$RMR$_{HB}$ with cutoff threshold <0.9 (51), [8]Estimated Physical Activity Level. PAL = physical activity level.
***** Established symptom of RED-S.
[l]Skewed distribution when n=11,
[ǂ]Presented as median with IQR when n=9,
[§]Presented as mean with SD when n=9.

4.2.2 Biomarkers of LEA

Reproductive Function

Reproductive function as described by level of oestradiol and testosterone are displayed in **Table 4.4**. Levels of oestradiol and testosterone were within clinical reference ranges, however two (33%) male subjects displayed levels in the lowest quartile of the clinical reference range. Among the female subjects, zero (0%) reported of primary amenorrhea. Two (40%) low-risk subjects reported previous secondary amenorrhea (one using contraceptives) in which one subject also reported current oligomenorrhea (20%). One (20%) subject at risk reported notable menstrual changes with increased training load and/or intensity. Hormonal contraceptives (intrauterine device) were used in four (80%) female subjects.

Table 4.4 Potential biomarkers of LEA in the total study group and among participants at high risk of RED-S

	Symptom	All, Mean (SD)	All, Median (25th, 75th) (N=11)	At Risk, Mean (SD)§ or Median (25th, 75th)¤ (n=9)	Prevalence of deviation from clinical reference ranges, n (%) (N=11)	Clinical reference ranges[1]
Reproductive Function	E2[2] (nmol·L^{-1})*	0.30 (0.22)	0.31 (0.12, 0.49)	0.33 (0.14, 0.33)¤	0 (0)	0.00-1.30
	TES[3,ł] (nmol·L^{-1})	16.8 (4.2)	16.5 (12.8, 21.3)	16.5 (12.8, 21.3)¤	0 (0)	8.0-35.0
Bone Mineral Density[4]	Lumbar spine L1-L4 (g·cm$^{2-1}$)	1.162 (0.174)	1.196 (0.997, 1.301)	1.146 (0.191)§	Na	Na
	Lumbar spine L1-L4 Z-score*	-0.2 (1.2)	0.3 (-1.2, 0.4)	-0.3 (1.3)§	4 (36)	-1.0-1.0
	Femoral neck (g·cm$^{2-1}$)[5]	1.094 (0.350)	0.978 (0.941, 1.276)	0.964 (0.203)§	Na	Na
	Femoral neck Z-score*[5]	-0.1 (1.4)	-0.2 (-0.8, 0.9)	-0.5 (1.3)§	2 (18)	-1.0-1.0
	Total body (g·cm$^{2-1}$)	1.195 (0.138)	1.219 (1.124, 1.304)	1.180 (0.149)§	Na	Na
	Total body Z-score*	0.9 (1.2)	0.5 (0.2, 2.0)	0.6 (1.1)§	1 (9)	-1.0-1.0
Metabolic Biomarkers	TSH[6] (mU·L^{-1})	1.47 (0.65)	1.10 (1.00, 2.00)	1.44 (0.63)§	0 (0)	0.20-4.00
	fT3[7,ł] (pmol·L^{-1})*	6.0 (0.4)	6.2 (5.6, 6.3)	6.1 (5.5, 6.3)¤	0 (0)	3.5-6.5
	fT4[8] (pmol·L^{-1})	14.7 (1.3)	14.8 (13.9, 15.6)	15.0 (1.1)§	0 (0)	11.0-23.0
	Cortisol (nmol·L^{-1})	418 (97)	423 (348, 503)	408 (104)§	0 (0)	200-650
Nutritional Biomarkers	Vitamin D 25[OH][9] (nmol·L^{-1})	70 (17)	70 (51, 88)	68 (49, 88)¤	6 (55)	(50) 75-150
	s-TIBC (µg·L^{-1}) [10,ł]	65 (6)	65 (59, 69)	64 (5)§	0 (0)	49-83
	s-Ferritin (µg·L^{-1})*					

Female[11]	83 (53)	72 (44, 128)	84 (59, 84)[ll]	0 (0)	15-200
Male[12]	116 (27)	119 (90, 142)	119 (90, 142)[ll]	0 (0)	20-300
Transferrin Saturation (%)[l]					
Female[10]	25 (8)	24 (18, 33)	30 (20, 30)[ll]	0 (0)	(15) 16 -50
Male[11]	34 (11)	34 (24, 42)	34 (24, 42)[ll]	0 (0)	(15) 16-57

Note: Presented as mean with SD and median with IQR. [1]As provided by the laboratory (71), [2] Oestradiol (n=5), [3]Testosterone (n=6), [4]Cutoff threshold <-1.0 (36), scanning procedures affected by spasticity and artefact in spine for seven and three subjects, respectively, [5](n=10) data from one subject was excluded due to extreme values: Z-score mean changed from 0.5 to -0.1 and g/cm^2 from 1.094 to 1.006 , [6]Thyroid-stimulating hormone, [7]Free triiodothyronine (n=10), [8]Free thyroxine, [9]Cutoff threshold <70 (70), [10]Serum total iron binding capacity, [11]n=5, [12]n=6. LEA=low energy availability, RED-S= relative energy deficiency in sport.
*Established symptom of RED-S.
[l]Skewed distribution when n=11,
[ll]Presented as median with IQR when n=9,
[§]Presented as mean with SD when n=9.

Bone Mineral Density

BMD derived from the DXA scan for all subjects and among those at risk of RED-S are presented in **Table 4.4.** Among subjects with BMD Z-score <-1.0 at one or more measurement site, all five (45%) subjects were at increased risk of RED-S. The most frequent skeletal site of which BMD Z-score was below clinical reference range was lumbar spine. Among these, three (75%) subjects were wheelchair-reliant (data not shown). Both subjects with femoral neck Z-score <-1.0 were wheelchair-reliant. On visual inspection, the mean femoral neck Z-score as well as total body Z-score were lower for participants at risk of RED-S than the total study group (**Table 4.4**). However, these differences were not statistically proven as only two subjects were not at risk of RED-S. Lumbar spine Z-score and total body Z-score were significantly lower among wheelchair-reliant subjects compared to non-wheelchair reliant subjects (P=0.048 and P=0.009, respectively). There were no significant differences between sexes regarding areal BMD nor BMD Z-scores (P>0.222). Two (18%) subjects reported of a previous diagnosed osteoporosis.

Metabolic and Nutritional Biomarkers

Metabolic and nutritional biomarkers are presented in **Table 4.4**. Biomarkers obtained from blood were mostly found within clinical reference ranges among the total study group as well as the high-risk group. The exception was vitamin D levels which were below the cutoff threshold for six subjects, despite reported supplementation in 64% of these participants (data not shown). No statistical differences were found between male and female participants regarding either of the measurements in **Table 4.4** (P>0.139).

4.3 Associations

4.3.1 Risk of RED-S and Bone Mineral Density

Risk of RED-S determined by percentage score of LEAF/M-Q (for male and female subjects combined) did not correlate significantly with any of the BMD sites (P>0.169). **Figure 4.1** displays BMD lumbar spine ($g \cdot cm^{2-1}$) where a medium yet non-significant, negative correlation was detected (r_p=-0.446, P=0.169).

4.3.2 Risk of RED-S and Endocrine and Nutritional Biomarkers

No significant associations were found between LEAF/M-Q percentage score and biomarkers (P>0.228). In relation to fT3, a non-significant negative correlation of moderate degree was detected (r_{sp}=-0.419, P=0.228) **(Figure 4.1)**. After analysis for males and females separately, there was a strong negative association between LEAM-Q and RMR-ratio$_C$ (r_{sp}=-0.771). Nevertheless, this relationship was not significant (P=0.072). LEAF-Q and oestradiol levels strongly related in a positive matter, yet non-significantly (r_{sp}=0.821, P=0.089). All other parameters showed no associations with LEAF-Q and LEAM-Q separately (P>0.266).

4.3.3 BMD and Detected Altered Biomarkers

When evaluating associations between biomarkers which were observed altered compared to cutoff thresholds, BMD lumbar spine Z-score and testosterone levels demonstrated a strong positive relationship with statistical significance (r_{sp}=0.899, P=0.015) (**Figure 4.1**). Association between total body Z-score and testosterone was also strong in a positive matter, although non-significant (r_{sp}=0.783, P=0.066). No other detected altered biomarkers of LEA was associated to BMD (P>0.111).

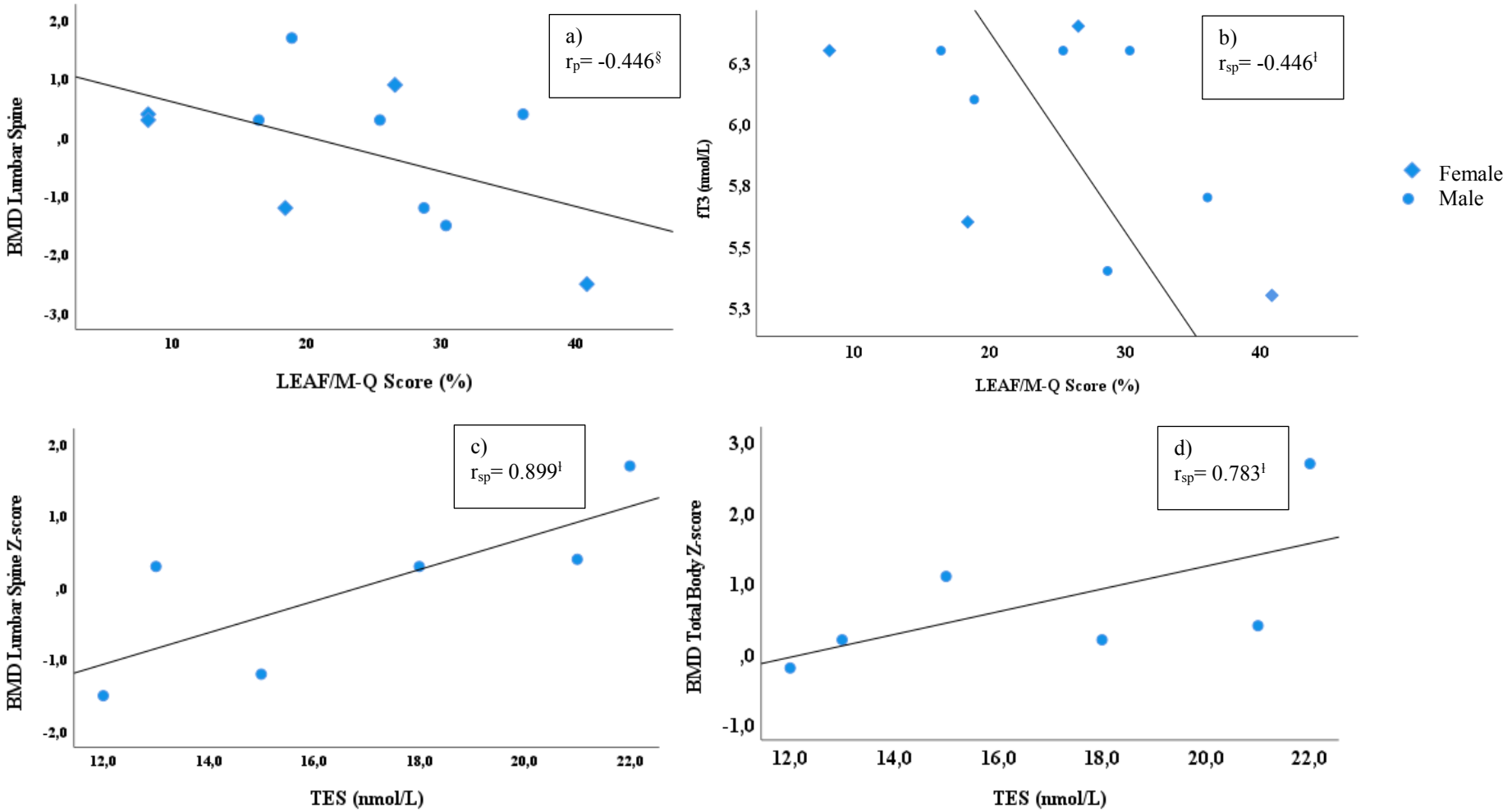

Figure 4.1 Correlations between risk estimates of RED-S and biomarkers, and between BMD and detected altered biomarkers

Note: Top row presenting correlation between Low Energy Availability in Female/Male-Questionnaire score (%) and a) bone mineral density lumbar spine ($g \cdot cm^{2-1}$) and b) free triiodothyronine. Lower row presenting correlation between testosterone ($nmol \cdot L^{-1}$) and c) bone mineral density lumbar spine Z-score and d) bone mineral density total body Z-score. §Pearson's and łSpearman's analyses were used to evaluate relationship between variables. BMD=bone mineral density, fT3= free triiodothyronine, LEAF/M-Q= low energy availability in female questionnaire and low energy availability in male questionnaire, TES= testosterone, RED-S= relative energy deficiency in sport.

4.4 Body Weight Concerns

4.4.1 Factors Associated to Body Weight Concerns

Some of the most prevalent factors associated to BWC are outlined in **Figure 4.2**. Of the study population, eight (73%) reported of intentional BWM in which seven (54%) were of current nature or within the previous three years. BWM was not reported in (27%) subjects. A yearly body weight fluctuation of ≥ 4.0 kg was reported in four participants (36%) with a median of 3.0 kg and a range from 1.0 to 10.0 kg. Discrepancy of ≥ 4.0 kg between current body weight and desired body weight was reported in six (55%) subjects with a mean of -0.4kg ranging from -16.2 to 9.7 kg. An ambition for a reduced body weight was indicated in five (46%) subjects and three (27%) subjects were aiming for an increased muscle mass. Of the participants reporting intentional BWM, athletic performance was the rationale in five (46%) of the participants, while three (27%) subjects indicated a weight management not associated to athletic performance. Of the latter proportion, two (18%) subjects also reported a current or previous problematic relationship to food and body weight, of which one (9%) participant reported a previously diagnosed ED during the athletic career. Body weight or nutritional concerns preventing athletic participation was reported in one (9%) subject. Adherence to a specific diet was reported in two (18%) subjects.

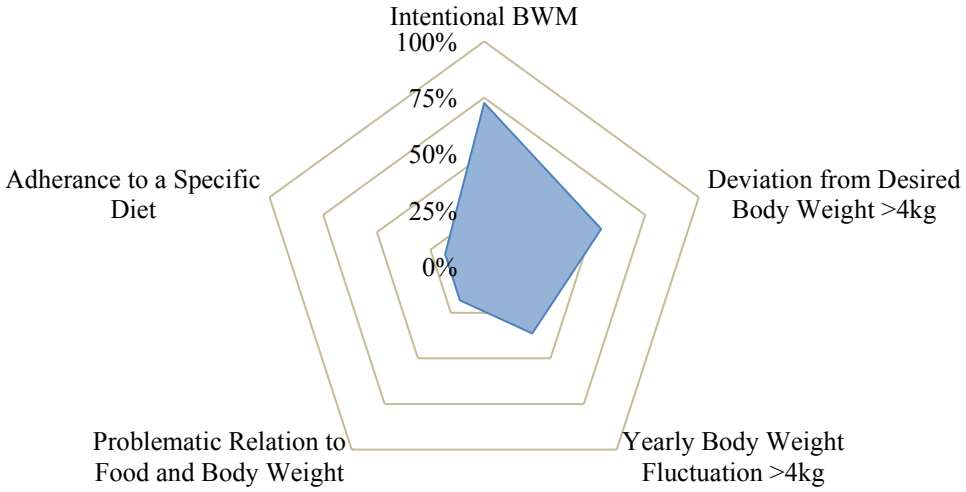

Figure 4.2 Prevalence of factors related to body weight concerns

Note: Prevalence presented as percentage of total study group (n=11). BWM = body weight management.

4.4.2 Body Weight Concerns and Risk Factors of LEA

The prevalence of risk factors of LEA among subjects with (n=7) and without (n=4) current or recent (within the previous three years) intentional BWM are presented in **Figure 4.3**. The prevalence of LEA risk factors were higher among subject with intentional BWM compared to those without BWM regarding risk estimates of RED-S (86% vs 75%) and RMR-ratio (71% vs 50%), whereas subjects without BWM displayed a higher frequency of reduced BMD than subject with intentional BWM (75% vs 43%).

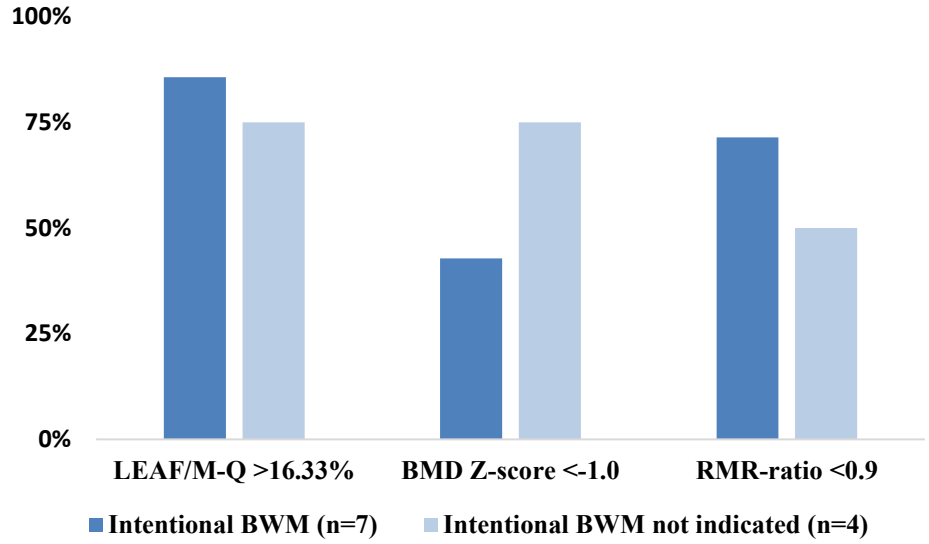

Figure 4.3 Prevalence of risk factors of LEA among subjects with and without intentional BWM

Note: Presented as percentages of total number within groups. LEAF/M-Q: Low Energy Availability in Female/Male-Questionnaire cutoff threshold >16.33%, BMD: Bone mineral density Z-score < -1.0 at any measurement site (36), RMR-ratio: Resting metabolic rate ratio includes both Cunningham (47) and Harris-Benedict (48) equations with cutoff threshold <0.9 (79).

5 Discussion

5.1 Discussion of Results

5.1.1 Summary of Findings

The observations of this master thesis are in line with the suggested hypothesis of disabled athletes being at risk of RED-S. The risk estimates of RED-S were predominantly high; the LEA-associated risk factors BMD Z-score and RMR-ratio were altered compared to determined cutoff thresholds in a considerable proportion of the sample, while endocrine and metabolic profiles were in large left within clinical reference ranges. Most subjects reported intentional BWM mainly for athletic performances, with a prevalent discrepancy between current and desired body weight.

5.1.2 Risk of LEA

Low Energy Availability in Female and -Male Questionnaires

For the validated questionnaire LEAF-Q, most of the female subjects were found at high risk of RED-S, as 60% of the subjects scored >8 with a median score of 9. In line, similar results were seen for LEAF+M-Q. All male subjects scored >20 with a median score of 33, thus at high risk of RED-S as detected by LEAM-Q. As the LEAM-Q awaits validation, the focus is on the LEAF-Q results in this thesis.

In line with our results, the study by Pritchett et al. which applied the same screening tool, found a great majority of the female disabled athletes at high risk of RED-S (59). According to the LEAF-Q, 78% of their female subjects scored >8 (9±4) as compared to the prevalence in this study with 60% at risk. They reported a non-consistency with the calculated EA states, and concerns were raised for the validity of the questionnaire in disabled athletes (59). Although they calculated EA using the traditional equation with associated cutoff thresholds, thus a methodology deviating from ours, this is in concordance with our findings as no consistency was found between the risk estimates and the estimated energy status of the subjects. In the current study, the latter was suggested by a non-significant difference between RMR-factor and estimated PAL in spite of an apparent high risk of RED-S. Similar to Pritchett et al., this study failed to control for contraceptive use among the female athletes. The accuracy of the total LEAF-Q is therefore compromised considering the menstrual

function section accounts for 1/3 of the questionnaire, and contraceptive use was true for 80% of the female subjects. A larger cross-sectional study by Brook et al. which investigated the prevalence of risk factors of LEA among American elite disabled athletes (n=260), concluded disabled athletes to be at high risk of RED-S. This was based on the prevalence of various risk factors also explored in the LEAF-Q, such as menstrual dysfunction and low BMD/stress fractures (20). Noteworthy, female subjects who had used oral contraceptives within 12 months prior to the study were excluded for analyses regarding menstrual function. Albeit a different screening methodology being a self-developed online questionnaire, female subjects (n=25) presented with a relatively high prevalence of oligomenorrhea (24%), secondary amenorrhea (20%) and low BMD (12.7%) (20).

Although we observed (non-significant) trends between the risk estimates and fT3 as well as lumbar spine Z-score, the current findings are not uniformly in concordance with previously documented data. Studies have demonstrated a significant relationship between the LEAF-Q results and surrogate markers of LEA among AB athletes, such as those described in Heikura et al. (23) and Staal et al. (51). However, it is difficult to demonstrate significant correlations in a small sample size. The positive association between LEAF-Q and oestradiol observed in the current study is surprising (**Figure 4.1**), as research have documented the contrary among AB athletes in high risk of LEA (23, 80). It may be speculated that the association is plausibly due to use of contraceptives as previously described.

Among the male subjects, all subjects were found in high risk of RED-S. As this is the first study to apply the LEAM-Q among disabled athletes, the data presented may be considered as preliminary findings regarding the use of the questionnaire as it has not been validated in this cohort. Akin to the female subjects in the study by Brook et al., male disabled athletes have previously been described as in high risk of RED-S, although the report was based on a questionnaire other than LEAM-Q. The authors reported male disabled athletes at increased risk of RED-S based on a high prevalence of dietary restraint behaviour as detected by the recognized Eating Disorder Examination Questionnaire (36.7%) (20). Contrary, other studies have described male disabled athletes at low risk of RED-S based on EA and dietary behaviour associated to RED-S (58, 59). Hence the literature is inconsistent regarding risk of RED-S among male para-athletes (20, 58, 59). In the current study, a trend was observed between the LEAM-Q score and RMR-ratio suggesting a possible association, however, more

studies are needed to confirm or challenge this finding, considering that validation of the questionnaire awaits.

In both LEAF-Q and LEAM-Q, ambulation state is a plausible confounding factor regarding the total score, as 45% of the subjects were wheelchair-reliant. However, wheelchair use did not seem to impact prevalence of gastrointestinal issues although such are commonly reported among wheelchair-reliant individuals (1). The heterogeneity concerning impairments as well as the use of female contraceptives makes it difficult to evaluate the apparent high risk of RED-S in this population. As biomarkers could proceed as validation measurements of the questionnaire, one could question the accuracy of the questionnaire in this population. This is reasoned by a high prevalence of risk of RED-S, yet endocrine biomarkers were in large left unaltered. This notion is in agreement with the considerations of Pritchett et al. (59).

Energy Intake and PAL

On a group level, a discrepancy between the RMR-factor in relation to the estimated PAL and the scores of the questionnaire is apparent. Although the risk estimates were high in most subjects, the energy level seemed to be sufficient considering the nearby results of estimated PAL and RMR-factor. However, it is important to illuminate the time perspectives in which the two methods operate: the questionnaire is designed to detect long-term LEA whereas these estimates reflect the 15 days of data collection where energy balance is assumed. Furthermore, as uncertainties were greatly present concerning estimation of EI and PAL, the RMR-factor relative to estimated PAL must be cautiously interpreted.

5.1.3 Biomarkers of LEA

Reproductive Function

Menstrual dysfunction is a crucial marker to evaluate regarding risk of RED-S in female athletes. Previous secondary amenorrhea was reported in 40% of the female subjects, in which one subject also reported of current oligomenorrhea. This study reports a high prevalence of impaired menstrual function despite oestradiol levels within clinical reference ranges, however the sample size was small. Moreover, evaluation of the findings in relation to risk estimates and other biomarkers are difficult on a group level, as the time in which secondary amenorrhea occurred was not recorded. Furthermore, as neither subject with impaired menstrual function displayed with high risk of RED-S, factors other than inadequate EA

might have caused these conditions. Evaluation of oestradiol levels and self-indicated menstrual function is challenging due to factors such as contraceptive use and recall bias. Self-reported information regarding recent menstrual activity was missing, deemed unreliable (due to use of contraceptives or inability to recall details), or not specific enough to determine cycle phase of the respective participants. Previous studies have reported menstrual function among disabled female athletes as abnormal albeit the issue remaining largely unknown (19, 20, 59). The prevalence of oligomenorrhea among pre-menopausal American female disabled athletes have been reported to be 32% (n=91) (19), and 44% (n=25) of the female athletes indicated oligomenorrhea/amenorrhea in another study (20).

Male reproductive function is a matter yet to be elucidated regarding RED-S. In the current study, two (33%) of the male subjects displayed testosterone levels in lower quartile of the clinical reference ranges which, according to literature, in athletes are suggested as low levels (23). Nevertheless, the relation between testosterone levels and risk of LEA was insignificant. A newly published study reported of 100% of the male participants of exhibiting low testosterone levels (7.9 ±2.3 $nmol \cdot L^{-1}$) although with an apparent adequate EA (59). However, their reported testosterone levels were possibly confounded by the high prevalence of SCI (56%) and thus suggested not rendered by a LEA state. Among AB athletes, testosterone levels in the lowest quartile of the clinical reference range have been reported in 40% of male distance runners, and the levels were significantly lower among males in LEA states compared with males in higher EA states (23). Although the present findings are in agreement with the aforementioned and thus one can argue it possibly supports previous findings, the result is plausibly rendered by the impairments possibly furthering a reduced testosterone level. Finally, the heterogeneity and small study group makes it difficult to evaluate testosterone as a component in RED-S.

Bone Mineral Density

Nearly half (45%) of the subjects were found with BMD Z-score <-1.0 at one or more measurement site suggesting these participants to be at increased risk of impaired bone health and bone fractures. These findings are in concordance with the risk estimates, and whether long-term LEA contributed to low BMD could be speculated. Notably, the subjects with low femoral neck Z-score were wheelchair-reliant, and the BMD Z-score was significantly lower among wheelchair-reliant subjects in spinal region and total body compared to ambulatory subjects. Hence, the high prevalence of reduced BMD might be confounded by wheelchair

use. According to a 2019 ISCD official position, research has reported minimal loss of BMD in the lumbar spine region in longitudinal studies investigating wheelchair reliant individuals diagnosed with SCI, nor in comparison with an able-bodied population (12). Although not differentiating based on the impairment but rather the ambulation state, our findings suggest otherwise. This is surprising as, depending on the site and severity of injury as well as the sport, disabled athletes reliant of wheelchair may still load their spine and are thus more likely to display a less decreased BMD in spine, due to increased load and resistant training. Indeed, increased BMD have been noted elsewhere among wheelchair-reliant individuals performing in upper-and lower-extremity activities (12, 13, 81). Noteworthy, these reports concerns individuals with SCI and might not be relevant concerning other impairments.

Studies conducted on AB male cyclists have demonstrated lumbar spine and femoral neck as sites negatively impacted by RED-S (35). In this thesis, all subjects with low lumbar spine Z-score were in high risk of RED-S, and our results show a higher prevalence of reduced BMD compared to the study by Brook et al which also reported of high risk of RED-S. They noted 8.5% of the subjects (N=260) to be categorized with low BMD, albeit with an inferior methodology concerning BMD measurement (20). Our study further supplies the previous research by Pritchett et al. by exploring an additional skeletal site regarding BMD. They investigated the femoral neck and total body and reported 72% of subjects with low BMD Z-score in the hip region across sexes (F -1.5 ±1.2, M -1.7 +0.7). They also suggested their population at a high risk of RED-S. Their study population differed from our distribution regarding impairment and ambulation state as their study mainly consisted of athletes with SCI, with all subjects being wheelchair-reliant (59). A study conducted on six elite disabled track athletes diagnosed with CP reported a BMD Z-scores closely resembling the BMD of the healthy controls (82), while another study reported lower bone mass among 141 elite CP footballers than healthy controls (83). A study conducted by Chad et al. suggested the reduced BMD reported in CP patients may largely be impacted by the following wheelchair-reliance due to the condition (84). Thus, the nature of impairments must be considered when evaluating the reduced BMD detected in the current study population.

In the current study, there was a strong association between BMD and testosterone, which supports the findings of previous studies conducted on AB athletes regarding RED-S (23, 35). Considering the notion of testosterone release decreases with LEA states (30, 33), the observed relationship could be speculated as due to long-term LEA as a low BMD was

concurrently observed. As a reciprocal interaction between testosterone and bone has been described among sedentary males (85), alterations of both of these parameters might be expected if one is already impaired. To our awareness, this is the first study to explore the relationship between BMD and testosterone levels among disabled athletes. Nevertheless, the nature of disability and ambulation state are notable which could possibly confound the observed correlation between BMD and testosterone.

Metabolic and Nutritional Biomarkers

The metabolic and nutritional biomarkers were found within clinical reference ranges for all subjects including those at risk, except for vitamin D which were depleted in most subjects. Our study did not detect any alterations of the thyroid hormones, but rather found the median fT3 level, reviewed as an established biomarker, in the highest quartile of clinical reference ranges. Our findings support the results of the previously mentioned study by Pritchett et al. which reported all (n=18) subjects with fT3 levels within clinical reference ranges when examining athletes with predominantly SCI and CP (59). Contrary, previous studies conducted on AB athletes have reported decreased levels of fT3 concomitantly with LEA conditions (22, 40). Research have reported unchanged levels of TSH and fT4 among AB athletes in relation to LEA, which are in line with our findings (34). In the current study, the lack of altered levels of thyroid hormones might be reasoned an absence of RED-S, or attributed by detection instrument uncertainties.

Detection of normal values regarding cortisol is consistent with previously reported findings of unaltered levels among AB athletes (86-88). However, research is inconsistent regarding its relation to LEA and other studies have documented otherwise (31, 43, 89, 90). Cortisol levels are subject to great within-day variation due to circadian rhythms and thus alterations as a component of RED-S are difficult to detect (32).

The normal ferritin levels detected suggest a possible adequacy of EA as research have reported low levels where LEA is indicated (8, 57). Depleted levels of vitamin D plausibly reflects a long-term suboptimal micronutrient intake, as well as a low compliance to supplemental intake as such was indicated by most subjects. Moreover, the measurements were conducted at a northern latitude where depleted levels of vitamin D are commonly reported during the winter months (91).

The observations concerning RMR as a surrogate marker of LEA suggests a stabile RMR as, on a group level, the RMR-ratio were unaltered relative to the cutoff threshold. Interestingly, on an individual level around half of the population was detected with RMR-ratio <0.9, despite unaltered thyroid hormones. As the thyroid hormones are central regulators of the metabolic rate (31), one would expect reduced hormonal levels to accompany reduced RMR. As such, factors other than a reduced RMR may have caused the aforementioned, as most of these subjects fell right below the cutoff threshold suggesting individual variation. The results could also be inclined to a high proportion of wheelchair-reliant subjects in this study, which is argued by an observed reduction of RMR among wheelchair-reliant individuals (1). However, no differences between subgroups were found based on ambulation state concerning RMR-ratio.

5.1.4 Body Weight Concerns

Among the eight subjects indicating intentional BWM, in which seven were of current nature or within the last three years, the greater proportion reported a motivation of athletic purposes. The desired body weight deviated from their current body weight, with a drive for an increased muscle mass and a reduced body weight being indicated. However, only two subjects indicated a problematic relationship to food and body weight. An interpretation of this suggests a management of body weight possibly absent of restrictive dietary behaviour in most subjects. An elevated yearly body weight fluctuation was also apparent. However, this is not synonymous with BWC although research have suggested such as an indicator of a purposeful dietary behaviour for obtaining a desired body weight among AB individuals (26). Rather, it possibly relates to natural variation during the course of a training season (60), medication use or the nature of the impairment. Whether this contribute to a greater or a reduced BWC is worthy of thought which is beyond the scope of this thesis.

It is difficult to determine a behaviour regarding BWM as conscious management profitable for athletic performance, or as a focus on bodily affairs beyond the favourable. In this thesis a high prevalence of LEA-associated risk factors among subjects indicating BWM was displayed, with the high LEAF/M-Q score of particular interest. Melin et al. suggests a follow-up assessment of subjects with increased score of one of the topics within LEAF-Q, as such subjective physiological symptoms has been documented as highly prevalent among patients with DE/ED (24, 36, 92). Pathological eating behaviour and DE/ED are associated

with BWC making this claim interesting when investigating the prevalence of such concerns in the population in question. Considering the abovementioned, our results may suggest concerns regarding body weight as a potential contributor of LEA states and subsequently RED-S. Previous studies, in which the majority conducted on disabled athletes with SCI, have observed similar findings where LEA is of notable concern with the presence of BWC (9, 11, 20, 64). Brook et al. (N=260) reported a high prevalence (61.5%) of disabled athletes dissatisfied with current body weight or composition in relation to sport performance, in which athletic purposes was the main motivation. A small fraction of their subjects indicated a history of diagnosed ED (3.1%), while their applied screening tool (EDE-Q) unveiled substantially increased amount of having dietary restraints or pathological behaviour (18.5% and 32.4%, respectively) (20). In addition to our findings, these statistics may indicate a high prevalence of factors associated to BWC and potentially mirror the impact BWC imparts on disabled athletes. However, this might be of challenge to accurately assess. Additionally, it is important to note such bodily concerns as they may progress into deleterious conditions (93, 94). As researchers argue athletes as prone to restrictive and unhealthy dietary behaviour (21, 32, 63, 95), the importance of furthering the understanding of BWC among disabled athletes is clear.

As BWC may be stigma-associated (96), by its very nature, a stigma may give way for dishonest answers regarding body weight and its implications. The questions concerning body weight and the subjects' relation to such are personal matters and might be considered intimidating. Furthermore, the subjects were queried with subjective questions prone to disparate interpretations. If BWC is indeed present, a discrepancy between the subjective indication and the objective nutritional wellbeing of the body might befall. As such, the reliability of the results limits the generalization of the results.

5.2 Methodological Considerations

5.2.1 Study Population

Elite disabled athletes is a greatly heterogeneous and thus limited researched group. Considering a rapid growth of the para-sports both nationally and internationally, research is of even greater importance (21). The study population included in this master thesis, akin to the greater population, consisted of a variety of disability types, sports and age. Due to lack of

information regarding the distribution of sex and age in the greater population, the representativeness in terms of sex and age is hard to determine. Both individual- and team sports were represented; sport emphasizing leanness and those described with less focus on the body composition. As the subjects represented a minority group within society, the small study sample was somewhat expected although the ongoing global pandemic limited the study size even further.

Impairment and ambulation state are factors worthy of discussion. There was a risk of results being confounded by type of impairment and/or ambulation state regarding all measurements. Ambulation state was corrected for using stratification reducing potential bias. This probably led to further reduction of statistical power due to small subgroups. Thus, the results must be interpreted with caution.

5.2.2 Study Design

A cross-sectional study design was employed as this design is best suited for prevalence investigations, and it is relatively cheap and feasible to perform (97). A cross-sectional study describes nutrition-related features of the study population which provides evidence for potential future intervention studies. It also allows for a big and heterogeneous study group, although the latter limits the ability to conclude (97). As such, this master thesis did not evaluate the causation between risk estimates and surrogate markers of LEA, but rather whether the two coexisted, as well as the potential associations between the two. Sampling bias, which is reported as a common weakness of the study design, was reduced as all elite para-athletes were invited to participate. Nevertheless, information regarding non-responders was unattainable which must be noted. As the number of subjects in low-risk group was small (n=2), comparisons between high- and low-risk groups regarding prevalence of biomarkers and BWC were irrelevant.

5.2.3 Measurements and Data Collection

Questionnaires and Medical Interview

Questionnaires are feasible, relatively cheap and easily administered for screening purposes. Although LEAF-Q and LEAM-Q provided subjective and perceived information, there is good evidence of the questionnaires to be of promising value to detect potential LEA when interpreted along with biochemical data such as the endocrine profile of the reproductive and

metabolic hormones (49). Question clarifications were facilitated which limited misclassification bias. The LEAF-Q has been validated among AB female athletes which refrained from contraceptive use (24); however, only one previous study has applied it on disabled athletes (59). This introduces both strengths and weaknesses. Applying this screening tool in elite disabled athletes while measuring markers of LEA may elucidate whether the screening tool is indeed appropriate in this population. However, the nature of impairment, ambulation state and contraceptive use may confound the results giving a false high prevalence of RED-S among disabled athletes. LEAM-Q is awaiting validation, and thus the appropriateness of the use of this questionnaire among this population is unknown. As the section regarding wellness and restitution accounted for a considerable part of the questionnaire, the results must be interpreted while considering the ongoing global pandemic contributing to the appearance of series of mental health issues (Wilke et al.). Akin to LEAF-Q, it was developed among AB athletes which must be considered when interpreting the results.

Both in the LEAF-Q and the LEAM-Q and the medical interview, the subjects were queried with some questions with negative connotations. Furthermore, questions concerning bodily affairs and the subjects' relation to such which are personal matters and might be considered intimidating. Thus, in addition to recall bias, social desirability bias and response bias is plausible. Interviews as a means of data collection presents challenges as the data conducted is self-reported entailing limitations as mentioned above. However, all subjects were queried following the same order of questions and by the same study operator for all interviews, which limited information bias.

Assessment of EI and PAL

Assessment of EI using the five-step multiple-pass 24h recall method is a relatively feasible method which reduces participation burden and increases accuracy (73, 74). However, it is subject to recall bias, social desirability bias, and over- and underreporting of EI, in which the latter is reported more frequently (98). Another limitation is misclassification of dietary components in the applied software for energy calculation. To limit possible biases and to increase accuracy, one specifically trained dietitian conducted all recalls and subsequently managed the dietary data.

Self-reported training log is subject to recall bias and misclassification bias (23). However, it is a feasible method familiar for most athletes, and thus reduces participation burden. There is a paucity in literature concerning the activity level and energy expenditure of the para-athletic population (1, 8), and the training log did not include registration of non-exercise activities. Consequently, limited information was obtained about their overall activity level. Thus, estimating a hypothetical PAL based on such data may introduce uncertainties. Despite the aforementioned, evaluating the RMR-factor in relation to estimated PAL combined with the surrogate markers of LEA, allow for an evaluation of the risk estimates derived from the LEAF/M-Q.

Assessment of BMD

DXA scan is considered the gold standard for determination of BMD (99) in able-bodied as well as disabled athletes, although validation among disabled athletes is lacking (1, 100). Although total body scan has been suggested as the most reliable scanning site regarding BMD measurement (1), the femoral neck and spine were included as the two regional sites with better predictive ability of osteoporotic fractures in each site, respectively (101). Potential spasticity, tremors and internal metal objects are possible sources of measurement error when conducted on disabled athletes (12). The latter was corrected for where relevant which limited measurement errors. Considerations of the ambulation state, nature of impairments, e.g. scoliosis, missing body part, and contraceptive use must be done while interpreting the data. (12, 102, 103).

Analyses of Metabolic and Nutritional Biomarkers and Reproductive Function

Biomarkers are according to literature a superior method of detecting risk of RED-S (23, 33). It is an objective measurement not subject to common biases associated with self-reported data (23, 33). Furthermore, as athletes may impart RED-S on a graded scale from optimal EA to LEA, biomarkers may unmask LEA states not yet developed into detectable symptoms such as menstrual dysfunction, reduced libido, and bone fractures (21, 49). Notably, the reliability of biomarker measurements obtained from blood are impacted by the variation coefficient of the respective measurement which presents some uncertainties (71). Cortisol along with testosterone and oestradiol are circadian hormones (104, 105) and this thesis allowed for a single time baseline measurement for detection of baseline levels to reduce participation burden.

RMR measurement: Indirect calorimetry

Indirect calorimetry is non-invasive and easily administered which measures RMR with high accuracy (1, 106). As all measurements were performed by one trained personnel, measurement bias was limited. It requires a rested supine position which was not ensured for all subjects due to spasticity. Thus, an increased RMR compared to the actual RMR was potentially observed.

5.3 Strength and Limitations

5.3.1 Strengths

This master thesis contributed preliminary work to the gap in literature regarding an athletic population in rapid growth where nutritional issues would be expected to have high priority. The study was conducted within one country eliminating dissimilarities of sporting practices and demographic differences observed in previous international studies. It applied the best methodology available for risk estimation and the measuring of a multifold of established biomarkers. As all elite athletes with a disability were deemed eligible for participation, the representativeness of the greater population was retained.

5.3.2 Limitations

Although the heterogeneity facilitated representativeness, when combined to a small sample size it also challenged internal validity and thus threatened the generalizability. The applied cutoff threshold for all measurements were based on AB athletic or sedentary populations which might not be applicable for disabled athletes regarding detection of RED-S. Due to the prevalent contraceptive use among the female subjects, evaluation of female reproductive function was greatly limited. As the impairments of the subjects plausibly confounded the results, conclusions could not be made regarding the risk of RED-S, nor its implications. Nevertheless, limitations considered, the findings of this master thesis provide new knowledge and serves as a springboard for future studies.

6 Conclusion

RED-S is detrimental to health, both in a short-term and long-term perspective. This master thesis provided preliminary findings regarding this issue among disabled athletes, as it was the first study to be conducted on Norwegian elite disabled athletes regarding RED-S, LEA biomarkers and the exploring of BWC. Although limitations were present, the study provides findings applicable for information and provide a framework for future investigations:

- The risk estimates supports the hypothesis of a high risk of RED-S as assessed by the LEAF/M-Q among Norwegian elite disabled athletes, but questions were also raised concerning the appropriateness of applying these questionnaires among disabled athletes.
- LEA biomarkers such as low BMD and a reduced RMR were prevalent, while other established surrogate markers such as fT3 and ferritin were left unaltered.
- Menstrual function was reported currently and previously impaired in some of the female subjects. However, female reproductive function was difficult to evaluate as contraceptives were utilized.
- Regarding male testosterone levels, the findings demonstrated reduced levels in some of the subjects in high risk of RED-S, and a positive correlation between testosterone levels and BMD. This may indicate that testosterone could be a surrogate marker of LEA.
- Factors possibly related to BWC such as intentional BWM and discordance between current and desired body weight were highly prevalent. Considering Norway as a leading country of preventative work regarding development of RED-S, such records may provide new cynosure in this effort.

As the disabilities may introduce physiological symptoms also recognized as markers of LEA, research regarding the true prevalence of RED-S among disabled athletes remain a challenge. Although a non-consistency between the risk estimates and biomarkers was noted, LEA may display without the detection of associated risk factors. On this account, risk of RED-S cannot be waived in the current population. This master thesis underlines the issue of RED-S among elite disabled athletes as deserving of increased attention both in the field of research and in athletic environments.

7 Perspectives and Future Research

Further research is warranted for quantification of findings regarding risk estimates of RED-S and to elucidate its implications among Norwegian disabled athletes. A suggestive approach involves a larger study group enabling subgroup analyses concerning different sports and physical impairments. Increasing the study size would greatly strengthen the study design and may enable analytical in addition to descriptive research. There is a limited number of Norwegian disabled athletes, thus international collaboration is necessary for further advancement in this field. Of such, researchers must consider potential differences regarding sports practices, culture and demographic relations.

Validation studies regarding the use of LEAF-Q and LEAM-Q among disabled athletes, or a development of a risk screening tool specifically validated for this population, are needed for a better evaluation of RED-S among disabled athletes. Additionally, establishment of appropriate cutoff threshold for the respective impairments where relevant, is warranted for better evaluation of LEA biomarkers. For a better detection of BWC as a possible contributing factor of LEA states, application of validated screening tool could be of potential interest in future studies.

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List of Appendices

LEAF-skalaen

Spørreskjema til kvinnelige idrettsutøvere

Department of Nutrition, Exercise and Sports
Life Science
University of Copenhagen
Denmark
Contact: Anna Melin, aot@life.ku.dk

1. Skader

Sett kryss i det svaralternativet som best beskriver din situasjon

A: Har du vært skadet i løpet av det siste året og dermed hatt fravær fra eller vært markant begrenset i forhold til din trenings-/ konkurranseevne?

☐ Nei, slett ikke ☐ Ja, 1-2 ganger ☐ Ja, 3-4 ganger ☐ Ja, 5 ganger eller flere

A1: Hvis ja, hvor mange dager i løpet av det siste året har du ikke trent eller deltatt i konkurranse som planlagt på grunn av skader?

☐ 1-7 dager ☐ 8-14 dager ☐ 15-21 dager ☐ 22 dager eller flere

A2: Hvis ja, hvilke typer av skader har du hatt i løpet av det siste året? _____

_____

_____

Evt. kommentar eller utdyping angående skader: _____

_____

2. Magefunksjon

A: Føler du deg oppblåst eller oppsvulmet i magen, også når du ikke har menstruasjon?

☐ Ja, flere ganger/dag ☐ Ja, flere ganger/uke ☐ Ja, 1-2 ganger/uke eller sjeldnere
☐ Sjeldent eller aldri

B: Har du kramper og/eller magesmerter, som ikke kan relateres til din menstruasjon?

☐ Ja, flere ganger/dag ☐ Ja, flere ganger/uke ☐ Ja, 1-2 ganger/uke eller sjeldnere
☐ Sjeldent eller aldri

C: I gjennomsnitt, hvor ofte har du avføring?

☐ Flere ganger/dag ☐ 1 gang /dag ☐ Hver 2. dag ☐ 2 ganger/uke
☐ 1 gang/uke eller sjeldnere

D: Hvordan pleier din avføring å være?

☐ Normal (fast eller bløt) ☐ Meget tynn, som diaré ☐ Hard og tørr

Evt. kommentar eller utdyping angående magefunksjon: _____

---

3. Prevensjonsmiddel

A: Bruker du p-piller?

☐ Ja ☐ Nei

A1: Hvis ja, hvorfor bruker du p-piller?

☐ Prevensjonsmiddel ☐ Redusere menstruasjonssmerter ☐ Redusere blødningsmengden
☐ For å regulere menstruasjonssyklus i forbindelse med konkurranser etc.
☐ Hvis ikke, uteblir menstruasjonen
☐ Annet_____

_____

A2: Hvis nei, har du brukt p-piller tidligere?

☐ Ja ☐ Nei

A2:1 Hvis ja, når og hvor lenge?_____

_____

B: Bruker du noen annen form for hormonell prevensjon? (f.eks. p-stav, hormonspiral)

☐ Ja ☐ Nei

B1: Hvis ja, hvilken type?

☐ P-plaster ☐ P-stav ☐ Hormonspiral ☐ Annet

4. Menstruasjon

Sett kryss i det svaralternativet som best beskriver din situasjon

A: Hvor gammel var du da du fikk din første menstruasjon?

☐ 11 år eller yngre ☐ 12-14 år ☐ 15 år eller eldre ☐ Husker ikke
☐ Har aldri hatt menstruasjon (Hvis du svarte "Har aldri hatt menstruasjon" er det ikke flere spørsmål å besvare)

B: Kom din første menstruasjon naturlig? (av seg selv)

☐ Ja ☐ Nei ☐ Husker ikke

B1: Hvis nei, hva ble gjort for å igangsette din menstruasjon?

☐ Hormonbehandling ☐ Vektøkning ☐ Redusert treningsmengde ☐ Annet

---

C: Har du normal menstruasjon?

☐ Ja ☐ Nei (**gå til spørsmål C6**) ☐ Vet ikke (**gå til spørsmål C6**)

C1: Hvis ja, når hadde du sist menstruasjon?

☐ 0-4 uker siden ☐ 1-2 måneder siden ☐ 3-4 måneder siden ☐ 5 måneder eller lenger siden

C2: Hvis ja, har du regelmessig menstruasjon? (hver 28.-34. dag)

☐ Ja, som regel ☐ Nei, som regel ikke

C3: Hvis ja, hvor mange dager pleier du å ha blødning?

☐ 1-2 dager ☐ 3-4 dager ☐ 5-6 dager ☐ 7-8 dager ☐ 9 dager eller mer

C4: Hvis ja, har du noen ganger problemer med kraftig menstruasjonsblødning?

☐ Ja ☐ Nei

C5: Hvis ja, hvor mange menstruasjonsblødninger har du hatt i løpet af det siste året?

☐ 12 eller flere ☐ 9-11 ☐ 6-8 ☐ 3-5 ☐ 0-2

C6: Hvis nei eller husker ikke, hvor lenge er det siden du sist hadde menstruasjon?

☐ 2-3 måneder siden ☐ 4-5 måneder siden ☐ Mer enn 6 måneder siden ☐ Jeg er gravid og har derfor ikke menstruasjon ☐ Jeg bruker minipiller og har derfor ikke menstruasjon

---

D: Har din menstruasjon uteblitt helt i 3 måneder eller lengre uten at det skyldes graviditet eller minipiller?

☐ Nei, det har aldri skjedd ☐ Ja, det har skjedd tidligere ☐ Ja, jeg opplever det nå

E: Opplever du at din menstruasjon endrer seg ved økt treningsintensitet, -frekvens og/eller -varighet?

☐ Ja ☐ Nei

E1: Hvis ja, hvordan? (sett ett eller flere kryss)

☐ Jeg blør mindre ☐ Jeg blør i færre dager ☐ Min menstruasjon uteblir ☐ Jeg har kraftigere blødning ☐ Jeg blør i flere dager

5. Svimmelhet

Sett kryss i det svaralternativ som best beskriver din situasjon

A: Kjenner du deg svimmel når du reiser deg raskt opp?

☐ Ja, flere ganger/dag ☐ Ja, flere ganger/uke ☐ Ja, 1-2 ganger/uke eller sjeldnere
☐ Sjelden eller aldri

B: Opplever du problemer med synet ditt (uskarphet, ser prikker, tunnellsyn etc)?

☐ Ja, flere ganger/dag ☐ Ja, flere ganger/uke ☐ Ja, 1-2 ganger/uke eller sjeldnere
☐ Sjelden eller aldri

6. Temperaturregulering i hvile

A: Fryser du selv om du har normalt med klær på deg?

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

B: Har du mer klær på deg/kler deg varmere enn de utøvere/personer du omgås uavhengig av vær?

☐ Ja, nesten alltid ☐ Ja, noen ganger ☐ Sjelden eller aldri

7. Velvære og restitusjon

Sett kryss i det svaralternativ som best beskriver din situasjon

A: Trøtthet

A:1 Jeg føler meg svært trøtt når jeg kommer hjem fra arbeid/skole

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

A:2 Jeg kjenner meg overtrøtt

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

A:3 Jeg har vanskeligheter med å konsentrere meg

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

A:4 Jeg kjenner meg sløv

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

A:5 Jeg fremskyver viktige beslutninger

☐ Ja, alltid ☐ Ja, ofte ☐ Ja, iblant ☐ Sjelden eller aldri

B: Velvære

B:1 Jeg har vondt i kroppen

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

B:2 Musklene mine føles stive og ømme på trening

☐ Ja, nesten på hver treningsøkt ☐ Ja, på mange treningsøkter
☐ Ja, iblant på noen treningsøkter ☐ Sjelden eller aldri

B:3 Jeg har muskelverk/er støl etter trening

☐ Ja, på nesten hver treningsøkt ☐ Ja, på mange treningsøkter
☐ Ja, iblant på noen treningsøkter ☐ Sjelden eller aldri

B:4 Jeg føler at jeg blir lett skadet

☐ Ja, alltid ☐ Ja, i de fleste treningsperioder ☐ Ja, i noen treningsperioder
☐ Sjelden eller aldri

B:5 Jeg har hodeverk

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

B:6 Jeg kjenner meg fysisk utmattet

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

B:7 Jeg kjenner meg sterk og har god progresjon i styrketreningen min

□ Ja, alltid □ Ja, i de fleste treningsperioder □ Ja, i noen treningsperioder □ Sjelden eller aldri

DEPARTMENT OF NUTRITION & EXERCISE
UNIVERSITY OF COPENHAGEN

FACULTY OF HEALTH AND SPORT SCIENCES
UNIVERSITY OF AGDER

7. fortsettelse

Sett kryss i det svaralternativ som best beskriver din situasjon

C: Søvn

C:1 Jeg sover tilstrekkelig

☐ Ja, nesten hver natt ☐ Ja, flere netter/uke ☐ Ja, 1-2 netter/uke eller sjeldnere
☐ Sjelden eller aldri

C:2 Jeg sovner fornøyd og avslappet

☐ Ja, nesten hver kveld ☐ Ja, flere kvelder/uke ☐ Ja, 1-2 kvelder/uke eller sjeldnere
☐ Sjelden eller aldri

C:3 Jeg våkner utsovet

☐ Ja, nesten hver morgen ☐ Ja, flere morgener/uke ☐ Ja, 1-2 morgener/uke eller sjeldnere
☐ Sjelden eller aldri

C:4 Jeg sover urolig

☐ Ja, nesten hver natt ☐ Ja, flere netter/uke ☐ Ja, 1-2 netter/uke eller sjeldnere
☐ Sjelden eller aldri

C:5 Min søvn forstyrres lett

☐ Ja, nesten hver natt ☐ Ja, flere netter/uke ☐ Ja, 1-2 netter/uke eller sjeldnere
☐ Sjelden eller aldri

C:6 I løpet av den siste måneden, hvor mange timer faktisk søvn har du fått i gjennomsnitt per natt? (PS: dette kan skille seg fra antall timer du tilbringer i sengen)

SØVN (TIMER) PER NATT: _____TIMER

D: Restitusjon

D:1 Jeg restituerer meg (henter meg inn igjen) bra fysisk

☐ Ja, etter nesten hver treningsøkt ☐ Ja, etter mange treningsøkter
☐ Ja, iblant etter noen treningsøkter ☐ Sjelden eller aldri

D:2 Jeg føler meg i god fysisk form

☐ Ja, alltid ☐ Ja, ofte ☐ Ja, iblant ☐ Sjelden eller aldri

D:3 Jeg kjenner meg energisk

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

D:4 Kroppen min føles sterk

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere ☐ Sjelden eller aldri

7. fortsettelse

Sett kryss i det svaralternativ som best beskriver din situasjon

E: Energinivå

E:1 Jeg føler meg veldig energisk til vanlig

Ja, nesten hver dag Ja, flere dager i uken Ja, en til to ganger i uken eller mindre Sjelden/aldri

---

E:2 Jeg føler meg energisk før trening og er klar til å prestere

Ja, nesten hver dag Ja, flere dager i uken Ja, en til to ganger i uken eller mindre Sjelden/aldri

---

E-3 Jeg føler meg glad og på topp i livet utenfor idretten

Ja, nesten hver dag Ja, flere dager i uken Ja, en til to ganger i uken eller mindre Sjelden/aldri

---

E-4 Jeg føler meg mer nedstemt og mindre glad enn jeg pleier eller ønsker å være

Ja, nesten hver dag Ja, flere dager i uken Ja, en til to ganger i uken eller mindre Sjelden/aldri

---

F: Sexlyst

Din sexlyst kan være en markør for balansen mellom trening, hvile og restitusjon.

a) Jeg vil beskrive min generelle sexlyst som:

☐ høy ☐ moderat ☐ lav ☐ sex er ikke så interessant

b) Min sexlyst den siste måneden har vært:

sterkere enn vanlig som vanlig litt mindre enn vanlig mye mindre enn vanlig

---

G. Hvilke **ernæringsmessige** tiltak tror du kunne bidra positivt i forhold til å: 1) redusere skader/sykdom, og 2) øke dine idrettslige prestasjoner?.....
.....
.....
.....
.....

Tusen takk!

FP:

KØBENHAVNS UNIVERSITET
DET NATUR- OG BIOVIDENSKABELIGE FAKULTET

UNIVERSITETET I AGDER
FAKULTET FOR HELSE- OG IDRETTSVITENSKAP

LEAM SKALAEN[1]

Spørreskjema til mannlige utøvere

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1. Svimmelhet

Sett kryss i det svaralternativ som best beskriver din situasjon

A: Kjenner du deg svimmel når du reiser deg raskt opp?

☐ Ja, flere ganger/dag ☐ Ja, flere ganger/uke ☐ Ja, 1-2 ganger/uke eller sjeldnere
☐ Sjelden eller aldri

B: Opplever du problemer med synet ditt (uskarphet, ser prikker, tunnellsyn etc)?

☐ Ja, flere ganger/dag ☐ Ja, flere ganger/uke ☐ Ja, 1-2 ganger/uke eller sjeldnere
☐ Sjelden eller aldri

2. Magefunksjon

A: Føles din mage "oppblåst"?

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

B: Har du kramper og/eller magesmerter?

☐ Ja, flere ganger/dag ☐ Ja, flere ganger/uke ☐ Ja, 1-2 ganger/uke eller sjeldnere
☐ Sjelden eller aldri

C: Hvor ofte har du avføring i gjennomsnitt?

☐ Flere ganger/dag ☐ 1 gang/dag ☐ Annenhver dag ☐ 2 ganger/uke
☐ 1 gang/uke eller sjeldnere

D: Hvordan pleier din avføring å være?

☐ Normal (fast og myk) ☐ Løs, som diaré ☐ Hard og tørr

Eventuelle kommentarer til magefunksjon: _____

3. Temperaturregulering i hvile

A: Fryser du selv om du har normalt med klær på deg?

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

B: Har du mer klær på deg/kler deg varmere enn de utøvere/personer du omgås uavhengig av vær?

☐ Ja, nesten alltid ☐ Ja, noen ganger ☐ Sjelden eller aldri

4. Helseproblemer som gir avvik fra trening og/eller konkurranse

Sett kryss i det svaralternativ som best beskriver din situasjon

I det følgende kommer noen spørsmål om hvor ofte du har vært tvunget til å endre dine trenings- og konkurranseplaner og hvor ofte du ikke har kunnet prestere maksimalt på trening og konkurranse på grunn av idrettsskade eller sykdom siste 6 måneder.
Med *akutt skade* menes plutselig oppståtte skader som har klart definert årsak eller starttidspunkt (eks overtråkk, muskestrekk). Med *belastningsskade* menes gradvis oppståtte skader som følge av overbelastning over tid (eks. beinhinnebetennelse, achillessenebetennelse, stressfraktur).

A: Hvor mange akutte skader har du hatt i løpet av de siste 6 måneder?

_____ akutte skader.

B: Hvor mange belasningsskader har du hatt i løpet av de siste 6 måneder (om samme belasningsskade kommer tilbake regnes hver ny skadeperiode som 1 skade)?

_____ belastningsskader.

C. Hvor mange sykdomsavbrekk fra planlagt trening har du hatt i løpet av de siste 6 måneder?

_____ avbrudd fra trening på grunn av sykdom.

D. Hvor mange dager på rad har du i løpet av de siste 6 måneder vært fraværende fra trening/konkurranse eller ikke kunnet prestere optimalt på den mest omfattende akutte skaden, belastningsskaden og sykdom i løpet av de siste 6 måneder?

	Ingen	1-7 dager	8-14 dager	15-21 dager	> 22 dager
Akutt skade	☐	☐	☐	☐	☐
Belastningsskade	☐	☐	☐	☐	☐
Sykdom	☐	☐	☐	☐	☐

Eventuelle kommentarer angående dine skader: _____

_____

_____

Eventuelle kommentarer angående dine sykdomsperioder: _____

_____

_____

5. Velvære og restitusjon

Sett kryss i det svaralternativ som best beskriver din situasjon

A: Trøtthet

A:1 Jeg føler meg svært trøtt når jeg kommer hjem fra arbeid/skole

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

A:2 Jeg kjenner meg overtrøtt

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

A:3 Jeg har vanskeligheter med å konsentrere meg

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

A:4 Jeg kjenner meg sløv

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

A:5 Jeg fremskyver viktige beslutninger

☐ Ja, alltid ☐ Ja, ofte ☐ Ja, iblant ☐ Sjelden eller aldri

B: Velvære

B:1 Jeg har vondt i kroppen

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

B:2 Musklene mine føles stive og ømme på trening

☐ Ja, nesten på hver treningsøkt ☐ Ja, på mange treningsøkter
☐ Ja, iblant på noen treningsøkter ☐ Sjelden eller aldri

B:3 Jeg har muskelverk/er støl etter trening

☐ Ja, på nesten hver treningsøkt ☐ Ja, på mange treningsøkter
☐ Ja, iblant på noen treningsøkter ☐ Sjelden eller aldri

B:4 Jeg føler at jeg blir lett skadet

☐ Ja, alltid ☐ Ja, i de fleste treningsperioder ☐ Ja, i noen treningsperioder
☐ Sjelden eller aldri

B:5 Jeg har hodeverk

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

B:6 Jeg kjenner meg fysisk utmattet

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

B:7 Jeg kjenner meg sterk og har god progresjon i styrketreningen min

□ Ja, alltid □ Ja, i de fleste treningsperioder □ Ja, i noen treningsperioder □ Sjelden eller aldri

5. fortsettelse

Sett kryss i det svaralternativ som best beskriver din situasjon

C: Søvn

C:1 Jeg sover tilstrekkelig

☐ Ja, nesten hver natt ☐ Ja, flere netter/uke ☐ Ja, 1-2 netter/uke eller sjeldnere
☐ Sjelden eller aldri

C:2 Jeg sovner fornøyd og avslappet

☐ Ja, nesten hver kveld ☐ Ja, flere kvelder/uke ☐ Ja, 1-2 kvelder/uke eller sjeldnere
☐ Sjelden eller aldri

C:3 Jeg våkner utsovet

☐ Ja, nesten hver morgen ☐ Ja, flere morgener/uke ☐ Ja, 1-2 morgener/uke eller sjeldnere
☐ Sjelden eller aldri

C:4 Jeg sover urolig

☐ Ja, nesten hver natt ☐ Ja, flere netter/uke ☐ Ja, 1-2 netter/uke eller sjeldnere
☐ Sjelden eller aldri

C:5 Min søvn forstyrres lett

☐ Ja, nesten hver natt ☐ Ja, flere netter/uke ☐ Ja, 1-2 netter/uke eller sjeldnere
☐ Sjelden eller aldri

C:6 I løpet av den siste måneden, hvor mange timer faktisk søvn har du fått i gjennomsnitt per natt? (PS: dette kan skille seg fra antall timer du tilbringer i sengen)

SØVN (TIMER) PER NATT: _____TIMER

D: Restitusjon

D:1 Jeg restituerer meg (henter meg inn igjen) bra fysisk

☐ Ja, etter nesten hver treningsøkt ☐ Ja, etter mange treningsøkter
☐ Ja, iblant etter noen treningsøkter ☐ Sjelden eller aldri

D:2 Jeg føler meg i god fysisk form

☐ Ja, alltid ☐ Ja, ofte ☐ Ja, iblant ☐ Sjelden eller aldri

D:3 Jeg kjenner meg energisk

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere
☐ Sjelden eller aldri

D:4 Kroppen min føles sterk

☐ Ja, nesten hver dag ☐ Ja, flere dager/uke ☐ Ja, 1-2 dager/uke eller sjeldnere ☐ Sjelden eller aldri

5. fortsettelse

Sett kryss i det svaralternativ som best beskriver din situasjon

E: Energinivå

E:1 Jeg føler meg veldig energisk til vanlig

☐ Ja, nesten hver dag ☐ Ja, flere dager i uken ☐ Ja, en til to ganger i uken eller mindre ☐ Sjelden/aldri

---

E:2 Jeg føler meg energisk før trening og er klar til å prestere

☐ Ja, nesten hver dag ☐ Ja, flere dager i uken ☐ Ja, en til to ganger i uken eller mindre ☐ Sjelden/aldri

---

E-3 Jeg føler meg glad og på topp i livet utenfor idretten

☐ Ja, nesten hver dag ☐ Ja, flere dager i uken ☐ Ja, en til to ganger i uken eller mindre ☐ Sjelden/aldri

---

E-4 Jeg føler meg mer nedstemt og mindre glad enn jeg pleier eller ønsker å være

☐ Ja, nesten hver dag ☐ Ja, flere dager i uken ☐ Ja, en til to ganger i uken eller mindre ☐ Sjelden/aldri

---

F: Sexlyst

F:1 Din sexlyst kan være en markør for balansen mellom trening, hvile og restitusjon.

a) Jeg vil beskrive min generelle sexlyst som:

☐ høy ☐ moderat ☐ lav ☐ sex er ikke så interessant

b) Min sexlyst den siste måneden har vært:

☐ sterkere enn vanlig ☐ som vanlig ☐ litt mindre enn vanlig ☐ mye mindre enn vanlig

---

F:2 Det er vanlig med ereksjon når man våkner om morgenen.

a) I løpet av den siste måneden har du opplevd dette:

☐ 5-7 ganger per uke ☐ 3-4 ganger per uke ☐ 1-2 per uke ☐ sjelden/aldri

b) Sammenlignet med hva du anser er normalt for deg, er dette:

☐ oftere enn vanlig ☐ omtrent like ofte ☐ litt sjeldnere enn vanlig ☐ mye sjeldnere enn vanlig

G. Hvilke **ernæringsmessige** tiltak tror du kunne bidra positivt i forhold til å: 1) redusere skader/sykdom, og 2) øke dine idrettslige prestasjoner?.....
.....
.....
.....
.....

Tusen takk!

FP ID:

Bakgrunns- og ernæringsspørsmål ParaNut

INITALER FORSØKSPERSON: _ _ _ _ _

ID FORSØKSPERSON: _ _ _ _ _

INITALER INTERVJUER: _ _ _ _ _

FP ID:

Ved ja/nei spørsmål, sett en sirkel rundt det riktige svaret og beskriv svaret dersom mer informasjon blir etterspurt.

1. Idrett

1.1	Hvilke(n) idrett(er) driver du med nå? Hvor gammel var du da du startet?
1.2	Hvilke(n) idrett(er) har du tidligere drevet med? Og på hvilket nivå? Hvor gammel var du da du startet og stoppet?
1.3	Hvor mange timer i uken trener du i nåværende periode? ___timer
1.4	Hva er din normale treningsmengde i uken i forberedelsesfasen? ___timer
1.5	Hvor mange år har du vært på junior/senior landslag i idretten(e) du nå driver med? På hvilket nivå konkurrerer du nå? (klubb, junior/senior landslag, profesjonelt, annet)
1.6	Er du idrettutøver på heltid? **Ja / Nei** Hvis nei, hva gjør du ved siden av idretten? (Heltidsjobb, deltidsjobb, studier, annet)
1.7	Hva er din beste plassering i Norgesmesterskap (NM)/enkeltkonkurranse i Norgescup?
1.8	Hva er din beste plassering i VM/PL eller enkeltkonkurranse i verdenscupen?
Kommentarer:	

FP ID:

2. Funksjonsnedsettelse

2.1	Diagnose som gjør at du er paralympisk utøver: Beskriv dysfunksjonen og begrensninger
2.2	Hvordan begrenser din dysfunksjon deg mest?
2.3	Er din dysfunksjon medfødt? **Ja / Nei**
2.4	Hvis nei, når opptrådte den?
2.5	Har du fått nedsatt funksjon som følge av sykdom eller skade? **Ja / Nei** Beskrivelse og dato: Øvrige nedsatte funksjoner:
2.6	Hva er din(e) IPC klassifiseringskode(r)?
Kommentarer:	

FP ID:

3. Generell medisinsk

3.1	Har du hatt en infeksjon siste 6 måneder? (lungebetennelse, urinveisinfeksjon, etc.) **Ja / Nei** Beskrivelse:
3.2	Hvis ja, har det påvirket treningen din? **Ja / Nei**
3.3	Har du epilepsi? **Ja / Nei**
3.4	Har du utenom din dysfunksjon andre kroniske sykdommer? **Ja / Nei** Hvis ja, beskriv:
3.5	Plages du av smerter? **Ja, mye / Ja, litt / Nei** Hvis ja, hvor har du smerter? Hvis ja, hva slags behandling får du for smertene?
3.6	Har du spasmer? **Ja, mye / Ja, litt / Nei** Hvis ja, hvor i kroppen? Hvis ja, hva slags behandling får du for spasmene? Hvis ja, endrer du behandlingen for å prestere bedre?
3.7	Har du nedsatt kognitiv funksjon? **Ja / Nei** Hvis ja, beskriv:
Kommentarer:	

FP ID:

4. Ernæring

4.1	Har du svelgevansker? **Ja / Nei**
4.2	Har du påvist cøliaki? **Ja / Nei**
4.3	Har du en matallergi? **Ja / Nei** Hvis ja, hva er du allergisk mot? (f.eks. laktoseintoleranse, peanøttallergi) Hvis ja, hva slags reaksjon får du?
4.4	Varierer vekten din i løpet av et år? **Ja / Nei** Hvis ja, hvor mye varierer vekten? ____ kg
4.5	Har du i perioder økt eller redusert vekten din bevisst? **Ja / Nei** Hvis ja, når? Hvis ja, hvorfor?
4.6	Hva er din høyeste registrerte vekt i voksen alder? ___ kg Når?
4.7	Hva er din laveste registrerte vekt i voksen alder? ____ kg Når?
4.8	Hva anser du som din konkurransevekt/«matchvekt»? ____kg
4.9	Har du et avslappet forhold til mat og vekt? **Ja / Nei** Har det alltid vært slik? **Ja / Nei**
4.10	Har du måttet avstå fra idrett pga ernæringsmessige årsaker? **Ja / Nei** Hvis ja, beskriv:
4.11	Har du hatt lavt nivå av vitamin D? **Ja / Nei** Hvis ja, når er dette fastslått? Hvis ja, endret du kosthold / tok du kosttilskudd? **Ja / Nei** Hvis ja, har du vært til kontroll for ny blodprøve (dato)? **Ja / Nei**
4.12	Har du hatt lavt nivå av jern? **Ja / Nei** Hvis ja, når er dette fastslått? Hvis ja, endret du kosthold / tok du kosttilskudd? **Ja / Nei** Hvis ja, har du vært til kontroll for ny blodprøve (dato)? **Ja / Nei**
4.13	Har du unormale verdier av andre ernæringsparametre? **Ja / Nei** For eksempel vitamin B12, forsyre, magnesium, kalsium, natrium, kalium Hvis ja, endret du kosthold / tok du kosttilskudd? **Ja / Nei** Hvis ja, har du vært til kontroll for ny blodprøve (dato)? **Ja / Nei**

FP ID:

4.14	Har du tatt DXA måling for kroppssammensetning? **Ja / Nei**
4.15	Har du fått påvist lav beintetthet? **Ja / Nei / Vet ikke** Hvis ja, når? Hvis ja, har du fått påvist beinskjørhet? **Ja / Nei / Vet ikke**
4.16	Lager du mesteparten av maten selv? **Ja / Nei** Hvem?
4.17	Hvor mange måltider spiser du per dag? _____ hovedmåltider* _____mellommåltider
4.18	Spiser du middag hver dag? **Ja / 3-5 ganger i uken / Nei**
4.19	Røyker du? **Ja / Nei** Hvis ja, hvor mye? Snuser du? **Ja / Nei**
4.20	Drikker du alkohol? **Ja / Nei** Hvis ja, hvor ofte? **Hver dag / Hver uke / Hver måned / Sjeldnere** Omtrent hvor mye?
4.21	Plages du av overoppheting? **Ja / Nei** - Svetter du lite på ikke funksjonelle kroppsdeler? **Ja / Nei** - Bruker du nedkjølingsstrategier utover å drikke? **Ja / Nei**
4.22	Får du ernæringsveiledning? **Ja / Nei** Har du hatt noen trening / undervisning om ernæring? **Ja / Nei**
4.23	Har du noen diett eller kostholdsregime i dag? Evt, hva? **Ja / Nei**
Kommentarer:	

* Hovedmåltider: frokost, lunsj, middag, kveldsmat

FP ID:

5. Magetarmfunksjon

5.1	Har du stomi? **Ja / Nei**
5.2	Har du utfordringer med urinveiene? **Ja / Nei** Hvis ja, drikker du mindre på reisedager eller ved dårlig toalettilgang? **Ja / Nei**
5.3	Bruker du kateter? **Ja / Nei** Hvis ja, selvkaterisering eller permanent?:
5.4	Har du mage-tarmplager? (kramper, luftsmerter, forstoppelse, diare, oppgulp eller oppkast) **utenom** konkurransesituasjon (spesifiser hvilke plager) **Ja / Nei** **under** konkurransesituasjon (spesifiser hvilke plager) **Ja / Nei**
5.5	Har du forstoppelse på lange reiser? **Ja, ofte / Ja, av og til / Nei**
5.6	For kvinner: når startet din siste menstruasjon? Dato: _____ Menstruerer du? Bruker du prevensjon?
Kommentarer:	

FP ID:

6. Assistanse

6.1	Har du brukerstyrt personlig assistent hjemme? **Ja / Nei** Hvis ja, hvor mange timer/uke? _____ timer
6.2	Bruker du rullestol utenom idretten? **Ja / Nei** Hvis ja, hvor ofte? **Alltid / Ofte / Av og til** Hvis ja, hvilken type stol? **Elektrisk / Manuell / Manuell med hjelpemotor / Annet:**
6.3	Bruker du gåstol? **Ja / Nei** Hvis ja, hvor ofte? **Alltid / Ofte / Av og til**
6.4	Bruker du krykker? **Ja / Nei** Hvis ja, hvor ofte? **Alltid / Ofte / Av og til**
6.5	Bruker du protese? **Ja / Nei** Hvis ja, hvor sitter protesen? (arm eller bein, venstre eller høyre og startpunkt) Hvis ja, bruker du protesen både i trening og hjemme? **Trening / Hjemme / Begge**
6.6	Bruker du andre hjelpemidler? **Ja / Nei** Hvis ja, beskriv:
6.7	Hvilke transportmidler håndterer du? -kjører bil **Ja / Nei** - sykler **Ja / Nei** - går **Ja / Nei** - tar offentlig transport **Ja / Nei**
Kommentarer:	

FP ID:

7. Medisiner

Har du i løpet av de siste 6 månedene brukt medisiner eller kosttilskudd? **Ja / Nei** Eksempler; kortikosteroider, kolesterolsenkende, bisfosfonat (osteoporose), betennelsesdempende, smertestillende						
Preparat/tilskudd	Daglig dose	Årsak	Start dato	Stopp dato	Hvor ofte	Tillatt ADN*

* Husk at du må få bekreftelse fra Antidoping Norge (ADN) på at alle legemidlene er tillatt. www.felleskatalogen.no

NIH
NORGES IDRETTSHØGSKOLE

TRENINGSLOGG PARANUT

Deltakernummer:

Periode:

Fyll inn skjemaet etter hver treningsøkt. Du oppgir tidspunkt for start og stopp, type trening og intensitet basert på skalaen under. Hvis du har 2 treninger en dag fyller du inn både trening 1 og trening 2 den dagen. Hvis du ikke har trening lar du det stå åpent.

Opplevd treningsintensitet (RPE)	
0	Hvile
1	Meget lett
2	Lett
3	Moderat
4	Litt anstrengende
5	Anstrengende
6	-
7	Meget anstrengende
8	-
9	Ekstremt anstrengende
10	Maksimalt

Dag 1:

1

Fra (tid)	
Til (tid)	
Type trening	
RPE intensitet 1-10	
Kommentar	

2

Fra (tid)	
Til (tid)	
Type trening	
RPE intensitet 1-10	
Kommentar	

3

Fra (tid)	
Til (tid)	
Type trening	
RPE intensitet 1-10	
Kommentar	

FORESPØRSEL OM DELTAKELSE I FORSKNINGSPROSJEKTET

ENERGIBEHOV, ERNÆRING OG KROPPSSAMMENSETNING HOS PARAUTØVERE

Norges idrettshøgskole har startet et internasjonalt forskningssamarbeid med idrettshøgskolen og olympisk komité i Nederland for å kartlegge energibehov, ernæringsstatus og kroppssammensetning hos parautøvere, med målsetning om å gi spesifikke råd om ernæring for å bedre både helse og prestasjon.

Vi henvender oss til deg, som parautøver for å spørre om du kan være interessert i å være med i prosjektet.

Resultatene fra denne studien vil bidra med ny kunnskap om energibehov, ernæringsinntak, kroppssammensetning og eventuelle helseutfordringer hos parautøvere generelt (som benhelse og relativ energimangel i idrett), for idrettsutøvere med spesifikke funksjonsnedsettelser (som amputasjon, ryggmargsskader og CP) og for ulike idretter. Basert på resultatene vil det lages egne retningslinjer i idrettsernæring for parautøvere.

HVA INNEBÆRER PROSJEKTET?

Denne studien er en kartleggingsstudie som strekker seg over 2 uker, der målingene som utføres på testdagen samt kartlegging av trening, ernæringsinntak og energiforbruk i løpet av de 2 påfølgende ukene blir evaluert og sammenlignet anonymt med de andre deltakerne i studien.

Testdag

Testdagen vil vare rundt 4 timer og utføres ved Norges idrettshøgskole (NIH) på Sognsvann i Oslo. Du bes møte opp fastende (ikke spise eller drikke) på morgenen for måling av hvilemetabolisme, kroppssammensetning og bentetthet (DXA-scan) og blodprøve. Deltakerne som ønsker det vil også ta en urinprøve og måle blodvolum ved å kombinere en pusteprøve og måling av hemoglobini blod fra fingerstikk. Etter frokost vil du bli bedt om å fylle inn to spørreskjema om energitilgjengelighet og ernæringskunnskap, oppgi informasjon om din bakgrunn med fokus på ernæring, og vi gir deg informasjon om det du blir bedt om å gjøre de påfølgende to ukene. Hvis du ønsker, kan du få innsyn i bakgrunnsspørsmålene i forkant.

Kartlegging av trening og ernæringsinntak

I løpet av de påfølgende to ukene etter testdagen blir du bedt om å måle daglig aktivitetsnivå ved å ha på en akselerometerklokke og notere kort hva du har trent hver dag. I tillegg vil vi på 3 ulike dager i løpet av disse 2 ukene ha en kort ernæringssamtale med deg

via telefon eller PC for å kartlegge hva du spiste og drakk dagen før (hver samtale tar ca. 30-45 min).

Måling av energiforbruk – dobbelt merket vann

I tillegg til de andre målingene kan du få kjennskap til ditt eget energibehov på hvile- og treningsdager ved å delta i måling av energiforbruk ved dobbeltmerket vann målingen. Dette innebærer at du får en liten flaske med «merket» vann som du drikker på kvelden etter testdagen før du legger deg. Vannet er merket med flagg (isotoper) som gjør at vi kan måle ditt energiforbruk ved å analysere urinprøver. Derfor blir du bedt om å samle en liten kopp urin syv ganger innenfor en periode på to uker.

Det er fullt mulig å delta i studien og gjennomføre alle andre målinger selv om man ikke ønsker å delta på dobbeltmerket vann målingen.

MULIGE FORDELER OG ULEMPER

Du vil inviteres til en testdag ved NIH som varer 4 timer. Videre krever noen av målingene tid og innsats fra deg i 2 uker etter testdagen (som beskrevet over). Undersøkelsene vil muliggjøre at vi kan gi deg personlig informasjon om ditt energiforbruk, ernæringsbehov, inntak av næringsstoffer og kroppssammensetning.

Innen fire uker etter testperioden vil du få individuell tilbakemelding på ditt energiforbruk i hvile, totalt aktivitetsnivå ved akselerometerklokken, blodverdier, ernæringsinntak og kroppssammensetning og beintetthet.

Innen et halvt år etter den siste målingen vil du få informasjon om ditt totale daglige energiforbruk (dersom du deltar i dobbeltmerket vann målingen), energitilgjengelighet og eventuell risiko for lav energitilgjengelighet, samt din overordnede ernæringsstatus.

FRIVILLIG DELTAKELSE OG MULIGHET FOR Å TREKKE SITT SAMTYKKE

Det er frivillig å delta i prosjektet. All data anonymiseres. Dersom du ønsker å delta, undertegner du samtykkeerklæringen på siste side. Da samtykker du til at dine data brukes til forskning.

Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke. 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. Dersom du senere ønsker å trekke deg eller har spørsmål til prosjektet, kan du kontakte Kristin L. Jonvik som utfører studien, telefon: 94137624, eller på e-post: k.l.jonvik@nih.no.

HVA SKJER MED OPPLYSNINGENE OM DEG?

Opplysningene som registreres om deg skal kun brukes slik som beskrevet i hensikten med prosjektet. Du har rett til innsyn i hvilke opplysninger som er registrert om deg og rett til å få korrigert eventuelle feil i de opplysningene som er registrert. Du har også rett til å få innsyn i sikkerhetstiltakene ved behandling av opplysningene.

Alle opplysningene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En tallkode knytter deg til dine opplysninger gjennom en navneliste. Det er kun Kristin L. Jonvik og Truls Raastad som har tilgang til denne listen. Prosjektet avsluttes 31.12.2024. Opplysningene om deg vil bli anonymisert fem år etter prosjektslutt.

DELING AV DATA OG OVERFØRINGER TIL UTLANDET

Ved å delta i prosjektet, samtykker du også til at alle avidentifiserte opplysninger kan deles med forskningsgruppen i Nederland (som gjør tilsvarende prosjekt for sine parautøvere) som ledd i forskningssamarbeid og publisering. Kristin L. Jonvik vil sikre at dine opplysninger blir ivaretatt på en trygg måte. Koden som knytter deg til dine personidentifiserbare opplysninger vil ikke bli utlevert.

HVA SKJER MED PRØVER SOM BLIR TATT AV DEG?

Det av blodprøven som ikke analyseres direkte, samt urinprøver fra dobbeltmerket vann, fryses og oppbevares i en forskningsbiobank tilknyttet prosjektet uten kommersielle interesser (vurdert av regional etisk komité) fram til de analyseres. Truls Raastad er ansvarlig for biobanken. Urinprøvene (dersom du deltar i dobbeltmerket vann målingen) sendes til Nederland for analyser ved Maastricht Universitet hvor ansvarshavende er Guy Plasqui. De analyserte blod- og urinprøvene destrueres ved prosjektslutt.

FORSIKRING

Deltakere i prosjektet er forsikret dersom det skulle oppstå skade eller komplikasjoner som følge av deltakelse i forskningsprosjektet. NIH er en statlig institusjon og er således selvassurandør. Dette innebærer at det er NIH som dekker en eventuell erstatning og ikke et forsikringsselskap.

OPPFØLGINGSPROSJEKT

Hvis du velger å delta, kan du bli kontaktet omtrent ½ år eller 1 ½ år etter testperioden, og uforpliktende bli invitert til en ny runde med mange av de samme undersøkelsene. Hensikten med dette måletidspunktet er å undersøke forskjeller i energiforbruk, ernæringsinntak og kroppssammensetning i og utenfor sesong.

ØKONOMI

Prosjektet er fullfinansiert av Dutch Taskforce for Applied Research (SIA), Nederland. Det er ingen utfordringer knyttet til etiske eller praktiske sider ved økonomien i prosjektet. Det finnes ingen interessekonflikter mellom finansieringskildene og studien.

GODKJENNING

Regional komité for medisinsk og helsefaglig forskningsetikk har vurdert prosjektet, og har gitt forhåndsgodkjenning (Saksnummer 102284).

Etter ny personopplysningslov har behandlingsansvarlig Norges idrettshøgskole og prosjektleder Truls Raastad et selvstendig ansvar for å sikre at behandlingen av dine opplysninger har et lovlig grunnlag. Dette prosjektet har rettslig grunnlag i EUs personvernforordning artikkel 6 nr. 1a og artikkel 9 nr. 2a og ditt samtykke.

Du har rett til å klage på behandlingen av dine opplysninger til Datatilsynet.

KONTAKTOPPLYSNINGER

Dersom du har spørsmål til prosjektet kan du ta kontakt med Kristin L. Jonvik som utfører studien, telefon: 94137624, e-post: k.l.jonvik@nih.no.

Personvernombud er Rolf Haavik, telefon: 90733760, e-post: rolf.haavik@habberstad.no.

JEG SAMTYKKER TIL Å DELTA I PROSJEKTET OG TIL AT MINE PERSONOPPLYSNINGER OG MITT BIOLOGISKE MATERIALE BRUKES SLIK DET ER BESKREVET

Jeg ønsker/ønsker ikke å delta i blodvolum og hemoglobinmasse målingen i tillegg til standardmålingene.
(Sett strek over det som ikke gjelder.)

Jeg ønsker/ønsker ikke å delta i dobbeltmerket vann målingen i tillegg til standardmålingene.
(Sett strek over det som ikke gjelder.)

Sted og dato

Deltakers signatur

Deltakers navn med trykte bokstaver

Jeg bekrefter å ha gitt informasjon om prosjektet

Sted og dato

Signatur

Rolle i prosjektet

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK sør-øst D	Marianne Carson	22 84 55 26	19.05.2020	102284
			Deres referanse:	

Truls Raastad

102284 Optimalisering av kosthold for parautøvere

Forskningsansvarlig: Norges idrettshøgskole

Søker: Truls Raastad

Søkers beskrivelse av formål:

I sammenheng med det økende antall personer med funksjonsnedsettelse som driver idrett, øker behovet for (para)medisinsk støtte for idrett for funksjonshemmede. Parautøvere erfarer avvik i kroppssammensetning, metabolisme, treningsbelastning og daglig aktivitetsmønster sammenlignet med funksjonsfriske utøvere. Videre antas det at den velkjente utøvertriaden, og spesielt lav energitilgjengelighet og lav beintetthet, er en enda større utfordring hos parautøvere. Derfor er det ikke overraskende at støtteapparatet rundt parautøvere har uttrykt et sterkt behov for økt kunnskap og innsikt i ernæringsmessige krav hos denne gruppen. I dette prosjektet undersøkes energiforbruk, ernæringsinntak, kroppssammensetning og beinhelse hos parautøvere, med målsetning om å utvikle ernæringsanbefalinger som støtter helse og optimal prestasjon for denne unike gruppen. Ettersom det er viktig å ha en stor nok gruppe deltakere for å kunne gi svar på disse parameterne, er dette prosjektet et samarbeid mellom Nederland og Norge, hvor parautøvere tilknyttet både den nederlandske og norske olympiske og paralympiske komite er aktuelle deltakere. Tilsvarende målinger vil bli utført ved HAN University of Applied Science tilknyttet parautøvere i Nederland og ved Norges idrettshøgskole tilknyttet parautøvere i Norge. Ved siden av et forskningsfokus, er dette prosjektet i stor grad rettet mot optimalisering av yrkespraksis. Resultatene fra prosjektet vil bli direkte tilgjengelige for bruk av støtteapparatet i paraidretten, og vil kommuniseres for trenere og utøvere som deltar i prosjektet, for å sikre direkte implementering i daglig praksis.

REKs vurdering

Vi viser til søknad om forhåndsgodkjenning av ovennevnte forskningsprosjekt. Søknaden ble behandlet av Regional komité for medisinsk og helsefaglig forskningsetikk (REK sør-øst D) i møtet 29.04.2020. Vurderingen er gjort med hjemmel i helseforskningsloven § 10.

Hensikten med studien er å undersøke parautøveres energiforbruk, ernæringsinntak, kroppssammensetning og beinhelse, for å kartlegge helseutfordringer og utvikle paraspesifikke ernæringsanbefalinger. Studien kan bidra med ny kunnskap om energibehov, ernæringsbehov, kroppssammensetning og eventuelle helseutfordringer hos parautøvere generelt, for spesifikke tilstander og for ulike idretter.

Det skal inkluderes minimum 45 parautøvere i alderen 16-50 år som er på Olympiatoppens satsningsliste mot neste sommer og vinter Paralympics. Alle parautøvere med stipend fra Olympiatoppen og som gjennomgår en generell helsescreening vil bli invitert til å delta (n=60). Det skal gjøres kliniske undersøkelser og undersøkelse av kroppssammensetning ved DXA-scanning, samt medisinsk konsultasjon. Det skal også brukes dobbeltmerket vann for måling av totalt energiforbruk. Det skal gjøres intervjuer og observasjoner uten opptak. Deltakere skal fylle inn en treningsdagbok, og besvare spørreskjema om energitilgjengelighet og ernæringskunnskap. Blod og urinprøver oppbevares i en spesifikk forskningsbiobank tilknyttet prosjektet. Urinprøvene sendes til analyse i Nederland. Studien er samtykkebasert.

Komiteen har vurdert søknaden og har ingen innvendinger til at studien gjennomføres som beskrevet i søknad og protokoll. Komiteen setter imidlertid følgende vilkår for godkjenning:

- Komiteen ber om at norsk versjon av spørreskjemaet om ernæringskunnskap ettersendes REK til orientering før skjemaet tas i bruk. Skjemaet bes innsendes REK som svar på oppgave som prosjektleder finner under fanen «OPPGAVER» når innlogget i REK-portalen: https://rekportalen.no.

- Det er utviklet et eget informasjonsskriv til foreldre av deltakere i alderen 16-18 år. Komiteen ber om at det ikke sendes separat informasjon til foreldrene, da personer over 16 år selv kan samtykke til forskning.

- Innholdet i informasjonsskrivet til voksne og informasjonsskrivet til ungdom i alderen 16-18 år fremkommer som identiske. Det er derfor ikke nødvendig med et eget skriv til ungdom; alle som inkluderes kan få det samme skrivet, da alle er over 16 år.

Komiteen forutsetter at prosjektet tar alle forhåndsregler for minimalisering av risikoen for bakveisidentifisering når studien rapporteres, da det er noe risiko for dette grunnet studiens spesifikke deltakergruppe.

Vedtak

Godkjent med vilkår

REK har gjort en helhetlig forskningsetisk vurdering av alle prosjektets sider. Prosjektet godkjennes med hjemmel i helseforskningsloven § 10, under forutsetning av at ovennevnte vilkår er oppfylt.

Vi gjør samtidig oppmerksom på at etter ny personopplysningslov må det også foreligge et behandlingsgrunnlag etter personvernforordningen. Det må forankres i egen institusjon.

I tillegg til vilkår som fremgår av dette vedtaket, er godkjenningen gitt under forutsetning av at prosjektet gjennomføres slik det er beskrevet i søknad og protokoll, og de bestemmelser som følger av helseforskningsloven med forskrifter.

Tillatelsen gjelder til 31.12.2024. Av dokumentasjonshensyn skal opplysningene likevel bevares inntil 31.12.2029. Forskningsfilen skal oppbevares atskilt i en nøkkel- og en opplysningsfil. Opplysningene skal deretter slettes eller anonymiseres, senest innen et halvt år fra denne dato.

Forskningsprosjektets data skal oppbevares forsvarlig, se personopplysningsforskriften kapittel 2, og Helsedirektoratets veileder for «Personvern og informasjonssikkerhet i forskningsprosjekter innenfor helse og omsorgssektoren».

Dersom det skal gjøres vesentlige endringer i prosjektet i forhold til de opplysninger som er gitt i søknaden, må prosjektleder sende endringsmelding til REK.

Prosjektet skal sende sluttmelding på eget skjema, senest et halvt år etter prosjektslutt.

Komiteens avgjørelse var enstemmig.

Med vennlig hilsen

Finn Wisløff
Professor em. dr. med.
leder

Marianne Carson
rådgiver

Kopi: Norges idrettshøgskole

Sluttmelding
Søker skal sende sluttmelding til REK sør-øst D på eget skjema senest seks måneder etter godkjenningsperioden er utløpt, jf. hfl. § 12.

Søknad om å foreta vesentlige endringer
Dersom man ønsker å foreta vesentlige endringer i forhold til formål, metode, tidsløp eller organisering, skal søknad sendes til den regionale komiteen for medisinsk og helsefaglig forskningsetikk som har gitt forhåndsgodkjenning. Søknaden skal beskrive hvilke endringer som ønskes foretatt og begrunnelsen for disse, jf. hfl. § 11.

Klageadgang
Du kan klage på komiteens vedtak, jf. forvaltningsloven § 28 flg. Klagen sendes til REK sør-øst D. Klagefristen er tre uker fra du mottar dette brevet. Dersom vedtaket opprettholdes av REK sør-øst D, sendes klagen videre til Den nasjonale forskningsetiske komité for medisin og helsefag (NEM) for endelig vurdering.