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Trondheim, May 2016

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To Jorulf

## Norsk sammendrag

**Bakgrunn:** Kroppsbildeforstyrrelser og tvangspreget trening er definert som sentrale symptomområder hos pasienter med spiseforstyrrelser. Forskning har knyttet begge områdene til hele sykdomsforløpet; med betydning for utvikling, som vedlikeholdende faktor og som faktor for økt tilbakefallsrisiko. I fagfeltet har det utviklet seg en økende enighet om at dette er sammensatte fenomener. Kroppsbildeforstyrrelse inkluderer vurdering og oppfatning av egen kropp gjennom persepsjon, men også tanker, følelser og holdninger. Tvangspreget trening kan beskrives ved en kvantitativ og en kvalitativ del. Den kvantitative delen av refererer til elementer som frekvens, intensitet og varighet, og den kvalitative delen knyttes til negative og tvangspregede tanker og holdninger. Forståelsen for at kvalitative elementer kan ha større betydning enn kvantitative elementer for pasienter med spiseforstyrrelser har økt.

Mange pasienter oppnår tilfriskning gjennom behandling. På samme tid viser forskning at en relativt stor andel (20–30 %) ikke oppnår ønsket tilfriskning over tid. For å kunne utvikle mer tilpassede behandlingstiltak som kan fremme bedring hos flere pasienter er det behov for mer kunnskap. Gode kartleggingsverktøy en viktig faktor. For å forstå hvordan forskjellige faktorer påvirker hverandre, og betydningen de for behandlingsresultat, så er økt forståelse for endring gjennom behandling nødvendig. Målet med avhandlingen er å bidra med økt kunnskap om kroppsbildeforstyrrelser og holdninger til tvangspreget trening knyttet til disse punktene.

**Metode:** I alle tre studiene er pasientene rekruttert fra Regionalt kompetansesenter for spiseforstyrrelser (RKSF) i Helse Midt-Norge. Studie 1 og 3 er forløpsstudier med data fra innlagte pasienter ved spesialenhet i Levanger. Begge studiene har data fra innleggelse og utskriving. I studie 3 er det i tillegg oppfølgingsdata. I studie 2 gjennomføres en validering av selvrapporteringsskjemaet Exercise and Eating Disorders (EED). Her er det benyttet data fra oppstart i behandling ved spesialenhet i Levanger og spesialenhet i Stjørdal. Pasientene i denne studien sammenlignes med en kontrollgruppe bestående av kvinnelige elever og studenter fra en videregående skole og to høyskoler i regionen.

**Resultat:** I studie 1 viser resultatene en signifikant bedring av kroppsbildeforstyrrelsen fra innleggelse til utskriving, men forskjellige dimensjoner endres ulikt. Det delområdet som endres mest omhandler fortrolighet med egen kropp. Resultatene indikerer også at redusert kroppsbildeforstyrrelse har signifikant betydning for positiv endring av spiseforstyrrelsessymptom, målt ved Eating Disorder Inventory versjon 2 (EDI-2), fra

innleggelse til utskriving, og at omtrent hele denne effekten er knyttet til pasientenes fortrolighet med egen kropp.

I studie 2, valideringen av EED versjon 2, viser analysene at skjemaet har adekvate psykometriske egenskaper og en struktur med fire underskalaer: 1) *Positiv og frisk trening*, 2) *Tvangspreget trening*, 3) *Bevissthet om kroppslige signaler*, og 4) *Trening for kropp og utseende.* Måleinstrumentet skiller på et signifikant nivå mellom pasientgruppen og kontrollgruppen på Global skåre, alle fire underskalaer og alle 18 utsagn.

I studie 3, forløpsstudien med oppfølgingsdata, vises signifikant bedring på global skåre og alle fire underskalaer på EED fra innleggelse til utskriving, fra innleggelse til oppfølging og for tre av underskalaene også fra utskriving til oppfølging. Funnene indikerer at dimensjonene ved tvangspreget trening målt ved EED har betydning for behandlingsresultatet. Underskalaen *Tvangspreget trening* som signifikant prediktor for endring av spiseforstyrrelses symptom målt ved EDI-2 fra innleggelse til oppfølging, og at EED Global skåre som signifikant prediktor for økning i BMI fra innleggelse til oppfølging for de undervektige ved innleggelse (BMI $\leq$ 18.5).

**Konklusjon:** Resultatene fra forløpsstudiene viser endring av kroppsbildeforstyrrelser og tvangspreget trening gjennom behandlingsforløp for innlagte pasienter med spiseforstyrrelser, og indikerer at begge faktorene har betydning for behandlingsresultat. Resultatene fra valideringsstudien indikerer at EED skjemaet fanger opp kliniske problemområder knyttet til tvangspreget trening, og at det derfor kan være et nyttig klinisk måleinstrument. Resultatene bekrefter eksisterende kunnskap, men bidrar også med ny kunnskap om kroppsbildeforstyrrelser og tvangspreget trening sin rolle og betydning i behandlingen av pasienter med spiseforstyrrelser.

## English summary

**Background:** Body image disorders and compulsive exercise are defined as important symptoms in patients with eating disorders. Research has linked these factors to the course of the illness, through their impact on development, as maintenance factors, and as factors for increased patients' risk of relapse of eating disorder symptoms. In the field, there is a growing consensus that these are complex phenomena. Body image disorder includes evaluation and perception of the own body, but also thoughts, feelings, and attitudes. Compulsive exercise can be described in both quantitative and qualitative terms. Quantitative elements refer to, for example, frequency, intensity and duration, whereas qualitative elements are associated with negative and obsessive thoughts and attitudes. There is a growing understanding that qualitative elements are of greater importance than quantitative elements for patients with eating disorders.

Many patients with eating disorders recover as a result of treatment. However, research shows that a relatively large percentage (20–30%) does not achieve the desired recovery over time. In order to achieve more tailored treatment interventions, there is a need for more knowledge. Good measurement tools are important in this respect. To understand how different factors affect each other and their impact on treatment outcome, increased knowledge and understanding of change during treatment is also necessary. The aim of this thesis is to contribute with increased knowledge of body image disturbances and attitudes to compulsive exercise related to these topics.

**Method:** For all three studies on which this thesis is based, patients were recruited from the Regional Resource Center for Eating Disorders, Regionalt kompetansesenter for spiseforstyrrelser (RKSF), which serves the Central Norway Regional Health Authority (Helse Midt-Norge). Studies 1 and 3 were longitudinal studies with data from inpatients at the specialized treatment unit in Levanger. Both studies included data from admission and discharge. In Study 3 follow-up data were included too. In Study 2, a validation of the self-report questionnaire Exercise and Eating Disorders (EED) was conducted. Patient data from initiation of treatment in the specialized treatment and the specialized treatment unit in Stjørdal were analyzed. The patients were compared with a control group consisting of females from a community high school and two university colleges in the Central Norway region.

**Results:** The results of Study 1 showed a significant improvement in body image disturbance from admission to discharge, but different dimensions changed differently. The dimension that changed most was familiarity with the own body. The results also indicated that reduced body image disorder have a significant impact on positive changes in eating disorder symptoms, measured by the Eating Disorder Inventory Version 2 (EDI-2), from admission to discharge, and that almost all of this effect were related to the patients' familiarity with their own body.

In Study 2, the validation of the second version of the EED questionnaire, the analyses revealed that the questionnaire has adequate psychometric properties and a four-factor structure: (1) *Positive and healthy exercise*, (2) *Compulsive exercise*, (3) *Awareness of bodily signals*, and (4) *Exercise for body and appearance reasons*. The questionnaire discriminates significantly between patients and controls on the Global score, all four subscales, and all 18 items.

Study 3, the longitudinal study with follow-up, the results showed significant improvement on the EED questionnaire's global score and all four subscales from admission to discharge, from admission to follow up, and for three of the subscales also from discharge to follow up. The findings indicate that the dimensions of compulsive exercise measured by the EED questionnaire have an impact on treatment outcome. The subscale *Compulsive exercise* is a significant predictor of change in eating disorder symptoms measured by the EDI-2 from admission to follow-up, and the EED Global score is a significant predictor of increases in BMI from admission to follow-up for those with an admission BMI $\leq$ 18.5.

**Conclusions:** The results from the longitudinal studies show how, for hospitalized patients with eating disorders, body image disturbances and compulsive exercise change during the course of treatment, and indicate that both factors have an impact on treatment outcome. The results from the validation study indicate that the EED questionnaire captures clinical problems related to compulsive exercise, and can be a useful clinical instrument for the monitoring of this issue. The results confirm existing knowledge but also contribute new knowledge related to our understanding of body image disturbances and compulsive exercise in the treatment of eating disorder patients as well as the impact of such disturbances.

# CONTENTS

## ACKNOWLEDGEMENTS

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The research for this thesis was conducted as part of the PhD program in Clinical Medicine, Department of Neuroscience (INM), Faculty of Medicine, at the Norwegian University of Science and Technology (NTNU). The first year was financed by my employer, the Regional Resource Center for Eating Disorders (RKSF). The second and third years were funded by the Liaison Committee for the Central Norway Regional Health Authority and the Norwegian University of Science and Technology (NTNU). The funding made it possible for me to complete the thesis according to plan.

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While participating in the PhD program, I encountered a professional organization with highly qualified staff at all levels. Engaged lecturers shared their knowledge with commitment to their respective academic fields, and the fellowship I have experienced with other PhD candidates will always be a good memory.

My daily workplace has remained in Levanger. Maintaining contact with colleagues and management at RKSF has been important for me, and their interest in my work as well as their support and good company has meant a lot to me.

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language checking. Deborah checked Papers I and II, and an early draft of Paper III. She also contributed to a precise translation of the Exercise and Eating Disorder (EED) questionnaire, and made important comments on the content of Paper II. Catriona carried language editing and checking of the final version of Paper III and the thesis.

My family is very important to me. Spending time with Jacob, Anne Kathrine, Petter, Stine, and Jøran, and their partners always inspire me. During the past three years I sometimes felt that the most important issues in my life were statistics, good references and reviews. Within seconds of being together with our three grandchildren, Georg, Emil and Tobias, I am reminded of what really matters in life and I am very grateful for that.

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# LIST OF PAPERS

## Paper I

Danielsen, M., & Rø, Ø. (2012). Changes in body image in treatment predict outcome. *Eating Disorders: The Journal of Treatment and Prevention*. doi: 10.1080/10640266.2012.689205

## Paper II

Danielsen, M., Bjørnelv, S., & Rø, Ø. (2015). Validation of the Exercise and Eating Disorder Questionnaire. *International Journal of Eating Disorders*. doi: 10.1002/eat.22393

## Paper III

Danielsen, M., Rø, Ø., Romild, U., & Bjørnelv, S. (2016). Impact of female adult eating disorder inpatients' attitudes to compulsive exercise on outcome at discharge and follow-up. Submitted to the *Journal of Eating Disorders* on the 10th of January 2016.

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Journal of Eating Disorders (2016) 4:7, doi: 10.1186/s40337-016-0096-0

## ABBREVIATIONS

| | |
|---|---|
| **AN** | anorexia nervosa |
| **ANOVA** | analysis of variance |
| **BAT** | Body Attitude Test |
| **BDI** | Beck Depression Inventory |
| **BED** | Binge Eating Disorder |
| **BMI** | body mass index |
| **BN** | bulimia nervosa |
| **CBT/CBT-E** | cognitive behavioral therapy/cognitive behavioral therapy for eating disorders |
| **CES** | Commitment to Exercise Scale |
| **CET** | Compulsive Exercise Test |
| **CI** | confidence interval |
| **CIP** | Circumflex of Interpersonal Problems (a short version of the IIP-64) |
| **CMR** | crude mortality rate |
| **DSM-IV** | Diagnostic statistical manual of mental disorders, 4$^{th}$ edition |
| **DSM-5** | Diagnostic statistical manual of mental disorders, 5$^{th}$ edition |
| **EAI** | Exercise Addiction Inventory |
| **EEBQ** | Eating and Exercise Behavior Questionnaire |
| **EED** | Exercise and Eating Disorders (questionnaire) |
| **EDE/EDE-Q** | Eating Disorder Examination/Eating Disorder Examination Questionnaire |
| **EDI-2** | Eating Disorder Inventory 2 |
| **EDNOS** | eating disorder not otherwise specified |
| **EDQ/EDS-R** | Exercise Dependence Questionnaire/Exercise Dependence Scale-Revised |
| **GSI** | Global Severity Index |
| **ICC** | intraclass correlation |
| **IPT** | interpersonal therapy |
| **IIP-64** | Inventory of Interpersonal Problems |
| **INM** | Institutt for Nevrovitenskap (Department of Neuroscience) |
| **KMO** | Kaiser-Meyer-Olkin (measure) |
| **MAR** | missing at random |
| **MCAR** | missing completely at random |
| **MNAR** | missing not at random |
| **NPMP** | Norwegian Psychomotor Physiotherapy |
| **NSD** | Norsk samfunnsvitenskapelig datatjeneste (Norwegian Social Sciences Data Service) |

| | |
|---|---|
| **OEQ/OEQ-R** | Obligatory Exercise Questionnaire/Obligatory Exercise Questionnaire Revised |
| **PCA** | Principal Component Analysis |
| **REI** | Reasons for Exercise Inventory |
| **REK** | Regional komité for medisinsk og helsefaglig forskningsetikk (Regional Committee for Medical and Health Research Ethics) |
| **RKSF** | Regionalt kompetansesenter for spiseforstyrrelser (Regional Resource Center for Eating Disorders) |
| **RTC** | randomized controlled trial |
| **SCL-90/SCL-90R** | Symptom Checklist-90 and Symptom Checklist-90 Revised |
| **SD** | standard deviation |
| **SE** | standard error |
| **SMR** | standardized mortality rate |
| **SPSS** | Statistical Package for the Social Sciences |
| **SSRI** | selective serotonin reuptake inhibitor |
| **STATA** | Statistical Package for Data Analysis |

# 1 INTRODUCTION

## 1.1 Topic

For many years I worked as a clinical specialist in Norwegian psychomotor physiotherapy in the Department of Psychiatry at Levanger Hospital, and in 2003 I started to specialize in eating disorders while working at the Regional Resource Center for Eating Disorders (Regionalt kompetansesenter for spiseforstyrrelser (RKSF)) in Levanger. As a physiotherapist in the field of eating disorders, two areas have been of special interest, namely body image and physical activity/exercise.

During specialization I wanted to extend both my clinical and theoretical knowledge. I worked with different kinds of eating disorder patients, including inpatients as well as outpatients in group therapy and individual therapy. In the multidisciplinary team I was able to contribute with knowledge and treatment approaches to facilitate the recovery of patients with a disturbed body image and who were compulsive exercisers. In the eating disorder literature I found a range of different definitions and measures related to disturbed body image and compulsive/excessive exercise, and I experienced a lack of consensus related to the understanding of both issues. Moreover, I did not find any recommended guidelines for choice of treatment for them. I also experienced a discrepancy between parts of the published literature and how our patients at Levanger Hospital described their symptoms and responded to treatment.

An increasing interest in developing my knowledge in a scientific way evolved. The aims of the three studies on which this thesis is based were founded on unanswered questions and on issues experienced during clinical work. A combination of clinical work and clinical research has allowed me to work with my interests from different perspectives. Hopefully, the findings will provide positive contributions to both the clinical and scientific fields.

In this thesis I aim to shed light on the phenomenon of disturbed body image and problematic exercise in a historical and theoretical perspective, and through the achieved research results in the current studies. Issues related to research methods are also presented and discussed. The main focus is directed towards eating disorder patients. Due to the framework of this doctoral thesis it has been necessary to leave out most of the research based on samples outside clinical settings. The interesting research volume related to biological theory and models falls outside the scope of this thesis too.

## 1.2 Perspective

Anorexia nervosa (AN) as a diagnostic term was first presented by Sir William Gull in 1874 in London. In other very early publications, similar symptoms were described and referred to by terms such as "Nervous consumption" by Morton in 1689, and "De l'anorexie hysterique" by Laseque in 1873. The first descriptions of eating disorders in Norway have been linked to Vetlesen (1886) and what he called "Nervous dyspepsia". Today, eating disorders are viewed as a group of related and severe disorders, with a complex etiology and nature. Risk factors for developing eating disorder have been presented in a number of reviews (Bulik et al., 2006; Jacobi, Hayward, de Zwaan, Kraemer, & Agras 2004; Striegel-Moore & Bulik, 2007), and include: genetic factors (Striegel-Moore & Bulik, 2007); personality traits (Ghaderi & Scott, 2000); negative life experiences, such as bullying, and sexual and physical childhood trauma (Jacobi et al., 2004, Striegel-Moore & Bulik, 2007); social and cultural settings with dieting and thin body ideals, other body image related issues (e.g., dissatisfaction) (Striegel-Moore & Bulik, 2007); and exercise issues (Meyer, Taranis, Goodwin, & Haycraft, 2011). In addition, specific risk factors have been reported for athletes (Bratland-Sanda & Sundgot-Borgen, 2013). Cultural body ideals may initiate increased body dissatisfaction and negative self-evaluation (Striegel-Moore & Bulik, 2007).

Both anorexia nervosa (AN) and bulimia nervosa (BN) are described as independent diagnoses in the criteria presented in the fourth edition of the *Diagnostic and statistical manual of mental disorders* (DSM-IV) (American Psychiatric Association, 1994), together with one eating disorder not otherwise specified (EDNOS) group. The DSM-IV criteria are presented in Table 1, in Section 1.3 below. In the fifth edition of the *Diagnostic and statistical manual of mental disorders* (DSM-5) (American Psychiatric Association, 2014), the inclusion criteria of AN and BN are broader and binge eating disorder (BED) is included as a separate diagnosis. The requirement of amenorrhea in AN has been removed and the minimum frequency of binge eating and compensatory behavior in BN has been reduced from twice per week to weekly. The first paper in this thesis was published before DSM-5 was available. In order to ensure consistency in the presented results, all patient diagnoses were based on the DSM-IV criteria. One exception was made in Study 2, the validation study (Danielsen, Bjornelv, & Ro, 2015), when BED patients were diagnosed in order to reduce the heterogeneity of the EDNOS group.

### 1.2.1 Incidence, prevalence, and mortality

Eating disorders are relatively rare in the general population (Hoek & van Hoeken, 2003; Smink, van Hoeken, & Hoek, 2012). The incidence in a given population (the estimation of new cases during a specified period) is often reported per 100,000 person-years. Prevalence may be reported as point prevalence, as 1-year period prevalence or as lifetime prevalence. In a 1-year period prevalence, point prevalence is presented together with the incidence rate for the year. In the following paragraphs, cases of both point prevalence and lifetime prevalence are referred to. It is necessary to be aware of several factors that may affect reported incidences and prevalence, such as cultural differences, the investigated population (general population, clinical register, or community samples), sex, age groups, and differences in methodology (Hoek & van Hoeken, 2003; Smink et al., 2012). Reports of increased occurrence may also be questioned if the increase is due to increased awareness, improved detection rate, or a real increase (Smink et al., 2012).

The incidence rates based on health registers in the primary health care sector are in general lower than community rates (Smink et al., 2012). In two European studies based on general practitioner registers with data from two periods, the researchers found a relatively stable incidence rate of AN (Currin, Schmidt, Treasure, & Jick, 2005; Turnbull, Ward, Treasure, Jick, & Derby, 1996; van Son, van Hoeken, Bartelds, van Furth, & Hoek, 2006). The age and sex adjusted incidence rate was 4.2 per 100,000 person-years in 1993, and 4.7 in 2000 in the United Kingdom (Currin et al., 2005; Turnbull et al., 1996), while in the Netherlands the overall incidence rate of AN was 7.4 per 100,000 person-years in the period 1985–1989 and 7.7 in 1995–1999 (van Son et al., 2006). Few incidence studies of BN have been conducted (Smink et al., 2012), but a decreasing trend in incidence rate has been reported. In the UK, the incidence rate dropped from 12.2 per 100,000 person-years in 1993 to 6.6 in 2000 (Currin et al., 2005), and in the Netherlands it dropped from 8.6 per 100,000 person-years in the period 1985–1989 to 6.1 in the period 1995–1999 (van Son et al., 2006).

**Point prevalence in females:** In two Norwegian population-based studies, the point prevalence of eating disorders among females has been investigated. The mean age of the females in the two studies was respectively 32.1 (±11.9) and 40.4 (±12.7) (Gotestam & Agras, 1995; Zachrisson, Vedul-Kjelsas, Gotestam, & Mykletun, 2008). The reported prevalence was respectively 3.8% and 2.9%. In a Swedish population-based sample that included females in the age group 18–30 years, the reported prevalence was 3.2% (Ghaderi & Scott, 2001).

Gotestam & Agras (1995) found a point prevalence of 0.3% in AN and 0.7% in BN, and in the above-mentioned Swedish study it was reported as 0.1% in AN and 1.3% in BN (Ghaderi & Scott, 2001). Hoek & van Hoeken (2003) have estimated an average point prevalence rate of 0.3% (AN) in young females. Bulik et al. (2006) compared the point prevalence of AN using both strict and broad diagnostic criteria and estimated the respective percentages as 0.6% and 1.9%. A generally accepted point prevalence in BN has been estimated as 1% (Hoek & van Hoeken, 2003; Smink et al., 2012).

**Lifetime prevalence in females:** In one Norwegian population-based study (Gotestam & Agras, 1995), the eating disorder lifetime prevalence was estimated to 8.7%. In another study, with European samples, the percentage was 3.7% (Preti et al., 2009). In the two studies the prevalence in AN was respectively 0.4% and 0.9%, and 1.6% and 0.9% in BN. Lifetime prevalence has been estimated in two Finnish birth cohorts with reported prevalence based on strict and broad DSM-IV diagnostic criteria. In AN the reported prevalence were respectively 2.2% and 4.2% (Keski-Rahkonen et al., 2007), and in BN they were 1.7% using strict criteria and 2.3% when based on broad criteria (Keski-Rahkonen et al., 2009). If the DSM-5 criteria are used, the estimated percentages might be up to 4% in AN and up to 2% in BN (Smink, van Hoeken, & Hoek, 2013).

**EDNOS**: It has been noted that prevalence estimation of EDNOS is difficult, due both to the definitions used in research and the heterogeneity found among patients' (Hoek & van Hoeken, 2003; Smink et al., 2012). In the Norwegian study published in the mid-1990s (Gotestam & Agras, 1995), proposed diagnostic criteria were used, and the point prevalence was estimated as 1.3% with a lifetime prevalence of 3.0%. In the Swedish study the point prevalence was 0.5% (Ghaderi & Scott, 2001). Point prevalence in a nationwide community sample was reported as 2.4% (P. P. Machado, B. C. Machado, Goncalves, & Hoek, 2007). As a result of the application of the DSM-5 criteria, both the incidence and prevalence of EDNOS now appear to be decreasing (Smink et al., 2013).

**BED:** The fact that BED was not registered as a specified diagnostic group before the DSM-5 criteria were published has had an impact on reported prevalence. Prior to 2014, no separate BED diagnostic group existed in the DSM criteria, but there were proposed criteria that also were used in research. The Norwegian researchers Gotestam and Agras (1995) included proposed diagnostic criteria and estimated a point prevalence of 1.5% and a lifetime prevalence of 3.2%. In the Swedish study the point prevalence was estimated as 1.2 (Ghaderi

& Scott, 2001). Based on samples in Europe, the lifetime prevalence of female BED patients was reported as 1.9% (Preti et al., 2009), and as 3.5% in samples in the USA (Hudson, Hiripi, Pope, & Kessler, 2007). Research based on the DSM-5 criteria has indicated a lifetime prevalence of 2% (Smink et al., 2013).

**Prevalence in males:** A calculated point prevalence of 0.1% for AN has been reported based on both strict and broad DSM-IV criteria (Bulik et al., 2006). A similar percentage has also been reported by Hoek & van Hoeken (2003). For all eating disorders, it has been estimated that the lifetime prevalence in females is between three and eight times higher than among males (Preti et al., 2009). Further, a lifetime prevalence of AN in males has been reported as in the range of 0.0 to 0.3% (Hudson et al., 2007; Preti et al., 2009; Raevuori et al., 2009). In BN and BED the estimated values are respectively 0.5% and 2.0% (Hudson et al., 2007). Raevuori et al. (2009) have noted that the uncertainty related to these estimates is due to a low number of detected cases.

**Mortality:** Smink et al. (2012) have reported an elevated mortality risk among all types of eating disorders, and the highest rates and ratios have been reported in AN (Smink et al., 2012; Welch & Ghaderi, 2014). However, the reported mortality in AN shows large variations (Welch & Ghaderi, 2014). Mortality can be reported in different ways, and factors such as diagnostic criteria and gender may have an impact on mortality risk.

Crude mortality rate (CMR) and standardized mortality ratio (SMR) are reported in this thesis. CMR represents the number of deaths within the study population over a specified period (Smink et al., 2013). SMR is calculated as a ratio including the number of deaths and the number of expected deaths during the follow-up period in the population (Smink et al., 2013; Welch & Ghaderi, 2014). The SMR makes results more comparable between studies (Welch & Ghaderi, 2014).

Meta-analysis data with a mean follow-up time of 14.2 years have revealed a CMR for AN of 5.1 per 1000 person-years and an overall SMR of 5.9 (Arcelus, Mitchell, Wales, & Nielsen, 2011). Keshaviah et al. (2014) reported a lower overall estimated SMR in AN ranging from 4.9 to 5.7. Mortality is reported to be lower in BN with a CMR of 1.7 and an SMR of 1.9 with an average follow-up time of 9.7 years (Arcelus et al., 2011). In longitudinal data, the SMR for lifetime AN (adjusted for age, sex, and race) has been estimated as 4.4, and without elevated mortality for BN patients (Franko et al., 2013). It is difficult to find specific

mortality rates for EDNOS and BED (Smink et al., 2013). Due to this ambiguity in the published data, mortality rates are not reported for these groups in this thesis.

### 1.2.2 Outcome

Regarding eating disorders, there are several outcomes of interest, such as diagnostic criteria, specific eating disorder symptoms, psychological symptoms (e.g., depression and personality), and physiological factors (e.g., weight restoration) (Berkman, Lohr, & Bulik, 2007). Outcome is also reported in terms of recovery, improvement, chronicity, mortality, and crossover to other eating disorder. Comparison of outcomes between studies may be difficult due to the diversity of definitions in use (Steinhausen, 2009). The length of follow-up period and diversity in investigated patient population may also have an impact on reported recovery rates in cases of eating disorders (Keel & Brown, 2010). However, it is commonly reported that too many eating disorder patients do not achieve satisfactory recovery, and there are indications that approximately 20–30% of patients experience a long and enduring course of their illness (Keel & Brown, 2010; Steinhausen, 2009). Keel and Brown (2010) have provided an update on the course and outcome of AN, BN, BED, and EDNOS, and found that the lowest percentage of recovery was linked to a short follow-up period and recovery rates increased over time in all of their study groups. Indications of a better long-term outcome in BN than in AN have been presented (Keel & Brown, 2010; Steinhausen, 2009). Differences in outcome between BN and EDNOS (with BED included) showed a decreasing trend when the follow-up time was five years or more (Keel & Brown, 2010). Reports of predictive factors of outcome have been found inconsistent and heterogeneous (Keel & Brown, 2010; Steinhausen, 2009).

Remission can be classified in categories such as *full recovery*, and *good*, *intermediate*, or *poor recovery*, but there is diversity in the definitions of these categories (Clausen, 2008; Dare, Eisler, Russell, Treasure, & Dodge, 2001; Strober, Freeman, & Morrell, 1997). Weight and psychological aspect have been proposed as the most important factors (Couturier & Lock, 2006). Reported remission rates in a Danish eating disorder cohort (outpatient and inpatients) rates after 20 months were 25% in AN, 35% in BN, and 62% in EDNOS (Clausen, 2008). Two-year follow-up data in a Norwegian cohort with long and enduring eating disorders gave the following results: 14% recovered, 35% with moderate symptoms, 26% with serious symptoms, and 25% with very serious symptoms, of which 71% had improved (i.e., shifted to a less severe category) (Ro, Martinsen, Hoffart, Sexton, & Rosenvinge, 2005). The same sample was assessed in a five-year follow-up and it was found that 34% had

completely recovered, 22% had moderately recovered, and 44% had either poor or no recovery (Vrabel, Rosenvinge, Hoffart, Martinsen, & Ro, 2008).

### 1.2.3 Evidence-based treatment

Guidelines published by the National Institute for Clinical Excellence (NICE) contain recommendations for psychological therapies graded from A to C, based on published research (National Institute for Clinical Excellence 2004). Grade A indicates that the recommendations are supported by randomized controlled trials (RTCs), B indicates that it is supported by controlled studies without randomization, and C indicates that the recommendations are supported by expert opinion, but lack strong data. With regard to the treatment of AN, no therapies are classified as having an A recommendation. Family therapy for children and adolescents are classified as a B recommendation. No other therapies have B recommendations for AN patients. For BN and BED patients, cognitive behavioral therapy (CBT-BN and cognitive behavioral therapy for eating disorders (CBT-ED) are classified as an A recommendation, and Interpersonal Therapy (IPT) as a B recommendation.

Wilson, Grilo, and Vitousek (2007) have summarized evidence of psychological treatment related to application and effectiveness in clinical practice. They discuss the strengths and limitations of the research supporting the NICE recommendations. In a more recent review, Hay (2013) has investigated updated evidence for psychological treatments in eating disorders. She reports increased evidence of family-based treatment in adolescents with AN and for CBT in full and guided forms for BN, BED and EDNOS. In follow-up data, she found that IPT was associated with greater improvement than CBT for AN and BED, and support for the use of dialectical behavior therapy for BED (one trial) (Hay, 2013). Wilson et al. (2007) and Hay (2013) discuss possible directions for future research. Wilson et al. (2007) also note that therapies are not necessarily ineffective merely because they have not been tested in randomized controlled trials, and that it is important to evaluate alternative psychological therapies.

The World Federation of Societies of Biological Psychiatry has presented recommendations for the pharmacological treatment of eating disorders. Due to comorbidity between eating disorders and other psychiatric disorders, a broad spectrum of associations has been investigated. The federation's recommendations are based on studies published between 1977 and 2010 (Aigner, Treasure, Kaye, & Kasper, 2011). No evidence of A recommendations in AN was found, but zinc supplementation was presented as a B

recommendation. Given its usefulness in increasing weight (one RCT), olanzapine had been given a B recommendation too. In a recent review, olanzapine is no longer recommended on this indication, due to evaluated inconsistency in presented results (Zipfel, Giel, Bulik, Hay, & Schmidt, 2015). Tricyclic antidepressants and fluoxetine (a selective serotonin reuptake inhibitor (SSRI)) was classified as an A recommendations in the treatment of BN, and sertraline (an SSRI) and topiramate (an antiepileptic) as A recommendations for BED patients. Zipfel et al. (2015) note that many studies are based on trials with relatively short duration and that more research is necessary.

### 1.2.4 Disturbed body image and compulsive exercise in treatment

It is necessary to extend knowledge of additional aspects that are important to address in treatment and that might contribute to the recovery of more eating disorder patients over time. This could include increased knowledge of different symptoms and its impact on treatment outcome and course of the illness. In this thesis the focus is directed towards body image disturbances and compulsive exercise. It has been reported that different symptoms in AN and BN show different time paths to remission. In a Danish sample followed for two and a half years, aspects related to body image and non-purging compensatory behavior showed the longest time to remission (Clausen, 2004). There are known associations between body image and exercise. For example, exercising for weight and shape reasons is described in the DSM diagnostic criteria (American Psychiatric Association, 1994) and significant associations between obligatory exercise and body image problems have been found (Seigel & Hetta, 2001). It is reported that physical activity approaches may lead to improvement in body image (Campbell & Hausenblas, 2009; Hausenblas, Cook, & Chittester, 2008; Sundgot-Borgen, Rosenvinge, Bahr, & Schneider, 2002), and that body image problems and non-purging compensatory behavior are persistent symptoms in the recovery process (Clausen, 2004).

In early research, there were indications that body image therapy associated with improvements in body image could facilitate changes in eating disorders (Rosen, 1996). Few studies have investigated the nature and strength of the relationship between changes in body image and changes in eating disorder symptoms during inpatient treatment. Moreover, specific interventions aimed at achieving more positive attitudes and functional coping strategies towards the body are not commonly included in treatment programs (Rosen, 1996; Vocks, Wachter, Wucherer, & Kosfelder, 2008). No randomized controlled studies have been performed, and body image interventions are regularly part of more comprehensive treatment programs in inpatient treatment. This situation makes it difficult to draw conclusions about

specific effects and causality. Nevertheless, favorable changes related to different treatment approaches have been reported: mirror confrontation (Key et al., 2002), and indications that CBT addressing body image is more beneficial than CBT without a targeted body image component (Rosen, 1996; Legenbauer, Schütt-Strömel, Hiller, & Vocks, 2011; Vocks et al., 2008). Further, a prospective longitudinal study of 290 inpatients admitted to a specialized eating disorder unit that included body-oriented therapy (i.e., video confrontation, relaxation therapy, and bodily expression), found significant improvement for all outcome measures, including body experience, body mass index (BMI), and the Eating Disorder Inventory Version 2 (EDI-2) (Probst, Vandereycken, Van, & Pieters, 1999).

Few studies have investigated the effects of targeted exercise interventions on the course of eating disorders (Zunker, Mitchell, & Wonderlich, 2011). One such study, by Bratland-Sanda et al. (2010), revealed a significant positive correlation between reduced exercise dependency and reduced eating disorder symptoms during inpatient treatment. A few review papers have summarized existing literature with regard to excessive exercise in AN (Moola, Gairdner, & Amara, 2013; Zunker et al., 2011), and transdiagnostic samples (Hausenblas et al., 2008). A total of 13 studies have been evaluated, most of which were characterized by small sample sizes and considerable heterogeneity in definitions, outcome measures, and type of intervention. Despite this methodological heterogeneity, the studies collectively suggest that targeted exercise interventions have no significant adverse impacts on weight gain for AN patients (Hausenblas et al., 2008; Moola et al., 2013; Zunker et al., 2011). Four studies reported a positive association between exercise interventions and reduced eating disorder symptoms (Hausenblas et al., 2008; Moola et al., 2013). Moreover, improvements in psychological well-being and quality of life were observed (Moola et al., 2013). Of the 13 studies, 5 investigated adult inpatient samples, and none investigated illness course following discharge from inpatient treatment. Although initial studies investigating compulsive exercise in treatment show promising results, more research is warranted. The importance of increased understanding of necessary dimensions to be addressed, the effects of compulsive exercise during treatment, and the impact on longer term outcomes is emphasized (Hausenblas et al., 2008; Moola et al., 2013; Zunker et al., 2011).

## 1.3 Diagnostic criteria

In Table 1 the DSM-IV diagnostic criteria are presented together with descriptions of diagnostic features related to body image and exercise. The diagnostic criteria related to body image and exercise is emphasized in bold font in the table.

In the fifth edition of the DSM (American Psychiatric Association, 2014), diagnostic criteria and descriptions of body image and exercise remain unchanged. Inappropriate behavior in BN has been reduced from a minimum of twice per week to weekly, including compulsive exercise.

In addition the manual-based diagnostic criteria, the classification of eating disorders are debated. It has been claimed that a transdiagnostic model is more useful than dividing patients into groups (Fairburn & Bohn, 2005). One central argument is that certain features are common to all eating disorders. Over time it is common for patients' diagnostic status to change and the usefulness of having different diagnoses of a condition that change naturally over time in individuals has been questioned: Do they have different psychiatric disorders or do they experience different stages in their eating disorders? (Fairburn & Cooper, 2007).

In their book, Fairburn and Walsh (2002), claim to have provided a definition that covers the overall eating disorder symptomatology and is consistent with the DSM-IV definition of a mental disorder: "A persistent disturbance of eating behavior intended to control weight, which significantly impairs physical health or psychosocial functioning".

**Table 1.** *Diagnostic and statistical manual of mental disorders, 4th edition (DSM-IV): Diagnostic criteria for anorexia nervosa, bulimia nervosa and eating disorder not otherwise specified* (American Psychiatric Association, 1994).

| **Anorexia nervosa (AN) (307.1)** |
|---|
| **A.** Refusal to maintain body weight at or above a minimally normal weight for age and height (e.g., weight loss leading to maintenance of body weight less than 85 % of that expected; or failure to make expected weight gain during period of growth, leading to body weight less than 85 % of that expected).<br>**B. Intense fear of gaining weight or becoming fat, even though underweight.**<br>**C. Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight.**<br>**D.** In postmenarcheal females, amenorrhea, i.e., the absence of at least three consecutive menstrual cycles. (A woman is considered to have amenorrhea if her periods occur only following hormone, e.g., estrogen, administration.) |
| **Description of diagnostic features related to body image and exercise in AN** |
| • *The intense fear of becoming fat is usually not alleviated by weight loss. In fact, concern about weight gain often increases even as actual weight continues to decrease.*<br>• *The experience and significance of body weight and shape are distorted in these individuals. Some individuals feel globally overweight. Other realize that they are thin but are still concerned that certain parts of their bodies, particularly the abdomen, buttocks, and thighs, are too fat.*<br>• *Excessive exercise is described as an additional method of weight loss.* |
| **Bulimia nervosa (BN) (307.51)** |
| **A.** Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following:<br>**(1)** eating, in a discrete period of time (e.g., within any 2-hour period), an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances<br>**(2)** a sense of lack of control over eating during the episode (e.g., a feeling that one cannot stop eating or control what or how much one is eating)<br>**B. Recurrent inappropriate compensatory behavior in order to prevent weight gain,** such as self-induced vomiting; misuse of laxatives, diuretics, enemas, or other medications; fasting; or **excessive exercise.**<br>**C.** The binge eating and inappropriate compensatory behaviors both occur, on average, at least twice a week for 3 months.<br>**D. Self-evaluation is unduly influenced by body shape and weight.**<br>**E.** The disturbance does not occur exclusively during episodes of anorexia nervosa. |
| **Description of diagnostic features related to body image and exercise in BN** |
| • *The essential features of bulimia nervosa are binge eating and inappropriate compensatory methods to prevent weight gain. To qualify for the diagnosis the binge eating and the inappropriate behavior must occur, on average, at least twice a week for three months.*<br>• *Exercise may be considered to be excessive when it significantly interferes with important activities, when it occurs at inappropriate times or inappropriate settings, or when the individual continues to exercise despite injury or other medical complications.*<br>• *Among other factors, feelings related to body weight and body shape may be triggers for binge eating.*<br>• *Individuals with bulimia nervosa place an excessive emphasis on body shape and weight in their self-evaluation, and these factors are typically the most important ones in determining self-esteem. Individuals with this disorder may closely resemble those with anorexia nervosa in their fear of gaining weight, in their desire to lose weight, and in the level of dissatisfaction with their bodies.* |
| **Eating disorder not otherwise specified (EDNOS) (307.50)** |
| The EDNOS category is for disorders of eating that do not meet the criteria for any specific eating disorder. Examples may include:<br>**1.** For females, all of the criteria for anorexia nervosa are met except that the individual has regular menses.<br>**2.** All of the criteria for anorexia nervosa are met except that, despite significant weight loss, the individual's current weight is in the normal range.<br>**3.** All of the criteria for bulimia nervosa are met except that the binge eating and inappropriate compensatory mechanisms occur at a frequency of less than twice a week or for duration of less than three months.<br>**4.** The regular use of inappropriate compensatory behavior by an individual of normal body weight after eating small amounts of food (e.g., self-induced vomiting after the consumption of two cookies).<br>**5.** Binge-eating disorder: recurrent episodes of binge eating in the absence of the regular use of inappropriate compensatory behaviors characteristic of bulimia nervosa. |
| **Description of diagnostic features related to body image and exercise in EDNOS** |
| • *Nothing special is described related to body image disturbance in EDNOS.*<br>• *The frequency criteria for inappropriate behavior is reduced in EDNOS; less than twice a week or for a duration of less than three months.* |

Note: Diagnostic criteria related to body image and exercise ere emphasize in bold font

## 1.4 Body image

### 1.4.1 Development of body image/disturbed body image

Cash and Pruzinsky (2002) present a comprehensive view of the body image concept in their book titled *Body image: A handbook of theory, research, & clinical practice*. Due to natural changes in the human body throughout life, embodiment is a continuous process of adapting to physical changes. Perspectives on the development of body image and body image disturbances vary due to the differing theoretical backgrounds of researchers. Some elements related to cognitive-behavioral and psychodynamic perspectives are presented in the following paragraphs.

#### 1.4.1.1 Cognitive behavioral perspectives on body image

Cash (2002) explains how body image attitudes and schemas develop in close interaction with several factors. How individuals feel, think, and act are predisposed by their personal characteristics, life events, life experiences, and social learning, and both historical and current factors interact in these processes. Body attitudes may be divided into two basic elements: body evaluation and body investment. Body evaluation refers to satisfaction with one's body as opposed to dissatisfaction with it. Body investment refers to the importance that individuals attribute to their appearance. Body schemas are described as a higher order of attitudinal constructs related to personal appearance.

Valued physical characteristics and appearances are established and communicated within cultures, in social contexts, and in the media. Basic body image attitudes will be influenced by integrated ideals and standards that commonly are unrealistic and difficult to attain (Derenne & Beresin, 2006). How well personal physical characteristics fit into social and cultural standards, personal self-esteem, and self-confidence will have impact on the perception of body image. Within families and among friends and peers, expectations, nonverbal communications, and attitudes all contribute to development of body image, and attitudes for comparing and evaluating one's body image are established (Cash, 2002).

The abovementioned factors are apparent in daily life to a smaller or greater extent. Body image schema may develop in a sound and healthy way if the different factors have a positive influence over time. However, if the factors are mostly negative, they may contribute to the development of a disturbed body image. Evaluation of body image may also be described as the degree of discrepancy between experienced physical characteristics and personal and cultural ideals of appearance. The need for social acceptance and the wish or drive to achieve

ideals may lead to increased personal investments to try to attain a different physical appearance. The more importance a person attributes to their appearance, the more they are likely to invest efforts to change their appearance.

The development of negative body attitudes and schemas may lead to pathological coping strategies that may include compensatory strategies and attempts to change appearances in order to regulate and reduce body image discomfort.

#### 1.4.1.2 Psychodynamic perspective body image

In a psychodynamic perspective, body image together with body function and body sensation form the body self. The personal body image may be looked upon as the dynamic and developed mental representation of the body-self (Krueger, 2002).

The body-self and body image develop through stages. The earliest feelings of an individual body emerge through body sensations in relationships with caregivers. Sensory stimuli, especially tactile sensations, enable the child to discriminate their own body from the environment. This process is enhanced by interpersonal relationships between the child and his or her caregivers. Later on, the child will experience the boundaries of their body surface and learn to distinguish different internal states of their body. Body image may be perceived as something one either has or does not have, and the image may be considered accurate or disturbed. A more dynamic view is that having a healthy body image is an ongoing developmental process towards the coherence of body and mind and a foundation for self-awareness (Krueger, 2002).

The process of development may be interrupted in differing ways during the different stages, and in turn this may lead to what can be understood as a *developmental arrest* and an incomplete experience of a body self, and hence a disturbed body image. The consequences of an interrupted development may be expressed as a range of different attempts to generate perceptions of the body, with the aim to reduce tension and achieve control over the body. Such attempts may take the form of for example, intense physical stimulation and the induction of physical pain (e.g., exercise and self-harm). In difficult emotional periods these problems may increase and lead to experiences of a more distorted body image. It is important to emphasize that affected individuals do not necessarily deny body awareness, but during their development they fail to achieve good integration of body and mind, which is a precondition for differentiating between them (Krueger, 2002).

### 1.4.2 History of body image disturbances in eating disorders

Body image disturbance has a long history within the medical field as a symptom associated with different illnesses. In the context of eating disorders, such disturbances have been described from the earliest clinical reports (Cash & Pruzinsky, 2002). Based on clinical observations, Bruch (1962) described body image disturbances in AN patients, and in her opinion these disturbances could be on a delusional level. Patients with skinny and emaciated bodies who were not at all concerned about their somatic condition expressed a great fear of becoming fat. Bruch claimed that body image disturbance was a core feature of AN and necessary to treat in order to achieve recovery.

In the diagnostic criteria (DSM-IV (American Psychiatric Association, 1994), descriptions of body image disturbances include a fear of weight gain despite being underweight together with a disturbed way of experiencing one's own body in AN, and an undue impact of body weight and shape on self-evaluation in both AN and BN. A principal debate regarding the specific nature and impact of body image in eating disorders had been ongoing for many years (Cash & Deagle, 1997). According to many relatively early researchers, a perceived distortion of one's body was equated with having a disturbed body image (Cash & Deagle, 1997). In contrast, Hsu & Sobkiewicz (1991) argued that it was unfortunate to use the terms *overestimation of body size* and *disturbance of body image* interchangeably because they are not synonymous, and that the term *body image distortion* itself is unwarranted in explanations of the disparagement of body experiences in eating disorders. In the opinion of Hsu & Sobkiewicz, the published research related to overestimation did not contribute to a better understanding of the psychopathology of eating disorders.

Despite the abovementioned arguments, measures of overestimation were given most attention in research. These measures related to whole bodies or to body parts and were directed towards perceptions of current size and/or ideal size. Several approaches were used, such as image marking, analogue scales, optical distortion, and silhouette figures (Cash & Deagle, 1997; Hsu & Sobkiewicz, 1991). Beside the overestimation, cognitive, evaluative components towards one's body were investigated. These components were viewed as multidimensional and were assessed in interviews or by self-report questionnaires covering behavioral elements in combination with cognitive and affective elements. Contrary to this comprehensive understanding, to a great extent only the body dissatisfaction dimension was targeted in research. Body dissatisfaction may be defined as a negative subjective evaluation of one's own physical body. The degree of body dissatisfaction could be linked to ratings of

body parts, body function, weight and shape, and/or a calculated difference between current and ideal body size (Cash & Deagle, 1997).

The first meta-analysis evaluating body image parameters in samples of female eating disorders (AN and BN) was published in 1997 (Cash & Deagle, 1997). The main conclusions were that body dissatisfaction and perceptual body-size distortion was significantly greater in individuals with eating disorders than controls, and that there was evidence of a distinction between the two factors. Cash and Deagle's (1997) findings also indicate that the body size distortion is not related to a generalized sensory perceptual deficit.

More recently, attention has been directed towards the complexity of disturbed body images and it has been highlighted that it is important to include a comprehensive perspective in treatment and research (Hrabosky et al., 2009). It is necessary to differentiate between body dissatisfaction presented as a common feature in females and having self-worth solely based on shape and weight evaluation (Hrabosky, Masheb, White, & Grilo, 2007). Little research has investigated the importance of body image disturbances in BED patients. However, findings reported by Hrabosky et al. (2007) showed a correlation between higher levels of over-evaluation of weight/shape and higher levels of eating disorder pathology, body dissatisfaction, depression, and lower self-esteem. Their finding are in accordance with earlier research indicating that these body image issues are representative factors not only in AN and BN, but in all eating disorders (Wilfley, Wilson, & Agras, 2003).

The over-evaluation of one's own body size is still viewed as a component of body image disturbance in eating disorders. However, its role has been questioned. It is argued that this feature may be affected by several factors, and its impact is not clear (Farrell, Lee, & Shafran, 2005). The view of body size estimation has gradually been extended to include feelings and/or evaluation, and it is emphasized that this disturbance is not due to a perceptual problem (Hrabosky et al., 2009). A further expansion of the understanding has been achieved by Espeset et al., 2011) who developed a dimensional model related to body image disturbances. They investigated the concept in connection with AN patients and different contexts in daily life, and explored the patients' subjective experiences. Their research identified four phenotypes that were interpreted on a continuum scale from integration to delusion: *integration*, *denial*, *dissociation*, and *delusion*. Espeset et al. (2011) related these components to experiences of s*ubjective reality* and *objective reality* that ranged from having an undistorted and adequate experience of one's body appearance of being underweight to being convinced that one's subjective body image is undistorted and shared by others. There are

indications that this model has extended utility and may be applied to body image disturbances in BN and EDNOS patients too (Danielsen & Bratberg, 2013). Also Espeset, Gulliksen, Nordbo, Skarderud, and Holte (2012) have highlighted the dynamic nature of body image disturbances, and found that they are sensitive to situations related to eating, awareness of one's own body appearance, and emotional signals, including interpreting these issues in relation to other people.

Another important dimension of the disturbed body image is body checking and avoidance, which is considered associated with the impact of over-evaluation of weight and shape in eating disorders (Fairburn, Cooper, & Shafran, 2003; Reas, White, & Grilo, 2006). The checking behavior includes, for example, checking for bone protrusions, pinching soft body tissue, and ritualistic weighing (Reas, Whisenhunt, Netemeyer, and Williamson, 2002). The avoidance is related to ways of not relating to one's own body, such as avoiding mirrors and wearing clothes that are too big. A significant relationship has been found between such behavior and body dissatisfaction, and increased frequency of the behavior is associated with women of a younger age and a relatively lower BMI. However, body checking behavior is also associated with BED patients (Reas et al., 2006).

In the current understanding, the complexity of the phenomenon of body image is broadly accepted. A definition of body image disturbances includes perceptual, attitudinal, and affective components, and is viewed as a multidimensional concept. In addition to acceptance of body image as an important clinical feature, existing knowledge also highlights the importance attached to the maintenance of the disorder and increased risk of relapse (Cash & Deagle, 1997; Garner, 2002; Fairburn, Peveler, Jones, Hope, & Doll, 1993; Probst, M., Van Coppenolle, H., & Vandereycken, W, 1995; Stice, 2002; Striegel-Moore & Franko, 2002; Vocks et al., 2008).

### 1.4.3 Classification of body image disturbance

The diagnostic criteria confirm the importance of body image disturbances in eating disorders, and body image components are specified for AN and BN in DSM-IV and DSM-5. Those diagnosed with EDNOS do not meet all criteria in the specific diagnostic groups, and there may be heterogeneity due to body image (Probst, Pieters, & Vanderlinden, 2008). No body image disturbance components are included for BED in DSM-5, but research findings highlight the existence of such conditions (Reas, D. L., Grilo, C. M., Masheb, R. M., & Wilson, G. T, 2005). Since the disturbed body image is a diagnostic criterion in both AN and

BN, its prevalence may be estimated in the same range as prevalence of the respective diagnosis.

Discrimination between eating disorder patients and healthy controls may indicate a cutoff point where their body image disturbance becomes pathological. This may be represented by a calculated cutoff score in questionnaires. In the Body Attitude Test (BAT) questionnaire, which is used as a measure of disturbed body image in this thesis, a cutoff score of 36 (maximum score = 100) has been calculated (Probst et al., 1995). In a clinical sample with AN and BN patients compared with controls, Probst et al. (2008) evaluated four different body image questionnaires, including the BAT. The discrimination between patients and controls is confirmed, but the authors discuss a lack of knowledge of what the normal range of attitudes toward one's body includes. Probst et al. (2008) also propose an alternative view based on severity groups related to percentiles: one group with scores below the 25 percentile, a second group with scores between the 25 and the 75 percentile, and a third group with scores above the 75 percentile. Those within the group with the highest scores were viewed as having extreme levels of disturbed body image, while those with the lowest scores were considered not having a problematic body image disturbance. However, it is necessary to be aware of any possible underreporting. Those in the middle group were viewed as representing individuals with an average normative level of body concern. Within this group, the body image at one level will become pathological, and more research is necessary to estimate these cutoff scores (Probst et al., 2008). A severity perspective has also been supported by the dimensional model presented by Espeset et al. (2011). They found that increased severity of body image disturbance was associated with phenotypes on a continuum from integration to delusion. Espeset et al. (2011) suggest that different phenotypes may need different treatment approaches to achieve recovery. In their opinion, this model could contribute as a useful tool in the clinic, assisting choice of treatment approaches and also having a prognostic value.

## 1.5 Compulsive exercise

### 1.5.1 Theoretical models of compulsive exercise

Theoretical models illuminating important dimensions of exercise in eating disorders have been developed (Hausenblas et al., 2008; Meyer et al., 2011), and are presented below.

**Model 1:** Hausenblas et al. (2008) aimed to improve the understanding of exercise in eating disorders, and to provide a better basis for choice of exercise as an approach to increase

beneficial treatment outcomes. In their model they provide *a conceptual framework for the effects of exercise on eating disorders*. This model is shown in Figure 1. The presented framework is built on a principal of reciprocal relationships, which can illuminate how both positive and negative circles can develop. One possible positive pathway may occur if performed exercise leads to increased well-being, and in turn improved well-being leads to increased exercise. However, a prerequisite for this to be a positive relationship is that the exercise has to be carried out in a healthy way. Another positive relationship may occur when improved well-being leads to reduced risk and maintenance factors of eating disorders, which over time may reduce the prevalence of eating disorders.

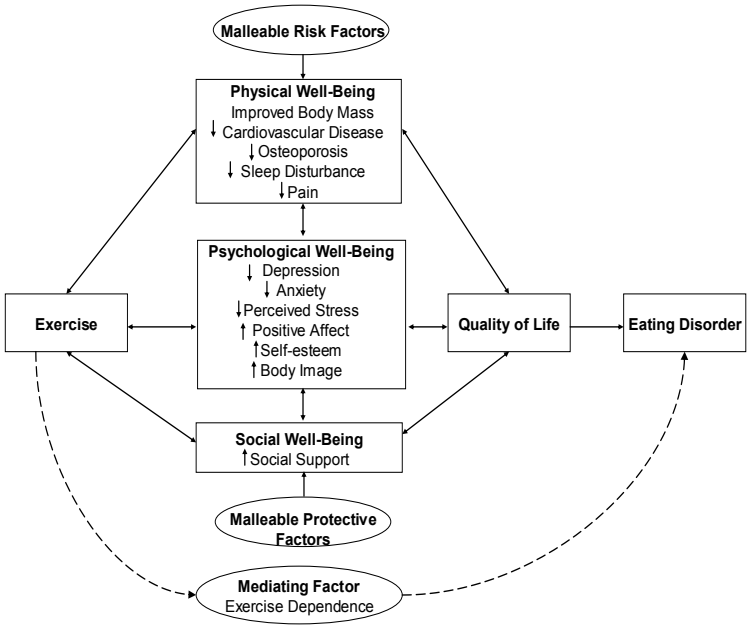



**Figure 1.** Conceptual framework of exercise on eating disorders (reproduced with permission from Hausenblas et al., 2008)

**Model 2**: The model developed by Meyer et al. (2011) is a cognitive behavioral model with an overall perspective on compulsive exercise. The authors have identified key factors associated with compulsive exercise. Each of these factors is indicated to have an impact on the maintenance of compulsive exercise in eating disorders, and the following factors are highlighted:

- Weight and shape concern
- Affect regulation
- Compulsivity (i.e., avoidant coping)
- Perfectionism
- Rigidity

In Meyer et al.'s (2011) opinion, the identified factors are empirically supported and testable. The authors emphasize that it is important to include these dimensions in research related to exercise in eating disorders. For example, they may include references to the continuation of exercise to avoid negative affect when exercise is stopped or restricted, rigid and inflexible attitudes, and behavior and weight and shape concerns.

### 1.5.2 History of compulsive exercise in eating disorders

Throughout the history of eating disorders, increased physical activity has been described as a prevalent feature among eating disorder patients. In early clinical case reports of AN, Laseque (1873) and Gull (1874) reported restlessness and compulsive physical activity. Bruch (1962) described over-activity in her AN patients as "*a manifestation of falsified awareness of the bodily state*." The activity could be based on interests in sports for some patients, but in her experience this behavior was often aimless. Among other compensating behaviors, the over-activity could assist in the attempt of removing unwarranted food from the body. In a phase of emaciation, the amount of exercise could be small but still a remarkable and regular behavior. Bruch highlighted the reduced ability of recognizing bodily states, such as awareness of fatigue, weakness, and being hungry and tired, as important characteristics of AN patients, together with the deficiency in identifying emotional states (Bruch, 1962).

Early publications were mostly based on case studies and retrospective investigations of patient records (Brewerton, Stellefson, Hibbs, Hodges, & Cochrane, 1995; Crisp, Hsu, Harding, & Hartshorn, 1980; Kron, Katz, Gorzynski, & Weiner, 1978). Much attention was directed towards an increased amount of physical activity, using descriptions such as hyperactivity, excessive exercise, and high-level exercise, and excessive exercise was described as a prevalent feature of AN (Kron et al., 1978).

Eisler and le Grange (1990) compared excessive exercise in AN to excessive exercise in athletes, and presented different perspectives on how to understand this behavior. One perspective was that increased level of exercise in AN patients was related to preoccupation with weight and shape and the goal of weight reduction. By contrast, in the case of athletes

high-level exercise and the desire for lean bodies was understood as secondary to the goal of increased performance. Eisler and le Grange (1990) also discuss how high-level exercise in itself could increase an individual's risk of developing an eating disorder, and that excessive exercising could be a variant of eating disorders. In their opinion it was difficult to draw conclusions from existing research at the time, due to methodological problems. Eisler and le Grange (1990) concluded that it was necessary to investigate different perspectives further.

Davis, Brewer, and Ratusny (1993) present issues of clinical and theoretical relevance in order to distinguish between exercise that is pathological and not pathological. One issue is the meaning of terms that could increase misunderstanding. Davis et al. (1993) mention that the terms *addictive* and *obsessive/compulsive* exercise have sometimes been used interchangeably in the literature, even representing different traits. The addicted persons have been described as doing something that they like to do, and which they did not want to stop doing, in contrast to the obsessive-compulsives who do not enjoy what they are doing, which they do not manage to stop. Davis et al. (1993) highlight the importance of investigating other aspects than exercise behavior, such as frequency, intensity, and duration, and include topics related to commitment to exercise. They also suggest that a dimensional approach could be favorable in future investigations.

More recently, many researchers have contributed with additional knowledge. Adkins and Keel (2005) have made some clarifying statements. They suggest that a definition should differentiate between two dimensions: a quantitative dimension representing the excessive elements and a qualitative dimension representing the compulsivity elements. They also highlight that compulsive elements of exercise seem to be more closely related to exercise in eating disorders than the excessive elements.

As summarized by Meyer and Taranis (2011), problems related to inconsistency in the use of terminology have posed a great challenge in the research field of eating disorders. They have found that *exercise addiction*, *exercise dependence*, *obligatory exercise*, *compulsive exercise*, and *excessive exercise* have been the most commonly used terms, but the use of more than 30 different terms is reported (Adkins & Keel, 2005). In the early 1990s, le Grange and Eisler pointed out that it could be difficult to know for certain whether published research was reporting the same phenomenon (le Grange & Eisler, 1993), and almost 20 years later this was still reported as a challenge (Meyer & Taranis, 2011). Due to the content, and to ensure

consistency in the description of exercise in this thesis, the term *compulsive exercise* is used throughout.

### 1.5.3 Measures of compulsive exercise

Existing questionnaires measure a range of different aspects related to compulsive exercise. Information related to the different questionnaires listed below is presented in Table 2 (p. 25):

- Eating and Exercise Behavior Questionnaire (EEBQ) (Brandon, Loftin, & Thompson, 1988)
- Obligatory Exercise Questionnaire (OEQ) (Pasman & Thompson, 1988).
- Commitment to Exercise Scale (CES) (Davis, Brewer, & Ratusny, 1993)
- Reasons for Exercise Inventory (REI) (Cash, Novy, & Grant, 1994).
- Exercise Dependence Questionnaire (EDQ) (Ogden, Veale, & Summers, 1997).
- Exercise Dependence Scale-Revised (EDS-R) (Downs, Hausenblas, & Nigg, 2004)
- Exercise Addiction Inventory (EAI) (Griffiths, Szabo, & Terry, 2005)
- Compulsive Exercise Test (CET) (Taranis, Touyz, & Meyer, 2011).

**Table 2.** Exercise questionnaires

| Questionnaire | Items | Subscales | Adressed |
|---|---|---|---|
| OEQ (1988) | 21 | Obligatory exercise level, one factor | Obligatory exercise level |
| | | | |
| EEBQ (1988) | | Antecedents | Control of obesity |
| | | Actual eating behaviors | |
| | | Consequences | |
| | | Exercise behavior | |
| | | | |
| CES (1993) | 8 | Obligatory aspects | Individual commitment to exercise |
| | | Pathological aspects of exercise | |
| | | | |
| REI (1994) | 24 | Appearance and weight management | Motivation for exercise |
| | | Fitness and health management | |
| | | Stress and mood management | |
| | | Socializing | |
| | | | |
| EDQ (1997) | 29 | Interference with social/family/work life | Measure of exercise dependency |
| | | Positive reward | |
| | | Withdrawal symptoms | |
| | | Weight control | |
| | | Insight into problems | |
| | | Social reasons | |
| | | Health reasons | |
| | | Stereotyped behavior | |
| | | | |
| EDS-R (2004) | 31 | Tolerance | Dependency on exercise |
| | | Withdrawal | |
| | | Continuance | |
| | | Lack of control | |
| | | Reduction in other activities | |
| | | Time | |
| | | Intention effects | |
| | | | |
| EAI (2005) | 6 | Exercise addiction | Exercise addiction, screening |
| | | | |
| CET (2011) | 24 | Avoidance and rule-driven behavior | Maintenance of excessive exercise |
| | | Weight control exercise | |
| | | Mood improvement | |
| | | Lack of exercise enjoyment | |
| | | Exercise rigidity | |

### 1.5.4 Classification of compulsive exercise

To maintain health, the official Norwegian recommendations for the general adult population are *at least 30 minutes of exercise per day* (Helsedirektoratet, 2008), but there are no clear definitions of the transition from beneficial to harmful exercise. Due to diversity in definitions of compulsive exercise in eating disorders, reported prevalences show great variation. In transdiagnostic samples the prevalence is in the range 39–46% (Dalle Grave, Calugi, & Marchesini, 2008; Penas-Lledo, Vaz Leal, & Waller, 2002; Shroff et al., 2006). Commonly, prevalence in AN is reported as higher than in other diagnostic groups: 44% (Shroff et al., 2006), 46% (Penas-Lledo et al., 2002), and 43% and 80% in AN purging and restrictive subtypes respectively (Dalle Grave et al., 2008.

One early approach to identifying harmful exercise in AN patients was a subjective judgment based on the amount of exercise undertaken by patients compared with their peers (Kron et al., 1978). Later on, different definitions of high-level exercise were proposed, using combinations of frequency, duration, and/or intensity of the behavior. One definition was exercising for more than three hours per day (Shroff et al., 2006). Several researchers have suggested exercising five to seven times or hours per week as a measure of high-level exercise (Brewerton et al., 1995; Davis & Kaptein, 2006; Davis et al., 1995; Seigel & Hetta, 2001). Others have specified that the reported exercise should last for one hour without stopping (Penas-Lledo et al., 2002) or should be intense and over the past three months. In addition to the diversity in the measures, there are additional challenges. Some reports have been based on activity level at time of diagnoses, while others focus on activity throughout the course of the illness (Meyer & Taranis, 2011). Davis and Kaptein (2006) have specified that the performed exercise should be motivated by weight and shape reasons, while Seigel and Hetta (2001) argued that in order to consider the behavior as pathological, obligatory attitudes towards the performed exercise should be included. Another important issue is the individual somatic condition, since evaluation of exercise may lead to different conclusions for a patient with a BMI of 11 compared with a normal weight or overweight person.

Most measures of amounts of activity are either based on self-reports or interviews, but there are also methods for objective measurement, and it has been reported that the use of accelerometer seemed to be a valid method for measuring the amount of activity in AN (Gummer et al., (2015). In two studies, it was reported that significant underestimation occurred when subjective measures were compared with objective measures of physical

activity in patients (Alberti et al., 2013; Bratland-Sanda et al., 2010), but not among controls (Bratland-Sanda et al., 2010).

The debate focusing on the boundary for defining exercise level as harmful/pathological in eating disorders is complex. However, in recent years it has been stated that it is even more important to address the compulsive element of this complex feature (Adkins & Keel; Meyer et al., 2011). Researchers have claimed that defining problematic exercise in eating disorders only by the quantitative amount is not sufficient (Meyer & Taranis, 2011). The next challenge to address in the field is the lack of a consensus on the definition of compulsive exercise (Dalle Grave et al., 2008). However, in recent years published research has suggested some necessary elements of such a definition (Meyer et al., 2011). Meyer et al. propose that working definitions should address elements of weight and shape concerns, guilt, and/or negative affect when unable to exercise, rigid/inflexible attitudes and behaviors, and standards that are high to the point of perfection, and heightened concern about the perceived negative consequences of not exercising (Meyer et al., 2011).

## 1.6 Aims of the thesis

The overall objective of this thesis is to extend existing knowledge and thereby increase the quality of treatment offered to patients with eating disorders, and hopefully contribute to more patients' recovery over time. The thesis includes three papers, with the following aims:

Paper I:

1. To investigate changes in body image during inpatient treatment in a transdiagnostic sample
2. To investigate how changes in body image predict changes in eating disorder psychopathology and BMI in comparison with changes in general psychopathology and personality measures during inpatient treatment

Paper II

1. To test the psychometric properties of the revised version of the Exercise and Eating Disorders (EED) questionnaire in a female clinical sample and a control group
2. To test the factor structure
3. To determine a classification scheme based on the EED global score in order to yield an estimate of severity, which may be useful in clinical decision-making

Paper III

1. To examine how various dimensions of compulsive exercise change between admission, discharge, and at follow-up in a transdiagnostic sample of female eating disorder patients.
2. To identify whether changes in compulsive exercise predict the course of eating disorder psychopathology and BMI in relation to changes in general mental distress, interpersonal problems, and depression.

# 2 METHOD

## 2.1 Regional Resource Center for Eating Disorders (RKSF)

The research for this thesis was conducted at RKSF, an eating disorder resource center serving the Central Norway Regional Health Authority. RKSF was established in 2003, and currently consists of two units: a specialized treatment unit in Levanger, established in 2003, and a specialized treatment unit in Stjørdal, established in 2006). The center is a part of the adult psychiatric services that treat patients aged 18 years or older, but patients as young as 16 years can be referred too. RKSF has several functions: treatment, education, supervision, treatment evaluation, and clinical research.

Comprehensive treatment is offered to all eating disorder patients in outpatient and inpatient settings. The treatment programs at RKSF are based on psychodynamic theory, with elements of cognitive behavioural therapy and motivational interviewing, and the staff have multidisciplinary backgrounds.

Since both Papers I and III present the results of investigated data relating to inpatient samples in the special unit in Levanger, some elements of the inpatient treatment program are presented in the following text. The treatment program is described in more details in Paper I (Danielsen & Ro, 2012). All patients are admitted voluntarily. The main goals are to establish normal eating behaviors, address physical complications, and target psychological issues accompanying the illness. A BMI of 20.0 is the target weight, and for those with a lower admission BMI, the weekly weight claim is 0.7 kg from the fifth week of their hospitalization. Calculations of admission times for underweight patients therefore include the number of weeks necessary to reach the target weight and the time to stabilize, in addition to other considerations.

In the multidimensional treatment program, approaches towards body image and physical activity/exercise are an integral part of the treatment from admission to discharge. These approaches complement the stages of the treatment program and patients' individual needs. The body-oriented therapy is based upon the theory and principles of Norwegian Psychomotor Physiotherapy (NPMP) (Ekerholt, 2010), and is also part of a Nordic physiotherapy/body-oriented therapy tradition (Meurle-Hallberg & Armelius, 2006). The treatment for exercise is not manualized, but is based on Norwegian guidelines of *physical activity in treatment and prevention* (Helsedirektoratet, 2008) and adjusted to the specific symptoms and needs of eating disorder patients. Dysfunctional body-related thoughts and

emotions are systematically identified and challenged, with the aim of helping patients to discover and integrate healthy alternatives. During hospitalization, patients are gradually exposed to a variety of body image interventions, outdoor activities, and exercise groups. The initial focus is upon relaxation, body awareness, and modified outdoor activity. These activities are adjusted to all patients, but individuals may be taken out of activities due to severe health conditions. Later in the treatment program, regular exercise groups are offered, including one hour of strength training and one hour of aerobic activity per week. Patients are exposed to different levels of intensity in the exercise groups, but mostly to a moderate level. Underweight patients are required to achieve a minimum BMI of approximately 17.0 before participation in the exercise groups, and planned weight gain must be achieved in order to continue participation.

## 2.2 Study design

Studies 1 and 3 had a longitudinal design with more than one measuring point, and investigated inpatient cohorts of eating disorder patients. A broad definition of a cohort as described by Rothman (2012, pp. 69): "any designated group of individuals who are followed or traced over a period of time". The patient cohorts were followed to investigate how their symptoms changed and interacted during treatment. In Paper I, two assessment points are reported, namely admission and discharge, and in Paper III a follow-up assessment is included. Both samples were recruited from an "open patient cohort" (Rothman, 2012) at RKSF. When admitted to the inpatient unit, patients start with an introductory week. Thereafter, those who decide to continue with treatment sign a treatment contract. In the studies, patients who consented to participate in research were included in the cohort. No one was excluded due to comorbidity.

Paper II presents the results of a validation study of the EED questionnaire (hereafter referred to as the EED). The study had a cross-sectional design and all measures referred to one point in time. Female eating disorder patients (inpatients and outpatients) were compared with female students within the same age range as the patients as the regarding the prevalence of compulsive exercise and eating disorder symptoms. For patients, the measure point was linked to the initiation of treatment. Exclusion criteria were pregnancy or not fulfilling diagnostic criteria for an eating disorder. No one was excluded due to comorbidity. The students attending school on the actual days of data collection were invited to participate.

## 2.3 Participants

The clinical samples in the three studies were recruited from the patient population referred for treatment at RKSF between the beginning of 2005 and the end of 2013 (inpatients and outpatients). All patients admitted for inpatient treatment showed serious symptoms of eating disorders and had received psychiatric treatment without satisfactory effect prior to hospitalization in RKSF. The investigated samples consisted of female participants, with the exception of two male patients who were included in the study reported in Paper I. In accordance with the aims of Papers II and III, patients who had completed the EED at baseline were eligible for participation.

**Participants in the study reported in Paper I:** A total of 63 patients were admitted to the special unit in Levanger from February 2005 to October 2008, and of these 50 patients were included in the sample and 13 patients (12 females and 1 male) were excluded. Their exclusion was due to incomplete datasets (n = 10), and three patients discharged themselves before receiving active treatment. The mean admission time for the whole sample was 145 days (± 60, range 18–81). In the diagnostic groups, the mean admission time for AN was 166 days (±56, range 53–281), BN 93 days (±36, range 18–145), and EDNOS 133 days (±63, range 54–251).

The diagnostic distribution was 60% (n = 30) AN patients, 18% (n = 9) BN, and 22% (n = 11) EDNOS. Both of the male patients had an admission BMI below 17 and were diagnosed as AN. The inclusion of males in the sample should be taken into consideration when interpreting the results, but is evaluated as not having any noteworthy impact on the results due to the low number.

**Table 3.** Participants in the study reported in Paper I

| **Paper I** | All patients n = 50 | AN n = 30 | BN n = 9 | EDNOS n = 11 |
|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) |
| Age (years) | 20.8 (4.2) | 19.8 (3.3) | 23.1 (4.8) | 21.8 (5.3) |
| Range | 16–36 | 16–30 | 18–34 | 18–36 |
| BMI | 17.6 (4.4) | 15.1 (1.6) | 19.9 (2.5) | 22.7 (5.5) |
| Range | 11.7–34.1 | 11.7–17.5 | 17.5–24.7 | 18.1–34.1 |

**Patient participants in the study reported in Paper II:** The patient group consisted of 244 outpatients and inpatients in the special units in Levanger and Stjørdal. They were referred for

treatment from February 2009 to October 2013. The majority of patients were referred to RKSF for the first time, but a few had had a prior treatment period which had ended before the new referral. One patient was excluded due to pregnancy and eight patients did not fulfill the diagnostic criteria for an eating disorder. The diagnostic distribution was: 32.4% (n = 79) AN, 23.4% (n = 57) BN, 34.4% (n = 84) EDNOS, and 9.8% (n = 24) BED.

**Control group participants in the study reported in Paper II:** The control group consisted of second-year female students from a community high school and two university colleges in the Central Norway region. The high school offers education in different programs such as science, economics, design and crafts, and media and communications. The university college students were recruited from different programs among others: driving instructors, multimedia, economy & administration, animal science, nature management, nursing and physiotherapy). The diversity in the students' background supported the representability of this study population. A total of 219 females attending school on data collection days completed the forms. Of these, 14 students responded to one of the questions that they had an eating disorder and they were excluded from the study, leaving a total of 205 participants in the control group. To investigate the test-retest reliability, a group of 69 students completed the EED questionnaire a second time after one week.

**Table 4.** Participants in the study reported in Paper II

| **Paper II** | All patients n = 244 | AN n = 79 | BN n = 57 | EDNOS n = 84 | BED n = 24 | Controls n = 205 |
|---|---|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) |
| Age (years) | 27.1 (9.5) | 23.4 (7.3) | 27.7 (9.3) | 26.6 (9.9) | 36.1 (8.9) | 21.4 (6.3) |
| Range | 16–59 | 16–50 | 16–50 | 16–55 | 24–59 | 16–59 |
| BMI | 22.4 (9.4) | 15.4 (1.8) | 22.6 (4.0) | 22.6 (6.5) | 44.5 (7.4) | 23.6 (3.6) |
| Range | 8.7–62.1 | 8.7–17.6 | 17.5–35.0 | 17.5–48.0 | 33.1–62.1 | 17.3–37.6 |

Note: BMI could not be calculated for one BN patient, one EDNOS patient, and two controls, due to missing weight data

**Participants in the study reported in Paper III:** 128 patients were admitted for inpatient treatment in the special unit in Levanger from January 2005 to December 2013. Six men were excluded because the EED has only been validated for women, and six female patients were excluded because they decided not to receive treatment after the introductory week. Of the remaining 116 female patients, 78 participated in the follow-up assessment, giving a response

rate of 67.2%. Of these patients, 26 were also included in the study reported in Paper I. The diagnostic distribution was: 59% (n = 46) AN, 20.5% (n = 16) BN, and 20.5% (n = 16) EDNOS. The mean duration of illness prior to admission (partly self-reported and partly addressed in interview) was 5.3 years (± 3.8, range 1–20 years). The mean duration of inpatient admission was 134 days (± 56, range 14–281), and the mean admission time for AN was 149 days (± 61, range 14–281), BN 115 days (± 36, range 49–192), and EDNOS 111 days (± 48, range 15–184). The average follow-up period after discharge from treatment was 26 months (±15 months). Participants and non-participants were compared due to relevant variables: age at admission, and BMI, EED global score, and EDI-2 sum score at admission and discharge. No significant differences were found.

**Table 5.** Participants in the study reported in Paper III

| **Paper III** | All patients n = 78 | AN n = 46 | BN n = 16 | EDNOS n = 16 |
|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) |
| Age (years) | 21.3 (3.9) | 20.4 (3.3) | 22.2 (4.5) | 22.2 (4.8) |
| Range | 16.0–36.5 | 16.0–31.7 | 17.8–34.8) | 16.6–36.5 |
| BMI | 17.7 (3.5) | 15.5 (1.4) | 20.7 (2.5) | 20.8–(4.1) |
| Range | 12.4–34.1 | 12.4–17.6 | 17.5–24.7 | 18.1–34.1 |

## 2.4 Procedure

The collection of patient data at RKSF has a twofold purpose. The primary purpose is to assist in clinical work. The secondary purpose is the basis for treatment evaluation and research. Whether patients opt to participate in research has no consequences for the treatment they are offered. Data are systematically collected and included in a patient register approved by the Norwegian Social Sciences Data Service (Norsk samfunnsvitenskapelig datatjeneste (NSD)).

Patients are diagnosed by licensed psychologists or psychiatrists. Diagnoses are based on clinical interviews in accordance with diagnostic criteria, and self-report questionnaires are used to gain additional information in the diagnostic procedure. Preliminary diagnoses are discussed in meetings with a minimum of two specialists prior to reaching a final consensus diagnosis.

The first collection of patients' data takes place at the initiation of treatment. Patients are provided with written and oral information. Those who agree to participate in research give their written consent. Inpatients fill out self-report forms on admission for hospital treatment,

but if the period since the initiation of outpatient treatment is shorter than four weeks, these data are considered admission data. All patients complete the same questionnaires at discharge. From 2003 to 2011 only paper questionnaires were used, from 2011 onwards there was a transition to online data collection.

Contact with potential participants to the control group in Paper II was made via school or university college administration services, to provide information about the research and to make an agreement regarding data collection. All second-year female students from a community high school and students from different faculties at two university colleges in the Central Norway region were invited to participate as a control group. Participation was voluntary and anonymous. Questionnaires were administered by teachers at the high school and by me at in the university colleges. Written information about the study was distributed together with the questionnaires. In accordance with advice from the Regional Committee for Medical and Health Research Ethics (Regional komitee for medisinsk og helsefaglig forskningsetikk (REK)), the handing in of anonymous completed forms was regarded as giving consent to participate in the study. Due to anonymity of the data, it was not possible to withdraw submitted forms afterwards. The 69 students who participated in test-retest of the EED were given a negligible value lottery ticket (value USD 4, without any guarantee of winning) as compensation for their participation. No other compensation was offered.

In 2009 a larger follow-up study at RKSF was approved by REK, and aimed to investigate different dimensions of eating disorder treatment and treatment outcomes. Written invitations with study information, consent forms and questionnaires were mailed to patients (n = 179) admitted from January 2003 to December 2013. In total, 104 patients responded, giving a response rate of 58.1%. Study 3 was part of this larger follow-up study.

## 2.5 Measurements

Self-report questionnaires are a regular part of intake and discharge procedures and treatment evaluation at RKSF. With one exception, already validated questionnaires covering different symptoms of eating disorder patients had been chosen. In 2003 we did not find an existing questionnaire covering the range of symptoms related to problematic exercise described and observed in our patients, and this prompted the development of the EED questionnaire.

### 2.5.1 Compulsive exercise

The development of the EED started in 2003 in the special unit in Levanger. As a part of the intake routine, all patients were interviewed to investigate attitudes towards exercise and

exercise behavior. Important clinical information was considered with regard to: (1) earlier experience of exercise, and positive and negative outcomes of the exercise; (2) the consequences when exercise was restricted or stopped, as it would be when patients signed the treatment contract; (3) awareness of bodily signals such as hunger, thirst, and feeling tired; and (4) the amount of exercise. This information was used when patients formulated their treatment goals during the planning of treatment approaches, and was also addressed during treatment. Our clinical observations were systematized and discussed in the multidisciplinary team and with patients. Patients gave feedback on proposed statements, to ensure the meaning of the content was in accordance with their experiences. Preliminary data relating to these questions were collected and evaluated. In combination with existing research and literature, the first version of the EED was developed and ready for clinical testing in 2005. It consisted of 20 statements on a 6-point scale ranging from 0 (*never*) to 5 (*always*). At the time, the items were thematically divided into three subscales covering different dimensions of compulsive exercise: (1) *intentions to exercise* (eight items), (2) *consequences of not exercising* (seven items), and (3) *bodily signals* (five items). Sum scores were calculated, and higher scores indicated more compulsivity and unhealthy exercise. To address low-intensity activity, the phrase *physically active* was used in the statement text. Together with information about workouts per week, one additional question addressing whether activity was performed mainly alone was included. Workouts were reported in a range from no workouts to more than five workouts per week.

In a pilot study, Version 1 of the EED was tested and 50 eating disorder patients (inpatients) were compared with 51 female controls (Danielsen, Bratberg, & Ro, 2012). The preliminary results was promising and showed good internal reliability (Cronbach's alpha of 0.92 on the whole scale), and significant discrimination ($p < 0.01$ to $p < 0.01$) between patients and controls in sum score, subscales, and items (except for one item) (Danielsen et al., 2012).

In the revised EED (Version 2), the statement, *I am physically active to be strong*, was removed because it was equally important for both patients and controls. Two items were included to extend the range of covered dimensions in the questionnaire: *I am physically active to avoid difficult feelings* and *I feel/notice pain*. Two items were rewritten to clarify content of meaning. To achieve more differentiated reports of the excessive exercise quantity, three questions were included. These were validated measures similar to those used in a longitudinal population health study in Norway, the HUNT study (Kurtze, Rangul, Hustvedt,

& Flanders, 2008). There are five alternatives for reporting frequency of exercise, ranging from *never* to *almost every day*. Three alternatives for intensity, ranging from *taking it easy without breaking into a sweat or losing my breath* to *pushing myself to near-exhaustion*, and four alternatives for the duration of each exercise session, ranging from *less than 15 minutes* to *more than 1 hour*.

In 2014 a complete validation study of the EED Version 2 was conducted (Danielsen et al., 2015). The results showed that the EED is valid and reliable measure of attitudes towards compulsive exercise in eating disorder patients. It has adequate psychometric properties and a four-factor structure: (1) *compulsive exercise*, (2) *positive attitudes to exercise*, (3) *awareness of bodily signals*, and (4) *exercise for weight and shape reasons*. For the whole sample, the *compulsive exercise* subscale showed the strongest correlation with eating disorder symptomatology ($r = 0.70$) (Danielsen et al., 2015). Calculations of *global score* and subscale scores were based on mean values. Similar to Version 1, higher scores on the EED indicate greater compulsivity and unhealthy exercise. The Cronbach's alpha coefficient of the global EED score in the whole sample was 0.90, and in subscales the value ranged from 0.80 to 0.93 and in the controls from 0.81 to 0.85.

To assist in clinical work, an indicative classification of severity was estimated for patients. This scale was based on the EED global score in patients: Group 1, global score < 1.80 (no symptoms of compulsive exercise); Group 2, global score 1.80–2.39 (low severity); Group 3, global score 2.40–3.19 (moderate severity), and Group 4, global score > 3.20 (high severity). The groups were not strictly separated, but indicate a gradual increase in severity.

### 2.5.2 Body image

A questionnaire that took into account the multidimensionality of the concept of body image was chosen. The BAT (Body Attitude Test) is a clinically derived questionnaire developed to identify different aspects of body image problems in eating disorder patients (Probst et al., 1995). It consists of 20 items scored on a 6-point scale from 0 (*never*) to 5 (*always*). Higher scores indicate increasingly severity of problems in body image dimensions. The maximum score is 100. An estimated cutoff score between patients with eating disorders and normal controls is 36 (Probst et al., 1995). Studies have revealed that the BAT has a stable four-factor structure: (1) *negative appreciation of body size*, (2) *lack of familiarity with one's own body*, (3) *general body dissatisfaction*, and (4) a rest factor. Satisfactory reliability and validity has been established both as a screening tool and assessing treatment outcome (Probst et al., 2008;

Probst et al., 1995). In Paper III, Cronbach's alpha values for the BAT sum score at admission and follow-up were 0.92 and 0.96.

### 2.5.3 Eating disorders

Two questionnaires measuring eating disorder pathology were used in the studies. The Eating Disorder Inventory (EDI-2) was used in the studies reported in Paper I and III, and The Eating Disorder Examination Questionnaire (EDE-Q) in the study reported in Paper II.

The EDI-2 (Garner, 1991; Garner, Olmsted, & Polivy, 1983) is a validated self-report tool for measuring symptoms, attitudes, and behaviors associated with eating disorders, both in screening and for measuring progress and outcome. The first version with 60 items included 8 subscales (Garner et al., 1983). Later, 3 subscales with 31 items were added to the EDI-2 which consists of 91 items and 11 subscales (Garner, 1991).The questionnaire has been validated and tested for reliability in Nordic countries (Clausen, Rokkedal, & Rosenvinge, 2009; Nevonen, Clinton, & Norring, 2006). Cronbach's alpha values for the EDI-2 sum score in Paper III at admission and follow-up were 0.95 and 0.98.

The EDE-Q is a validated and well-known self-report questionnaire with 28 items based on the EDE interview. It investigates key eating disorder attitudes and behavior in the last 28 days (Fairburn & Beglin, 2008), and consists of 4 subscales: Dietary restraint, Weight concern, Shape concern, and Eating concern, as well as a global score. Norwegian norms for the EDE-Q have been established (Ro, Reas, & Lask, 2010). In Paper II, the Cronbach's alpha coefficient is reported as 0.96 for the whole sample, 0.94 for patients, and 0.95 for controls.

### 2.5.4 Interpersonal problems, general psychopathology, and depression

**General psychopathology:** The Symptom Checklist-90 (SCL-90) is a self-report questionnaire that was developed in 1973 (Derogatis, Lipman, & Covi, 1973) and later revised (SCL-90R) (Derogatis, 1977). The SCL-90R is validated and has 90 items divided into 10 subscales. The mean score for all items, the Global Severity Index (GSI), is a global measure of psychological symptoms and distress, and was used in the studies reported in Papers I and III. Cronbach's alpha values (Paper III) at admission and follow-up were 0.97 and 0.99.

**Interpersonal problems:** The Inventory of Interpersonal Problems (IIP) is a validated self-report instrument consisting of 64 items and 8 subscales. The IIP measures interpersonal problems and is frequently used in research to describe personality characteristics that have

most recently been salient across diverse interpersonal situations (Alden, Wiggins, & Pincus, 1990; Horowitz, Rosenberg, Baer, Ureno, & Villasenor, 1988). The Circumflex of Interpersonal Problems (CIP) is a brief Norwegian version of the IIP-64, with 48 items (Pedersen, 2002) and was used at RKSF from 2003 to 2006. Since 2006, the IIP64 has been used. In Paper I, the reported collected data consisted of both CIP and IIP64. All items in CIP were similar to items in IIP64, and IIP64 data were converted into CIP data. The CIP has shown acceptable psychometric properties (Pedersen, 2002). All participants in the study reported in Paper III completed the IIP64. Cronbach's alpha values were 0.96 at admission and follow-up.

**Depression:** The Becks Depression Inventory (BDI) (Beck & Beamesderfer, 1974) is a validated and widely used self-report instrument with 21 questions, measuring the severity of depression. The BDI global score is included in Paper III. Cronbach's alpha value at admission was .89.

## 2.6 Statistical analysis

Several statistical analyses are used in all three papers. Descriptive analyses, analyses investigating differences between groups, internal consistency of measurements, correlations, and effect size calculations are provided in all three papers. The significance level was set at $p < 0.05$. The data reported in Paper I and II were analyzed using SPSS (Statistical Package for the Social Sciences) Versions 15 and 21 respectively. For the analyses reported in Paper III, both SPSS Version 21 and STATA (Statistical package for Data Analysis) Versions 13 and 14 were used.

### 2.6.1 Paper I

Outcome measures were defined as change in eating disorder symptoms measured by the EDI-2 and the BMI from admission to discharge. The impact of changes in body image (BAT), general psychopathology (SCL-90R), and interpersonal problems (CIP) on outcome measures was tested by linear multiple regression analyses. Patients were divided into groups in analyses, with BMI as outcome measure: (a) *severe underweight* (BMI ≤ 17.5), and (b) *moderate underweight* (BMI between 17.5 and 20). Normal weight patients were not included in the analyses related to change in BMI.

### 2.6.2 Paper II

To explore the factor structure of the EED, a principal component analysis (PCA) was performed, including a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, a

correlation matrix, two criteria for retaining factors (Kaiser's criterion and scree plot), and oblique rotation (direct oblim). The criterion for an acceptable level of internal consistency was 0.70, and accepted level of factor loading was 0.4.

The EED Version 2 originally consisted of 20 items. Clinical experience has shown that the item *I feel/notice pain* could be interpreted in dissimilar ways. It was possible to interpret it either as a question of having pain or not, or as it was intended if one could recognize bodily signals related to pain in the same manner such as hunger, and feeling tired. Preliminary statistical analyses of factor structure showed that the item *I'm physically active to be the first or best performer* influenced the reliability of the actual subscale negatively, and did not discriminate significantly between groups. These two items were excluded, and the final validation was performed on a version with 18 items. Because many patients communicated difficulties in estimating the extent to which their physical activity was performed alone or not, and several patients did not report it, this additional question was removed from the EED questionnaire.

### 2.6.3 Paper III

To explore the predictive values of the EED, linear mixed model regression analyses were performed. Eating disorder symptoms measured by the EDI-2 and BMI (underweight patients at admission) were defined as outcome measures. This statistical model takes into account the dependency between observations from the same individuals in longitudinal data. Observations are considered as Level 1, nested in patient clusters (Level 2) in a hierarchical structure. The analysis allows for patient-specific regression lines with random intercepts and random slopes (Rabe-Hesketh & Skrondal, 2012). Separate models are developed for each outcome measure. In the null model, intercept values of the outcome measure (mean value) and its variances psi ($\psi$) and theta ($\theta$) are calculated. In Model 1, the covariate of special interest in this study (EED score) were included; and in Model 2, the values were adjusted for all significant covariates. Models 1 and 2 are random intercept models. R-squared is calculated based on differences in variance between the null model and the other models. Intraclass correlation (ICC) represents the within-cluster correlation and is estimated.

## 2.7 Missing data

Missing data on single items in self-report questionnaires were replaced in the same way in all three studies reported in Papers I–III. An average of available items on the actual subscale for each participant was calculated and this value replaced the missing value.

**Study I:** Ten patients were excluded from the sample due to an incomplete dataset. Data from one patient in the sample were excluded from the regression analysis because of missing admission data, and partly missing discharge data in two patients were treated in a conservative manner and actual admission data were carried forward.

**Study II:** The EDE-Q (Fairburn & Beglin, 2008) was taken into regular use at RKSF in 2008. Six patients were admitted prior to this date and were excluded from analyses that included the EDE-Q. The reduced sample size is reported in the text and tables in Paper II.

**Study III:** A total of 4.5% data were missing when all measures were included. In addition to single item replacement, imputation analyses were performed to replace the missing values.

## 2.8 Ethical issues

Considering ethical issues is an important part of conducting clinical research. Ezekiel, Wendler, and Grady (2000) highlight seven necessary requirements and state that these requirements are universal, based on widely accepted ethical values, and essential to ensure that clinical research is ethical. Still, it should be remembered that these are general statements and there is a need for some flexibility in different types of research, and when interpretation is dependent on context and culture (Ezekiel et al., 2000).

The seven requirements stated by Ezekiel et al. (2000) are:

- Value: That the research will lead to improved health and well-being and/or increased knowledge
- Validity: That the research is conducted based on accepted methods and principles
- Fair subject selection: That the selection of participants is based on the goals of the study
- Favorable risk-benefit ratio: That the risks for participation are minimized and the potential benefits both for the individual and society are enhanced
- Independent review: That there is conducted an independent review of the research protocol/research trial to provide high quality and public accountability
- Informed consent: That the individuals are given sufficient information to understand the purpose of the research, possible risks, benefits, and alternatives to make a voluntary decision in whether to participate; the information must be communicated with respect for the individual

- Respect for subjects: That the respect for the participants' autonomy and welfare are continued through the research process.

In our research ethical issues were emphasized through awareness of ethics and established procedures. Patient data were primarily collected for use in clinical work. In the written consent, there is a second part related to the use of data in research. All patients are given written and oral information about data collection and its purpose. Staff were available to the patients to answer questions and provide support. Patients' participation in the research had no consequences for their treatment.

In the studies, the issues related to "fair subject selection" and "favorable risk-benefit ratio" was not considered particularly relevant. The patient participants were patients referred for treatment. They were not exposed to risk when completing the forms, although the process took some time. The patients personally benefited from their data during treatment, but they did not derive any direct benefit from the research results. However, it is a mainly accepted principle that contribution in research will lead to improved knowledge and increased quality of treatment for future patients.

The external evaluation further ensured the quality of the data. The patient data register at RKSF is approved by the NSD. All research projects conducted under the Hospital Trust Nord-Trøndelag (Helse Nord-Trøndelag HF) are evaluated by the data access committee at the research department in the Hospital Trust, and REK evaluates and approves the overall quality of the research protocol.

# 3 SUMMARY OF RESULTS

## 3.1 Results reported in Paper I

Significant improvement ($t = 3.6$, $p < 0.01$) in the mean sum score of BAT from admission to discharge was found in this transdiagnostic sample of 50 eating disorder patients. Body image dimensions measured by the subscales showed different degrees of change, ranging from highly significant in the subscale *lack of familiarity with one's own body* ($t = 5.0$, $p < 0.001$), to significant in the subscale *general body dissatisfaction* ($t = 2.6$, $p < 0.05$), and not significant in the subscale *negative appreciation of body size*.

Patients with an admission BMI ≤ 17.5 were defined as being severely underweight. The mean BMI in this group changed from 15.2 (±1.6) to 19.7 (±1.2) during hospitalization. Patients with admission BMI in the range 17.5–20 were defined as being moderately underweight. The mean BMI changed from 19.2 (±0.7) to 21.1 (±1.9) at discharge. A paired sample *t*-test showed that these changes were statistically significant for both groups ($p < 0.001$ and $p < 0.01$, respectively).

Changes in EDI-2 scores ($t = 4.2$, $p < 0.001$), SCL-90-R ($t = 5.4$, $p < 0.001$) and CIP ($t = 4.0$, $p < 0.001$) were all statistically significant.

A significant correlation was found ($\rho = 0.44$–$0.78$) between change scores of the BAT, EDI-2, SCL-90R, and CIP. The strongest correlation coefficient was estimated between change scores of the BAT and EDI-2. Regression analyses showed that the BAT change score during treatment was the strongest predictor of the change score of EDI-2 ($\beta = 0.46$, $t = 5.7$, $p < 0.001$), and accounted for 39% of the variance in the EDI-2. Further regression analyses that included the BAT subscales identified that the subscale *lack of familiarity with one's own body* accounted for 38.1% of this variance ($\beta = 0.46$, $t = 5.7$, $p < 0.001$). Change scores of the SCL-90R accounted for 5.5% ($\beta = 0.30$, $t = 3.6$, $p < 0.001$). The change score of CIP was not a significant predictor of change of the EDI-2. No predictors of change in BMI were found.

## 3.2 Results reported in Paper II

The validated EED consists of 18 items, and the analyses confirmed that the EED questionnaire has adequate psychometric properties. The differences between the 244 eating disorders patients and the 205 healthy controls were highly significant ($p < 0.001$) in all EED items, subscales, and the global score, thus showing discriminate validity. The analyses were adjusted for age differences without any change in significance level.

Test-retest reliability (paired sample *t*-test) was satisfactory ($r = 0.86$). Convergent validity was demonstrated by a high correlations between the global score in the EED and the global score on the EDE-Q for the whole sample ($r = 0.79$).

The results of the PCA showed a four-factor structure of the questionnaire, giving the following subscales: (1) *compulsive exercise* (eight items), (2) p*ositive and healthy exercise* (three items), (3) *awareness of bodily signals* (four items), and (4) *weight and shape related exercise* (three items). The internal consistency was shown to be satisfactory. The calculated Cronbach's alpha coefficient of the global score and subscales for the whole sample were respectively 0.90 (global score), 0.93 (*compulsive*), 0.82 (*positive and healthy*), 0.80 (*bodily signals*), and 0.89 (*weight and shape*).

To make interpretation of the EED easier, a clinical severity scale was estimated. The scale was based on quartile groups of the EED global score in the patient group. The results yielded the following classification: Group 1, global score < 1.80 (no symptoms of compulsive exercise), Group 2, global score in the range 1.80–2.39 (low severity), Group 3, global score in the range 2.4–3.19 (moderate severity), and Group 4, global score > 3.20 (high severity). It is important to emphasize that these groups are not interpreted as strictly separated but indicate a gradual increase in severity.

### 3.3 Results reported in Paper III:

The results demonstrated significant improvements in compulsive exercise during treatment, and these changes were maintained at a follow-up in the inpatient sample consisting of 78 female eating disorder patients. The global score and all subscale scores in the EED improved significantly ($p < 0.01 - p < 0.001$) from admission to discharge, with smaller yet significant ($p < 0.05$) improvement during the follow-up period for the EED subscales *compulsive exercise*, a*wareness of bodily signals*, and e*xercise for weight and shape reasons*.

Mixed model analyses investigated the impact of the EED scores on the two outcome measures. The outcome measures were defined as change in eating disorder symptoms measured by the EDI-2 and change in BMI for underweight patients (admission BMI ≤ 18.5).

**EDI-2 as outcome measure:** The results showed that EED scores predicted EDI-2 scores significantly ($p < 0.01$) during treatment and follow-up in the sample. In Model 2, all of the other covariates, except BMI, were found to contribute significantly ($p< 0.01$ - $p < 0.001$) to the change in the outcome measure, and explained 82.3% of the total variance in the EDI-2.

After adjustment for the other covariates, the EED compulsive exercise score remained a significant predictor for change in the EDI-2, but with lower values ($z = 2.92$, $p < 0.01$, 95% CI: 1.50, 7.66). The reduction in the z-value from Model 1 to Model 2 indicated that the EED shared content with the other covariates, but also accounted for unique explained variance.

**BMI as outcome measure:** In the models with BMI as outcome measure (patients with BMI ≤ 18.5 at admission), the EED was shown to be a significant predictor of increased BMI ($p < 0.001$) during treatment and follow-up. When adjusted for the other covariates in Model 2, the $z$-value of the EED was attenuated by 1.51. This indicated some shared content of the measures, but also confirmed the importance of the EED as a unique and significant predictor of improvement in BMI ($z = -5.78$, $p < 0.001$, 95% CI: -2.24, -1.11). Additional significant covariates in Model 2 ($p < 0.001$) included the BAT sum score and BDI sum score, and the combined total explained variance was 36.5%.

# 4 DISCUSSION

## 4.1 Main findings

The findings in this thesis have illuminated the importance of body image disturbances and compulsive exercise in eating disorders. The EED has been developed specifically for use in the treatment of eating disorders. It is a short form and easy to administer and its validity and reliability have been confirmed. As the first clinically-derived questionnaire, the use of the EED has contributed to increased knowledge of different dimensions of compulsive exercise. In addition, the results of the three studies have highlighted that change in attitudes towards disturbed body image and compulsive exercise has an impact on treatment outcome, post-treatment, and at follow-up. These findings may lead to an increased awareness of these aspects in treatment and research.

In most publications related to exercise in persons with eating disorders, the lack of consensus on definitions has been highlighted, but the general impression is that progress has been made. Adkins and Keel (2005) have proposed a differentiation between quantitative and qualitative elements of exercise, and have presented an understanding of the qualitative issues as more closely related to eating disorders than the quantitative elements. This understanding has been supported and developed further by Meyer et al. (2011), who have presented an empirical cognitive behavioral model of compulsive exercise in connection with eating disorders. The content of the EED and the findings in this thesis may have contributed towards consensus in the field. They support the understanding of the complexity of exercise in eating disorders, the differentiation between qualitative and quantitative elements, and are in accordance with proposed issues in the cognitive behavioral model.

To identify treatment goals and be able to develop tailored treatment interventions, it is important to recognize and understand different dimensions of compulsive exercise among patients. The initial development of the EED in 2003 was based on a clinical need for an assessment tool with a broader perspective than that captured by existing questionnaires. Each of the existing questionnaires at the time covered elements of symptoms that had been reported and observed in our clinic. In the OEQ (Pasman & Thompson, 1988), the items reflected a subjective need to engage in exercise behavior of a repetitive kind. Different factors that motivated exercise behavior were in focused in the REI (Cash et al., 1994) and included weight and appearance issues, stress and mood management, and motives related to fitness and socializing. One tradition among exercise questionnaires is based on the

dependency on exercise, as in EDQ (Ogden et al., 1997) and in the EDS-R (Downs et al., 2004). Items in the EDS-R were linked to diagnostic criteria of dependency in DSM-IV and covered elements such as exercising to avoid negative emotions, behavior related to lack of control, continuation of exercise despite negative consequences and harm, and interference with activities in daily life. Later in the development of the EED, a new questionnaire within a cognitive-behavioral framework was presented: the Compulsive Exercise Test (CET) (Taranis et al., 2011). The CET represented a multidimensional view on the maintenance of compulsive exercise with more issues in common with the EED than other questionnaires. However, two issues evaluated as important in treatment are included in the EED but not in the CET. The first issue is the ability to recognize bodily signals such as thirst, hunger, and feeling fit or tired. In order to be able to regulate exercise in a healthy way it is essential to both be aware of the signals and take them into consideration. One interesting distinction appeared in the factor loading in the EED, which showed that an ability to recognize the bodily signals loaded together in one factor, while taking them into consideration loaded together with what have been defined as compulsive elements. Problems of awareness of bodily signals were described in AN patients by Bruch in the early 1960s (Bruch, 1962). Findings reported in Papers II and III indicate that these issues may have relevance for patients in other diagnostic groups too.

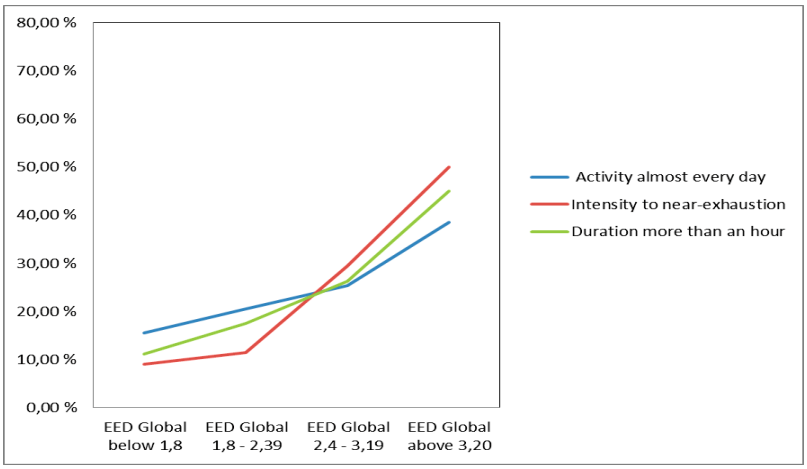
The second issue, the relationship between compulsive exercise and body image, has been further illuminated. Exercising for weight and shape reasons is included in both the EED and CET and is a well-known feature. In addition, two items in the EED express how perceived body image may be negatively affected if exercise is stopped. This is not only related to a feeling of increased body size, but also includes increasing feelings of disgust towards one's own body. These two items loaded in the *compulsive exercise* subscale and not in the *exercise for weight and shape reasons* subscale, which may indicate differences in meaning content. To summarize, these findings indicate that the EED can be a useful assessment tool in studies of eating disorder patients.

The validated EED Version 2 consists of 18 items. From a clinical perspective it was considered useful to include one more item to the validated version. Exercising despite pain and injury is a part of the diagnostic criteria of excessive exercise (American Psychiatric Association, 1994, 2014), and one item related to awareness of physical pain was included: *I notice physical pain*; hence, the third version of the EED consists of 19 items. The item was added to subscale 3 (*awareness of bodily signals*) after the validation, and was not a part of

any calculations reported in Papers II and III. Another change has been the incorporation of a time frame of four weeks related to item response, which in future research may provide a greater understanding of when changes occur. The EED Version 3 has replaced Version 2 in clinical use. The questionnaire can be used freely. In June 2015, Version 3 was translated into Swedish in cooperation between Danielsen and qualified bilingual persons, with a translation from Norwegian to Swedish and a blind back-translation. Canadian researchers have requested the use of the EED questionnaire in their research. One team has translated the questionnaire into French, and the translation was done in accordance with established translation guidelines.

The EED includes self-reported measures of amounts of exercise, but these measures are not considered in this thesis. In the study reported in Paper II, the questions related to frequency, intensity, and duration had all been validated earlier (Kurtze et al., 2008) and were not part of the validation of the EED. The questions were included in the EED in 2009, and the former version included only workouts per week. Due to these differences, amount of exercise is not reported in Paper III either. However, in Paper II the relationship between high level exercise and severity of the EED global score is reported. To do this, the highest alternatives in frequency (*almost every day*), intensity (*pushing myself to near-exhaustion*), and duration (*more than an hour each time*) were chosen. The results are presented in Figure 2 (p 48), and show different profiles for patients and controls. In the patient group, the majority of high-level exercisers also had a high EED score, while the opposite was the case for the control group.

**Patients (a)**




**Controls (b)**

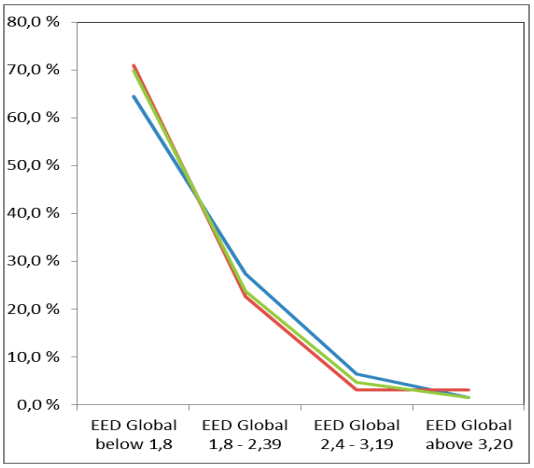



**Figure 2 a & b**. Patients (a) versus controls (b), showing the EED global score divided into four severity groups (approximately quartiles), the activity measures of the EED, and percentage of participants in each severity group.

Methods for objectively measuring amounts of exercise have been developed, such as the accelerometer. The individual's movements in different directions (longitudinal, transversal, and sagittal) are measured and a sum is calculated. Such devices can be worn on different body parts, including the ankle, wrist, upper arm, hip, or lower back (Gummer et al., 2015). In a review of 20 trials, Gummer et al. (2015) found that the objective measures used all seemed to be a valid way of measuring physical activity in AN patients. However, the results were

partly conflicting as to whether there were an association between objective measures of amounts of exercise and eating disorder pathology. In addition, they suggest that these measures should be used in combination with questionnaires, clinical observations, and self-reported activity. In addition, Gummer et al. (2015) emphasize factors that need to be improved in future implementations of such measures in treatment and research, such as those related to criteria of levels of exercise and a valid terminology. The quantitative activity measures in the EED are self-reported, and there are reports of discrepancy between subjective and objective measures, indicating significant underreporting in AN patients (Alberti et al., 2013) and in AN, BN, and EDNOS (Bratland-Sanda et al., 2010), but not in controls (Bratland-Sanda et al., 2010).

The findings presented in Paper I show that different dimensions of body image change differently during inpatient treatment; there was most change ($p < 0.001$) in the familiarity with one's body, less change ($p < 0.05$) in dissatisfaction, and no significant change related to negative appreciation of one's body size. Different paths and times to recovery in eating disorder symptoms, including body image disturbances, have been presented in earlier research too (Clausen, 2004). Body image disturbances are present at initiation of treatment. During inpatient treatment, patients go through an intense period of change in their complex illness. For underweight patients, the change also includes a physical change to *a new normal weight body*. For many patients the integration of the *new body* is very difficult. It is possible that if the body is evaluated very negatively, with a large overestimation of body size at admission, that may account for why these elements sometimes show little change during treatment. Elements related to familiarity to the body can be addressed and may change independently of the other two dimensions (i.e., dissatisfaction, and appreciation of body size). Items related to the familiarity subscale cover reported issues such as *my body appears to be a numb thing*, *my body appears as if it's not mine*, and *there are things going on in my body that frighten me.* From a clinician's perspective it is possible to reflect on whether improvement in *familiarity with one's body* may be a precondition of change in the other elements. In a state of lack of familiarity, which may be viewed as similar to the individual's ability for introspection and awareness of bodily signals, there may not be a good basis for change and integration.

In two surveys conducted to investigate the understanding of physical activity in eating disorders among clinicians (Bratland-Sanda et al., 2009; Hechler, Beumont, Marks, & Touyz,, 2005), the majority of respondents acknowledged problems related to physical activity as

important in eating disorders, but the authors' reports of the treatment approaches differ. Hechler et al. (2005) report that specific treatment approaches were rare, while Bratland-Sanda et al. (2009) report that most treatment units were positive towards the inclusion of physical activity in their treatment programs. They suggest that these differences may have been influenced by cultural diversity and tradition related to how the type and impact of physical activity is understood and how the activity is performed. However, Bratland-Sanda et al. (2009) emphasize that attitudes were more positive towards exercise interventions in BN and BED than in AN. Especially in underweight AN patients, there seemed to be a dilemma between restricting exercise as harmful behavior and the possibility of including it as a positive element in treatment (Bratland-Sanda et al., 2009).

In this thesis, We have shown that both changes in attitudes towards body image and compulsive exercise are significant predictors of treatment outcome defined as improvement in eating disorder symptoms and increased BMI (i.e., in underweight patients). In common with existing research findings (Hausenblas et al., 2008; Moola et al., 2013; Zunker et al., 2011), no adverse effects on weight gain in underweight patients were found when different exercise interventions were included in treatment programs. However, the study design in the studies in this thesis does not allow for any conclusions to be drawn about the effect of the exercise intervention. The findings have extended existing knowledge of compulsive exercise and body image, especially related to the longer course of eating disorders.

In summary, body image disturbances and compulsive exercise are closely connected to eating disorder symptomatology. There has also been a gradually increase in the acceptance of body image disturbances and compulsive exercise in eating disorders as complex and important features. However, from an overall perspective, the modern understanding may appear more in accordance with the early clinical reports, such as the one by Bruch (1962). For many years, definitions and research questions were reduced to elements that were easy to quantify and measure, such as estimation of body size, dissatisfaction, and amount of exercise. Today, the complexity there is more agreement among researchers and this may lead to improved quality in treatment and research.

## 4.2 Methodology

In the studies on which this thesis is based we aimed to answer the research questions in accordance with advised methodology and statistics. The majority of the data from the three studies on which this thesis is based were derived from self-reported information. We chose models that fitted our data and reduced unexplained variance. However, when interpreting the

results it was necessary to take certain issues into consideration, and these are presented and discussed in the following subsections.

### 4.2.1 Measurement error

Variables can be measured in different ways. For example, weight and height can be measured objectively by trained staff with calibrated equipment or they can be self-reported. Both methods were used in the studies. Ideally, measured variables should have the same meaning across time and situations. Measurement error can be defined as the difference between the real value and the value representing it. Bias that is generally related to over- and underreporting of self-report measures must be considered (Field, 2009). Self-reported height and weight measurements tend to be highly correlated, but when interpreting the calculated BMI, a certain degree of discrepancy must be considered. Such discrepancy seems to be more common in the highest and lowest weight categories (Stommel & Schoenborn, 2009). At RKSF, patients are weighed in person at initiation of treatment/admission and at discharge. At the first measuring point the majority of patients in the group are in the low-weight categories, but the measurement error is considered low due to the measurement method. There is more uncertainty linked to the self-reported weight at follow-up, and that must be taken into consideration when interpreting results. The majority of participants in the control group are in the normal weight range, where the discrepancy between measured weight and self-reported weight is assumed to be smaller.

### 4.2.2 Validity and reliability

Validity concerns the ability of an instrument to measure what it is designed to measure (i.e., the purpose of the measure), whereas reliability concerns how well the instrument can be interpreted across time and situations (i.e., the consistency of the measure) (Crosby & Wonderlich, ResearchTeaching Day, 2013; Field, 2009).

To contribute to validity and reliability in our data, we chose well-known self-report questionnaires which have been shown to be valid and reliable in studies of eating disorders. The exception is the EED, but the validation of the EED was part of the research undertaken for this thesis. Different aspects of validity and reliability are presented below, and the validation of the EED questionnaire is used as an example.

Significant values in performed factor analysis, group discrimination (patients and controls), content validity, and convergent validity support the internal validity of the EED questionnaire. However, the validation study did not include men, and analyses were

conducted on a transdiagnostic sample. Both of these factors should be taken into consideration when evaluating the internal validity of the questionnaire.

The external validity concerns the generalizability of the findings. A number of factors, including sample size, broad inclusion criteria, naturalistic study settings and procedures, and matching clinical settings, can contribute to increased external validity (Crosby & Wonderlich, Research Teaching Day, 2013).

The evaluation of adequate sample size is an issue for discussion, Field (2012) notes that samples that include more than 30 participants are large enough to achieve acceptable statistical results. However, it is also necessary to address clinical relevance. Enhancing these factors support the external validity of the EED. However, the samples were not randomized or compared to patients in other treatment units and this limits the generalizability of the findings.

To investigate the internal consistency of measures used in our studies, Cronbach's alpha coefficient was calculated. This was performed for global scores and/or the sum scores of the different measures used in the studies. For the study reported in Paper I this was also calculated for subscales of the BAT, and the study reported in Paper II for the EED subscales. As a coefficient, Cronbach's alpha will show an increased value when the number of items increases (Field, 2009), and it is necessary to take this into consideration when evaluating the results. In the studies, all Cronbach's alpha coefficients showed acceptable values and supported the reliability of the used measures.

Test-retest analysis provides information on the consistency of a measure. A reliable instrument will show similar scores at two points of time within similar conditions (Field, 2009; Marx, Menezes, Horovitz, Jones, & Warren, 2003). The time period between the test and retest may be affected by different factors. When the time period is short, memory and carryover effects are more likely to influence the responses. When the period is long, changes in conditions may appear. To date, reported results have indicated no significant differences between time periods of two days and two weeks (Marx, Menezes, Horovitz, Jones, & Warren, 2003). In the test-retest of the EED questionnaire, the time period was one week, and the results indicated that the EED has a satisfactory level of stability (Danielsen et al., 2015).

### 4.2.3 Statistical models

The use of models that represent data in an appropriate way was a goal in the research conducted for this thesis, and different models were used to answer the research questions. The outcome in research is in general defined as predicted from a chosen model plus some amount of error. It is important to assess how well a model represents the data, known as the fit of the data (Field, 2009).

Analyses of repeated measures can be conducted in several ways. In the study reported in Paper I linear regression analysis was used to investigate the impact of different factors and predictors on treatment outcome, and the predictors were measured as change scores from admission to discharge for the same individuals. A mixed model approach was used for the study reported in Paper III. This takes into account the dependency between repeated measures from the same persons by treating it as clustered data with random intercepts (Rabe-Hesketh & Skrondal, 2012). Knowledge acquired from repeated measures during academic training indicated that the mixed model approach had the potential to generate some additional information in the study reported in Paper I.

### 4.2.4 Measures of variance and accuracy

These measures give information about the degree of precision of results, and are an important consideration when results are evaluated and interpreted (Field, 2009).

**Variance:** We used standard deviation (SD) to express the variance in the investigated samples, and standard error (SE) as an expression of variance related to the overall mean (Field, 2009). In the mixed model analysis the variance components are separated into two components, psi ($\varphi$) and theta ($\theta$), which provide information on how much variance is expressed respectively between and within clusters (Rabe-Hesketh & Skrondal, 2012).

**Confidence interval (CI):** The CI expresses the calculated boundaries within which the true value of the mean is assumed to fall, and can be calculated as 99% CI and 95% CI. Using *z*-scores, it can be expressed as: 95% CI = overall mean +/- 1.96 SE. In our studies we have calculated 95% CIs.

### 4.2.5 Test statistics and effect size

**Test statistics:** To compare groups, we used different test statistics (*t*-test, paired *t*-test, analysis of variance (ANOVA)) to investigate how much of the systematic variation in the data could be explained by the model, in contrast to the unsystematic variation, which could not be explained by the model. As the values of the test statistics increase, the more unlikely it

is that they have occurred by chance (the p values become smaller) (Field, 2009). Our results showed significant differences in scores between tested independent groups and groups measured at points in time. This indicated that the test statistics showed acceptable fit to the collected data and that the probability that these differences occurred by chance was small.

**Effect sizes:** Significant p-values of a test do not necessarily confirm that the result is clinically meaningful. Hence, in order to provide information of possible clinical relevance, the effect size of differences was calculated. The effect size provides an objective measure of the strength of the observed difference (Crosby & Wonderlich, 2013; Field, 2009). In the studies on which this thesis is based we used Cohen's *d* and Eta squared ($\eta^2$). The calculated values are presented in tables in Papers I–III, to assist in the interpretation of results. Large effect size indicates the clinical relevance of the results.

### 4.2.6 Missing data

There is a frequent occurrence of missing data in research and this is an important statistical issue since it leads to reduction in both the sample sizes and the precision of results (Veierød, Lydersen, & Laake, 2012). There are different methods for dealing with this issue. We tried to minimize the consequences of missing data by using recommended methods. In all three studies, single missing items were replaced by the average value of available item scores in the scale for each participant. As a general rule, if at least half of the answers are given, the average score may be computed (Veierød et al., 2012). This assumption was checked before the average values were calculated.

**Paper I:** One patient was excluded from the analysis because of missing admission data. In two patients with partly missing discharge data this was handled by carrying the admission value forward. The exclusion of data always reduces the size of a sample and hence the precision of the results. The method of carrying last values forward may understate differences and give bias in the results (Veierød et al., 2012). Due to the low number of patients involved in the studies, the consequences of the choices are not considered to have had much impact on results.

**Paper II:** The EDE-Q (Fairburn & Beglin, 2008) was included as one of the regularly used questionnaires at RKSF in 2008. Six patients were missing EDE-Q data because they were admitted prior to that date, and we chose not to perform any imputations on these data. These patients were excluded from analyses that included the EDE-Q. This may have affected the

results, but due to a total patient sample size of 244 the proportion of the missing data accounted only for 2.5% of the EDE-Q data and was thus evaluated as not of considerable importance.

**Paper III:** Missing data totaled 4.5% when all measures were included. In addition to the replacement of single missing variables, the relationship between the missing data and the reasons why they were missing were discussed with a statistician. In order to choose the appropriate method for replacing the missing data, we considered whether the data were missing completely at random (MCAR), missing at random (MAR), or missing not at random (MNAR) (Veierød et al., 2012). The actual missing data were evaluated to be MCAR and MAR, and imputation analyses were performed to replace them in order to increase the sample size.

## 4.3 Implications

### 4.3.1 Clinical implications

The three studies in this thesis were not RCTs and therefore the conclusions drawn from them are preliminary since causality cannot be evaluated. However, the overall clinical implications of the thesis may be that interventions directed towards body image disturbances and compulsive exercise are useful and important to incorporate in treatment programs for eating disorders. Due to the close relationship between body image disturbances and compulsive exercise, both issues can be addressed in body-oriented therapy interventions. Much debate has been related to how exercise should be assessed and addressed in treatment of eating disorders, and I examine this further in the following text.

In inpatient treatment, interventions may be included in specific individual therapy sessions and in groups. Clinical experience emphasizes that qualified staff with specific knowledge both of eating disorders and exercise is an important factor. At the same time, it is important that all personnel are able to recognize when exercise symptoms increase and decrease, and understand how they interact with other eating disorder symptoms. When patients start inpatient treatment, many different symptoms are addressed. Keeping the exercise intervention within the program makes it easier to discover improvements in symptoms or when there is just a transition to another symptom. Interventions that merely restrict the level of exercise without also addressing what motivates and maintains it, may increase the risk of patients only adjusting to the rules. They will still do what they have to do but in a more hidden way.

No adverse effect on weight gain has been reported when exercise interventions have been included in treatment programs. This indicates that it is possible to include also underweight patients. For underweight patients in the three studies, the transition from adjusted physical activity to regular exercise groups required a BMI of approximately 17. For underweight patients, it is also necessary to evaluate participation, due to somatic contraindications such as low bone density, and that weight gain according to plan must continue. At RKSF, from admission to discharge there is a plan for rest to regular exercise groups in accordance with the stages in the treatment program. These interventions have been an integrated part of the treatment program since the opening of the special unit in Levanger in 2003. They have since been modified in accordance with clinical experience and results from research.

Research and clinical experience has indicated that, if exercise interventions are to contribute to patients' recovery, it is necessary to incorporate the following important practices:

- Undertake assessments of former exercise experience, the motives and maintenance factors, how exercise interacts with other eating disorder, and the amount of exercise at admission of all patients, by using questionnaires and interviews. This information could be included in treatment planning, approaches and in evaluation.
- Provide psychoeducation in what constitutes healthy exercise and physical activity, as well as the prerequisites for it to become healthy, such as finding a balance between activity, nutrition, and restitution.
- Establish an understanding of how the exercise is part of an eating disorder, and how it interacts with other symptoms.
- Address negative and compulsive attitudes in psychoeducation, and in practical situations help patients to recognize and develop alternative and healthy ways of relating to exercise and physical activity.
- Give that many patients have carried out their exercise solely and in rigid and repetitive ways, in future treatment programs it is important to facilitate a social arena for the activities and exercise groups, thereby giving patients experience of healthy activities in a joyful and noncompetitive atmosphere.
- Designing exercise groups by applying basic training principles, such as variation in the activities, individually supervised and adjusted progression, and good restitution, enhancing general cardiovascular endurance, muscular strength and endurance, and

specifically in the case of underweight AN patients, the application of the principles has to be adjusted to a history of low bone density and loss of muscular tissue.

- Explore how exercise and physical activity could play a role in the future healthy life, and provide conditions for the transition of these new experiences to the life patients live when they have recovered from their eating disorders.

In order to include exercise interventions in outpatient treatment, some challenges have to be overcome. In inpatient units, the personnel commonly have multidisciplinary backgrounds, whereas in outpatient clinics it is less common to find staff who are qualified in both exercise and eating disorders. The behavior of never sitting down, never relaxing or just moving from A to B is not always looked upon as physical activity or exercise among patients, and the possibility to observe such behavior is more difficult in an outpatient setting. Compulsive exercise is not a problem experienced by all eating disorder patients. The proportion of patients without this symptom may be higher in outpatient settings, but it is important to identify those who struggle with compulsive exercise so that this factor can be incorporated in their treatment. It is also is important to be aware of subgroups of persons with eating disorders who may experience overweight and physical inactivity. Also, helping individuals to start healthy activities requires knowledge of exercise and eating disorders. If possible, these patients should be referred to qualified staff such as physiotherapists or personnel educated in sports who also have knowledge of eating disorders.

### 4.3.2 Research implications

The EED is a new questionnaire and further research is needed in several areas to increase the generalizability of the findings. It is important to replicate the presented findings in larger samples that allow for more analyses related to diagnostic groups. To provide knowledge about possible gender differences, it is necessary to validate the EED in men. With regard to compulsive exercise, it may be necessary to examine cultural differences as well as specific issues related to athletes. Due to shared issues between the EED and CET questionnaires, future studies should investigate whether they measure the same aspects and/or whether diagnostic differences can be discovered.

Other research questions may be related to samples representing different degrees of severity of eating disorders, such as outpatients versus inpatients, differences due to personality traits, and different follow-up periods.

When investigating the importance of disturbed body image and compulsive exercise in clinical samples it is necessary to overcome certain challenges. For example, such treatment approaches are commonly a part of more comprehensive treatment programs and this restricts the possibility to evaluate causality and to conduct randomized clinical trials. To be able to draw conclusions regarding the effect of treatment interventions, it is necessary to include control groups.

# 5 CONCLUSIONS

The thesis may contribute to extended understanding and increased attention towards disturbed body image and compulsive exercise in the treatment of eating disorders, and thereby emphasize the importance of including these issues in treatment.

The EED questionnaire has been confirmed as a valid and reliable measure of compulsive exercise as a comprehensive concept, and the subscales cover different dimensions of this complex phenomenon. Due to the properties of the questionnaire, it can be applied as a useful measure in clinical work, for yielding relevant information, increasing understanding, and possibly assisting in clinical decision-making.

Other findings show the development of attitudes towards disturbed body image and compulsive exercise during treatment and follow-up: These findings are change, interaction with other symptoms, and impact on treatment outcome. It is important to include this knowledge in treatment planning, treatment interventions, and treatment evaluations.

Attitudes towards body image changed significantly during the investigated period. The dimensions of body image were found to change differently over time, which is clinically important information. Highly significant changes were related to familiarity with one's own body, significant changes were found in general dissatisfaction with the body, and no significant changes were found in the negative appreciation of evaluated body size.

Both body image disturbances and compulsive exercise were closely associated with other eating disorder symptoms. Possibly the most important findings are that these aspects were also predictors of treatment outcome, reduced eating disorders symptoms, and increased BMI in underweight patients.

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## 7 PAPERS I-III

# Paper I

**Danielsen, M., Rø, Ø. (2012).**

**Changes in body image in treatment predict outcome.**

**Eating Disorders: The Journal of Treatment and Prevention**

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# Paper II

**Danielsen, M., Bjørnelv, S., Rø, Ø. (2015)**

**Validation of the Exercise and Eating Disorder Questionnaire**

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ORIGINAL ARTICLE

# Validation of the Exercise and Eating Disorders Questionnaire

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**ABSTRACT**

**Objective:** Compulsive exercise is a well-known feature in eating disorders. The Exercise and Eating Disorder (EED) self-report questionnaire was developed to assess aspects of compulsive exercise not adequately captured by existing instruments. This study aimed to test psychometric properties and the factor structure of the EED among women with eating disorders and a control group.

**Method:** The study included 449 female participants, including 244 eating disorders patients and 205 healthy controls. The patient group consisted of 32.4% ($n = 79$) AN patients, 23.4% ($n = 57$) BN, 34.4% ($n = 84$) EDNOS and 9.8% ($n = 24$) with BED diagnosis.

**Results:** The analyses confirmed adequate psychometric properties of the EED, with a four-factor solution: (1) compulsive exercise, (2) positive and healthy exercise, (3) awareness of bodily signals, and (4) weight and shape exercise. The EED discriminated significantly ($p < .001$) between patients and controls on the global score, subscales, and individual items. Test-retest reliability was satisfactory ($r = 0.86$). Convergent validity was demonstrated by high correlations between the EED and the Eating Disorder Examination Questionnaire (EDE-Q; $r = 0.79$).

**Discussion:** The EED is the first clinically derived, self-report questionnaire to assess compulsive exercise among ED patients. The EED offers assessment that has broader clinical utility than existing instruments because it identifies treatment targets and treatment priorities. © 2015 Wiley Periodicals, Inc.

**Keywords:** eating disorders; compulsive exercise; physical activity; questionnaire

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## Introduction

Compulsive/excessive exercise is a well-known feature in eating disorders. It has been reported as an important factor to consider in all stages of the illness, and has been identified as a predictor of poor outcome.[1–3] In the DSM-IV and DSM 5 criteria, the phrase "excessive exercise" is described in relation to fear of gaining weight for anorexia nervosa (AN) and as a compensatory behavior to control weight for bulimia nervosa (BN). Exercise is defined as excessive when interfering with important activities, occurring at inappropriate times and settings, and continuing despite injuries and/or medical complications.[4]

Meyer and Taranis[5] have described challenges in this research field as a consequence of great variation and inconsistency in use of terms and definitions. Similar to other researchers,[6,7] they have highlighted the lack of a consensus definition of compulsive/excessive exercise. Measurement has largely focused on motivation, i.e., exercise motivated by shape/weight concern/control, and the amount of exercise.[6,8,9] Across different inpatient samples, 39 to 45.5% of patients have been classified as compulsive/excessive exercisers.[6,9]

Improving our knowledge and understanding of compulsive exercise among clinical samples of eating disorders is an important and clinically relevant research direction. In addition to exercise motivated by shape and weight concerns, research has elucidated the role of exercise in affect regulation in clinical samples,[10,11] and emerging evidence

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suggests the importance of withdrawal symptoms and negative consequences of not exercising.[3,12,13] It has been stated that "compulsive" is a more appropriate term than "excessive" when describing exercise in patients with eating disorders.[5,14] These authors differentiated between a quantity dimension (excessive) measured by frequency, intensity and duration, and the qualitative dimension related to compulsivity.

Different assessments have measured different constructs related to excessive/compulsive exercise. The Obligatory Exercise Questionnaire (OEQ) was developed to measure exercise attitudes and activities.[15] A revised version (OEQ-R) covers emotional elements, behavioral elements and exercise preoccupation.[16] The Eating and Exercise Behavior Questionnaire[17] focuses on behavioral control of obesity, with one scale covering exercise behavior. The Commitment to Exercise Scale[18] was developed to tap feelings of well-being, maintenance, and exercise regimes. The Reasons for Exercise Inventory (REI)[19] includes four subscales to assess management of fitness and health, attractiveness and weight loss, emotional regulation, and social interaction. Another perspective in the measurement of excessive exercise is linked to theories of addiction or dependence on exercise. For example, the Exercise Dependence Questionnaire[20] and Exercise Dependence Scale-Revised (EDS-R)[21] both represent this tradition. In the EDS-R, all the criteria for dependence in the DSM-IV were included and linked to exercise behavior. The Exercise Addiction Inventory[22] is a short version related to addiction models of understanding exercise. Within this framework, eating disorders are theoretically linked to secondary dependency of exercise. Other models have focused on primary factors related to the maintenance of compulsive exercise within a cognitive-behavioral framework. In 2011, for example, preliminary results were published from a validation study of a new questionnaire entitled the compulsive exercise test (CET).[23] The content of this questionnaire stems from a multidimensional view of eating disorders. All of these questionnaires were validated in nonclinical samples.

In our clinical practice, we experienced a lack of correspondence between the challenges reported by the eating disorder patients and available questionnaires, and no questionnaires have been developed in clinical eating disorder units. Restriction of exercise and regulation of rest and meals are elements in treatment programs. It is necessary to understand how emotional and behavioral aspects influence the relationship between exercise and other symptoms in treatment. We aimed to develop an instrument for clinical purposes that addressed aspects of excessive exercise not adequately captured by existing questionnaires. Specifically, we attempted to fill a gap in the assessment literature by covering clinically relevant constructs such as negative emotions, or consequences if exercise was delayed or interrupted,[18,24] the ability to perceive and/or interpret body signals (e.g., hunger, satiety and fatigue) despite being emaciated,[25] and changes in body perception when exercise was restricted. Based on existing research and clinical observations, a new questionnaire, the Exercise and Eating Disorder (EED), was developed. A pilot study showed promising preliminary results,[13] and subsequent revisions to the EED in 2009 made necessary further validation. More information about the pilot study is provided in the method section. The specific aims of this study were to (1) test the psychometric properties of the revised version of the EED in a female clinical sample and a control group, (2) to test the factor structure, and (3) to determine a classification scheme based on the EED global score to yield an estimate of severity, which may be useful in clinical decision-making.

## Method

### *Participants and Procedure*

The study included 449 female participants, 244 eating disorder patients (inpatients and outpatients), and 205 healthy controls. The patients were recruited from an eating disorder unit between the beginning of 2009 and the end of 2013. Questionnaires, which included informed consent, were administered at the beginning of treatment in accordance with routine assessment procedures at intake. Exclusion criteria in the patient group were not fulfilling criteria for an eating disorder diagnosis ($n = 8$) and pregnancy ($n = 1$). Patients were diagnosed by licensed psychologists or psychiatrists. Diagnoses were based on clinical interviews in accordance with diagnostic criteria,[26] as supported by the Eating Disorder Examination Questionnaire (EDE-Q)[27] and the Eating Disorder Inventory (EDI-2).[28] Preliminary diagnoses were discussed in meetings with a minimum of two specialists prior to reaching a final consensus diagnosis. The patient sample consisted of 32.4% ($n = 79$) AN patients, 23.4% ($n = 57$) BN, 34.4% ($n = 84$) with an eating disorder not otherwise specified (EDNOS) and 9.8% ($n = 24$) with a binge eating disorder (BED) diagnosis. In the AN group, 77.2% ($n = 61$) were diagnosed as restrictive subtype, and 22.8% ($n = 18$) as binge-eating/purging subtype. Because there were so few patients in the bulimic subtype, the AN group was collapsed into one group for the analyses. All

**TABLE 1. Characteristics of participants**

| | All Patients $n = 244$ | AN $n = 79$ | BN $n = 57$ | EDNOS $n = 84$ | BED $n = 24$ | Controls $n = 205$ | Difference[ab] | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | *F* value[ab] | *p* values | Bonferroni Post hoc |
| Age (years | 27.1 (9.5) | 23.4 (7.3) | 27.7 (9.3) | 27.6 (9.9) | 36.1 (8.9) | 21.4 (6.3) | 1: 52.30<br>2: 13.92 | 1***<br>2*** | AN vs. BN and EDNOS*<br>BED vs. BN**<br>BED vs. AN and EDNOS*** |
| Range | 16–59<br>$n$ =242[3] | 16–50 | 16–50<br>$n$ = 56[3] | 16–55<br>$n$ = 83[3] | 24–59 | 16–59<br>$n$ = 203[c] | | | |
| BMI | 22.4 (9.4) | 15.4 (1.8) | 22.6 (4.0) | 22.6 (6.5) | 44.5 (7.4) | 23.6 (3.6) | 1: 63.70<br>2: 213.11 | 1 NS<br>2*** | AN vs. BN, EDNOS and BED***<br>BED vs. BN and EDNOS*** |
| Range | 8.7–62.1 | 8.7–17.6 | 17.5–35.0 | 17.5–48.0 | 33.1–62.1 | 17.3–37.6 | | | |

[a]Independent *t* test two tailed: Age: $t\,(447) = 7.34$, BMI: $t\,(440) = -1.61$, between patient group and control group.
[b]One way ANOVA between diagnostic groups, df (3, 240) (age), df (3, 238). Bonferroni post hoc test, only significant relationships are reported.
[c]Reduced *N* is due to missing BMI data in individuals.
AN: anorexia nervosa; BN: bulimia nervosa; EDNOS: eating disorder not otherwise specified; BMI: body mass index; NS: not significant.
*p* values: * $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$.

BN patients were classified as BN-purging type. The reported duration of eating disorder in the patient group ($n = 240$) was on average 10.3 years, with a range from 1 to 40 years. Patients were weighed in-person, but height and weight of controls were self-reported on the EDE-Q. Patients were on average significantly older [$t\,(447) = 7.34$, $p < 0.001$] than controls, but the average BMI between groups was not significant [$t\,(440) = -1.61$, $p < 0.09$]. Group differences in age and BMI are presented in **Table 1**. The mean (SD) for patients on EDE-Q Global scores was 3.76 (1.42), and for controls it was 1.60 (1.17), $t\,(440) = 17.22$, $p < .001$.

All secondary female students from a community high school and from different faculties at two University Colleges in the region were invited to participate as a control group. The high school offers education in seven different programs such as science, economics, design and crafts, media and communication, etc. Together with students from different programs (driving instruction, multimedia, finance and administration, animal science, nature management, nursing, and physiotherapy), the control group provided a representative sample of this student population. Questionnaires were administrated by teachers in high school, by the first author (MD) in the University College, and were completed during regular classes (autumn 2013, and beginning of 2014). A total of 219 female students attending school on the data collection days were invited to participate, only four students chose not to participate. Fourteen of these female students reported having an eating disorder and, therefore, were excluded from the study, leaving a total of 205 students. To investigate the test-retest reliability, 69 controls completed the questionnaire a second time after one week. The questionnaires were pairwise coded for T1 and T2. The actual participants received both questionnaires at the same time, completing one on the actual day (T1) and the other (T2) one week later. These participants received a negligible lottery ticket (value $4, without any guaranty of winning) as a compensation for their participation.

The study was approved by the local Data Access Committee and the Regional Committee for Medical and Health Research Ethics. All patients have provided written informed consent before participation. Information from the control group participants was anonymous. Consent from the control group was organized and completed in accordance to advice received from the Regional Committee for Medical and Health Research Ethics. Both written and oral information were given to the participants. They were informed that completing and returning the questionnaire was equivalent to giving consent to participate in the study. Because of anonymity of the data, it was not possible to withdraw the consent later.

### *Development of the EED Questionnaire*

Based on systematized clinical data, discussions in the multidisciplinary team and existing research, the first version of the EED was developed in 2005.[13] It consisted of 20 statements on a 6-point Likert scale from zero to five (never, rarely, sometimes, often, usually, and always). The scale is reversed for statements with positive meaning. The questionnaire was developed to cover different dimensions of exercise. Originally, the items were divided thematically into three subscales: (1) intentions to exercise, (2) consequences of not exercising, and (3) bodily signals; based on clinical experience, without performing a factor analysis. Because the response scale is reversed on positive statements, higher scores of the EED indicate more compulsivity and unhealthy exercise. The phrase "physically active" was used in statements to capture low intensity activity. Questions about workouts per

week ranged from no workouts to more than five per week.

Results from the pilot study[13] (50 eating disorder patients and 51 controls) showed good internal reliability, and significant discrimination between groups (sum score and subscales). Afterwards, three statements were rewritten, one because it did not discriminate between patients and controls and two statements because their meaning overlapped with other items. Three questions exploring quantity dimensions were included. The questions were similar to those used in The HUNT study, which is a longitudinal population health study in Norway.[29] There are five alternatives for reporting frequency of exercise from "never" to "almost every day." There are three alternatives for intensity from "I take it easy without breaking into a sweat or losing my breath" to "I push myself to near exhaustion," and four response alternatives for duration of each exercise session from "<15 min" to "[mt]1 h." These questions have been validated.[29] Feedback from patients have shown that one of the new statements was difficult to understand (I feel/notice pain). Preliminary analysis showed that another statement (I'm physically active to be the first or best performer) had a considerably negative influence on reliability of the actual subscale and did not discriminate significantly between groups. These two statements have been excluded, and all analyses are performed on EED with 18 items. The same 6-point Likert scale, which was reversed in positive statements, was kept in the revised version of the EED. To make interpretation easier, mean scores were reported in the validated version. The EED global score was calculated as a mean score of all items because of the different number of items in subscales.

### *The Eating Disorder Examination — Questionnaire 6.0 (EDE-Q)*

The EDE-Q is a validated and well-known self-report questionnaire based on the Eating Disorder Examination interview, and investigates key eating disorder attitudes and behavior of the last 28 days.[27] It consists of Global score and four subscales: Dietary restraint, Weight concern, Shape concern and Eating concern. Norwegian norms for EDE-Q have been established.[30] In this study, differences in Global score between patients and controls are reported. To measure convergent validity with the EED, a Global score above 2.5[30] and the exercise frequency (item # 18 of the EDE-Q) were used to investigate the severity grading of the EED. The EDE-Q cut-off score of 2.5 was calculated by the mean value and one standard deviation in the Norwegian norms.[30] The exercise item was "exercising more than 5 times per week during the last 28 days to control weight and shape."[27] The Cronbach's alpha coefficient for the whole sample in this study was 0.96, for patients 0.94, and controls 0.95.

### *Statistical Analyses*

Statistical analyses were carried out using the SPSS version 21. Kolomorgov-Smirnow test did not show normality of all EED data. To achieve consistent presentation of the data, results of parametric tests were reported (independent and paired t-tests, one way ANOVA, Pearson's correlation). Nonparametric analyses were also performed. Any discrepancies between parametric and nonparametric results were reported. A Principal component analysis (PCA) was performed to explore the factor structure of the EED, including Kaiser-Meyer-Olkin measure of sampling adequacy (KMO), correlation matrix, two criteria for retaining factors (Kaisers and Scree plot) and oblique rotation (direct oblim), because correlations between factors could be expected. Chronbach alphas were calculated to investigate internal consistency. Univariate analyses adjusting for age differences between groups were performed. Effect size was calculated for comparative analyses, Cohens *d* for *t test* and eta squared ($\eta^2$) for ANCOVA analyses. Values of $\geq$0.70 were used as the criterion for acceptable level of internal consistency, significance levels were set at $p < 0.05$, and accepted level of factor loading at 0.4.

### *Missing Data*

Missing data on single items of the EED were replaced by a calculated mean on the actual subscale for each participant. The proportion of missing EED data was 0.37%. EDE-Q data from six patients were missing. These patients were excluded from analyses including EDE-Q data. Missing data, which were not replaced by the mean, were marked clearly to show the different Ns in the actual analyses. This is reported in text and tables.

## Results

### *Psychometric Properties of the EED*

Mean (SD), group differences and 95% Confidence interval (CI) are presented in **Table 2**. As shown in the table, the EED discriminated significantly ($p < .001$) between groups. Analyses adjusted for age differences did not affect the significance level. Adjusted mean differences and 95% CI are presented in **Table 2**. The subscales of the EED are established through a PCA, and more information is provided later in the result section.

In patients, age and BMI were significantly negatively related (Pearson's r, two-tailed) to EED Global score, $r = -0.21$, $p < 0.01$ (age), and $r = -0.27$,

**TABLE 2. Differences in items, subscales and global score of the EED, with effect size, patients versus controls**

| Items, Subscales, and Global Score | Patients $n = 244$ Mean (SD) | Controls $n = 205$ Mean (SD) | $t$ (447) $p$ values | Diff[a] | 95%CI | Effect Size Cohens d | Diff[b] Adjusted for Age | 95%CI |
|---|---|---|---|---|---|---|---|---|
| **Compulsive exercise** | | | | | | | | |
| I am physically active to avoid dealing with negative emotions. | 2.45 (1.70) | 1.27 (1.18) | 8.46*** | 1.18 | 0.90–1.46 | 0.82 | 1.43 | 1.15–1.71 |
| It feels wrong if I can't be physically active every day. | 2.34 (1.85) | 1.00 (1.18) | 9.96*** | 1.33 | 1.04–1.63 | 0.87 | 1.50 | 1.19–1.81 |
| If I haven't been physically active I don't eat. | 1.84 (1.70) | 0.37 (0.82) | 11.38*** | 1.47 | 1.22–1.73 | 1.10 | 1.67 | 1.40–1.93 |
| If I haven't been physically active, I can't relax. | 2.20 (1.78) | 0.81 (1.15) | 9.70*** | 1.39 | 1.12–1.73 | 0.93 | 1.57 | 1.27–1.87 |
| If I haven't been physically active, I get a bad conscience. | 3.23 (1.76) | 2.05 (2.06) | 6.65*** | 1.19 | 0.83–1.54 | 0.63 | 1.33 | 0.96–1.70 |
| If I haven't been physically active, my body feels big. | 2.99 (1.77) | 1.77 (1.50) | 7.89*** | 1.23 | 0.91–1.53 | 0.75 | 1.34 | 1.01–1.66 |
| If I haven't been physically active, my body feels disgusting. | 2.95 (1.80) | 1.51 (1.45) | 9.32*** | 1.44 | 1.14-1.75 | 0.89 | 1.61 | 1.28-1.93 |
| I listen to my body. | 3.12 (1.30) | 1.64 (1.15) | 12.70*** | 1.48 | 1.25–1.71 | 1.21 | 1.51 | 1.27–1.58 |
| **Subscale 1 mean score** | **2.64 (1.40)** | **1.30 (0.95)** | **11.75*** ** | **1.35** | **1.12–1.57** | **1.13** | **1.49** | **1.26–1.73** |
| **Positive and healthy exercise** | | | | | | | | |
| I enjoy being physical active. | 2.32 (1.58) | 1.76 (1.33) | 3.97*** | 0.56 | 0.30–0.84 | 0.38 | 0.53 | 0.24–0.82 |
| I like to exercise with other people. | 2.75 (1.57) | 1.64 (1.28) | 8.03*** | 1.11 | 0.84–1.38 | 0.77 | 1.01 | 0.73–1.30 |
| I am physically active to be healthy. | 2.16 (1.61) | 1.37 (1.26) | 5.64*** | 0.79 | 0.52–1.06 | 0.54 | 0.81 | 0.52-1.10 |
| **Subscale 2 mean score** | **2.41 (1.36)** | **1.59 (1.11)** | **6.85*** ** | **0.81** | **0.58–1.04** | **0.66** | **0.78** | **0.54–1.03** |
| **Awareness of bodily signals** | | | | | | | | |
| I notice when I get tired. | 1.68 (1.40) | 1.19 (1.14) | 4.04*** | 0.49 | 0.25–0.73 | 0.64 | 0.63 | 0.38–0.88 |
| I notice when I get thirsty. | 1.61 (1.58) | 0.92 (1.05) | 5.38*** | 0.69 | 0.44–0.95 | 0.52 | 0.78 | 0.51–1.05 |
| I notice when I get hungry. | 2.33 (1.63) | 0.88 (1.10) | 10.92*** | 1.45 | 1.19–1.71 | 1.05 | 1.62 | 1.35–1.90 |
| I notice when I feel fit/in shape. | 1.82 (1.34) | 1.05 (1.07) | 6.67*** | 0.77 | 0.54–1.00 | 0.64 | 0.88 | 0.64–1.12 |
| **Subscale 3 mean score** | **1.86 (1.18)** | **1.01 (0.90)** | **8.49*** ** | **0.86** | **0.66–1.05** | **0.81** | **0.98** | **0.77–1.19** |
| **Weight and shape exercise** | | | | | | | | |
| I am physically active to become thin. | 3.20 (1.74) | 2.25 (1.50) | 6.24*** | 0.97 | 0.65–1.26 | 0.53 | 1.10 | 0.78–1.42 |
| I am physically active to burn calories I have eaten. | 2.87 (1.79) | 1.36 (1.31) | 10.17*** | 1.51 | 1.22–1.81 | 0.97 | 1.69 | 1.38–2.00 |
| I am physically active for appearance reasons. | 2.92 (1.79) | 2.42 (1.40) | 3.24*** | 0.50 | 0.19–0.80 | 0.32 | 0.75 | 0.44–1.06 |
| **Subscale 4, mean score** | **3.00 (1.60)** | **2.01 (1.20)** | **7.37*** ** | **1.00** | **0.73–1.26** | **0.71** | **1.18** | **0.90–1.46** |
| **EED Global score** | **2.49 (0.96)** | **1.40 (0.65)** | **13.88*** ** | **1.09** | **0.94–1.24** | **1.09** | **1.21** | **1.05–1.37** |

$t$ test for independent samples, two tailed. $p$ values: *** $p < 0.001$.
[a]Diff: Mean difference between patients and controls and 95%.confidence interval (CI).
[b]Diff: Mean difference between patients and controls adjusted for age. 95%CI: 95% confidence interval.
Cohens $d$: Small effect size = 0.2, medium = 0.5, and large = 0.8.

**TABLE 3. EED scores (Global score and subscales) in diagnostic groups**

| | AN $n = 79$ Mean (SD) | BN $n = 57$ Mean (SD) | EDNOS $n = 84$ Mean (SD) | BED $n = 24$ Mean (SD) | $F$ | Difference[a] $p$ values | Bonferroni post hoc $p$ values | Effect size Eta squared Adjusted for age $\eta^2$ |
|---|---|---|---|---|---|---|---|---|
| EED Global score | 2.54 (1.03) | 2.63 (0.98) | 2.52 (0.89) | 1.87 (0.63) | 4.00 | ** | BED vs. AN and EDNOS* BED vs. BN** | 0.03 |
| EED Compulsive | 2.75 (1.53) | 2.88 (1.34) | 2.63 (1.33) | 1.72 (0.89) | 4.42 | ** | BED vs. AN, BN** BED vs. EDNOS* | 0.04 |
| EED Positive and healthy | 2.24 (1.48) | 2.44 (1.25) | 2.44 (1.30) | 2.79 (1.35) | 1.07 | NS | NS | 0.01 |
| EED Bodily signals | 2.12 (1.16) | 1.72 (1.28) | 1.95 (1.11) | 1.00 (0.82) | 6.29 | *** | BED vs. AN*** BED vs. EDNOS** | 0.05 |
| EED Weight and shape | 2.81 (1.62) | 3.37 (1.61) | 3.06 (1.49) | 2.53 (1.63) | 2.13 | NS | NS | 0.03 |

[a]One way ANOVA F(3, 240). AN: anorexia nervosa, BN: bulimia nervosa, EDNOS: eating disorder not otherwise specified. BED: binge eating disorder.
In Bonferroni post hoc test, only significant relationships are reported.
$p$ values: * $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$. NS: Not significant.
Effect size - Eta squared $\eta^2$: small effect size = 0.02, medium = 0.13, and large = 0.26.

**TABLE 4. Correlations between EED and EDE-Q global scores and subscale scores**

| | EED Global Score | EED Compulsive | EED Positive and Healthy | EED Bodily Signals | EED Weight and Shape |
|---|---|---|---|---|---|
| EDE-Q Global score Whole sample ($n = 443$)[a] | 0.79** | 0.70** | 0.36** | 0.39** | 0.65** |
| EDE-Q Global score Patient group ($n = 238$)[a] | 0.66** | 0.55** | 0.27** | 0.25** | 0.59** |
| EDE-Q Global score Controls ($n = 205$) | 0.73** | 0.67** | 0.14* | 0.16* | 0.64** |

Pearson's r (two-tailed). **Correlation significant at the 0.01 level. *Correlation significant at the 0.05 level.
EED: Exercise and Eating Disorders. EDE-Q: Eating Disorder Examination Questionnaire.
[a]Reduced $N$ is due to missing EDE-Q data in six patients.

$p < 0.01$ (BMI). These correlations indicated that the EED Global score increased with lower BMI and younger age in patients. In the control group, the tendency was the same regarding age, but opposite regarding BMI.

In **Table 3**, the EED Global and subscale scores, and the effect size eta squared ($\eta^{2;}$ adjusted for age difference) in diagnostic groups are presented. The analyses are adjusted for age differences, without changing the original result.

### *Reliability Testing*

The Chronbach's alpha coefficient of the Global EED in the whole sample was 0.90. Subscale coefficients of the whole sample and patients are presented in **Table 5**. In controls, the Chronbach's alpha coefficients in subscales ranged from 0.81 to 0.85. All subscale items were tested for effect on $\alpha$ if each item was deleted, and none of the items affected the $\alpha$-level to a considerable level. The factors for corrected item-total correlation ranged from 0.56 to 0.84. The results indicated an acceptable level of consistency.

### *Test-Retest Reliability (N = 69)*

Between test (T1) and retest (T2), the Pearson's correlation factor on Global score was .86 and ranged from .68 to .90 in subscales. Mean global scores (SD) were 1.41 (0.71) at T1 and 1.41 (0.70) at T2. No significant differences (paired sample $t$ test, two-tailed) were found between the two points of measurement on Global score $t$ (68) = 0.22, $p < 0.84$, or subscales. Values in subscale 1 (compulsive) were $t$ (68) = 1.00, $p < 0.33$, subscale 2 (positive): $t$ (68) = −1.89, $p < 0.07$, subscale 3 (bodily signals): $t$ (68) = 0.00, $p = 1.00$, and subscale 4 (weight and shape): $t$ (68) = 0.49, $p < 0.64$. The nonparametric test (Wilcoxon test) showed similar results except for subscale 2: $z = -2.3$, $p < 0.05$, indicating significant difference between T1 and T2. The overall results indicated a satisfactory level of stability of the EED, despite the limited discrepancy of results on subscale 2.

### *Convergent and Discriminant Validity*

Correlations between global score and subscales of the EED and EDE-Q are presented in **Table 4**. Higher correlations were found between EED subscales representing compulsive elements of exercise and EDE-Q weight/shape over concern than the other EED subscales. These associations indicated both convergent and discriminant validity between exercise measured by

**TABLE 5. PCA of the EED for the whole sample ($N = 449$) and patients ($n = 244$)**

| | Rotated Factor Loadings | | | |
|---|---|---|---|---|
| Factors and Items Factor 1 Compulsive exercise | Factor 1 | Factor 2 | Factor 3 | Factor 4 |
| If I haven't been physically active, I can't relax. | **0.96/*0.95*** [a] | −0.02 | −0.01 | −0.10 |
| It feels wrong if I can't be active every day. | **0.90/0.87** | −0.08 | −0.00 | −0.02 |
| If I haven't been physically active I don't eat. | **0.87/*0.85*** | 0.07 | −0.10 | −0.05 |
| If I haven't been physically active, I get a bad conscience. | **0.71/*0.68*** | 0.03 | 0.12 | 0.15 |
| If I haven't been physically active my body feels disgusting. | **0.65/*0.58*** | 0.04 | −0.00 | 0.32 |
| I am physically active to avoid dealing with negative emotions. | **0.61/0.57** | −0.17 | -.20 | 0.13 |
| If I haven't been physically active my body feels big. | **0.60/*0.51*** | 0.06 | 0.06 | **0.41/*0.50*** |
| I listen to my body. | 0.37/0.46 | 0.23 | −0.38 | 0.12 |
| **Factor 2** | | | | |
| **Positive and healthy exercise** | | | | |
| I enjoy being physically active. | −0.23 | **0.89/*0.85*** | −0.00 | 0.08 |
| I am physically active to be healthy. | 0.04 | **0.85/*0.84*** | −0.06 | −0.14 |
| I like to exercise with other people. | 0.13 | **0.84/*0.84*** | 0.01 | −0.018 |
| **Factor 3** | | | | |
| **Awareness of bodily signals** | | | | |
| I notice when I am thirsty. | −0.04 | 0.02 | −**0.86/*0.83*** | 0.01 |
| I notice when I feel fit/in shape | −0.05 | 0.09 | −**0.81/*0.79*** | 0.05 |
| I notice when I get tired. | −0.03 | −0.10 | −**0.79/*0.71*** | −0.03 |
| I notice when I am hungry. | 0.12 | 0.04 | −**0.77/*0.82*** | −0.02 |
| **Factor 4** | | | | |
| **Weight and shape related exercise** | | | | |
| I am physically active to become thin. | −0.02 | 0.07 | −0.01 | **0.94/*0.97*** |
| I am physically active for appearance reasons. | 0.01 | −0.16 | −0.01 | **0.85/*0.82*** |
| I am physically active to burn calories I have eaten. | 0.29 | 0.09 | −0.11 | **0.64/*0.76*** |
| Eigenvalue | 7.53/*7.25* | 3.05/*2.98* | 1.66/*1.84* | 0.91/*0.93* |
| % of variance | 41.81/*40.25* | 16.95/*16.54* | 9.22/*10.23* | 5.06/*5.78* |
| Chronbach's alpha | 0.93/*0.93* | 0.84/*0.82* | 0.83/*0.80* | 87/*0.89* |

Factor loadings above 0.4 is marked in bold.
[a]Patient group: Values are presented underscored in italic numbers.

EED and symptoms of eating disorders measured by EDE-Q.

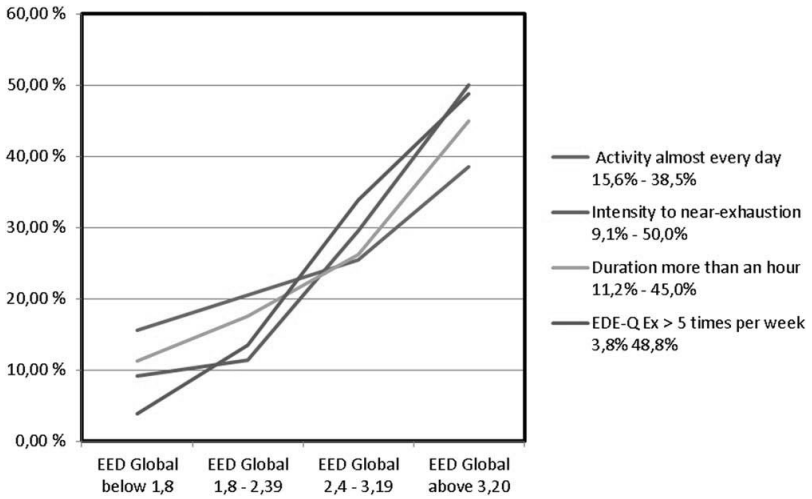
### *Factor Structure of the EED, PCA*

Results for the total sample indicated that all KMO values for statements were above 0.72. The KMO measure verified sampling adequacy (MSA = 0.91).[31] Bartlett's test of sphericity $X^2$ (153) = 5717.388, $p < 0.001$, indicated sufficiently large correlations between items for performing a PCA. Analyses of Kaisers criterion and scree plot showed that both a three and a four-factor solution could be justified. There were three factors with an eigenvalues above 1, and a fourth factor just below 1 (0.91). The inflexion point of the scree plot indicated a four-factor structure. Changing from three to four factors, communality values increased from an average of 0.68 to 0.73, explained variance increased from 67.8 to 73.0%, and three items in factor 1 established the fourth factor. In the patient and control group, MSA values (respectively, 0.88 and 0.85) and Bartlett's test of sphericity ($p < 0.001$) were acceptable. A summary of the PCA analyses and Chronbach's alpha coefficient in subscales is presented for the whole sample and patient group in **Table 5**. Factor structure was similar for the control group, except for one item, and the eigenvalue of the fourth factor increased to 1.21. Through evaluation of statistical and clinical arguments, the final conclusion was to retain four factors. Items of each factor were investigated to see how they captured common themes and clinically relevant dimensions. The three items in the fourth factor were related to exercise for weight and appearance reasons, which have been looked on as an important factor both clinically and theoretically. Eating disorder patients regularly report exercising for weight and appearance reasons. The other factors covered dimensions related to compulsivity, healthy exercise, and awareness of bodily signals. As shown in the table, the loading of one statement (if I haven't been physically active, my body feels big) was above 0.40 in two factors. It was kept in the factor with the highest loading. Another statement, "I listen to my body," was retained because it has clinical relevance[31] and higher loading above 0.40 in the patient group, despite loading below 0.4 in the total sample.

### *Clinical Guide of Severity Grading of the EED Scale*

To make interpretation of the EED for clinicians and the communication with patients easier, we have estimated a clinical severity scale. This scale

**FIGURE 1** EED Global score divided into four severity groups (approximately quartiles). Activity measures of the EED and the exercise measure of the EDE-Q (# 18 per week). Percentage of patients in each severity group are presented.




is based on quartile groups of the EED global score in the patient group.

The results yielded the following classification based on global EED score: Group 1, global score $<1.80$ (no symptoms of compulsive exercise); Group 2, global score $1.80-2.39$ (low severity); Group 3, global score $2.40-3.19$ (moderate severity) and Group 4, global score $>3.20$ (high severity). In **Figure 1**, the expected positive associations between EED severity groups and high level exercise for patients are shown. High level of exercise was defined as the highest alternative (frequency, intensity, and duration) of amount of exercise in the EED, together with exercising more than 5 times a week (EDE-Q, # 18). The same tendency (see **Fig. 1**), was found in those with an EDE-Q Global score above 2.5, 79.7% ($n=188$), and in diagnostic groups, except for the BED group. None of the 24 BED patients reported a high level exercise.

## Discussion

All analyses confirmed adequate psychometric properties of the EED and a four-factor solution. These results showed adequate test-retest reliability and discriminant validity between patients and healthy controls across different dimensions of compulsive exercise. Analyses showed that this discrimination between groups was not affected by age differences. Convergent validity was demonstrated by the high correlations between compulsive exercise measured by the EED and eating disorder symptoms measured by the EDE-Q. Findings indicate that the EED can be a useful assessment in eating disorder patients.

The EED is the first clinically derived, self-report questionnaire developed specifically for use in treatment settings for eating disorder patients. Considerable debate surrounds the issue of how exercise should be addressed in treatment for eating disorders.[32,33] The EED may prove to be a useful contribution as an assessment tool tapping clinically relevant dimensions of compulsive exercise within a broader perspective than captured by existing questionnaires. To identify treatment goals and plan treatment, it is important to recognize and understand the different dimensions related to compulsive exercise among patients.

Consistent with existing research, the results confirmed that exercising to control weight, shape, and appearance are important features of excessive exercise.[34,35] The results also supported the complex and multidimensional nature of exercise in eating disorders, which is consistent with C. Meyer's cognitive-behavioral maintenance model of compulsive exercise.[3] The subscale that explained the greatest part of the variance in the EED scale was related to what we have defined as the compulsive elements of exercising. The compulsive scale consisted of elements, which are

theorized to maintain this behavior. Exercising to avoid difficult emotions and the concern about consequences if exercise is restricted, postponed or interrupted are primary features of the compulsive scale on the EED. The importance of compulsive attitudes has also been highlighted in research related to a conceptual model of understanding the relationship between EEDs.[36] Addiction models of excessive exercise report that withdrawal symptoms related to negative affect such as guilt, anxiety, and depression are involved in maintenance.[37] In the EED, consequences of not exercising are included that are related to eating disorder symptoms, such as difficulty with regular meals and changes in perceived body image when they do not exercise. These elements are important to understand the complex nature of exercise in clinical samples of eating disorder patients, and they may directly affect treatment.

The two other subscales are related to healthy issues of exercise, which also is important. The positive effects of healthy exercise are well-known, and it has been reported that healthy exercise may be a positive factor in treatment of eating disorder patients.[10,38] The ability to notice bodily signals is a component not focused on in other questionnaires. Awareness of physical signals, such as fatigue, thirst, etc., is a precondition for attending to these needs and regulating exercise in a healthy way. Hilde Bruch has highlighted difficulties with perceiving and interpreting bodily signals as a symptom of AN patients. In this study, these difficulties also appeared in the other diagnostic groups. When interpreting these two subscales, it is important to remember that the response scales are reversed, and low score indicates healthy exercise and good ability to recognize bodily signals, a high score indicates the opposite.

Correlations indicated that higher scores of the EED were associated with lower BMI and younger age in patients. The AN patients were on average younger and had a lower BMI than BN and EDNOS patients, but the age range was wide across groups. Analyses adjusting for age showed that age was a factor to consider, though it did not change the results. Our lack of differences between diagnostic groups in the patient sample diverged from a study that found the highest prevalence of compulsive exercise among AN patients compared to BN and EDNOS.[6] However, similar levels of excessive exercise across diagnostic groups has been previously shown.[39] Differences across studies may depend on different levels of compulsive exercise across samples, but it may also be due to differences in definitions and measures.[5] In our sample, only BED patients were shown to have significantly lower scores on the global scale and two subscales (compulsive exercise and awareness of bodily signals). However, these results should be interpreted with caution because of the low number of BED patients in the sample. Still, it is in accordance with our clinical experience, that these patients express less compulsivity concerning exercise.

Compulsive exercise is not a symptom of all eating disorder patients, and the reported prevalence of compulsive exercise in other clinical samples has been estimated between 39[9] and 45.5%.[6] It is not possible to compare these prevalence rates directly to the EED because different measures were employed. Yet, the proportion of patients with EED global score above 2.4 (estimated groups of moderate and high severity) was 50.8%, which falls in the same range as prior research. The estimated classification of severity (from "no symptoms of compulsive exercise" to "high severity") based on EED global score in the patients is meant to assist clinical work with patients. This scale should be interpreted as gradually increasing severity, not strictly separate groups, giving an indication of how much attention is needed in treatment. However, it is important to have a more overall perspective too. Consistent with other research,[40,41] a continuum model, may highlight the dynamic nature of features like compulsive exercise and related topics. Convergent validity was demonstrated by correlations between the severity groups and increasingly higher levels of exercise. This supports the clinical relevance of the severity grading of the global EED score, and emphasizes the importance of evaluating both qualitative (attitudes and thoughts related to compulsivity) and quantitative measures of compulsive exercise in eating disorders. In accordance with other research, the qualitative measures are regarded as the clinically most important aspect of exercise behavior[3,14] and the amount or frequency of exercise is considered supplemental information in our clinic. An evaluation as to whether the amount of exercise is harmful or not depends on the individual's health and fitness level, and may also depend on prior history of exercise behavior.

### *Strengths and Limitations*

A satisfactory sample size and acceptable number of patients in diagnostic groups strengthens this study.

Several limitations are important to consider. First, despite showing convergent validity with the

EDE-Q, the EED has not been validated against another exercise questionnaire. The exclusion of male students prohibits conclusions regarding gender differences. Patients were recruited from one eating disorder unit; and findings may not generalize to generalist treatment settings or community samples of eating disorders. Another limitation is lack of structured diagnostic reliability testing. However, well-experienced ED clinicians made the diagnoses. The BED patients were quite few and that made the results in this group more uncertain. In our sample, the patients were on average older than controls. These differences were adjusted for by statistical analyses. The EED is based on self-reported data, and bias associated with over-and under-reporting is possible. The same concern applies to the self-reported weight and the possibility of unreported ED by participants in the control group.

Exercising despite pain and injury is a part of the DSM-5 criteria of excessive exercise,[4] and the importance has also been confirmed in research and clinical observations.[23] This study reported psychometric data for the second version of the EED (version 2). Future versions of the EED will be designed to incorporate an item specific to awareness of physical pain and a timeframe of 4 weeks will be used to provide greater understanding of when changes occur. Additional research is also necessary to determine whether the EED captures changes through treatment, to investigate its potential predictive validity in determining outcome and to clarify relationships with other comorbidity and related symptomology. Comparing EED scores of compulsive exercisers with and without eating disorders and with athletes and other groups of physically active persons may also be interesting issues for future research.

## Conclusion

The results of this study confirm the EED (version 2) as a valid and reliable measure of compulsive exercise in eating disorder patients. This brief, self-report, easy-to-administer questionnaire includes 18 items divided into four subscales, which yield clinically relevant information that tap different dimensions of this phenomenon.

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# Paper III

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**Impact of female adult eating disorder inpatients' attitudes to compulsive exercise on outcome at discharge and follow-up**

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**Impact of female adult eating disorder inpatients' attitudes to compulsive exercise on outcome at discharge and follow-up**

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**Abstract**

**Background:** The link between compulsive exercise and eating disorders is well known, but research with clinical samples has been limited. The purpose of the study was to investigate changes in attitudes towards compulsive exercise and its impact on outcome at post-treatment and follow-up in relation to changes in general mental distress, interpersonal problems, and depression in female adult patients.

**Methods:** In the naturalistic follow-up study, the investigated sample consisted of 78 patients and had a diagnostic distribution of 59% (n = 46) anorexia nervosa, 20.5% (n = 16) bulimia nervosa, and 20.5% (n = 16) Eating Disorder Not Otherwise Specified (EDNOS). The data were collected at admission, discharge, and follow-up. Paired sample *t*-tests and mixed model regression analysis were conducted to investigate changes in compulsive exercise and predictors of outcome respectively. Compulsive exercise was measured by the Exercise and Eating Disorder (EED) questionnaire. Other measures included the Eating Disorder Inventory (EDI-2), Body Attitude Test (BAT), Symptom Checklist (SCL-90), Inventory of Interpersonal Problems (IIP 64), Beck Depression Inventory (BDI), and body mass index (BMI). The outcome was measured using EDI-2 and BMI (patients with admission BMI ≤ 18.5).

**Results:** All measures revealed significant improvements ($p < 0.01$ – $p < 0.001$) from admission to discharge. During the follow-up period, three out of four EED subscales and the BAT sum score showed smaller but yet significant ($p < 0.05$) improvements. Mixed model analyses revealed that EED scores significantly predicted changes in EDI-2 scores and BMI ($p < 0.01$ and $p < 0.001$ respectively). Other significant predictors were BAT, SCL-90, IIP-64, BMI ($p < 0.01$–$0.001$) (EDI-2 as outcome measure), and BAT and BDI ($p < 0.001$) (BMI as outcome measure).

**Conclusions:** The results demonstrated significant improvements in attitudes towards compulsive exercise measured by the EED during treatment and follow-up in the sample of female eating disorder inpatients, and the change in compulsive exercise predicted the longer term course of eating disorder symptoms and BMI.

**Keywords:** Eating disorders; Attitudes; Compulsive exercise; Inpatient; Treatment; Outcome

## Background

The DSM-IV and DSM-5 diagnostic criteria highlight excessive or compulsive elements of exercise as recurrent inappropriate behaviour in patients with eating disorders [1, 2]. Such behaviour is characterized as inappropriate when it significantly interferes with a person's life and persists despite injury or medical complications. In cases of anorexia nervosa (AN), the behaviour is described as a cause of weight loss, and in cases of bulimia nervosa (BN) as compensatory behaviour [1, 2]. Frequent and intensive physical activity is common in a number of human groups, such as athletes. However, in patients with eating disorders it has been suggested that negative and compulsive attitudes towards exercise are more closely related to symptoms of eating disorders than the excessive amounts of exercise [3, 4].

Numerous definitions and terms have been used in the literature to describe compulsive and/or excessive exercise, yet inconsistency in the definitions renders it difficult for readers to know whether different studies refer to the same phenomenon [5]. Further, this inconsistency may account for the wide range of prevalence rates reported. Two studies observed an overall prevalence of excessive exercise of 39% and 45% in transdiagnostic samples, with rates varying according to diagnostic type [6, 7]. In one of the samples, the prevalence was as high as 80% for patients diagnosed with restrictive anorexia nervosa (AN), 43.1% in AN binge-eating/purging subtype, 39.3% in bulimia nervosa (BN), and 31.9% in eating disorders not otherwise specified (EDNOS) (6). Other studies have shown smaller differences between diagnostic groups [8-10].

There has been an increased interest in the nature of excessive and/or compulsive exercise in eating disorders and the association with symptomatology and treatment outcome [3, 4]. Such attitudes and behaviour have been investigated in treatment programmes with and without exercise interventions. A drive for compulsive exercise present at discharge has been reported as a negative prognostic factor for the long-term course of AN [11]. Carter and colleagues [12] investigated high-level exercise in the first three months

after discharge from treatment, and found a significant association with the probability of relapse. Associations between objective measures of amount of exercise (at initiation of treatment) and eating disorder pathology have been investigated. In a review, Gummer and colleagues [13] reported that results were partly conflicting as to whether associations existed. In an inpatient treatment programme (without exercise intervention) the results revealed that a lower amount of pre-treatment exercise was a significant predictor of improvement in eating disorder symptoms [6].

Specific exercise interventions are not commonly incorporated in treatment programmes, and few studies have explored the influence of outcome when such interventions are included [12-14]. In one study with AN, BN, EDNOS, a significant positive correlation was found between reduced exercise dependency and reduced eating disorder symptoms during inpatient treatment [14]. Literature relating to excessive exercise and AN [15, 16] and in transdiagnostic samples [17] has been summarized. A total of 13 studies were evaluated, most of which were characterized by small sample sizes and considerable heterogeneity in definitions, outcome measures, and type of intervention. Despite their methodological heterogeneity, the studies indicate that exercise interventions as a part of treatment have no significant adverse impacts on weight gain for AN patients [15-17]. Four studies found a positive association between exercise interventions and reduced eating disorder symptoms (e.g. body image related symptoms and compensating behaviour) [15, 17]. Moreover, improvements in psychological well-being and quality of life were observed [15]. Of the 13 studies, 5 investigated adult inpatient samples. None of the studies investigated the course of illness following discharge from inpatient treatment. The authors of the reviews concluded that although initial studies showed promising results, more research is warranted to increase the understanding of compulsive exercise in eating disorders, associations with eating disorder pathology and influence on treatment outcome [15-17]. In order to contribute with increased knowledge to the field, the research focus in this article was directed towards negative and compulsive attitudes to exercise in female adult eating disorder inpatients through a naturalistic follow-up study.

The aims of the study were to:

1. Identify how various dimensions of attitudes towards compulsive exercise change between admission, discharge, and at follow-up in a transdiagnostic sample of hospitalized females with eating disorders.
2. Identify whether changes in attitudes to compulsive exercise predict the course of eating disorder psychopathology and BMI in relation to changes in general mental distress, interpersonal problems, and depression.

## Methods

### Participants and procedure

The study was conducted as part of a larger follow-up study, and participants in the cohort were recruited from an adult inpatient eating disorder unit in the Central Norway region. Between January 2005 and December 2013, a total of 128 patients were admitted to the unit. Six men were excluded because the EED questionnaire was only validated for women, and 6 female patients were excluded because they decided not to receive treatment after the introductory week. Of the remaining 116 female patients, 78 participated in the follow-up assessment, yielding a response rate of 67.2%. No compensation was given for participation. Written invitations with study information, consent forms, and questionnaires were mailed to former patients for the follow-up assessment.

The baseline values for participants and non-participants were compared (*t*-test for independent groups). No differences were found between the groups: age ($t$ (114) = 0.85, p = 0.40), body mass index (BMI) ($t$ (114) = -1.47, p = 0.15), EED global score ($t$ (114) = 0.64, p = 0.52) and Eating Disorder Inventory (EDI-2) ($t$ (114) = 1.26, p = 0.21). Similarly, no differences between participants and non-participants were found in the discharge values: BMI ($t$ (114) = -0.11, p = 0.91), EED global score ($t$ (114) = 1.17, p = 0.24), and EDI-2 sum score ($t$ (114) = 1.07, p = 0.29). Among the 78 participants, 78.2% (n = 61) had completed treatment as planned, 16.7% (n = 13) had discharged themselves from treatment, and 5.1%

(n = 4) had been discharged in accordance with routine procedures due to breaking the treatment contract.

Diagnostic assessment and clinical interviews at admission were performed by licensed psychologists or psychiatrists, in accordance with DSM-IV diagnostic criteria [1]. The diagnostic distribution in the sample was 59% (n = 46) AN, 20.5% (n = 16) BN, and 20.5% (n = 16) EDNOS. All patients were admitted to inpatient treatment due to having serious symptoms of ED and having received prior treatment without satisfactory effect. The mean duration of illness (self-reported) prior to admission was 5.3 years (±3.8, range 1–20 years) and the mean duration of inpatient admission was 134 days (±56, range 14–281 days). The mean admission time for AN patients was 149 days (±61, range 14–281), BN 115 days (±36, range 49–192), and EDNOS 111 days (±48, range 15–184). Underweight patients were defined as having a BMI ≤18.5, which has been described by the World Health Organization (WHO) as the threshold for a healthy weight. In this sample, 71.8% (n = 56) had a BMI below 18.5 at admission (mean 15.9 ± 1.6, range 12.4–18.5).

The data were collected at admission, discharge, and follow-up. The average follow-up period after discharge from treatment was 26 months (±15 months, median 22 months, range 9.5–92.5 months). The range of follow-up time was large and one patient had an extraordinarily long follow-up period of 92 months. The analysis of change during treatment and the analysis of predictors of outcome were performed both with and without the inclusion of the latter participant in the sample. The difference did not have a noteworthy effect on the results and data relating to the participant have been included in all reported results. The study received approval from The Regional Committee for Medical and Health Research Ethics and all participants provided written informed consent. The baseline characteristics of the sample are presented in Table 1.

**Table 1.** Baseline values for the whole sample and diagnostic groups

| | Alle patients | AN | BN | EDNOS | | | Effect size |
|---|---|---|---|---|---|---|---|
| | N = 78 | n = 46 | n = 16 | n = 16 | | Bonferroni Post hoc. | Eta squared adjusted for age |
| | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | F-value | | $\eta^2$ |
| Age (years) | 21.1 (3.9) | 20.4 (3.3) | 22.2 (4.5) | 22.2 (4.8) | 2.00 | | |
| Range | 16.0 - 36.5 | 16 -31.7 | 17.8 34.8 | 16.6 - 36.5 | | | |
| BMI | 17.7 (3.5) | 15.5 (1.4) | 20.7 (2.5) | 20.8 (4.1) | 46.10*** | AN vs BN and EDNOS*** | |
| Range | 13.4 - 34.1 | 12.4 - 17.6 | 17.5 - 24.7 | 18.1 - 34.1 | | | |
| EED global score | 3.0 (0.8) | 3.0 (0.7) | 3.1 (1.0) | 2.9 (0.9) | 0.11 | | 0.00 |
| EED compulsive | 3.4 (1.2) | 3.4 (1.2) | 3.4 (1.2) | 3.5 (1.1) | 0.46 | | 0.00 |
| EED positive | 2.3 (1.4) | 2.3 (1.2) | 2.6 (0.9) | 1.9 (0.9) | 1.75 | | 0.04 |
| EED bodily signals | 2.5 (1.0) | 2.6 (1.0) | 2.3 (0.9) | 2.5 (1.0) | 0.32 | | 0.00 |
| EED weight & shape | 3.6 (1.2) | 3.5 (1.2) | 4.0 (1.1) | 3.5 (1.0) | 1.03 | | 0.04 |
| EDI-2 sum score | 111.2 (40.8) | 105.5 (36.0) | 138.8 (43.2) | 100.1 (41.8) | 5.23** | AN vs BN, and BN vs EDNOS* | 0.13 |
| BAT sum score | 66.0 (17.4) | 63.8 (16.6) | 72.3 (18.1) | 66.2 (18.5) | 1.44 | | 0.04 |
| SCL-90 mean score | 1.6 (0.7) | 1.6 (0.6) | 1.9 (0.7) | 1.6 (0.8) | 1.60 | | 0.04 |
| BDI sum score | 30.5 (10.4) | 29.9 (8.2) | 34.7 (13.1) | 27.8 (12.5) | 1.95 | | 0.05 |
| IIP-64 mean score | 1.6 (0.6) | 1.6 (0.6) | 1.8 (0.6) | 1.6 (0.8) | 0.79 | | 0.02 |

Note: One way ANOVA between diagnostic groups, df (2, 75). Bonferroni post hoc test, only significant relationships are reported.
AN: anorexia nervosa, BN: bulimia nervosa, EDNOS: eating disorder not otherwise specified.
BMI: Body mass index. EED: Exercise and Eating Disorder. EDI-2- Eating Disorder Inventory, BAT: Body Attitude Test,.
SCL-90: Symptom Checklist. BDI: Beck Depression Inventory. IIP-64: Inventory of Interpersonal Problems.
P value: * p < .05, ** p < .01, and *** p < .001.
Effect size - Eta squared $\eta^2$: small effect size =: 0.02, medium = 0.13, and large = 0.26.

### Treatment programme

The treatment programme was multidimensional and has been described in detail elsewhere [18]. In brief, the staff had multidisciplinary backgrounds and the treatment programme was based on psychodynamic theory, with elements of cognitive behavioural therapy and motivational interviewing. All patients were admitted voluntarily. Following an introductory week, each patient signed a contract formulating their individual goals and formally approving the terms of their treatment.

**Physical activity and exercise interventions**

Physical activity and exercise interventions were an integrated part of the treatment programme from admission to discharge. According to procedure in the unit, the participants' former exercise experiences were addressed individually at admission, including the reasons why they exercised, how their exercise affected other eating disorder symptoms and vice versa, and the amount of exercise they did. An individualized treatment plan and goals for physical activity as well as an exercise intervention were prepared for each patient.

Each week there was a structured programme with group therapy and individual therapy sessions, which also included body-oriented therapy, adjusted outdoor activity (e.g. walking, horse riding, climbing, kayaking, and skiing in the winter) and regular exercise groups. Underweight patients were required to have a minimum BMI of approximately 17.0 before participation in exercise groups and a planned weight gain had to be met in order to continue participation. Qualified personnel were responsible for planning and supervising the activities. The body-oriented therapy was based upon the theory and principles of Norwegian Psychomotor Physiotherapy (NPMP) [19], which in turn forms part of the Nordic physiotherapy and body-oriented therapy tradition [20]. The initial focus in body image therapy was upon relaxation and body awareness movements. All patients were gradually exposed to diverse approaches that address the relationships between the body, emotions, and interpersonal and social aspects. Regular exercise groups were offered later on in the treatment programme, with one hour of strength training and one hour of aerobic activity. These exercise groups were based on basic training principles such as muscular strength and endurance, cardiovascular endurance, variation, progression, and restitution, and were adjusted to individual needs and capacity. One of the aims was to expose the patients to different levels of intensity, but the exercise was mainly performed at a moderate level. The personnel facilitated a social arena in which patients could enjoy the activities and get new experiences in a non-competitive atmosphere. Individual goals and challenges were addressed before and after exercise sessions to help patients to integrate healthy attitudes and behaviour in accordance with their treatment plan. Participants also received individual

supervision, during which a heart rate monitor could be used as an additional tool. Psychoeducation formed part of the intervention and included anatomy, physiology, what constitutes healthy exercise, and what is unhealthy exercise. At discharge, plans were made for the transference of the achieved changes to the participants' daily life at home.

**Measures**

**Compulsive exercise:** The Exercise and Eating Disorder (EED) self-report questionnaire [9] is a validated, short questionnaire. It is the first clinically-derived questionnaire measuring attitudes towards compulsive exercise in patients with eating disorders and is intended for use in clinical settings [9]. It consists of 18 statements with a four-factor structure and a six-point response scale from zero to five (*never*, *rarely*, *sometimes*, *often*, *usually, and always*). The global score and subscale scores are based on mean values. Higher scores indicate greater compulsivity and unhealthy exercise. The subscales cover clinically relevant issues:

(1) *Compulsive exercise* (being physically active to avoid dealing with negative emotions; if not active: it feels wrong, I don't eat, I can't relax, I get a bad conscience, my body feels big or nasty; and I listen to my body).
(2) *Positive and healthy exercise* (enjoy being physically active; physically active to be healthy; like to exercise with other people).
(3) *Awareness of bodily signals* (I notice when: I feel fit/am in shape, when I get tired, thirsty, or hungry).
(4) *Exercise for weight and shape reasons* (active in order to: be thin, burn calories, and for appearance reasons).

The EED has been shown to have satisfactory psychometric properties [9]. The subscale on compulsive exercise showed the strongest correlation with eating disorder symptomatology ($r$ = 0.70). In the study, Cronbach's alpha at admission was 0.86 for the EED global score, and subscale values were in the range of 0.65–0.90. At follow-up, the respective values were 0.94 (global score) and 0.75–0.94 (subscales). Three versions of the EED were used in the

study. Despite some small changes to the wording across the revised versions, the meaning of the content has remained unchanged. Version 2 of the EED included three questions investigating the frequency, intensity, and duration of exercise, all of which have been validated and used elsewhere [21]. Due to differences in the way amount of exercise was reported in Versions 1 and 2 of the EED [9, 22], these quantitative measures are not presented in this article. During the study, the EED global score was used to predict BMI at outcome and follow-up, and the subscale on compulsive exercise was used as a predictor variable in the analyses using EDI-2 as the main outcome measure.

**Disturbed body image**: The Body Attitude Test (BAT) [23] is a short self-report questionnaire addressing subjective body experience and the attitude that a person with eating disorders has towards their body. It is a self-report measure with 20 items measured on a six-point response scale from *never* to *always.* The items are divided into four subscales: (1) negative appreciation of body size, (2) lack of familiarity with one's own body, (3) general dissatisfaction, and (4) a rest factor with two items which is not considered a separate subscale. The BAT has shown good validity and reliability [23, 24]. Cronbach's alpha values at admission and follow-up for BAT sum score were 0.92 and 0.96, while the respective values for the *lack of familiarity with one's own body* subscale were 0.82 and 0.92. The BAT has been found to be a significant predictor of changes in EDI-2 from admission to discharge, and most of the predictive value was represented by the BAT subscale on lack of familiarity with one's own body [18]. Therefore, the BAT sum score and *lack of familiarity with one's own body* subscale were respectively selected as covariates for the outcome variables BMI and EDI-2.

**Eating disorder symptoms:** The Eating Disorder Inventory (EDI-2) [25] is a widely used self-report tool with 91 items and 11 subscales, covering eating disorder symptoms, attitudes, and behaviours. EDI-2 does not cover exercise-related issues. EDI-2 has been validated in Nordic samples [26, 27]. Cronbach's alpha values at admission and follow-up

were 0.95 and 0.98. The EDI-2 sum scores were one of the outcome measures, and EDI-2 was included as covariate in the analyses with BMI as outcome measure.

**General psychopathology:** The Symptom Checklist 90 revised version (SCL-90R) [28] was used to measure general psychopathology. The SCL-90R is a validated self-report tool with 90 items divided into 11 subscales [29]. In the study, we only report the mean score of the severity index. Cronbach's alpha values at admission and follow-up were 0.97 and 0.99. The mean scores of the SCL-90R were included as a covariate in both models.

**Depression:** The Beck Depression Inventory (BDI) [30] is a validated self-report inventory with 21 questions measuring the severity of depression. The BDI global score was included as a covariate in both models. Cronbach's alpha value at admission was 0.89.

**Interpersonal problems:** The Inventory of Interpersonal Problems (IIP-64) [31] was used as a measure of interpersonal problems. The IIP-64 is a validated self-report inventory consisting of 64 items and 8 subscales. Cronbach's alpha values were 0.96 at admission and follow-up. The mean scores of the IIP-64 were included as covariates.

**Body mass index**: BMI is calculated using the following formula: $kg/m^2$. A BMI of 20.0 was the target BMI in the inpatient unit. During treatment, patients were weighed in the morning before breakfast, while wearing only undergarments. At follow-up, body weight was self-reported. When using BMI as outcome measure, analyses were performed for all underweight patients (admission BMI ≤18.5). The BMI for the whole sample was included as a covariate in the analyses with EDI-2 as an outcome measure. Weight gain during treatment for eating disorders is especially associated with AN. To provide additional information, separate analyses including only AN patients were performed.

**Statistical analysis**

The Kolmogorov-Smirnov test confirmed normality for the EED global scores at admission, discharge, and follow-up ($D(77) = 0.066 – 0.080$, $p = 0.200$). The following analyses were performed: descriptive analyses, one-way ANOVA with the Bonferroni post-hoc test, paired sample *t*-test, and Cronbach's alpha. Effect sizes were calculated using Cohen's *d* [32]. Linear mixed model regression analyses were used to investigate the predictive value of the EED. Due to the small size of the diagnostic groups and the lack of significant differences in the EED global scores between groups at admission ($p = 0.89$), these analyses were performed for the whole sample. In the linear mixed models regression analyses, three models were explored and the results reported: (1) the null model represented the intercept values of the outcome measure and its variances, (2) Model 1 included the covariate of particular interest (i.e. the EED score), and (3) in Model 2 values were adjusted for all significant covariates. R-squared was calculated based on differences of variance between the null model and the other models, and R-squared, the likelihood ratio test (LR test), change in variances, and log-likelihood values were used as measures of model improvement. The intraclass correlation (ICC), which represents the within-cluster correlation, is reported. Significance levels were set at $p < 0.05$, and data were analysed and presented for the whole sample and subgroups using SPSS Version 21 and Stata/MP 13 software.

**Missing data**

In total, the amount of missing data in the returned self-report questionnaires was 4.5%. Missing data were handled in two ways. Missing single items were replaced by a calculated mean for the specific subscales for each participant. Admission data were completely missing for two patients, while for one patient the discharge data were missing. Data at one or two measure points were missing for eight other patients. Evaluation of the data showed that the missing data were missing at random, and therefore multiple imputations could be performed to replace them.

## Results

### Study aim 1 – change of measures

The mean values of the EED, global score, and subscales improved significantly ($p < 0.01$ to $p < 0.001$) from admission to discharge and admission to follow-up. The effect size was large for the global score (0.93) and medium to large for the subscales (0.49–0.84). From discharge to follow-up, the changes were smaller, yet significant for the EED subscales: *compulsive exercise, awareness of bodily signals*, and *exercise for weight and shape reasons* ($p < 0.05$). The effect sizes were small (0.26–0.32).

Significant changes ($p < 0.001$) were observed for the measures of general psychopathology, body image, and eating pathology across the three time points. Effect sizes from admission to follow-up were large for the BDI (1.00), medium to large for EDI-2, the BAT sum score, the *lack of familiarity with one's own body* subscale, and the SCL-90R (0.74, 0.66, 0.73, and 0.63, respectively), and low to medium for the IIP-64 (0.43). From discharge to follow-up, there were significant changes only in the BAT sum score, with small effect size (0.29). No significant changes were observed for the EDI-2, BDI, SCL-90R, and IIP-64 during the follow-up period. The scores at admission, discharge, and follow-up are summarized in Table 2.

**Table 2:** EED scores (global score and subscales) for the whole sample at admission, discharge and follow-up and differences from admission to follow-up.

| | Admission N = 78 | | Discharge N = 78 | | Follow-up N = 78 | | Diff[1] A - F | Effect size A - F Cohen's *d* |
|---|---|---|---|---|---|---|---|---|
| | Mean (SD) | 95% CI | Mean (SD) | 95% CI | Mean (SD) | 95% CI | *T* | |
| EED Global score | 3.03 (0.81) | 2.83; 3.21 | 2.34 (0.86) | 2.15; 2.54 | 2.13 (1.08) | 1.89; 2.37 | 6.90*** | 0.93 |
| EED Compulsive | 3.43 (1.18) | 3.16; 3.70 | 2.68 (1.28) | 2.40; 2.98 | 2.33 (1.43) | 2.03; 2.67 | 6.80*** | 0.84 |
| EED Positive and healthy | 2.31 (1.12) | 2.05; 2.56 | 1.55 (0.93) | 1.33;1.74 | 1.77 (1.07) | 1.52; 2.00 | 3.58** | 0.49 |
| EED Bodily signals | 2.50 (0.98) | 2.27; 2.71 | 1.96 (0.89) | 1.75; 2.15 | 1.63 (1.13) | 1.35, 1.86 | 6.17*** | 0.82 |
| EED Weight and shape | 3.53 (1.24) | 3.30; 3.86 | 2.94 (1.26) | 2.64; 3.21 | 2.59 (1.47) | 2.27; 2.93 | 5.94*** | 0.69 |

[1]Paired sample t-test from admission to follow-up A: Admission, F: Follow-up.
P values: * p < .05, ** p < .01, and *** p < .001. Cohens *d*: Small effect size = 0.2, medium = 0.5, and large = 0.8.

**Study aim 2**

**EDI-2 as outcome measure:** The initial analyses indicated multicollinearity between the EED global score and BAT sum score. These global scores were therefore replaced with the EED subscale on compulsive exercise and the BAT subscale on lack of familiarity with one's own body as covariates. In the null model, EDI-2 scores from admission to follow-up improved significantly ($p < 0.001$), but with large values of unexplained variance. Model 1 showed model improvement, R-squared = 47.5%, and the EED compulsive exercise was a significant predictor ($z = 15.22$, $p < 0.001$). In Model 2, all covariates except BMI were found to contribute significantly ($p < 0.001$) and R-squared = 82.3%. In this model, the EED compulsive exercise score remained significant, but with lower values ($z = 2.92$, $p < 0.01$). The reduced z-value indicated shared content between EED with the other covariates, but also accounted for unique explained variance. Significant LR test ($p < 0.001$) as well as reduced variance and log-likelihood values, and increased R-squared all indicated a further improvement of model fit to the data. The addition of a patient-specific random slope indicated further model improvement (LR test, $p < 0.01$). The results for the models are presented in Table 3.

**Table 3.** Random intercept models with EDI-2 as outcome measure for the whole sample

| Fixed part | Null model | | | Model 1 | | | Model 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coefficient (SE) | z-value | 95% CI | Coefficient (SE) | z-value | 95% CI | Coefficient (SE) | z-value | 95% CI |
| Intercept | 90.66 (4.25) | 21.32*** | 82.33; 98.99 | 18.56 (5.69) | 3.26** | 7.38; 29.72 | -3.95 (4.08) | -0.97 | 11.95; 4.03 |
| EED compulsive | | | | 25.55 (1.68) | 15.22*** | 22.25; 28.83 | 4.58 (1.57) | 2.92** | 1.50; 7.66 |
| BAT familiarity | | | | | | | 1.18 (0.30) | 3.93*** | 0.59; 1.77 |
| BDI sum score | | | | | | | 1.09 (0.19) | 5.75*** | 0.72; 1.47 |
| SCL-90R mean score | | | | | | | 12.15 (4.05) | 3.00** | 4.20; 20.10 |
| IIP-64 mean score | | | | | | | 13.23 (3.81) | 3.48** | 5.77; 20.70 |
| Random part | | | | | | | | | |
| ψ variance | 927.42 | | | 548.36 | | | 126.65 | | |
| θ variance | 1447.78 | | | 695.34 | | | 294.33 | | |
| Derived estimates | | | | | | | | | |
| R-squared | | | | 47.5 | | | 82.28 | | |
| ICC | 0.39 | | | | | | 0.30 | | |
| Log likelihood | -1225.35 | | | -1145.06 | | | -1029.47 | | |

EED: Exercise and Eating Disorders, BAT: Body Attitude Test, BDI: Beck depression Inventory, SCL-90R: Symptom checklist revised, IIP-64: Inventory of interpersonal problems.

ψ Variance: Variance between patients. θ Variance: Variance within observations in patients. ICC: Intraclass correlation. P values: * p < .05, ** p < .01, and *** p < .001.

**BMI as outcome measure (admission BMI (< 18.5, n = 56)):** No signs of multicollinearity were present in these analyses, and the EED global score and BAT sum score were used as covariates in the models. Model 1 showed improved model fit to the data and R-squared = 24.2%. The EED global score was a significant predictor of change in BMI ($z$ = -7.29, $p < 0.001$). The negative z-value indicated an association between reduced EED global score and increased BMI. In Model 2, non-significant covariates (EDI-2, SCL-90, and IIP-64) were removed. Each of these variables was separately included in the model once more, without any change in significance level. Additional significant covariates retained in Model 2 included BAT sum score ($p < 0.001$) and BDI ($p < 0.001$), and R-squared = 36.5%. The EED global score continued to be a significant predictor in Model 2 ($z$ = -5.78, $p < 0.001$). Adjusted for the other covariates, the z-value of the EED was attenuated by 1.51, indicating some shared content of the measures, but also confirmed the importance of the EED as a unique and significant predictor of improvement in BMI. Reduced variance and log-likelihood, increased R-squared, and significant LR test ($p < 0.001$) all confirmed improvement in the model fit to the data. Inclusion of a patient specific slope did not improve any of the models significantly. Additional analyses of the AN group showed almost similar values to those in the whole underweight group. The results of the models for the whole underweight group and the AN group are presented in Table 4. The values confirmed that Model 2 provides the best fit to the data.

**Table 4.** Random intercept models, BMI as outcome measure for patients withBMI ≤ 18.5 at admission (n = 56) and AN patients (n = 46)

| Fixed part | Null model<br>**Null model AN** | | | Model 1<br>**Model 1 AN** | | | Model 2<br>**Model 2 AN** | | |
|---|---|---|---|---|---|---|---|---|---|
| Intercept | Coefficient (SE) | z-value | 95% CI | Coefficient (SE) | z-value | 95% CI | Coefficient (SE) | z-value | 95% CI |
| BMI | 18.53 (0.28)<br>**18.33 (0.25)** | 67.86***<br>**72.63*** ** | 19.04; 20.18<br>**17.84; 18.83** | 21.80 (0.49)<br>**21.83 (0.59)** | 44.92***<br>**36.72*** ** | 20.86; 22.76<br>**20.67; 23.00** | 20.66 (0.52)<br>**20.68 (0.61)** | 33.79***<br>**33.90*** ** | 19.64; 21.68<br>**19.48; 21.87** |
| EED global score | | | | -1.37 (0.19)<br>**-1.45 (0.23)** | -7.29***<br>**-6.34*** ** | -1.73, -1.00<br>**-1.90; -1.00** | -1.67 (0.29)<br>**-1.82 (0.34)** | -5.78***<br>**-5.34*** ** | -2.24; -1.10<br>**-2.49; -1.15** |
| BAT sum score | | | | | | | 0.07 (0.01)<br>**0.08 (0.02)** | 4.85***<br>**4.85*** ** | 0.04; 0.10<br>**0.05; 0.11** |
| BDI sum score | | | | | | | -0.10 (0.02)<br>**-0.11(0.24)** | -4.96***<br>**-4.60*** ** | -0.14; -0.06<br>**-0.16; -0.06** |
| Random part | | | | | | | | | |
| ψ variance | 0.00<br>**0.00** | | | | 0.00<br>**0.00** | | 0.27<br>**0.31** | | |
| θ variance | 7.49<br>**8.34** | | | | 5.68<br>**6.39** | | 4.49<br>**4.88** | | |
| Derived estimates | | | | | | | | | |
| R-squared | | | | | 24.2<br>**23.5** | | 36.5<br>**37.8** | | |
| ICC | 0.00<br>**0.00** | | | | 0.00<br>**0.00** | | 0.06<br>**0.06** | | |
| Log likelihood | -405.1<br>**-324.9** | | | | -382.0<br>**-307.4** | | -366.9<br>**-293.7** | | |

EED: Exercise and Eating Disorders, BAT: Body Attitude Test, BDI: Beck depression Inventory

ψ Variance: Variance between patients. θ Variance: Variance within observations in patients.

ICC: Intraclass correlation. P values: * p < .05, ** p < .01, and *** p < .001.

**Discussion**

Our results showed significant improvement across different dimensions of attitudes towards compulsive exercise in the patient cohort during inpatient treatment and follow-up. Overall, significant changes were either maintained or continued to show additional improvement at follow-up. Further, the results demonstrated that improvements in these compulsive exercise dimensions significantly predicted the course of the illness, as measured by the EDI-2 and BMI. Regarding BMI as outcome measure, additional analyses of the AN group showed almost similar results to those for the whole underweight group.

Although different measures were used, the positive change found in attitudes towards compulsive exercise during treatment is consistent with earlier research [8, 14]. Our follow-up data are the first evidence of show how such attitudes develop in the course following discharge from inpatient treatment. The improvements were significant in three out of four subscales of EED and in the BAT sum score, compared to no changes in other measurements.

Meyer and colleagues [4] propose that weight and shape issues, regulation of negative affect and rigidity, and perceived negative consequences when exercise is restricted or stopped are factors that should be investigated in research directed towards exercise in eating disorders. These factors are in accordance with the view that qualitative measures of excessive exercise are clinically most important [3]. Our research has been conducted in accordance with these recommendations and perspective. The lack of other long-term follow-up studies investigating attitudes towards compulsive exercise limited our ability to compare our findings to existing research directly. However, our results indicate that changes in attitudes towards compulsive exercise during treatment and follow-up may prove to be a beneficial factor that would facilitate treatment progress and outcome. Similar trends have been found in other studies that have reported results during treatment [15-17]. Two studies with comparable treatment settings were found [8, 14]. Despite differences in sample sizes and sample characteristics, as well as some inconsistencies in definitions and measurements, these studies found a significant association between reduced exercise

dependency and reduced eating disorder symptoms during treatment. The longitudinal design of our study has built upon and extended earlier research, and the main findings emphasize the importance of attitudes towards compulsive exercise for the outcome of eating disorder symptoms following discharge.

To date, researchers have directed more attention towards the relationship between weight gain and exercise interventions in treatment programmes for patients with AN. The results of their research have indicated that the incorporation of exercise interventions in treatment does not have an adverse effect on achieving weight gain [15-17]. Our findings support the existing literature, and the follow-up data strengthen and extend the knowledge in the field.

Relapse after inpatient treatment is common and it has been suggested that it is important to take exercise-related elements into consideration [11, 12]. Moola and colleagues [15] have stated that if patients' exercise beliefs are allowed to remain unchanged during inpatient treatment that might increase their risk of continued unhealthy exercise after discharge. The extent to which improvements in negative attitudes towards compulsive exercise persist following discharge has not been reported previously, nor have earlier studies investigated the predictive significance of attitudes towards compulsive exercise on eating pathology following treatment.

Compulsive exercise is a complex phenomenon. In our study, different domains of attitudes towards exercise were shown to be significant predictors of changes in eating pathology and BMI. In the first model, using the EDI-2, the compulsive exercise subscale of the EED was used as covariate and the results indicated a significant association between compulsive elements of exercise and eating disorder symptoms. In the second model, using BMI as the outcome variable, the EED global score significantly predicted weight gain, thus highlighting the relationship between BMI and various dimensions of attitudes towards exercise. It is important to note that these values were almost similar in the whole underweight group and in additional analyses which included only AN patients. The proportion of explained variance increased in both models when other measures were added

as covariates, from 47.5% to 82.3% (EDI-2 as outcome measure) and 24.2 to 36.5% (BMI as outcome measure). These findings illustrate the importance of the other covariates, yet exercise remained a significant predictor, thus emphasizing the importance of addressing compulsive exercise and attitudes towards exercise in the treatment of eating disorders.

**Strengths and limitations**

The study was a naturalistic cohort study investigating a medium-size sample of female inpatients with eating disorders. All admitted patients were invited to participate. None of the patients was excluded due to symptoms or comorbidity, and this has probably improved the representativeness of our sample and generalizability of our findings to other inpatient settings. The inclusion of follow-up data is a notable strength and adds significantly to existing knowledge of longer term outcomes and compulsive exercise.

However, it is necessary to consider several limitations of the study. The study was a cohort study with no control group and it is uncertain whether the findings related specifically to our treatment programme, which included a physical activity component, or whether they indicate a general pattern of associations between various aspects of eating disorders over time. All patients were recruited from the same inpatient unit, and the findings may not be generalizable to outpatient or other treatment settings. The ability to generalize is also limited by the fact that the EED has only been validated in women. The follow-up of 67.2% is a general weakness, yet no baseline differences were found for age, BMI, EED sum global scores, and EDI-2 scores, or for discharge scores for EED and EDI-2 between participants compared to non-participants. Trained and specialized clinicians provided diagnostic quality, yet the diagnostic procedures did not include structured interviews. A transdiagnostic sample was used for the majority of the analyses in the study, due to a lack of diagnostic group differences in EED scores at baseline. Our results might have been influenced by the small sample size of BN and EDNOS patients.

The quantity dimension of exercise was not reported in the study, which may be considered a limitation. Due to differences in how this behaviour has been reported in EED

Versions 1 and 2, we decided not to include this information. However, in the validation study an association was found between EED scores and high-level exercise (frequency, intensity, and duration). The majority of patients who were high-level exercisers had high EED scores, whereas among controls the majority of such high-level exercisers had low EED scores. From a clinical perspective, defining the level of exercise as harmful or not should also be evaluated in relation to somatic conditions (e.g. degree of underweight), fitness level (e.g. athletes), and former exercise behaviour [9].

Admission time showed great variation in the study, and prolonged admissions were mainly due to the time necessary to restore weight in severely underweight AN patients, but also related to symptoms of comorbidity. There was only one measurement following discharge and the duration of the follow-up interval varied across individual patients. It is important for our results to be replicated in a sample that is large enough to examine different diagnostic groups and different follow-up periods.

So far, there have been no published reports of randomized control trials in which exercise intervention in an inpatient treatment programme has been compared to no exercise intervention, and this makes it difficult to draw conclusions about the impact of exercise interventions. However, the findings in our study show the importance of attitudes towards compulsive exercise for outcome in patients with eating disorders and support the relevance of assessing and addressing attitudes towards compulsive exercise during treatment.

**Conclusions**

We found a significant reduction in thoughts and attitudes towards compulsive exercise during treatment and that these changes predict outcome, as indicated by reduced eating disorder pathology and increased BMI for underweight patients. The results of the study have implications for future research. In order to evaluate the impact of exercise interventions on outcome, it is important to include a control group and to investigate the relationship to both quality and quantity dimensions.

**Abbreviations**

| | |
|---|---|
| AN | anorexia nervosa |
| BAT | Body Attitude Test |
| BDI | Beck Depression Inventory |
| BMI | body mass index |
| BN | bulimia nervosa |
| DSM | Diagnostic and Statistical Manual of Mental Disorders |
| EDI | Eating Disorder Inventory |
| EED | Exercise and Eating Disorder |
| EDNOS | Eating Disorder Not Otherwise Specified |
| ICC | intraclass correlation |
| IIP | Inventory of Interpersonal Problems |
| LR | likelihood ratio |
| NPMP | Norwegian Psychomotor Physiotherapy |
| SCL | Symptom Checklist |

**Competing interests**

The authors are responsible for the writing this paper and its content. No conflicts of interest are reported.

**Authors' contributions**

MD was responsible for conducting the study and ØR and SB has contributed through the whole process. The manuscript was written collaboratively.UR provided statistical support. All authors have read and approved the final manuscript.

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# 8 Appendix

NORD-TRØNDELAG HOSPITAL TRUST
DEPARTMENT OF PSYCHIATRY, NORWAY

# **Exercise and Eating Disorders (EED19)** Version 3

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English translation by D. Reas in collaboration with M. Danielsen

Please check the alternative for each statement that best describes you over the past four weeks.

| | | never | rarely | sometimes | often | usually | always |
|---|---|---|---|---|---|---|---|
| 1 | I enjoy being physically active. | | | | | | |
| 2 | I like to exercise with other people. | | | | | | |
| 3 | I am physically active to be healthy. | | | | | | |
| 4 | I am physically active to become thin | | | | | | |
| 5 | I am physically active to burn calories I've eaten. | | | | | | |
| 6 | I am physically active to avoid dealing with negative emotions. | | | | | | |
| 7 | I am physically active for appearance reasons. | | | | | | |
| 8 | It feels wrong if I can't be active everyday. | | | | | | |
| 9 | If I haven't been physically active, I don't eat. | | | | | | |
| 10 | If I haven't been physically active, I can't relax. | | | | | | |
| 11 | If I haven't been physically active, I get a bad conscience. | | | | | | |
| 12 | If I haven't been physically active, my body feels big. | | | | | | |
| 13 | If I haven't been physically active, my body feels disgusting. | | | | | | |
| 14 | I notice when I feel fit/in shape. | | | | | | |
| 15 | I notice when I get tired. | | | | | | |
| 16 | I notice when I get thirsty. | | | | | | |
| 17 | I notice when I get hungry. | | | | | | |
| 18 | I notice physical pain. | | | | | | |
| 19 | I listen to my body. | | | | | | |

20 How frequently do you exercise? By exercise we mean, for example, going for walks, skiing, swimming or training/sport? Give an average.

- Never ☐
- Less than once a week ☐
- Once a week ☐
- 2 – 3 times per week ☐
- Almost every day ☐

21 If you do such exercise as frequently as once or more times a week: How hard do you push your self? Give an average.

- I take it easy without breaking into a sweat or losing my breath ☐
- I push myself so hard that I lose my breath and break into a sweat ☐
- I push myself to near-exhaustion ☐

22 How long does each session last? Give an average.

- Less than 15 minutes ☐
- 15 – 29 minutes ☐
- 30 minutes – 1 hour ☐
- More than 1 hour ☐

Question 20 – 22 comes from The HUNT study, a longitudinal population health study in Norway (HUNT)

Subscales

1. Compulsive exercise. Statement number: 6, 8, 9, 10, 11, 12, 13 and 19.
2. Positive and healthy exercise. Statement number: 1, 2 and 3.
3. Awareness of bodily signals. Statement number 14, 15, 16, 17 and 18.
4. Exercise for weigth and shape reasons. Statement number 4, 5 and 7.

Calculation

All items has a response scale from never til always, zero to five. The scale is reversed for statements with positive meaning.

Items 4, 5, 6, 7, 9, 10, 11, 12, and 13. Never = 0 and Always = 5

Items 1, 2, 3, 14, 15, 18 and 19. Always = 0 and Never = 5

In calculations of Global score and subscale score, the mean scores of all actual items are used.

The validated version, EED version 2 consists of 18 items. In EED Version 3 one item covering awareness of physical pain is included (item number 18), and a timeframe of four weeks to provide a greater understanding of when change occur

To assist in clinical work it is estimated a classification of severity of the EED questionnaire. In this classification the patients are divided into approximately four equal groups based on Global score. This is not strictly separate groups, but increased severity is associated with increasing exercise frequency and intensity, and eating disorder symptoms. We interpret this phenomenon as being on a continuum scale

Group 1: No symptom of compulsive exercise: Global score below 1.8.
Group 2: Low severity of compulsive exercise: Global score from 1.8 to 2.4.
Group 3: Moderate severity of compulsive exercise: Global score from 2.4 to 3.2.
Group 4: High severity of compulsive exercise: EED Global score above 3.2.