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Predictors and moderators of treatment outcome in inpatients with anorexia nervosa

Kumulative Habilitationsschrift

vorgelegt von

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Summary

1. Background

Anorexia nervosa (AN) is a severe, life-threatening eating disorder that is typically marked by underweight, restrictive eating behavior, and body image disturbance (American Psychiatric Association, 2013). Inpatient treatment significantly increases body weight and decreases disordered eating behaviors (Schlegl et al., 2016; Schlegl et al., 2014). However, relapse rates are high, particularly within the first year after discharge (Berends et al., 2018). Thus, there is a need of not only examining short-term but also long-term success of inpatient treatment. Moreover, there is considerable heterogeneity in treatment outcome, indicating individual differences in treatment response. Thus, identification of predictors and moderators of treatment outcome is needed that may help in tailoring treatment individually and preventing relapse by arranging appropriate aftercare. Finally, while most studies focus on core AN symptoms when examining treatment outcome, effects of inpatient treatment on other important aspects such as life satisfaction, sleep quality, and obsessive–compulsive symptoms have rarely been investigated in persons with AN.

2. Method

This habilitation includes a series of retrospective analyses for testing treatment outcome and its predictors and moderators in patients with AN who received inpatient treatment at the Schoen Clinic Roseneck (Prien am Chiemsee, Germany). The inpatient treatment offered at the hospital adheres to the German S3-guidelines for the treatment of AN (Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften, 2020; Resmark et al., 2019) in terms of admission criteria, treatment elements, and therapy goals. Thus, patients received a cognitive-behavioral therapy-oriented, multimodal AN treatment that—in addition to a high-calorie refeeding schedule—included several treatment elements such as individual psychotherapy sessions, group therapy sessions, supervised meals, exercise therapy, meal preparation classes, body image exposure, nutrition counseling, and food intake protocols as well as clinical management of medical complications.

3. Findings

3.1 Seasonal effects on body weight at admission

In a first analysis (Meule et al., 2020b), we examined differences in body weight at admission between AN subtypes (restrictive vs. binge/purge vs. atypical AN). Patients with restrictive type AN had lower body weight at admission in the winter than in the summer. This difference was not found in patients with binge/purge type and atypical AN. Thus, seasonal variations in body weight in patients with restrictive type AN seem to be opposite to seasonal variations in healthy persons (who tend to have a higher body weight in winter than in summer). Proposed mechanisms of this effect are biological and behavioral aspects of thermoregulation, suggesting that heat treatment may facilitate treatment success in patients with AN in the colder months (Gutiérrez & Carrera, 2020).

3.2 Illness duration as predictor of treatment outcome

Illness duration has often been tested as predictor of treatment outcome in patients with AN but studies have yielded inconsistent findings (Radunz et al., 2020). In our analyses, longer illness duration was related to poorer treatment outcome but effect sizes were small (Meule, Kolar, et al., 2023). Moreover, illness duration was strongly correlated with patients' age and comparing their predictive value showed that models were indistinguishable, indicating that illness duration does not add further information to considering patients' age when predicting treatment outcome.

3.3 Depressive symptoms as predictor of treatment outcome

Similar to illness duration, the role of depressive symptoms on treatment outcome in patients with AN has often been tested but these studies produced mixed results (Eskild-

Jensen et al., 2020; Meule et al., 2020a). In our analyses, more depressive symptoms related to larger weight gain during inpatient treatment but this effect was small and could be explained by longer treatment duration (Meule et al., in revision). Thus, depressive symptomatology does not appear to adversely affect treatment outcome (at least in terms of weight gain) in inpatients with AN.

3.4 Weight suppression as predictor of treatment outcome

Weight suppression refers to the difference between an individual's current and highest body weight. Higher weight suppression has been found to predict larger weight gain in both non-clinical and clinical samples (Lowe et al., 2018). In our analyses, body weight increased non-linearly during inpatient treatment (Meule, Kolar, & Voderholzer, 2022). Higher weight suppression predicted larger weight gain but the nature of this effect depended on body mass index at admission. In patients with a relatively low body weight at admission, those with high weight suppression started at a lower weight and showed a nearly linear and steeper weight gain than those with low weight suppression. In patients with a relatively high body weight at admission, those with high weight suppression started at a similar weight and showed a non-linear and larger weight gain than those with low weight suppression. These findings further support that weight suppression is a robust predictor of weight gain in addition to—and in interaction with—current body weight. As weight suppression can easily be assessed at admission, it may help to anticipate treatment course and outcome in patients with AN.

3.5 Treatment outcome in adolescent AN patients at one-year follow up

In a sample of adolescent inpatients with AN, we examined treatment outcome at one-year follow up after discharge (Meule et al., 2021). On average, body weight increased and eating disorder symptoms and depressive symptoms decreased from admission to discharge and remained stable at follow up. Compulsive exercise decreased and life satisfaction

increased from admission to discharge and even improved further at follow up. Age, illness duration, previous inpatient treatments, length of stay, and readmission after discharge moderated changes in several outcome variables. Thus, this study confirmed the high effectiveness of inpatient treatment for adolescents with AN and demonstrated that treatment effects remain stable or even improve further within the first year after discharge. However, subgroups of patients (e.g., those with an older age, longer duration of illness, and previous inpatient treatments) require special attention during inpatient treatment and aftercare to prevent relapse.

Current treatment guidelines (e.g., by the National Institute for Health and Care Excellence and the American Psychiatric Association) recommend that inpatients with eating disorders—particularly adolescents with AN—should receive treatment at facilities within close distance to their home (Anderson et al., 2017; Resmark et al., 2019). Therefore, we also tested whether distance from home would moderate treatment outcome across admission, discharge, and follow up (Meule, Kolar, Naab, et al., 2022), which it did not. This analysis is the first to indicate that specialized inpatient treatment for adolescents with AN is effective both close to and away from home.

In another analysis of this study, we tested whether patients' own predictions about their future weight would be related to their actual weight changes after discharge (Meule, Furst Loredo, et al., 2022). Indeed, patients' own predictions about their future weight trajectories predicted their actual weight change after discharge: those who indicated that they would gain weight, gained weight, those who indicated that they would lose weight, lost weight, and those who indicated to maintain their weight, had no weight change on average. Similarly, expected weight change in kilograms correlated positively with actual weight change after discharge. Thus, patients who expect that they will lose weight again should receive intensified aftercare that fosters motivation to change.

3.6 Changes in life satisfaction, sleep quality, and obsessive–compulsive symptoms during inpatient treatment

A final set of analyses examined changes in other important aspects that are not part of core AN symptoms. Life satisfaction significantly increased in inpatients with AN and other eating disorders from admission to discharge and this increase was significantly larger than in inpatients with other mental disorders (Meule & Voderholzer, 2020). This pattern of results was similarly found for improvements in sleep quality (Meule, Riemann, et al., 2023). Although life satisfaction and sleep quality increased with large effect sizes, discharge scores were still below the scores of non-clinical samples.

Obsessive–compulsive disorder (OCD) is one of the most prevalent comorbidities in AN but reducing obsessive–compulsive symptomatology is not the primary objective during treatment of AN and, thus, these symptoms may remain unchanged or even increase in terms of a "symptom shift" (Garke et al., 2019). In our analyses (Meule & Voderholzer, 2022), obsessive–compulsive symptoms decreased from admission to discharge, irrespective of whether patients had comorbid OCD or not and whether they were adolescents or adults. Within-person decreases in obsessive–compulsive symptoms weakly correlated with increases in body weight. These results indicate that obsessive–compulsive symptoms decrease during inpatient treatment of AN although they are not primarily targeted during treatment. Furthermore, these improvements seem to be associated with general improvements in AN symptomatology. Yet, effect sizes were small and obsessive–compulsive symptoms were still clinically elevated in patients with comorbid OCD at discharge, suggesting that these patients need OCD-specific, psychotherapeutic aftercare.

4. Conclusions

The current studies corroborate that inpatient treatment is highly effective in increasing body weight and decreasing eating disorder symptoms in both adolescents and adults with AN. They also show that individual differences in treatment outcome are predicted by easily assessable variables (e.g., age, weight suppression, patients' expectations) that may help in anticipating treatment course. Yet, other variables that would be intuitively deemed relevant seem to play a minor (e.g., depression, distance to home) or redundant (e.g., illness duration) role in predicting treatment outcome. Finally, they demonstrate that aspects that are not specifically targeted during AN treatment (e.g., life satisfaction, sleep quality, obsessive–compulsive symptoms) also improve during inpatient treatment but that these improvements do not reach levels found in non-clinical samples, thus highlighting the importance of continued psychotherapeutic treatment after discharge.

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BRIEF REPORT

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Seasonal and subtype differences in body mass index at admission in inpatients with anorexia nervosa

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Abstract

Objective: In the general population, body weight is—on average—higher in the winter than in the summer. In patients with anorexia nervosa (AN), however, the opposite pattern has been reported. Yet, only a handful of studies exist to date that suffer from small sample sizes and inconsistent results. Therefore, the current study examined seasonal effects on body weight in a large sample of patients with AN to dissolve previous inconsistencies.

Method: Clinical records of N = 606 inpatients (95.4% female) who received AN treatment at the Schoen Clinic Roseneck (Prien am Chiemsee, Germany) between 2014 and 2019 were analyzed.

Results: Patients with restrictive type AN had lower body mass index at admission in the winter than in the summer. This difference was not found for patients with binge/purge type AN and patients with atypical AN.

Discussion: Individuals with restrictive type AN show seasonal variations in body weight that are opposite to seasonal variations in body weight in individuals without AN. These seasonal effects are specific to the restrictive subtype and cannot be found for the binge/purge or atypical subtypes. Future studies that replicate this effect in other cultures or latitudes and that examine the mediating mechanisms are needed.

KEYWORDS

anorexia nervosa, atypical anorexia nervosa, binge/purge subtype, body mass index, restrictive subtype, seasonality

1 | INTRODUCTION

Seasonal variations in body weight have been consistently reported. In European and North American countries, body mass index (BMI) is on average higher in the winter than in the summer (Mehrang, Helander, Chieh, & Korhonen, 2016). This pattern has been found both in the general population (Visscher & Seidell, 2004) and in overweight adults participating in a behavioral weight loss intervention (Fahey, Klesges, Kocak, Talcott, & Krukowski, in press). Possible mechanisms that explain increases in body weight during the winter include a reduction in physical activity and increased consumption of high-calorie foods compared to the summer period (Lloyd & Miller, 2013; Ma et al., 2006; Sabbağ, 2012; Sturm, Patel, Alexander, & Paramanund, 2016; Westerterp, in press).

In a small sample of 37 adolescents with anorexia nervosa (AN; 68% restrictive type) from the Netherlands, Carrera et al. (2012) reported the peculiar finding that participants during the cold season (October to April) had lower BMI than participants in the warm season, suggesting that seasonal changes in body weight in individuals with AN may be opposite to the seasonal changes found in persons without AN. Two later studies extended this finding, suggesting that seasonal variations in BMI in individuals with AN depend on AN subtype. Specifically, in a study from Spain, Fraga et al. (2015) found that BMI at admission in the cold season (November to April) was lower in adolescent inpatients with restrictive type AN than in binge/purge type AN, whereas subtypes did not differ in BMI in the warm season. Similarly, in a study from Germany, Born et al. (2015) found that BMI at admission during autumn and winter was lower in adult inpatients with restrictive AN than in binge/purge type AN, whereas subtypes did not differ in BMI during spring and summer. Both studies, however, were based on small sample sizes ($n = 86$ and $n = 68$) with particularly small groups of patients with binge/purge type AN.

To overcome these limitations, Kolar et al. (2018) examined clinical records of 304 adolescent inpatients from a multi-centric database in Germany. Although they indeed found an interactive effect between season and AN subtype on BMI at admission, the nature of this interaction indicated higher body weight during the cold than the warm season in patients with restrictive type AN. Hence, the current state of affairs is that the study with the largest sample size to date found seasonal differences in BMI in patients with restrictive type AN that are opposite to the seasonal differences found in three small-scale studies and, therefore, no clear conclusions can be drawn about the existence and the direction of seasonal BMI variations in AN. Thus, we examined clinical records of more than 600 patients with AN with the aim of dissolving previous inconsistent findings.

2 | METHOD

Clinical records of individuals with AN who received inpatient treatment at the Schoen Clinic Roseneck (Prien am Chiemsee, Germany) between 2014 and 2019 were analyzed. Data of $N = 606$ inpatients (95.4% female, $n = 578$) were available for the current analyses. Mean age was 22.7 years ($SD = 9.76$, range: 12–69). The majority of patients were diagnosed as restrictive type AN (F50.00; 61.6%); 22.4% were diagnosed as binge/purge type AN (F50.01); and 16.0% were diagnosed as atypical AN (F50.1; Table 1), according to the German version of the International Classification of Diseases (ICD-10-GM, https://www.dimdi.de/static/de/klassifikationen/icd/icd-10-gm/kode-suche/htmlgm2020/block-f50-f59.htm). These groups did not differ in age ($F_{[2,603]} = 2.87$, $p = 0.057$, $\eta^2_p = 0.009$) but differed in sex distribution ($\chi^2_{[2]} = 6.53$, $p = 0.038$, $\phi = 0.104$) with patients with atypical AN having a higher proportion of men (9.3%) than patients with binge/purge subtype (5.1%) and restrictive subtype (3.2%).

Previous studies applied different categorizations of warm versus cold season (e.g., differing in the assignment of October and April; Carrera et al., 2012; Fraga et al., 2015; Kolar et al., 2018). Thus, we decided to follow the classification of meteorological seasons (similar to Born et al., 2015): spring (March to May), summer (June to August), autumn (September to November), and winter (December to February) based on the patients' admission date. A univariate analysis of variance was run with IBM SPSS Statistics Version 24, entering subtype and season as between-subjects factors and BMI at admission as dependent variable. Significant effects ($p < 0.05$) were followed up with independent samples t-tests. The data that support the findings of this study are available in the Supplementary Material of this article.

3 | RESULTS

The main effect of season was not significant ($F_{[3,594]} = 0.28$, $p = 0.838$, $\eta^2_p = 0.001$). A significant main effect of subtype ($F_{[2,594]} = 14.4$, $p < 0.001$, $\eta^2_p = 0.046$) indicated that both the patients with restrictive type AN ($M = 14.7$ kg/m^2, $SD = 1.88$, $t_{[468]} = 5.72$, $p < 0.001$, $d = 0.652$) and the patients with binge/purge type AN ($M = 15.1$ kg/m^2, $SD = 2.06$, $t_{[231]} = 3.36$, $p = 0.001$, $d = 0.447$) had lower BMI than the patients with atypical AN ($M = 16.0$ kg/m^2, $SD = 1.92$). A significant interaction season × subtype ($F_{[6,594]} = 2.63$, $p = 0.016$, $\eta^2_p = 0.026$), however, qualified this effect. This interaction was also significant when age and sex were included as covariates ($F_{[6,592]} = 2.39$, $p = 0.027$, $\eta^2_p = 0.024$). Given the large number of possible group comparisons, we focused on the summer and winter seasons as these can be most clearly differentiated in terms of outside temperature. In the summer, the three subtypes did not differ from each other (all ps > 0.733). In the winter, the patients with restrictive type AN had lower BMI than both the patients with binge/purge type AN ($t_{[144]} = 2.93$, $p = 0.004$, $d = 0.580$) and the patients with atypical AN ($t_{[136]} = 3.30$, $p = 0.001$, $d = 0.730$). The patients with binge/purge type AN and the patients with atypical AN did not differ in BMI ($t_{[56]} = 0.62$, $p = 0.539$, $d = 0.164$). Furthermore, the patients with restrictive type AN had lower BMI in the winter than in the summer ($t_{[202]} = 2.89$, $p = 0.004$, $d = 0.407$), whereas BMI did not differ

TABLE 1 Descriptive statistics of body mass index (kg/m^2) at admission as a function of subtype and season

	Subtype								
N = 606	**Restrictive (n = 373)**			**Binge/purge (n = 136)**			**Atypical (n = 97)**		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Spring (*n* = 178)	101	14.5	1.92	48	14.8	2.12	29	16.4	1.64
Summer (*n* = 150)	91	15.2	1.85	36	15.3	1.94	23	15.4	2.22
Autumn (*n* = 107)	68	14.8	1.75	19	14.3	2.32	20	16.1	1.61
Winter (*n* = 171)	113	14.5	1.89	33	15.5	1.83	25	15.9	2.11

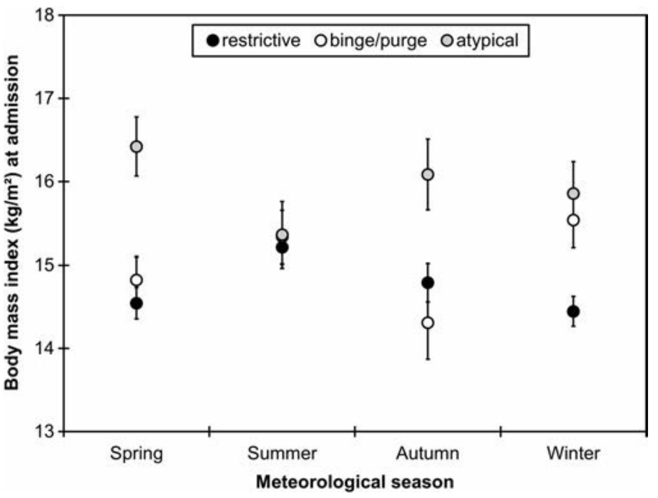

FIGURE 1 Mean body mass index at admission as a function of subtype and season. Error bars represent the standard error of the mean

between winter and summer in the other two subtypes (both *ps* > 0.431; Table 1; Figure 1).

4 | DISCUSSION

Previous studies have reported inconsistent and, in fact, opposing seasonal differences in body weight in inpatients with restrictive type AN. The current study reports the largest sample of patients with AN to date in which seasonal variations in BMI at admission were examined as a function of AN subtypes. In line with the findings by Fraga et al. (2015) and Born et al. (2015), inpatients with restrictive type AN had lower BMI at admission in the winter than in the summer, and this difference was not observed for binge/purge type and atypical AN.

Several possible mechanisms for this effect have been proposed. For example, seasonality effects on BMI might be mediated by increased physical activity in individuals with AN. Specifically, as individuals with AN have lower body surface temperature and self-perceived warmth than individuals without AN in most body parts (Belizer & Vagedes, 2019), they may increase physical activity at cold ambient temperatures as a thermoregulatory behavior (Carrera et al., 2012). In line with this, preliminary evidence based on case reports suggests that heat treatment results in a reduction of hyperactivity, anxiety, and depression in patients with AN (Gutierrez & Vazquez, 2001), although results from randomized controlled trials have been mixed (Carrera & Gutiérrez, 2018). Another explanation posits that individuals with AN have deficient insulation due to reduced subcutaneous fat, and thus, the body expends more energy for thermoregulation at cold ambient temperatures (Fraga et al., 2015). Hypothetically, this process may be mediated by brown adipose tissue, which is activated by hypothermia, dissipates energy, and generates heat (Freemark & Collins, 2018). Finally, it has also been suggested that reduced exposure to sunlight in the winter and lower vitamin D concentrations may also influence body weight, for example, through increased depressiveness (Kolar et al., 2018).

At least two methodological aspects need to be considered when interpreting findings from the current and from the previous studies. One aspect refers to the definition of AN subtypes. In the current study, this differentiation was based on the ICD-10-GM, whereas other studies referred to the criteria in the fourth (Carrera et al., 2012; Fraga et al., 2015) or fifth (Kolar et al., 2018) version of the Diagnostic and Statistical Manual of Mental Disorders (DSM) or did not specify the definition criteria (Born et al., 2015). Similarly, prevalence of patients being classified as binge/purge-type AN differed across studies between 4% (Kolar et al., 2018) and 53% (Born et al., 2015), which might be due to different subtype definitions. A crucial aspect may be the presence of excessive exercise, which would not represent a purging behavior according to the DSM but which is not explicitly excluded in the definition of binge/purge-subtype AN in the ICD-10-GM. Another aspect refers to the definition of the warm and cold seasons. In the current study, we differentiated between the four meteorological seasons (as the large sample size allowed us to do so), whereas previous studies combined autumn/winter and spring/summer (Born et al., 2015) or differentiated between warm and cold season based on outside temperature, but with different definitions (Carrera et al., 2012; Fraga et al., 2015; Kolar et al., 2018). Thus, these methodological differences may partly explain inconsistent findings about seasonal effects on body weight in AN.

Although the current study cannot answer the question about the mediating mechanisms, it offers robust support for the counterintuitive seasonal variations in body weight in a large, heterogeneous sample of patients with AN that includes both adolescents and adults as well as both males and females. Furthermore, it highlights the crucial role of differentiating between AN subtypes. In addition to examining possible mediators that drive reductions of body weight in persons with restrictive AN in the winter, future studies also need to examine possible moderators of this effect, for example, whether it replicates in cultures and latitudes outside of Europe as well.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available in the supplementary material of this article.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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Comparing illness duration and age as predictors of treatment outcome in female inpatients with anorexia nervosa

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ABSTRACT

It has been widely assumed that longer illness duration predicts poorer treatment outcome in persons with anorexia nervosa (AN). However, studies on the prognostic effects of illness duration have produced mixed results. Thus, the aim of the current study was to examine the relationship between illness duration and short-term treatment outcome in a large sample of female inpatients with AN (n = 902, aged 12–73 years). Treatment outcome variables included body mass index, therapist-rated global functioning (Global Assessment of Functioning scale and Clinical Global Impression–Improvement scale) and subscales of the Eating Disorder Inventory–2. Longer illness duration predicted smaller weight gain, smaller improvements in global functioning, and smaller decreases in self-reported eating disorder symptoms. However, illness duration was almost perfectly correlated with patients' age (r = .81, 95% CI [.76, .85]), and comparing regression models revealed that models using either illness duration or age were indistinguishable. Results suggest that longer illness duration does indeed relate to worse short-term treatment outcome in inpatients with AN. This effect, however, does not add significant information above and beyond patients' age and, thus, the importance of illness duration for anticipating treatment outcome both in research and in clinical practice must be critically examined.

Clinical Implications

- Longer illness duration related to worse treatment outcome in inpatients with anorexia
- Higher age also related to worse treatment outcome in inpatients with anorexiar
- Illness duration does not seem to add significant information above and beyond patients' age

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Introduction

In recent years, there has been a lively discussion about the definition and treatment of chronic cases with anorexia nervosa (AN)—usually termed severe and enduring AN (Broomfield et al., 2017; Wildes et al., 2017; Wonderlich et al., 2020). In addition to exposure to previous treatments, one essential component of severe and enduring AN is a long illness duration (e.g., longer than 3 years; Hay & Touyz, 2018). As current treatment approaches do not seem to result in long-term recovery in these patients, researchers have begun to examine treatment options that may better suit these cases (Wonderlich et al., 2020). While it has been widely assumed that a longer illness duration predicts poorer treatment outcome in patients with AN, studies on the prognostic effects of illness duration have produced mixed results (Wonderlich et al., 2020). A recent meta-analysis even concluded that eating disorder duration did not predict treatment outcome in patients with AN and bulimia nervosa (Radunz et al., 2020). Yet, substantial heterogeneity in the methodology and results of the individual studies was noted, and there were only few studies that allowed for a stand-alone analysis of a specific outcome (e.g., weight gain). Although there have already been newer studies that were not included in this meta-analysis, these have yet again produced heterogeneous findings: while one study found that longer illness duration predicted larger weight loss after discharge in a sample of adolescent and adult inpatients (M = 26 years, Range 14–64) with a mean illness duration of 9 years (Glasofer et al., 2020), another study did not find that illness duration was related to weight changes during and after inpatient treatment in a sample of adults (M = 33 years, Range 18–73) with a mean illness duration of 13 years (Redgrave et al., 2021).

An aspect of research on the effects of illness duration that has been widely neglected is the role of age, which has been repeatedly found to be a prognostic factor of treatment outcome in AN with younger patients having a more favorable outcome (e.g., Agras et al., 2014; Meule et al., 2021; Schlegl et al., 2016). As the age of AN onset often lies in adolescence and early adulthood, there is evidence that illness duration is highly correlated with age. For example, in a study by Raykos et al. (2018)—in which the correlation was not reported in the article but the data of which can be accessed elsewhere (https://osf.io/esgzb)—the correlation between AN outpatients' age (M = 24 years, Range 16–71) and illness duration was r = .84. In the study by Glasofer et al. (2020)—in which the correlation was also not reported—it was r = .79 (personal communication with the authors). In a recent study by Davis et al. (2020), the correlation between age and illness duration in 69 adolescent and adult inpatients (M = 24 years, Range 13–48) with AN was r = .84. Given that illness duration is subject to substantial recall bias when calculated by subtracting retrospectively reported age of onset from current age, the additional merit of using illness duration instead of current age in cross-sectional studies is questionable.

Therefore, the aim of the current study was twofold. First, given the inconsistent findings regarding the effects of illness duration on treatment outcome in patients with AN—which may partially be attributed to underpowered studies—there is a need to test the effect of illness duration on treatment outcome in large-scale samples. Thus, we examined data of more than 900 female inpatients with AN. Specifically, we tested whether illness duration predicted short-term treatment outcome on three levels: an objective indicator of treatment outcome (weight change from admission to discharge), external assessment of treatment outcome (therapist-rated change in global functioning), and self-report (subscales of the *Eating Disorder Inventory–2* [EDI–2]). Second, as illness duration appears to be highly—in fact, almost perfectly—correlated with patients' age, we examined the correlation between these two variables in the current sample and tested whether using illness duration or age at admission as predictors of treatment outcome would yield distinguishable results.

Methods

Sample description

Clinical records of female inpatients with AN who were treated at two Schoen Clinics (Prien am Chiemsee and Bad Staffelstein, Germany) between 2015 and 2020 were analyzed. At the (Schoen Clinics), data from the routine diagnostic assessment (e.g., age, sex, diagnoses, body weight, and questionnaire scores) are automatically transferred to a database from which they can be exported without any identifying information (e.g., name, date of birth, and place of residence) by authorized employees. Thus, accessing individual patient charts is unnecessary. According to the guidelines by the institutional review board of the (LMU Munich), retrospective studies conducted on already available, anonymized data are exempt from requiring ethics approval.

At both sites, the inpatient treatment adheres to the German S3-guidelines for the treatment of AN (Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften, 2020; Resmark et al., 2019) in terms of admission criteria, treatment elements, and therapy goals. Thus, patients received a cognitive-behavioral therapy-oriented, multimodal AN treatment that included several treatment elements such as individual psychotherapy sessions, group therapy sessions, exercise therapy, meal preparation classes, body image exposure, nutrition counseling, and food intake protocols as well as clinical management of medical complications. The treatment includes a high-calorie refeeding schedule (starting on the first day of treatment) that aims at a weight gain of 0.7–1.0 kg per week for all underweight AN patients. This schedule includes three meals per day, each having approximately 700 kcal and, thus, totaling to a daily caloric intake of approximately 2100 kcal. Meals are supervised by a nurse or therapist in earlier treatment stages. The schedule is individually tailored if patients do not finish their meals or do not show the expected weight gain by increasing portion size, adding snacks between meals, or offering sip feeds. As normalization of eating behavior is one of the therapeutic goals, patients do not receive nasogastric feeding. Patients can choose between vegetarian and non-vegetarian menus; vegan menus are not offered.

Measures

Illness duration was assessed by the patients' therapist in a non-standardized way. Specifically, psychotherapists at the (Schoen Clinics) are asked to complete a set of items about patient- and treatment-related information at discharge. One of these items asks about the patients' illness duration in years, with no further definition or assessment guidelines provided. This is because therapists are asked to provide this information for every patient (i.e., not only for the patients with AN), which is why no standardized definition can be specified. Furthermore, as completing the items is an extra effort in addition to the therapists' usual documentation, the item wordings were chosen to be very brief.

Six treatment outcome variables were analyzed. First, body mass index (BMI) at admission and discharge was calculated as kg/m^2 from patients' weight and height, which were measured at the hospitals. Second, therapists evaluated the patients' global functioning on the *Global Assessment of Functioning* (GAF) scale (American Psychiatric Association, 1994) before admission (retrospectively) and at discharge, scores of which can range between 1 (*severely impaired*) and 100 (*extremely high functioning*). Third, therapists rated change in global functioning at discharge on the *Clinical Global Impression–Improvement* (CGI) scale (Guy, 1976), scores of which can range between 1 (*very much improved*) and 7 (*very much worse*). For data analysis and comparability purposes, this scale was recoded to range from −3 (*very much worse*) to +3 (*very much improved*). Finally, patients completed the German version of the EDI–2 (Garner, 1991; Paul & Thiel, 2004) at admission and discharge. The EDI–2 has 11 subscales but only three of them assess core eating disorder symptoms: drive for thinness, bulimia, and body dissatisfaction. Thus, only these three subscales were used in the current analyses. Internal reliability coefficients were ω = .88 (drive for thinness), ω = .91 (bulimia), and ω = .83 (body dissatisfaction) at admission and ω = .91 (drive for thinness), ω = .84 (bulimia), and ω = .82 (body dissatisfaction) at discharge.

Data analyses

All data analyses were conducted using *R*, version 4.2.0 (R Core Team, 2020) and *RStudio*, version 2022.2.02 (RStudio Team, 2022). We computed robust linear regressions using the *MASS* package version 7.3–57 (Venables & Ripley, 2002) to regress treatment outcome measures on illness duration or age at admission. To account for baseline differences, admission scores of treatment outcome measures were added as covariates, if applicable. 95% CIs and p-values for model parameters were bootstrapped with k = 5000 iterations as described in Davison and Hinkley (1997, p. 592) by adapting existing code for robust linear regressions (Lancelot, 2016). The non-nested robust linear regression models for illness duration and age were compared using the *nonnest2* package version 0.5–5 (Merkle & You, 2020; Merkle et al., 2016). For each treatment outcome, models with illness duration or age at admission as predictors were tested for model distinguishability (variance test; can the models be possibly distinguished based on the observed data) and model fit (non-nested likelihood ratio test; H0: model fits are equal; H1A: the illness duration model fits better, H1B: the age model fits better) as described by Vuong (1989). On request of the reviewers, we conducted a sensitivity analysis by including treatment duration (in months) as a covariate into the robust regression models. The resulting models were then again tested for distinguishability and model fit. The data set and annotated *R*-code for our main analyses are available at https://osf.io/9hsvq.

Results

Between May 2015 and May 2020, N = 3297 female inpatients with AN were treated at the hospitals. However, therapist-rated illness duration was only available for n = 1538 patients. Therapist-rated GAF and CGI were missing for another 16 patients, and EDI–2 scores at admission and/or discharge were missing for another 480 patients. From the remaining 1042 patients for which complete data at both admission and discharge for all variables of interest were available, we further excluded patients (n = 140) with a BMI > 18.5 kg/m^2 as weight gain was not the primary treatment target in these patients. Thus, the final sample size was n = 902 patients who were treated for an average of 93.4 days (SD = 49.7). Mean age at admission was 23.4 years (SD = 9.35, Range 12–73) and mean illness duration was 6.89 years (SD = 7.28). Age at admission and illness duration were highly positively correlated (r = .81, 95% CI [.76, .85]). Descriptive statistics of treatment outcome variables and effect sizes of changes from admission to discharge are displayed in Table 1. Longer illness duration predicted smaller weight gain, smaller improvements in global functioning as assessed with the GAF and CGI, and smaller decreases in self-

Table 1. Overview of treatment outcome variables.

	Admission			Discharge			Test statistics		
N = 902	*M*	*SD*	Range	*M*	*SD*	Range	*d*	*t*	*p*
Body mass index (kg/m^2)	15.2	1.89	9.50–18.5	18.1	1.65	12.7–23.8	−1.65	−49.5	<.001
Global Assessment of Functioning	41.5	10.8	5–95	56.3	12.3	8–95	−1.13	−34.0	<.001
Clinical Global Impression—Improvement scale[a]	–	–	–	1.76	0.81	−2–3	–	–	–
Drive for thinness (EDI–2)	28.6	8.63	7–42	23.9	8.45	7–42	0.61	18.2	<.001
Bulimia (EDI–2)	13.4	7.88	7–42	9.61	4.22	7–37	0.61	18.2	<.001
Body dissatisfaction (EDI–2)	33.1	11.1	9–54	32.2	10.4	9–54	0.13	3.74	<.001

Notes. EDI–2 = Eating Disorder Inventory–2. [a]The Clinical Global Impression—Improvement scale was recoded to-3 (*very much worse*) to +3 (*very much improved*).

Table 2. Coefficients of the robust regression analyses for the prediction of treatment outcome by illness duration and age.

	Robust linear regression models							
	Illness duration				Age			
Dependent variable	*b*	*SE*	95% CI	*p*	*b*	*SE*	95% CI	*p*
Body mass index (kg/m^2)	−0.015	0.006	−0.027, −0.003	.010	−0.010	0.005	−0.023, 0.002	.054
Global Assessment of Functioning	−0.302	0.049	−0.400, −0.205	<.001	−0.263	0.037	−0.364, −0.174	<.001
Clinical Global Impression–Improvement scale (recoded)	−0.016	0.003	−0.022, −0.008	<.001	−0.012	0.003	−0.020, −0.006	.001
Drive for thinness (EDI–2)	0.112	0.032	0.050, 0.175	<.001	0.087	0.025	0.026, 0.152	.003
Bulimia (EDI–2)	0.027	0.009	0.010, 0.045	<.001	0.016	0.007	−0.001, 0.034	.029
Body dissatisfaction (EDI–2)	0.055	0.030	−0.005, 0.112	.037	0.047	0.024	−0.012, 0.106	.062

Notes. EDI–2 = Eating Disorder Inventory–2. Note that higher body mass index, higher global functioning scores, and higher (recoded) clinical global impression–improvement scores but lower EDI–2 scores represent a better treatment outcome, which is why the regression coefficients have opposite signs.

reported eating disorder symptoms (Table 2). When using age at admission instead of illness duration as predictor of treatment outcome, however, model comparisons revealed that regression models were indistinguishable and showed equal model fit for most treatment outcomes (Table 3). This is also reflected in the closeness of their model fit parameters (Table 3). Only when regressing CGI on either illness duration or age at admission, distinguishable models were obtained, but model fit was still equal for both models, with an additional year of illness duration explaining only marginally more variance than being one year older at admission. When including treatment duration as a covariate, results were mostly robust except for BMI, bulimia scores and body dissatisfaction scores as treatment outcomes (changes in statistical significance for illness duration on BMI, and for age on bulimia and body dissatisfaction scores; Table S1 in the supplementary file). Illness duration and age models were now distinguishable, but none was superior to the other regarding model fit (Table S2 in the supplementary file).

Table 3. Model fit parameters and model comparisons for the prediction of treatment outcome by illness duration and age.

	Model fit parameters				Model comparisons					
	AIC		BIC		Variance test		Non-nested likelihood ratio tests			
Dependent variable	Illness duration	Age	Illness duration	Age	ω_*^2	p	z_1	p_1	z_2	p_2
Body mass index (kg/m^2)	3182.64	3183.96	3201.86	3203.18	0.003	.238	0.433	.333	0.433	.667
Global Assessment of Functioning	6942.97	6937.67	6962.19	6956.89	0.018	>.999	−0.662	.746	−0.662	.254
Clinical Global Impression–Improvement scale (recoded)	2162.17	2164.67	2176.59	2179.09	0.007	<.001	0.495	.310	0.495	.690
Drive for thinness (EDI–2)	6024.27	6026.55	6043.49	6045.77	0.007	>.999	0.467	.320	0.467	.680
Bulimia (EDI–2)	4750.28	4752.06	4769.49	4771.28	0.001	.895	0.889	.187	0.889	.813
Body dissatisfaction (EDI–2)	6092.51	6092.52	6111.73	6111.74	0.001	>.999	0.006	.498	0.006	.502

Notes. AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion. ω_*^2 and p indicate whether the illness duration and age model were distinguishable; z_1 and p_1 indicate whether the illness duration model is distinguishable from the age model based on the observed data; z_2 and p_2 indicate whether the age model fits better than the illness duration model.

Discussion

In the current study, longer illness duration predicted worse short-term treatment outcome in a large sample of female inpatients with AN. Importantly, this effect was demonstrated across different assessment methods of treatment outcome, that is, an objective indicator (BMI), external assessment (therapist-rated global functioning), and self-report (drive for thinness, bulimia, and body dissatisfaction subscales of the EDI–2). These findings are in contrast to a recent meta-analysis that did not find an association between eating disorder duration and treatment outcome (Radunz et al., 2020). In that meta-analysis, however, each of the eight studies that examined weight gain in AN had fewer than 170 participants, and six of them even had fewer than 100 participants. Given that we obtained relatively small estimates in our analyses based on a more than five times larger sample size, previous studies most likely lacked the statistical power to detect the small relationship between illness duration and treatment outcome. Of note, most results were robust to including treatment duration as a covariate into analyses.

When examining the correlation between illness duration and age at admission, it turned out that both variables were highly correlated, with the size of the correlation being comparable to other studies (around $r = .8$; Davis et al., 2020; Glasofer et al., 2020; Raykos et al., 2018). In line with this, comparing regression models of illness duration and age turned out to be indistinguishable. This comes as no surprise when two variables are so strongly associated with each other. In the study by Davis et al. (2020), for example, illness duration was correlated with a measure of habit strength with $r = .38$, while the correlation between age and habit strength was $r = .40$, which likewise demonstrates that correlates of these two variables are highly similar. As patients' age is much easier to assess, however, it appears that the importance that illness duration has received in the literature as an important clinical predictor for treatment outcome is unjustified. Although there are, of course, patients with a relatively young age and a relatively long illness duration and patients with a relatively old age and a relatively short illness duration, these cases seem to be rare and explanatory effects that illness duration might have in these patients are overshadowed by the strong correlation between age and illness duration. Thus, when only considering linear effects on treatment outcome, the rule-of-thumb that patients who are older at admission are more likely to show worse treatment outcome might be sufficient for clinical practice without having to calculate illness duration based on self-report data.

The age of onset of the disorder in AN (and bulimia nervosa) is often in adolescence and young adulthood. In fact, it has been estimated that in approximately 80% of cases the onset is before 25 years of age (Solmi et al., 2022). This may explain why age and illness duration are so highly correlated in persons with AN as cases of newly onset AN are rarely found in middle and older adulthood. Thus, the finding that illness duration does not seem to add significant information to patients' age may be specific to persons with AN and may not translate to other types of eating disorders. For example, average age of onset in persons with binge eating disorder is usually in young adulthood, but new onset cases can also be found across the life span (Hudson et al., 2007). Furthermore, persons with avoidant/restrictive food intake disorder usually have an earlier age of onset than AN (Becker et al., 2019; Cañas et al., 2021), and age seems to be unrelated to illness duration (Duncombe Lowe et al., 2019). Thus, it may well be that age and illness duration are not so strongly related in other eating disorders as they are in AN and, therefore, that illness duration may be a more crucial characteristic to take into account when anticipating treatment outcome or considering different treatment options.

A limitation of this study is that assessment of illness duration by the therapists was not standardized. To date, however, it seems that there is no gold standard of how to assess illness duration. For example, previous studies either used self-reports by the patients or interviews or did not specify the assessment method (Radunz et al., 2020). Moreover, different definitions of illness onset have been used, for example, date when all AN criteria were first met but also less strict criteria such as the beginning of weight loss or even just the time spent waiting for treatment (Austin et al., 2021). Thus, a standardized definition and assessment of illness onset are urgently needed and surely would lead to findings that are more consistent than those found in the literature. Of course, interpretation of the current results is further limited to female inpatients with AN in Germany and, thus, may not extend to male patients, other eating disorders, or other countries (especially those with substantially different health care systems, which, e.g., result in shorter inpatient treatments than in the current study). Finally, the current study only tested the effects on short-term treatment outcomes and, thus, it cannot be inferred from these results if and how illness duration relates to long-term treatment outcome or course of illness.

In conclusion, the current study suggests that a longer illness duration is related to worse treatment outcomes in female inpatients with AN. However, this effect is small, which may explain previous null findings in smaller samples. In addition, it appears that illness duration is highly correlated with patients' age at admission and their predictive value is indistinguishable. Given inconsistent definitions and assessment methods of illness duration, while age is a much more straightforward variable to assess, the use of illness duration for anticipating treatment outcome in clinical practice and research must be critically evaluated.

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No potential conflict of interest was reported by the author(s).

Data availability statement

The data set and annotated *R*-code for our main analyses are available at https://osf.io/9hsvq.

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Depressive symptoms and weight change in inpatients with anorexia nervosa: a cross-lagged panel model

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Abstract

Anorexia nervosa (AN) is marked by a high rate of comorbid depression, which raises the question whether depressive symptoms may adversely affect treatment outcome. Thus, we examined whether depressive symptoms at admission would predict weight change from admission to discharge in a large sample of inpatients with AN. In addition, we also explored the reverse direction, that is, whether body mass index (BMI) at admission would predict changes in depressive symptoms. A sample of 3011 adolescents and adults with AN (4% male) who received inpatient treatment at four Schoen Clinics was analyzed. Depressive symptoms were measured with the Patient Health Questionnaire–9. BMI significantly increased and depressive symptoms significantly decreased from admission to discharge. BMI and depressive symptoms were unrelated at admission. Higher BMI at admission predicted smaller decreases in depressive symptoms and higher depressive symptoms at admission predicted larger weight gain. The latter effect, however, was mediated by longer length of stay. Results indicate that depressive symptoms do not adversely affect weight gain during inpatient treatment in persons with AN. Instead, higher BMI at admission is predictive of smaller improvements in depressive symptoms but this effect seems to be negligible in terms of clinical relevance.

Keywords

Depression; Weight gain; Anorexia nervosa; Inpatient treatment; Body mass index

1. Introduction

Anorexia nervosa (AN) is marked by a significantly low body weight, which often leads to medical complications and, thus, the primary objective of AN treatment is weight restoration (Gibson et al., 2019; Voderholzer et al., 2020). There is also a high rate of comorbid mental disorders in AN, the most common of which are affective disorders (Keski-Rahkonen & Mustelin, 2016; Udo & Grilo, 2019). In fact, it seems that inpatients with AN show similar levels of depressive symptom severity to inpatients with affective disorders (Voderholzer et al., 2019). As there are considerable individual differences in treatment response, psychiatric comorbidity may be one key variable that moderates treatment outcome in AN (Kask et al., 2016; Marcoulides & Waller, 2012).

A recent review article that examined effects of comorbid depression on weight gain during AN treatment concluded that studies were heterogeneous in design, purpose, and outcome (Eskild-Jensen et al., 2020). Similarly, findings were inconsistent and only one study that was included in the review suggested that depression negatively affects weight gain in patients with AN (cf. Meule et al., 2020). Specifically, a study in which patients were categorized into three groups based on body weight data during treatment found that those with a slow weight gain had higher rates of comorbid affective disorders than those with moderate or rapid weight gain (Berona et al., 2018). However, the slow weight gain group also had the highest body mass index (BMI) at admission and, therefore, the slow weight gain may simply be explained by the fact that these patients already started with a higher body weight at admission, independent of comorbid affective disorders or depressive symptoms.

A recent study in 87 inpatients with AN (22 of which were diagnosed with comorbid major depressive disorder) corroborated that weight gain from admission to discharge was smaller in patients with comorbid major depressive disorder than in patients without comorbid major depressive disorder (Panero et al., 2021). However, this finding does not hold when applying appropriate corrections for multiple testing and similar to the study by Berona et al. (2018), those with comorbid major depressive disorder had a higher BMI at admission than those without comorbid major depressive disorder (although this difference was not statistically significant, likely due to the small group sizes).

Most studies that investigated effects of comorbid depression on weight gain during AN treatment were conducted at the construct level, for example investigating whether individuals with AN who also fulfilled DSM–5 criteria for major depressive disorder showed a different weight gain outcome compared to those without comorbid major depressive disorder (e.g., Panero et al., 2021). In addition, most studies only investigated one potential causal direction, namely that depression might influence weight gain. This is problematic for three reasons: First, depression is an extremely heterogeneous syndrome: Two individuals with major depressive disorder are likely to present distinct symptom patterns even when showing the same depression severity on dimensional measurements (Fried & Nesse, 2015). Second, inpatients with AN are comparable to inpatients with primary diagnoses of depressive disorders regarding the severity of their depressive symptoms (Voderholzer et al., 2019). This might explain why studies investigating DSM–5 major depressive disorder as a potential moderator of weight gain during AN treatment showed inconsistent findings, given that many inpatients with AN but without a diagnosed comorbid depressive disorder also show high depressive symptom severity. Third, it is also possible to assume that weight gain during inpatient treatment might also affect depressive symptoms. For example, a small effect of fast weight gain on later depressive symptoms was found in a randomized controlled study investigating family-based treatment for adolescents with AN (Accurso et al., 2014).

Thus, it is currently unclear whether comorbid depression predicts smaller weight gain during AN treatment and, if so, whether this effect may simply be explained by higher body weight at admission. To clarify the role of comorbid depression on weight gain during AN treatment, we analyzed BMI and depressive symptom severity of more than 3,000 inpatients with AN at admission and discharge. Specifically, we used structural equation modeling to examine whether depressive symptom severity at admission predicted changes in BMI from admission to discharge. In addition, we also explored the reverse direction, that is, whether BMI at admission predicted changes in depressive symptoms from admission to discharge. Structural equation modeling allows to test and compare such effects in one model with at least two assessment time points—a cross-lagged panel model.

2. Methods

2.1 Sample description

Clinical records of patients with AN (N = 3011) were analyzed who received treatment at four Schoen Clinics in Germany (Schoen Clinic Roseneck in Prien am Chiemsee [n = 1427], Schoen Clinic Bad Arolsen [n = 785], Schoen Clinic Bad Bramstedt [n = 358], Schoen Clinic Bad Staffelstein [n = 441]) between 2015 and 2020. Inclusion criteria were (1) a diagnosis of either full syndrome or atypical AN, (2) BMI at admission <18.5 kg/m², (3) admission for inpatient treatment (as the Schoen Clinics also offer daypatient and interval treatment), and (4) complete information available about BMI at admission and discharge, depressive symptom scores at admission, and medication during the inpatient stay.

At the Schoen Clinics, data from the routine diagnostic assessment (e.g., age, sex, diagnoses, body weight, questionnaire scores) are automatically transferred to a database from which they can be exported without any identifying information (e.g., name, date of birth, place of residence) by authorized employees. Thus, accessing individual patient charts is unnecessary. According to the guidelines by the institutional review board of the LMU Munich, retrospective studies conducted on already available, anonymized data are exempt from requiring ethics approval.

The inpatient treatment offered at the Schoen Clinics adheres to the German S3-guidelines for the treatment of AN (Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften, 2020; Resmark et al., 2019) in terms of admission criteria, treatment elements, and therapy goals. Thus, patients received a cognitive-behavioral therapy-oriented, multimodal AN treatment that included several treatment elements such as individual psychotherapy sessions, group therapy sessions, exercise therapy, meal preparation classes, body image exposure, nutrition counseling, and food intake protocols as well as clinical management of medical complications. The treatment includes a high-calorie refeeding schedule (starting on the first day of treatment) that aims at a weight gain of 0.7–1.0 kg per week for all underweight AN patients. This schedule includes three meals per day, each having approximately 700 kcal and, thus, totaling to a daily caloric intake of approximately 2100 kcal. Meals are supervised by a nurse or therapist in earlier treatment stages. The schedule is individually tailored if patients do not finish their meals or do not show the expected weight gain by increasing portion size, adding snacks between meals, or offering sip feeds. As normalization of eating behavior is one of the therapeutic goals, patients do not receive nasogastric feeding. Patients can choose between vegetarian and non-vegetarian menus; vegan menus are not offered.

2.2 Measures

2.2.1 Patient Health Questionnaire–depressive symptom severity scale (PHQ–9). Depressive symptoms at admission and discharge were measured with the German version (Löwe et al., 2002) of the PHQ–9 (Kroenke & Spitzer, 2002; Kroenke et al., 2001), which is part of the routine diagnostic assessment at the Schoen Clinics. The PHQ–9 has nine items that are answered on a four-point scale (0 = *not at all* to 3 = *nearly every day*). It comprises nine common depressive symptoms of different symptom domains, including affective, cognitive, and somatic symptoms. Higher sum scores indicate higher depressive symptom severity. Internal reliability was $\omega = .854$ at admission and $\omega = .876$ at discharge.

2.2.2 Other information. Patients' height and weight were measured at the hospitals and used to calculate BMI (kg/m²) at admission and discharge. All other information was also taken from the clinical records of the hospitals (age, sex, comorbid mental disorders, type of AN [full syndrome vs. atypical], length of stay, medication).

2.3 Data analyses

All analyses were run with JASP version 0.16.3 (JASP Team, 2022) and RStudio version 2022.07.1 (RStudio Team, 2022) using R version 4.2.1 (R Core Team, 2022). Changes in BMI and depressive symptoms from admission to discharge were tested with paired-samples *t*-tests. Cross-sectional associations between BMI and depressive symptoms at admission and at discharge were tested with Pearson's correlation coefficients.

To examine the predictive effects of BMI at admission on changes in depressive symptoms and of depressive symptoms at admission on changes in BMI, we specified a cross-lagged panel model with the R package *lavaan* version 0.6-12 (Rosseel, 2012). Specifically, exogenous variables were BMI and depressive symptoms at admission and endogenous variables were BMI and depressive symptoms at discharge. The model included both autoregressive paths and both cross-lagged paths as well as the covariances between BMI and depressive symptoms at admission and between residual variances of BMI and depressive symptoms at discharge (Figure 1). Because of incomplete data (PHQ–9 scores were missing for $n = 615$ patients), full information maximum likelihood estimation with robust (Huber–White) standard errors was used. In additional models, we examined whether adding paths of length of stay, age, sex, type of AN, comorbid depression, or antidepressant medication on the endogenous variables would change the estimates of the original model. The R code for the cross-lagged panel models and the repeated measures correlation as well as the data with which the findings reported in this article can be reproduced are available at https://osf.io/dy9fn.

3. Results

3.1 Sample characteristics

Mean age was *M* = 24.3 years (*SD* = 10.5) and mean length of stay was *M* = 81.0 days (*SD* = 45.9). The majority of patients were female (96.0%, *n* = 2892; 4.0% male, *n* = 119), adults (72.8%, *n* = 2191; 27.2% adolescents, *n* = 820), and had full syndrome AN (ICD–10 code F50.0, 89.6%, *n* = 2698; 10.4% atypical AN [F50.1], *n* = 313). More than half of patients had comorbid depression (ICD–10 code F32 or F33, 62.4%, *n* = 1879; no comorbid depression: 37.6%, *n* = 1132). During the inpatient stay, 72.1% (*n* = 2171) did not receive any medication or medication other than antidepressants (e.g., nutritional supplementation, antipsychotics, tranquilizers, analgesics, antiphlogistics) and 27.9% (*n* = 840) received antidepressants (with or without additional medication).

3.2 Changes from admission to discharge

BMI significantly increased from admission (*M* = 15.0, *SD* = 1.81) to discharge (*M* = 17.4, *SD* = 1.97) with a large effect size ($t_{(3010)} = 73.9$, $p < .001$, $d = 1.35$). Depressive symptoms significantly decreased from admission (*M* = 15.0, *SD* = 6.21) to discharge (*M* = 8.95, *SD* = 5.71) with a large effect size ($t_{(2395)} = 49.8$, $p < .001$, $d = 1.02$).

3.3 Cross-sectional correlations

At admission, BMI and depressive symptoms were uncorrelated ($r_{(n\,=\,3011)} = -.011$, $p = .552$). At discharge, BMI and depressive symptoms were weakly, negatively correlated ($r_{(n\,=\,2396)} = -.048$, $p = .018$).

3.4 Cross-lagged panel model

Standardized estimates of the cross-lagged panel model are displayed in Figure 1. Similar to the correlation analyses, the covariances for BMI and depressive symptoms were not significant at admission but at discharge, indicating that higher BMI at discharge related to lower depressive symptoms at discharge. Both autoregressive paths were significant, indicating that BMI at admission predicted BMI at discharge and depressive symptoms at admission predicted depressive symptoms at discharge. Both cross-lagged paths were also significant with positive coefficients. This indicates that higher BMI at admission predicted smaller decreases in depressive symptoms and more depressive symptoms at admission predicted larger weight gain. To test whether the size of the two cross-lagged paths differed, we compared the original model with a restricted model, in which the paths were fixed to be equal. The restricted model had a significantly worse model fit ($\Delta\chi^2 = 21.0$, $p < .001$, ΔAIC = 20, ΔBIC = 14), indicating that the size of cross-lagged path estimates in the original model were different, that is, the effect of BMI at admission on changes in depressive symptoms was larger than the effect of depressive symptoms at admission on changes in BMI. However, albeit being statistically significant, these cross-lagged effects were clinically irrelevant: When comparing two patients with a BMI at admission either one *SD* above or below the mean BMI (i.e., 13.2 kg/m^2 or 16.8 kg/m^2) with at mean levels of depressive symptoms at admission, these participants differed by $\Delta = 1.01$ points in the PHQ–9 scores. Similarly, when comparing two patients with depressive symptoms either one *SD* above or below mean PHQ–9 scores at admission (i.e., a score of 8.8 or 21.2) and at mean levels of BMI at admission, their BMI differed by only 0.17 kg/m^2 at discharge.

When including paths of either age, sex, type of AN, comorbid depression, or antidepressant medication on the endogenous variables in our models, cross-lagged paths remained statistically significant and did not vary substantially in size (the standardized estimates for BMI on depressive symptoms ranged between .039 and .054 and for depressive symptoms on BMI between .073 and .091). However, including length of stay turned the cross-lagged path of depressive symptoms on changes in BMI non-significant (standardized estimate = –.001, p = .914), suggesting that the small effect of higher depressive symptoms at admission on larger weight gain might be mediated by a longer length of stay. We formally tested this by including an indirect effect of depressive symptoms on changes in BMI through length of stay in the model, which was significant (standardized estimate = .042, p < .001). That is, higher depressive symptoms at admission lead to longer length of stay, which in turn lead to larger weight gain. Note, however, that this indirect effect was also very small in size, suggesting that it is a negligible effect in terms of clinical relevance.

4. Discussion

The current study examined relationships between BMI and depressive symptoms in inpatients with AN cross-sectionally and longitudinally. On average, BMI increased and depressive symptoms decreased from admission to discharge. Cross-sectionally, BMI and depressive symptoms were unrelated at admission and although they were related at discharge, the size of this relationship was negligible. Longitudinally, both BMI and depressive symptoms predicted changes of the other respective variable. Although findings about the role of comorbid depression in AN treatment have been inconsistent, it has been previously suggested that comorbid depression might attenuate weight gain (Berona et al., 2018; Eskild-Jensen et al., 2020; Panero et al., 2021). However, our findings clearly indicate that this does not seem to be the case. First, higher depressive symptoms at admission actually predicted *larger* increases in BMI, suggesting—at first glance—that depressive symptoms might foster weight gain. However, the size of this effect was very small and could be explained by the fact that patients with higher depressive symptoms had a longer treatment duration, which in turned related to higher weight gain. Similarly, BMI at admission predicted changes in depressive symptoms with a larger effect size such that a higher BMI at admission related to smaller decreases in depressive symptoms. Of note, this was a robust effect that also held when controlling for length of stay, age, sex, type of AN, comorbid depression, or antidepressant medication. However, both cross-lagged effects were very small and, despite being statistically significant, border at clinical irrelevance. Thus, on average, neither do comorbid depressive symptoms affect weight gain nor does BMI at admission affect changes in depressive symptoms during inpatient treatment for AN on a meaningful level.

Interpretation of these findings is limited by the use of clinical diagnoses, which may be less precise compared to structured clinical interviews, and self-reported depressive symptoms, which may be influenced by social desirability, simulation, or recall bias. Thus, we cannot exclude the possibility that findings may be different when using diagnoses of comorbid depression derived from a structured clinical interview. Furthermore, interpretation is limited to inpatients with AN in Germany and, thus, findings may not translate to other countries, for example, as inpatient treatment for AN in Germany is longer than most of the structured treatments in other parts of the world (Attia, 2014). However, the average treatment duration in the current study (81 days) was close to the worldwide average treatment duration (76 days) and lower than the average treatment duration in Europe (106 days) that has been reported in a recent meta-analysis of inpatient and daypatient treatments (Kan et al., 2021), indicating that treatment duration was not substantially longer than in most other studies. Finally, from a methodological standpoint, cross-lagged panel models came under increased scrutiny in recent years as, despite their intention, they cannot fully disentangle between-person and within-person effects and causal claims based on these models may be unfounded (Hamaker et al., 2015; Lucas, 2022). Several of suggested alternatives such as the random-intercept cross-lagged panel model, however, need at least three assessment waves and were, therefore, not suitable for analyzing our data. Future studies should thus consider investigating whether our findings hold true when accounting for stable trait components examining longitudinal data with at least one follow-up assessment.

In conclusion, our findings suggest that depressive symptoms do not have a negative impact on short-term treatment outcome in terms of weight gain in inpatients with AN. Thus, eating disorder-specific inpatient treatment leads to a significant and similar increase in body weight in patients with AN, independent of their depressive symptomatology.

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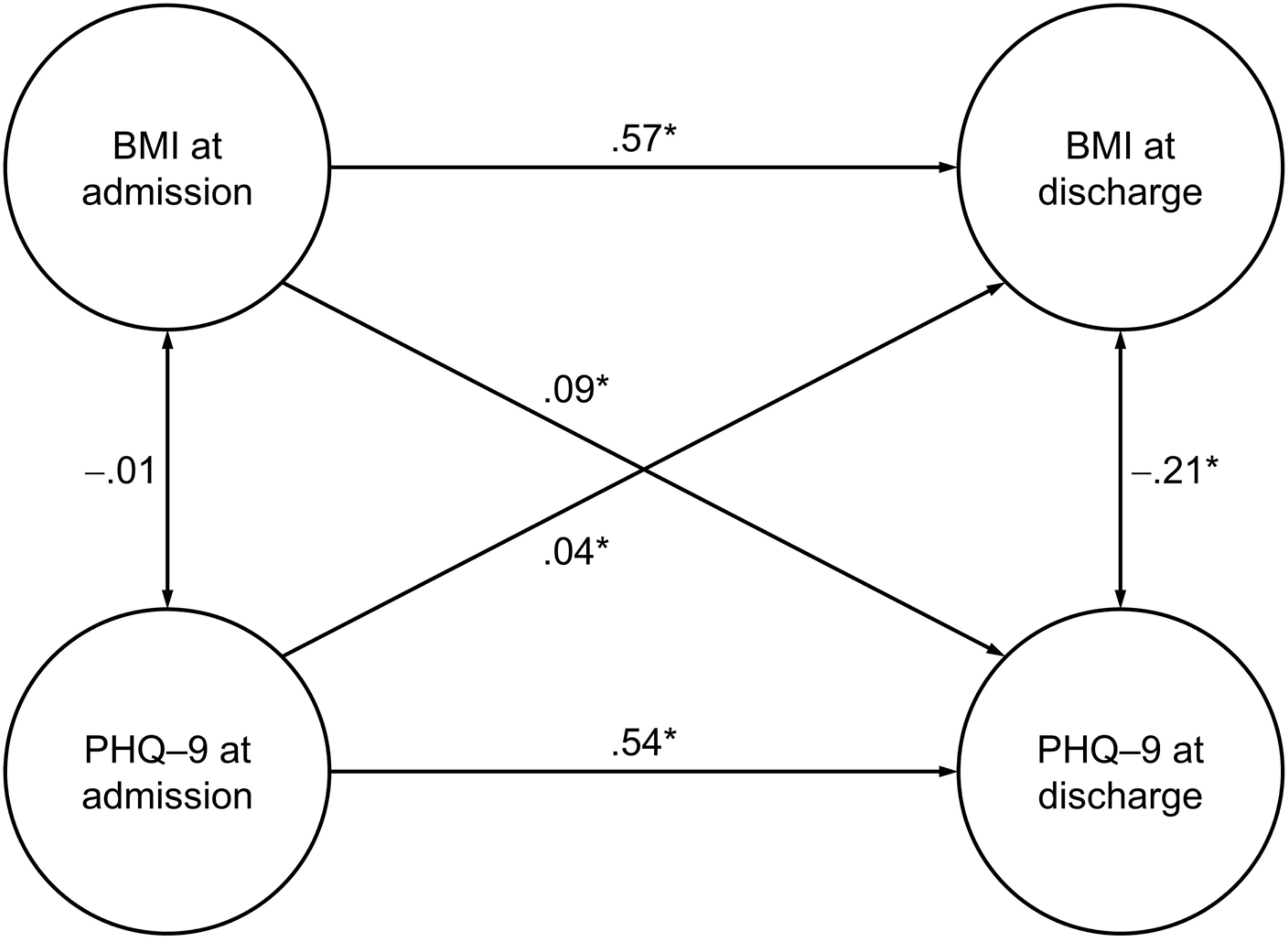
Figure caption

Figure 1. Standardized estimates of the cross-lagged panel model. Asterisks indicate $p < .005$. Coefficients for intercepts and (residual) variances are not displayed for the sake of simplicity and clarity. BMI = Body mass index, PHQ–9 = Patient Health Questionnaire–depressive symptom severity scale.


BMI at admission
BMI at discharge
PHQ–9 at admission
PHQ–9 at discharge
.57*
.09*
.04*
.54*
−.01
−.21*

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Weight suppression and body mass index at admission interactively predict weight trajectories during inpatient treatment of anorexia nervosa

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ABSTRACT

Objective: Weight suppression refers to the difference between an individual's current and highest body weight at their current height. Higher weight suppression has been found to predict weight gain in both non-clinical samples and patients with eating disorders. Few studies also have reported interactive effects between weight suppression and current body mass index when predicting weight gain.

Methods: In this retrospective study, we analyzed clinical records of inpatients with anorexia nervosa ($N = 2191$, 97% female) and tested whether weight suppression and body mass index at admission would interactively predict different weight trajectories during treatment.

Results: Body weight increased non-linearly during treatment. Higher weight suppression predicted larger weight gain but the nature of this effect depended on body mass index at admission. In patients with a relatively low body weight at admission, those with high weight suppression started at a lower weight and showed a nearly linear and steeper weight gain than those with low weight suppression. In patients with a relatively high body weight at admission, those with high weight suppression started at a similar weight and showed a non-linear and larger weight gain than those with low weight suppression.

Conclusion: Findings further support that weight suppression is a robust predictor of weight gain in addition to—and in interaction with—current body weight. As weight suppression can easily be assessed at admission, it may help to anticipate treatment course and outcome in patients with anorexia nervosa.

1. Introduction

Weight suppression refers to the difference between an individual's current and highest body weight at their current height [1]. Retrospectively, higher weight suppression thus indicates that a person has lost a larger amount of weight at some point in their life. Prospectively, however, higher weight suppression has been found to predict larger weight gain in both non-clinical samples [2–5] and in patients with eating disorders [6–9].

While weight suppression and current body mass index (BMI) seem to be not or only weakly correlated with each other, some studies reported interactive effects between the two [10–12]. For example, it appears that higher weight suppression relates to higher eating disorder psychopathology in individuals with low BMI in particular but this effect could not be found consistently across studies, that is, some studies did not find an interaction effect between BMI and weight suppression when predicting eating disorder psychopathology [10–12]. Yet, some studies also reported interactive effects between weight suppression and BMI when predicting weight changes. In a study with female inpatients with anorexia nervosa (AN), higher weight suppression predicted larger weight gain from admission to discharge in those with a relatively low BMI at admission but not in those with a relatively high BMI at admission [13]. A similar interaction effect was found in a non-treatment sample of adolescents with AN, in which higher weight suppression predicted a higher BMI at 6- and 10-year follow up particularly in those with a relatively low BMI [14].

When examining weight suppression as predictor of weight changes during inpatient treatment for eating disorders, most studies investigated BMI at admission and discharge [10–12]. During inpatient treatment for AN, however, weight changes are not linear but weight increases non-linearly across weeks. Specifically, the most common weight curve represents a rapid weight gain at the beginning that levels

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off near the end of treatment, which may be explained by both physiological and psychological factors [15,16]. Thus, there is a need to examine weight suppression's effects on weight gain during inpatient treatment in more detail, that is, to take non-linearity into account which fits the actual weight changes better than linear relationships (which are usually assumed with commonly used statistical methods). Therefore, we analyzed clinical data from a large sample of inpatients with AN and tested whether weight suppression would interact with BMI at admission when predicting (non-linear) weight trajectories across treatment weeks.

2. Material and methods

2.1. Sample description

Clinical records of patients with AN ($N = 2191$) were analyzed who received inpatient treatment at the Schoen Clinic Roseneck (Prien am Chiemsee, Germany) between 2015 and 2020. At the Schoen Clinics, data from the routine diagnostic assessment (e.g., age, sex, diagnoses, body weight, questionnaire scores) are automatically transferred to a database from which they can be exported without any identifying information (e.g., name, date of birth, place of residence) by authorized employees. Thus, accessing individual patient charts is not necessary. According to the guidelines by the institutional review board of the LMU Munich, retrospective studies conducted on already available, anonymized data are exempt from requiring ethics approval.

Inclusion criteria were (1) a diagnosis of either full syndrome or atypical AN according to the International Classification of Diseases (ICD–10 codes F50.0 and F50.1; https://icd.who.int/browse10/2019/en), (2) BMI at admission ≤18.5 kg/m^2, and (3) information available about their highest weight. The majority of patients were diagnosed with full syndrome AN (94.2%, $n = 2063$; atypical AN: 5.8%, $n = 128$), were female (96.5%, $n = 2115$; male: 3.5%, $n = 76$), and had at least one comorbid mental disorder (68.5%, $n = 1501$; no comorbidity: 31.5%, $n = 690$). The most common comorbid mental disorders were affective disorders (ICD–10 code: F3; 56.0%, $n = 1226$), neurotic, stress-related and somatoform disorders (ICD–10 code: F4; 26.8%, $n = 587$), and disorders of adult personality and behavior (ICD–10 code: F6; 8.4%, $n = 185$). Mean age was 23.5 years ($SD = 9.87$; adolescents (<18 years): 31.1%, $n = 681$). Mean BMI at admission was 14.8 kg/m^2 ($SD = 1.94$) and mean weight suppression was 6.19 kg/m^2 ($SD = 3.73$). Mean treatment duration was 94.2 days ($SD = 51.6$; 25th percentile: 57 days, 50th percentile: 92 days, 75th percentile: 127 days).

The inpatient treatment offered at the hospital adheres to the German S3-guidelines for the treatment of AN [17,18] in terms of admission criteria, treatment elements, and therapy goals. Thus, patients received a cognitive-behavioral therapy-oriented, multimodal AN treatment that included several treatment elements such as individual psychotherapy sessions, group therapy sessions, supervised meals, exercise therapy, meal preparation classes, body image exposure, nutrition counseling, and food intake protocols as well as clinical management of medical complications.

The treatment includes a high-calorie refeeding schedule (starting on the first day of treatment) that aims at a weight gain of 0.7–1.0 kg per week for all underweight AN patients. This schedule includes three meals per day, each having approximately 700 kcal and, thus, totaling to a daily caloric intake of approximately 2100 kcal. Meals are supervised by a nurse or therapist in earlier treatment stages. The schedule is individually tailored if patients do not finish their meals or do not show the expected weight gain by increasing portion size, adding snacks between meals, or offering liquid food (Fresubin®). As normalization of eating behavior is one of the therapeutic goals, patients do not receive nasogastric feeding. Patients can choose between vegetarian and non-vegetarian menus; vegan menus are not offered.

2.2. Measures

All information (i.e., age, sex, diagnoses, treatment duration, body height and weight) was taken from the clinical records of the hospital, that is, no structured clinical interview was applied. Patients' height and weight were measured at the hospital and used to calculate BMI (kg/m^2). As patients differed in their weighing schedule (i.e., some patients were weighed weekly or twice a week while others—e.g. those with very low body weight—were weighed daily as they needed to be monitored more closely), we averaged body weight data for each week. Moreover, as patients naturally had different treatment durations, there were fewer patients with body weight data in later weeks. Thus, we decided to analyze 18 treatment weeks as there were still more than 25% of the sample with body weight data in week 18 ($n = 585$, 26.7%). At admission, patients self-reported their highest weight at their current height, which was used to calculate highest BMI. Weight suppression was then computed by subtracting BMI at admission from highest BMI.

2.3. Data analyses

Associations between BMI at admission, weight suppression, age, and treatment duration were tested with Pearson's correlation coefficient. Differences in BMI at admission and weight suppression between male and female patients, between patients with full syndrome and atypical AN, and between patients with and without any comorbidity were tested with independent samples t-tests.

Changes in body weight across treatment weeks were analyzed with growth curve analyses [19] using the R-package *lme4* [20]. An important advantage of this analytic strategy is that it can handle missing data (i.e., cases with missing data are not excluded but included in the maximum likelihood estimation), which, therefore, allowed to analyze weight changes across the 18 weeks although only a subset of patients had such a long treatment duration. In model 1, we tested whether body weight changed linearly or non-linearly by adding a second-order polynomial of the time term to the linear term. The second-order polynomial represents a quadratic (i.e., non-linear) relationship between time and body weight and, if significant, means that weight change across treatment weeks is non-linear with the curve having a single "bend" or "peak". For this, we used orthogonal polynomials [as has been recommended; [19]], which were also included as random slopes in addition to a random intercept. Furthermore, intercept–slope covariances and the covariance of random slopes were modelled using an unstructured covariance matrix. In model 2, we added fixed effects of BMI at admission and weight suppression on all time terms. Specifically, to examine both linear and non-linear changes in body weight across treatment weeks as a function of BMI at admission and weight suppression, we ran a model that included the predictor variables week, week^2, BMI at admission, weight suppression, and all two-way and three-way interactions. In model 3, we added simple effects of age, sex, treatment duration, type of AN, and any comorbidity to examine whether effects would remain unchanged when controlling for these possibly confounding variables.

For data visualization of three-way interactions, separate weight trajectories over time for patients with BMI at admission or weight suppression above and below the respective 50th percentile were plotted. Of note, analyses were always based on the full range of BMI at admission and weight suppression, that is, not on any categorization. For all models, pseudo-R^2s were calculated using the *r.squaredGLMM* function of the R-package *MuMIn* [21]. This function computes two types of R^2s based on Nakagawa and Schielzeth [22], Johnson [23], and Nakagawa et al. [24]: *marginal* R^2 represents the variance explained by the fixed effects and *conditional* R^2 represents the variance explained by the entire model, including both fixed and random effects. Parameter-specific p-values were calculated with the R-package *lmerTest* [25]. Because of the large sample size, we considered p-values of <0.005 as indicating a significant effect, as has been suggested by others [26]. 95%

confidence intervals of model parameters were bootstrapped using 500 replications. To increase transparency and replicability, data and R-script are available at https://osf.io/7dujr.

3. Results

Higher BMI at admission weakly related to lower weight suppression ($r = -0.284$, $p < .001$) and shorter treatment duration ($r = -0.234$, $p < .001$) but did not relate to age ($r = -0.037$, $p = .086$). Higher weight suppression weakly related to longer treatment duration ($r = 0.084$, $p < .001$) and higher age ($r = 0.267$, $p < .001$). Male patients had a higher BMI at admission (M = 15.7 kg/m^2, SD = 1.67) and higher weight suppression (M = 9.06 kg/m^2, SD = 6.93) than female patients (BMI: M = 14.8 kg/m^2, SD = 1.94, $t_{(2189)} = 4.29$, $p < .001$, $d = 0.50$; weight suppression: M = 6.09 kg/m^2, SD = 3.52, $t_{(2189)} = 6.88$, $p < .001$, $d = 0.80$). Patients with atypical AN had a higher BMI at admission (M = 16.1 kg/m^2, SD = 1.94) and lower weight suppression (M = 4.66 kg/m^2, SD = 3.59) than patients with full syndrome AN (BMI: M = 14.7 kg/m^2, SD = 1.91, $t_{(2189)} = 7.91$, $p < .001$, $d = 0.72$; weight suppression: M = 6.29 kg/m^2, SD = 3.72, $t_{(2189)} = 4.83$, $p < .001$, $d = 0.44$). Patients with any comorbidity had a higher BMI at admission (M = 15.0 kg/m^2, SD = 1.89) and lower weight suppression (M = 6.03 kg/m^2, SD = 3.70) than patients without any comorbidity (BMI: M = 14.4 kg/m^2, SD = 1.98, $t_{(2189)} = 6.70$, $p < .001$, $d = 0.31$; weight suppression: M = 6.54 kg/m^2, SD = 3.77, $t_{(2189)} = 2.98$, $p = .003$, $d = 0.14$). Looking at weight trajectories, the majority of patients was underweight at *any* time point during our observation period: For example, at week 9, 76.5% of 1604 still admitted patients (M = 17.0 kg/m^2, SD = 1.92), at week 12, 69.0% of then 1276 patients (M = 17.5 kg/m^2, SD = 1.85), and at week 18, 59.7% of 585 patients still in treatment (M = 18.0 kg/m^2, SD = 1.63), had a BMI ≤ 18.5 kg/m^2.

Model 1 indicated that body weight increased non-linearly across treatment weeks (Table 1). As can be seen in Fig. 1, there was a steeper increase in the first few weeks and a slight flattening of the curve in later weeks. Model 2 indicated that this change in body weight was moderated by BMI at admission and weight suppression (i.e., the three-way interaction week^2 × BMI at admission × weight suppression was significant; Table 1). As can be seen in Fig. 2, higher weight suppression

Table 1
Coefficients of the mixed-effects models.

	Model 1			*Model 2*			*Model 3*		
Fixed Effects	Estimate [95% CI]	*SE*	*p*	Estimate [95% CI]	*SE*	*p*	Estimate [95% CI]	*SE*	*p*
Intercept	17.03 [16.95; 17.11]	0.04	<0.001	4.16 [3.57; 4.80]	0.31	<0.001	4.22 [3.63; 4.83]	0.31	<0.001
Week	4.67 [4.56; 4.78]	0.06	<0.001	12.3 [10.39; 14.16]	0.84	<0.001	12.3 [10.68; 14.00]	0.84	<0.001
Week^2	−0.46 [−0.51; −0.41]	0.02	<0.001	2.03 [1.30; 2.76]	0.38	<0.001	2.04 [1.26; 2.84]	0.38	<0.001
BMI at admission (kg/m^2)	–	–	–	0.84 [0.80; 0.88]	0.02	<0.001	0.84 [0.80; 0.88]	0.02	<0.001
Weight suppression (kg/m^2)	–	–	–	0.03 [−0.06; 0.09]	0.04	0.463	0.02 [−0.05; 0.10]	0.04	0.560
BMI at admission × weight suppression	–	–	–	0.002 [−0.002; 0.008]	0.003	0.393	0.002 [0.001; 0.004]	0.003	0.331
Week × BMI at admission	–	–	–	−0.54 [−0.67; −0.42]	0.06	<0.001	−0.54 [−0.65; −0.43]	0.06	<0.001
Week × weight suppression	–	–	–	−0.30 [−0.53; −0.09]	0.10	0.003	−0.30 [−0.51; −0.11]	0.10	0.003
Week^2 × BMI at admission	–	–	–	−0.16 [−0.21; −0.11]	0.03	<0.001	−0.16 [−0.21; −0.11]	0.03	<0.001
Week^2 × weight suppression	–	–	–	−0.15 [−0.24; −0.07]	0.05	<0.001	−0.15 [−0.24; −0.07]	0.05	<0.001
Week × BMI at admission × weight suppression	–	–	–	0.03 [0.01; 0.04]	0.01	<0.001	0.03 [0.01; 0.04]	0.01	<0.001
Week^2 × BMI at admission × weight suppression	–	–	–	0.01 [0.00; 0.02]	0.003	0.002	0.01 [0.00; 0.02]	0.003	0.002
Age (years)	–	–	–	–	–	–	0.002 [0.001; 0.004]	0.001	0.011
Sex (0 = male, 1 = female)	–	–	–	–	–	–	0.02 [−0.12; 0.08]	0.05	0.750
Treatment duration (days)	–	–	–	–	–	–	−0.0004 [−0.0008; −0.0001]	0.0002	0.026
Type of AN (0 = full syndrome, 1 = atypical)	–	–	–	–	–	–	0.04 [−0.04; 0.11]	0.04	0.260
Any comorbidity (0 = no, 1 = yes)	–	–	–	–	–	–	0.0004 [−0.04; 0.04]	0.02	0.983
Random effects	(Co)variance [95% CI]	–	–	(Co)variance [95% CI]	–	–	(Co)variance [95% CI]	–	–
Intercept	3.34 [3.15; 3.55]	–	–	0.72 [0.67; 0.77]	–	–	0.72 [0.67; 0.77]	–	–
Week	4.89 [4.55; 5.25]	–	–	4.24 [3.91; 4.56]	–	–	4.23 [3.92; 4.55]	–	–
Week^2	0.89 [0.82; 0.96]	–	–	0.88 [0.81; 0.95]	–	–	0.88 [0.80; 0.95]	–	–
Correlation (Intercept, Week)	0.08 [−0.11; 0.27]	–	–	1.28 [1.23; 1.32]	–	–	1.28 [1.23; 1.31]	–	–
Correlation (Intercept, Week^2)	−0.56 [−0.64; −0.49]	–	–	−0.28 [−0.31; −0.24]	–	–	−0.27 [−0.31; −0.24]	–	–
Correlation (Week, Week^2)	0.51 [0.41; 0.60]	–	–	0.41 [0.31; 0.50]	–	–	0.41 [0.31; 0.50]	–	–
Residual	0.037 [0.036; 0.038]	–	–	0.037 [0.036; 0.038]	–	–	0.037 [0.036; 0.038]	–	–
Variance explained by model	R^2	–	–	R^2	–	–	R^2	–	–
Marginal (fixed effects only)	0.233	–	–	0.815	–	–	0.816	–	–
Conditional (total model)	0.992	–	–	0.992	–	–	0.992	–	–

Notes. BMI = Body mass index, AN = Anorexia nervosa. Note that variables were not mean-centered.

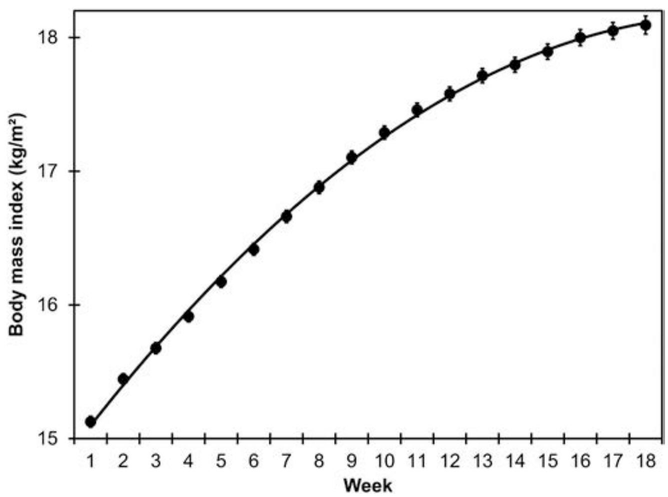

Fig. 1. Mean body mass index as a function of treatment week. The fitted line is a second-order polynomial trend line, visualizing the non-linear increase in body weight from week 1 to week 18. Error bars represent the standard error of the mean. Note that only observed data are plotted, which is why the standard errors increase with the number of weeks because fewer patients had longer treatment durations.

related to larger weight gain across treatment weeks. The nature of this effect, however, differed as a function of BMI at admission.

In patients with a relatively low BMI at admission, weight gain was nearly linear and those with high weight suppression had a lower BMI at admission but showed a steeper increase than those with low weight suppression (Fig. 2A). This means that a patient with a relatively low BMI at admission of 13.5 kg/m^2 (1st quartile) and a relatively high weight suppression of 7.81 kg (3rd quartile) increased their BMI by 4.50 kg/m^2 compared to a patient with the same BMI at admission but only a relatively low weight suppression of 3.83 kg (1st quartile) that increased their BMI by 4.18 kg/m^2 from week 1 to week 18, translating to an 8% steeper increase in BMI.

In patients with a relatively high BMI at admission, weight gain was non-linear with a flattening of the curve in later weeks and those with high weight suppression showed a steeper increase—leading to a higher body weight in later weeks—than those with low weight suppression (Fig. 2B). This indicates that a patient with a relatively high BMI at admission of 16.7 kg/m^2 (3rd quartile) and a relatively high weight suppression of 7.81 kg (3rd quartile) increased their BMI by 2.14 kg/m^2 from week 1 to week 9 and further by 1.71 kg/m^2 from week 9 to week 18, which is dampened by 20% compared to the first half of the observed time range. In contrast, a patient with the same BMI at admission but a relatively low weight suppression of 3.83 kg (1st quartile) only increased their BMI by 1.90 kg/m^2 from week 1 to week 9 and by 1.37 kg/m^2 from week 9 to week 18 (which is attenuated by 28% compared to the first half of the time range). Comparing these attenuation effects highlights that patients with high BMI at admission but low weight suppression experience a 40% more attenuated BMI increase in later treatment compared to patients with high BMI at admission but low weight suppression. In absolute values, this means a 0.58 kg/m^2 higher BMI at week 18 for a patient with high weight suppression and high BMI at admission compared to a patient with the same relatively high BMI at admission but relatively low weight suppression.

Finally, we tested if these effects held when controlling for potential covariates: Model 3 indicated that effects did not change when controlling for age, sex, treatment duration, type of AN, and any comorbidity (Table 1).

4. Discussion

The current study examined interactive effects of weight suppression and BMI at admission on weight trajectories during inpatient treatment in a large sample of persons with AN that included both male and female patients and both adolescent and adult patients. When examining general changes in body weight across all patients, it was found that weight increased non-linearly across treatment weeks. The curvature of this non-linear increase was similar to the finding by Vansteelandt et al. [15] such that the weight curve of the average patient was characterized by a steep increase in the first weeks that levels off in later weeks. We speculate that the nature of this trajectory is influenced by multiple factors that may include biological (e.g., water retention at the start of treatment, increased resting metabolic rate at the end of treatment), psychological (e.g., decreased motivation at the end of treatment), and therapeutic (e.g., weight gain is no longer the primary treatment objective in patients that have reached a normal weight in the first

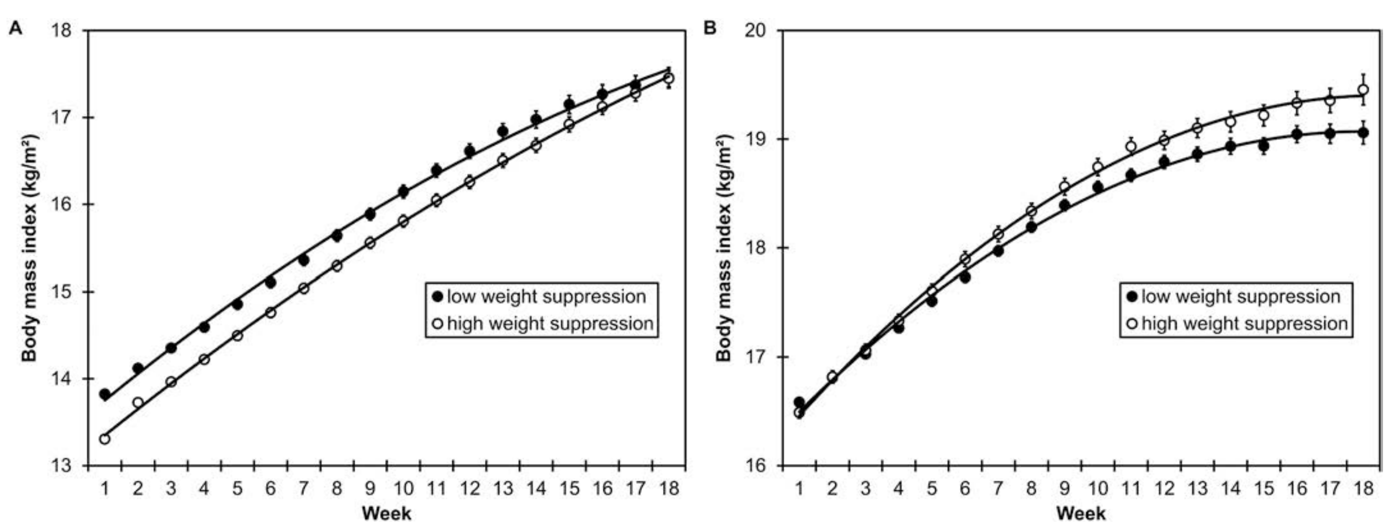

Fig. 2. Mean body mass index (BMI) as a function of treatment week in patients with (A) low BMI at admission and (B) high BMI at admission, and with low weight suppression (black circles) and high weight suppression (white circles). The fitted lines are second-order polynomial trend lines, visualizing the non-linear increase in body weight from week 1 to week 18. Error bars represent the standard error of the mean. Note that only observed data are plotted, which is why the standard errors increase with the number of weeks because fewer patients had longer treatment durations. The cut-off values were *Mdn* = 14.9 kg/m^2 for low versus high BMI and *Mdn* = 5.64 kg/m^2 for low vs. high weight suppression. Note, however, that patients were not categorized into groups in the statistical analyses. This depiction here only serves the purpose of visualizing the three-way interaction effect of week^2 × BMI at admission × weight suppression.

weeks) variables.

The non-linear increase in body weight was moderated by the interaction of weight suppression and BMI at admission, independent of age, sex, treatment duration, type of AN, and any comorbidity. Thus, our data replicate the findings by Berner et al. [13] such that higher weight suppression not only predicts larger weight gain during AN treatment but that this effect is conditional on BMI at admission. However, our findings are somewhat in contrast to the ones reported by Berner et al. [13], who found that higher weight suppression predicted larger weight gain during AN treatment in patients with a relatively low BMI at admission and this effect decreased with higher BMI at admission. In the present study, weight suppression predicted weight changes in individuals with both low and high BMI but the trajectories differed. Specifically, patients with low BMI and high weight suppression had a lower BMI at admission but a steeper and nearly linear increase in body weight compared to those with low BMI and low weight suppression. However, the difference in steepness of the increase was not very large, and trajectories were very similar, which might not be very meaningful in clinical practice. In patients with high BMI, however, those with high and low weight suppression had a similar BMI at admission and showed a non-linear increase across treatment weeks but weight gain in those with high weight suppression exceeded weight gain in those with low weight suppression. Especially in later treatment weeks, those with high BMI at admission and high weight suppression continued to increase weight with a larger slope, whereas for those with high BMI at admission and low weight suppression weight gain was attenuated in later weeks. This might be relevant for clinical practice as clinicians can anticipate the slower weight gain trajectories in later weeks when high BMI and low weight suppression is recorded at admission. For example, they may subsequently adjust caloric prescriptions for these patients once weight gain diminishes. However, as underlying physiological mechanisms are still unknown, increasing calorie intake might not be successful. Still, being mindful of this interactive effect might help in increasing treatment adherence of these patients once weight gain has decreased.

In contrast to the findings by Berner et al. [13], we found that higher weight suppression predicted a larger weight gain in patients with a relatively high BMI as well. Of note, however, is that patients in the study by Berner et al. [13] had a higher BMI (15.7 kg/m^2), slightly lower weight suppression (5.8 kg/m^2) and shorter treatment duration (35.2 days) on average than patients in the present study. Thus, these differences may explain differences in the nature of the interaction effects as, for example, the larger weight gain in those with high BMI and high weight suppression primarily emerged in later treatment weeks. Interpretation of these findings is, therefore, limited to inpatients with AN in Germany and, thus, findings may not translate to other countries, for example, as inpatient treatment for AN in Germany is longer than many of the structured treatments in other parts of the world [27]. However, although the average treatment duration in the current study (94 days) was longer than the worldwide average treatment duration (76 days), it was still shorter than the average treatment duration in Europe (106 days) that has been reported in a recent meta-analysis of inpatient and daypatient treatments [28], indicating that treatment duration was comparable to other (particularly European) studies.

Another limitation of the study's findings is, of course, that weight suppression was based on self-reported highest body weight. Yet, women with AN are extremely accurate when self-reporting their own weight. For example, self-reported weight has been found to be more accurate in women with AN than in normal-weight and overweight women [29]. Although it has been found that they slightly overestimate their weight, this overestimation is on average less than one kilogram [30–32]. However, self-reported highest weight may not be as accurate as self-reported current weight as its retrospective assessment introduces a stronger bias. As an objective measurement of highest weight would require that person's weight is closely monitored across their lifespan, it seems that research on weight suppression that does not rely on self-reported highest weight is hardly feasible. Thus, the use of weight suppression based on self-reported highest weight is in line with all studies about this topic that have been conducted in the past decades [10–12].

Furthermore, diagnoses of AN were based on clinician ratings rather than on structured clinical interviews in this study. This is a limitation, as subtypes of AN might not have been reliably recorded, limiting interpretability of the reported subtype effect on weight gain. Finally, we investigated trajectories of absolute BMI scores instead of percent target BMI. Our results might therefore slightly overestimate the dampening effects of weight suppression on weight gain as—at later time points—several patients may have already achieved their target weights and, thus, did not further gain weight. However, the majority of patients were underweight at *any* time point within the observed 18 weeks, making it highly likely that weight restoration was still a primary treatment target for a substantial part of the sample. Still, future studies that have reliable recordings of individual target weights might investigate whether weight suppression also predicts increases in percent target BMI.

Future studies may address several aspects that we did not investigate in the current study. First, there are potentially moderating variables that may influence weight suppression's effects on weight changes. Specifically, effects may differ in certain subgroups of patients, for example, those with restricting versus binge/purge type AN (e.g., one study found that patients with binge/purge type AN tend to have a faster weight gain during treatment [33]) or those receiving psychopharmacological medication to facilitate weight gain versus no psychopharmacological medication. While controlling for any comorbid mental disorder in the current study did not alter results, another potential moderator might be specific types of comorbid mental disorders. Although findings about the effects of comorbid mental disorders on weight gain during AN treatment have been inconsistent [34], one study found that patients who showed a slow weight gain during treatment had a higher prevalence of comorbid affective (but not anxiety) disorders than those who showed a rapid weight gain [35]. Thus, future studies may examine differential effects of certain comorbid mental disorders in more detail. Second, in addition to examining weight suppression's effects on body weight, future studies may examine the biological mechanisms of such effects in more detail, for example, by measuring body composition or nutritional status, which have been found to provide additional information about the biology of weight loss and weight regain in patients with AN [36,37]. Third, future studies may examine whether weight suppression (in interaction with BMI) at admission not only predicts weight trajectories during but also after inpatient treatment. Previous findings suggest that this might be the case as weight suppression predicted weight changes even after several years in a non-treatment sample [14] and weight suppression at discharge predicted later weight changes in patients with AN [38].

From a clinical perspective, it might be useful to assess not only current BMI but also weight suppression at admission to estimate the weight trajectories of individual patients. Patients with low BMI at admission and high weight suppression might take longer to reach their target weight compared to patients without substantial weight suppression. However, an encouraging finding of our study is that if these patients receive long enough treatment, their trajectories approximate those of patients with low weight suppression.

In conclusion, the present findings replicate the large body of studies showing that weight suppression is a robust predictor of weight gain in both non-clinical samples and in patients with eating disorders, even above and beyond the effects of current body weight [10–12]. In addition, they extend earlier reports that weight suppression's predictive effect is further modulated by current body weight in persons with AN [13,14] by providing a fine-grained analysis of weight trajectories during inpatient treatment. While the mediating mechanisms of such effects remain elusive—as they may involve a complex interplay of biological (e.g., resting metabolic rate) and psychological (e.g., weight and shape concerns) factors [12]—the current findings again highlight the importance of weight suppression as a prognostic factor in AN treatment and, thus, its potential use for anticipating treatment course and outcome in clinical practice.

Conflicts of interest and source of funding

No funding was received for this study and the authors declare that there are no conflicts of interest.

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RESEARCH ARTICLE

WILEY

Inpatient treatment of anorexia nervosa in adolescents: A 1-year follow-up study

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Abstract

Objective: Inpatient treatment effectively increases body weight and decreases eating disorder symptoms in adolescents with anorexia nervosa (AN). However, there is a high risk of relapse within the first year after discharge, which calls for investigating long-term treatment success and its moderators.
Method: Female adolescent inpatients with AN ($N = 142$) were assessed, of which 85% participated at 1-year follow-up. Dependent variables were body mass index percentiles, eating disorder symptoms, depressive symptoms, compulsive exercise and life satisfaction.
Results: On average, body weight increased and eating disorder symptoms and depressive symptoms decreased from admission to discharge and remained stable at follow-up. Compulsive exercise decreased and life satisfaction increased from admission to discharge and even improved further at follow-up. Age, duration of illness, previous inpatient treatments, length of stay and readmission after discharge moderated changes in several outcome variables.
Conclusions: This study confirms the high effectiveness of inpatient treatment for adolescents with AN and demonstrates that treatment effects remain stable or even improve further within the first year after discharge. However, subgroups of patients (e.g., those with an older age, longer duration of illness, and previous inpatient treatments) require special attention during inpatient treatment and aftercare to prevent relapse.

KEYWORDS
adolescents, anorexia nervosa, inpatient treatment, moderators, treatment outcome

1 | INTRODUCTION AND AIMS

Anorexia nervosa (AN) is an eating disorder marked by restriction of energy intake—which leads to a significantly low body weight—intense fear of gaining weight and body image disturbance (American Psychiatric Association, 2013). Although AN can occur at any age, the highest incidence rates can be found in adolescence (Zipfel, Giel,

Abbreviations: AN, anorexia nervosa; BDI–II, Beck Depression Inventory (revised version); BMI, body mass index; CES, Commitment to Exercise Scale; EDE–Q, Eating Disorder Examination–Questionnaire; SWLS, Satisfaction With Life Scale.

Bulik, Hay, & Schmidt, 2015). Inpatient treatment is an effective therapeutic approach for AN, that is, body weight significantly increases and eating disorder symptoms significantly decrease in the majority of both adolescent and adult patients from admission to discharge (e.g., Dalle Grave, Calugi, El Ghoch, Conti, & Fairburn, 2014; Herpertz-Dahlmann et al., 2014; Hiney-Saunders, Ousley, Caw, Cassinelli, & Waller, in press; Isserlin, Spettigue, Norris, & Couturier, 2020; Jaite et al., 2019; Schlegl, Quadflieg, Löwe, Cuntz, & Voderholzer, 2014; Schlegl et al., 2016). After inpatient treatment, however, there is a high risk of relapse—particularly between 4 and 12 months after discharge—with relapse rates tending to be lower in adolescents than in adults (Berends, Boonstra, & van Elburg, 2018; Carter, Blackmore, Sutandar-Pinnock, & Woodside, 2004, Carter et al., 2012). Thus, there is a need to study not only effects of inpatient treatment from admission to discharge but also its effects at later follow-up measurements, particularly within the first year post-treatment.

Previous studies that examined effects of inpatient treatment in adolescents with AN 1 year after discharge reported encouraging findings: improvements in body weight and eating disorder symptoms were largely maintained from discharge to follow-up (e.g., Dalle Grave et al., 2014; Herpertz-Dahlmann et al., 2014; Madden et al., 2015). However, several moderators of treatment outcomes have been reported, indicating that there are individual differences in short- and long-term treatment response (Berends et al., 2018). For example, it has been found that younger age, shorter duration of illness, no previous inpatient treatments and other variables were predictive of a better treatment outcome in adolescents with AN (e.g., Agras et al., 2014; Schlegl et al., 2016). Yet, it appears that these findings have not been consistent (Berends et al., 2018; Bulik, Berkman, Brownley, Sedway, & Lohr, 2007; Vall & Wade, 2015). A recent review even came to the conclusion that 'it is not possible to draw firm conclusions about moderators or mediators of treatment' for AN in adolescents (Hamadi & Holliday, 2020, p. 17). Thus, there is an urgent need for further examination of potential moderators of treatment outcomes in adolescents with AN.

Therefore, the aims of the current study were to report treatment outcomes from admission to discharge and at 1-year follow-up in adolescent inpatients with AN and to examine potential moderating variables. As outcome measures, we examined changes in body weight, eating disorder symptoms, depressive symptoms, compulsive exercise and life satisfaction. As moderators of treatment effects, we tested age, duration of illness, previous inpatient treatments, length of stay and readmission after discharge.

Highlights

- Inpatient treatment of anorexia nervosa in adolescents is highly effective
- On average, improvements in body weight and eating disorder symptoms remain stable in the first year after discharge, although this may be due to outpatient psychotherapy after discharge
- Several variables moderate these treatment effects, indicating that there are substantial individual differences in treatment response with subgroups of patients showing further improvements or worsening of symptoms after discharge

2 | METHOD

2.1 | Participants

Female, adolescent, consecutively admitted inpatients with AN ($N = 142$) who received treatment at the Schoen Clinic Roseneck (Prien am Chiemsee, Germany) between 2016 and 2018 participated in this study. Five of these patients (3.5%) were diagnosed with atypical AN (ICD–10 code: F50.1; all others: F50.0). Mean age was 15.4 years (SD = 1.37, range: 12–18). Almost all participants indicated that they had received any treatment (outpatient, daycare, inpatient) before (95.1%, $n = 135$, data missing for one participant). Thirty-nine patients (27.7%) reported no previous inpatient treatment, 53 patients (37.6%) reported one previous inpatient treatment and 49 patients (34.8%) reported at least two previous inpatient treatments. Sixteen patients (11.3%) reported no previous outpatient treatment, 84 patients (59.6%) reported one previous outpatient treatment and 41 patients (29.1%) reported at least two previous outpatient treatments. One-hundred and thirty-two patients (93.6%) reported no previous daycare treatment and nine patients (6.4%) reported one previous daycare treatment.

Mean self-reported duration of illness was 29.8 months (SD = 22.8, range: 4–144). Mean length of stay at the hospital was 115 days (SD = 41.4, range: 23–254). Fifty-one patients (35.9%) received psychopharmacological medication during their stay (antidepressants: 17.6%, $n = 25$; antipsychotics: 21.8%, $n = 31$; other: 1.4%, $n = 2$). Comorbid mental disorders included depressive episode (F32; 45.8%, $n = 65$), phobic anxiety disorders (F40, 12.0%, $n = 17$), obsessive-compulsive disorder (F42, 9.2%, $n = 13$), recurrent depressive disorder (F33, 6.3%, $n = 9$), reaction to severe stress, and adjustment disorders (F43, 3.5%, $n = 5$), habit and impulse disorders (F63, 3.5%, $n = 5$), somatoform disorders (F45, 2.8%, $n = 4$), other anxiety disorders (F41, 1.4%, $n = 2$), specific personality disorders (F60, 0.7%, $n = 1$), and hyperkinetic disorders (F90, 0.7%, $n = 1$).

2.2 | Measures

2.2.1 | Body weight

Sex- and age-specific body mass index (BMI) percentiles at admission, discharge and follow-up were calculated based on German reference values (Kromeyer-Hauschild et al., 2001) using an established online tool (www.labor-limbach.de/laborrechner/labor-rechner/bmi-perzentile-und-sds).

2.2.2 | Eating disorder symptoms

Eating disorder symptoms were measured with the German version (Hilbert & Tuschen-Caffier, 2016) of the Eating Disorder Examination–Questionnaire (EDE–Q; Fairburn & Beglin, 1994). The EDE–Q has 28 items, six of which assess the frequency of binge and purge behaviours in the past 28 days and are not included in the total score. The other 22 items are answered on a seven-point scale (0–6) with different response labels. For these 22 items, a four-factor structure has been proposed representing eating restraint, eating concern, weight concern and shape concern. However, this factor structure could not be replicated in the literature (Heiss, Boswell, & Hormes, 2018; Rand-Giovannetti, Cicero, Mond, & Latner, 2020). Therefore, we only used the total score in the current analyses. Higher scores indicate higher eating disorder psychopathology. Internal reliability was excellent (McDonald's $\omega = 0.954$ at admission, 0.963 at discharge and 0.962 at follow-up).

2.2.3 | Depressive symptoms

Depressive symptoms were measured with the German version (Hautzinger, Keller, & Kühner, 2009) of the revised Beck Depression Inventory (BDI–II; Beck, Steer, & Brown, 1996). The BDI–II has 21 items that are answered on a four-point scale (0–3) with different response labels. Higher scores indicate higher depressive symptomatology. Internal reliability was excellent (McDonald's $\omega = 0.926$ at admission, 0.942 at discharge, and 0.954 at follow-up).

2.2.4 | Compulsive exercise

Compulsive exercise was measured with the German version (Zeeck et al., 2017) of the Commitment to Exercise Scale (CES; Davis, Brewer, & Ratusny, 1993). The CES has eight items and, in the original version, these were answered on a visual analogue scale with different anchors. In the current study, we applied a four-point scale (e.g., 1 = *never* to 4 = *always*) response format, in line with other studies (Dittmer et al., 2018, 2020; Thome & Espelage, 2007). Higher scores indicate stronger compulsive exercise tendencies. Internal reliability was excellent (McDonald's $\omega = 0.930$ at admission, 0.908 at discharge, and 0.910 at follow-up).

2.2.5 | Life satisfaction

Life satisfaction was measured with the German version (Glaesmer, Grande, Braehler, & Roth, 2011) of the Satisfaction With Life Scale (SWLS; Diener, Emmons, Larsen, & Griffin, 1985). The SWLS has five items that are answered on a seven-point scale (1 = *strongly disagree* to 7 = *strongly agree*). Higher scores indicate higher life satisfaction. Internal reliability was good (McDonald's $\omega = 0.874$ at admission, 0.886 at discharge, and 0.896 at follow-up).

2.3 | Procedure

The study was approved by the review board of the LMU Munich. Measurement of body weight and height and completion of the questionnaires were part of the routine diagnostic assessment at the hospital at admission and discharge. The inpatient treatment offered at the hospital adheres to the German S3-guidelines for the treatment of AN (Herpertz et al., 2018; Resmark, Herpertz, Herpertz-Dahlmann, & Zeeck, 2019) in terms of admission criteria, treatment elements, and therapy goals (c.f.Supplementary Material S1). Thus, patients received a cognitive-behavioural therapy-oriented, multimodal AN treatment that included several treatment elements (percentage of patients who reported to have participated in each treatment element in brackets): individual psychotherapy sessions (100%), general cognitive-behavioural group therapy (100%), eating disorder-specific cognitive-behavioural group therapy (98%), supervised meals (98%), social skills group therapy (97%), family therapy (94%), relaxation- and mindfulness-focused exercise therapy (93%), body image-focused exercise therapy (92%), meal preparation classes (89%), exercise therapy (76%), mirror-based body image exposure (47%), nutrition counselling

(46%), video-based body image exposure (38%), food intake protocols (35%), progressive muscle relaxation (35%), healthy exercise behaviour group therapy (32%), depression group therapy (24%), and social phobia group therapy (14%). At discharge, patients were approached on whether they would like to take part in the study. If they agreed, they were contacted 1 year after discharge, self-reported their current height and weight, and completed the questionnaires again.

2.4 | Data analyses

Data were analysed with growth curve analyses (Mirman, 2014) using the R-package *lme4* (Bates, Mächler, Bolker, & Walker, 2015). This analytic strategy has multiple advantages as compared to, for example, analysis of variance. For instance, it can handle missing data better (i.e., cases with missing data are not excluded), both categorical and continuous predictor variables can be used, random effects can be specified and both linear and non-linear trajectories can be modelled. To examine overall changes in body weight, eating disorder symptoms, depressive symptoms, compulsive exercise and life satisfaction, separate models were run with second-order orthogonal polynomials of the time term (i.e., the three measurements) as predictors of BMI percentiles, EDE–Q total scores, BDI–II total scores, CES total scores and SWLS total scores. The models also included random effects of patients on all time terms. The second-order polynomial of the time term was added individually to the linear time term and its effects on model fit was evaluated with model comparisons (likelihood ratio test). Parameter-specific *p*-values were calculated with the R-package *lmerTest* (Kuznetsova, Brockhoff, & Christensen, 2017). For all models, Pseudo-R^2s were calculated using the *r.squaredGLMM* function of the R-package *MuMIn* (https://www.rdocumentation.org/packages/MuMIn). This function computes two types of R^2s based on Nakagawa and Schielzeth (2013), Johnson (2014) and Nakagawa, Johnson, and Schielzeth (2017): *marginal* R^2 represents the variance explained by the fixed effects and *conditional* R^2 represents the variance explained by the entire model, including both fixed and random effects. To examine possible moderators of changes in body weight, eating disorder symptoms, depressive symptoms, compulsive exercise and life satisfaction, separate models were calculated in which fixed effects of either age (in years), duration of illness (in months), previous inpatient treatment (0 = no previous inpatient treatment, 1 = one previous inpatient treatment, 2 = at least two previous inpatient treatments), length of stay (in days) or readmission (0 = no readmission after discharge, 1 = readmission after discharge) on all time terms were added. All other statistical analyses reported in this manuscript were performed with JASP version 0.12.2 (www.jasp-stats.org). The data that support the findings of this study are available from the corresponding author upon reasonable request.

3 | RESULTS

One-hundred and twenty-one patients (85.2%) participated at 1-year follow-up. Those who participated at follow-up did not differ from those who did not participate at follow up in age ($t_{(140)} = 1.36$, $p = 0.175$, $d = 0.322$), duration of illness ($t_{(139)} = 0.43$, $p = 0.670$, $d = 0.101$), length of stay at the hospital ($t_{(140)} = 0.59$, $p = 0.557$, $d = 0.139$), BMI percentile at admission ($t_{(140)} = 0.28$, $p = 0.783$, $d = 0.065$) and discharge ($t_{(140)} = 0.354$, $p = 0.724$, $d = 0.084$), and whether they received psychopharmacological medication ($\chi^2_{(1)} = 0.52$, $p = 0.473$, $\phi = -0.060$) or had a comorbid mental disorder ($\chi^2_{(1)} = 2.52$, $p = 0.112$, $\phi = -0.133$). Of the 121 patients who participated at follow-up, almost all indicated that they received outpatient psychotherapy after discharge (94.2%, $n = 114$). Twenty-nine patients (24.0%) indicated that they were readmitted to inpatient treatment after discharge.

3.1 | Overall changes

3.1.1 | Body weight

Adding the quadratic time term to the linear time term significantly improved model fit ($\chi^2_{(4)} = 320$, $p < 0.001$). Similarly, the quadratic time term was a significant predictor of BMI percentiles (estimate = –6.35, SE = 0.96, $p < 0.001$), indicating that body weight changed non-linearly from admission to follow-up. For the final model, R^2s were 0.264 (marginal) and 0.984 (conditional). As can be seen in Figure 1a and Table 1, BMI percentiles increased from admission to discharge and remained stable from discharge to follow-up. When examining cut-off scores for severe underweight (3rd percentile) and underweight (10th percentile; Kromeyer-Hauschild et al., 2001), 85.9% had a BMI percentile ≥ 3 and 69.0% had a BMI percentile ≥ 10 at discharge. At follow-up, 78.5% had a BMI percentile ≥3 and 56.2% had a BMI percentile ≥10.

3.1.2 | Eating disorder symptoms

Adding the quadratic time term to the linear time term significantly improved model fit ($\chi^2_{(4)} = 44.5$, $p < 0.001$).

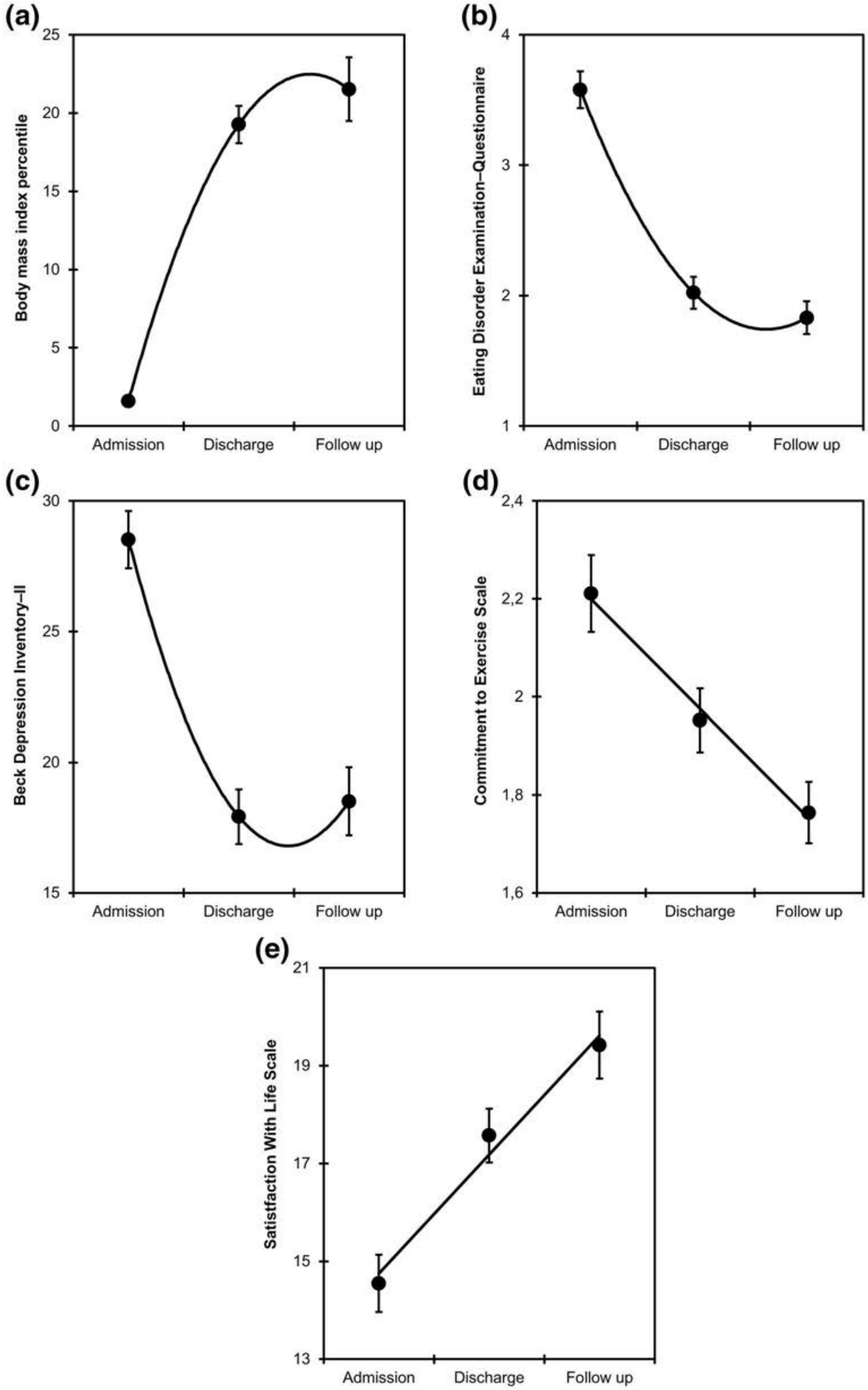

FIGURE 1 Mean body mass index percentiles (a) and mean total scores of the Eating Disorder Examination–Questionnaire (b), Beck Depression Inventory–II (c), Commitment to Exercise Scale (d), and Satisfaction With Life Scale (e) at admission, discharge, and 1-year follow up. Error bars represent the standard error of the mean. Panels (a)–(c) depict second-order polynomial fit lines. Panels (d) and (e) depict linear fit lines as adding a second-order polynomial did not improve model fit

TABLE 1 Descriptive statistics of the dependent variables at admission, discharge and follow-up

	Admission				Discharge				Follow up		
	n	***M***	**SD**		***n***	***M***	**SD**		***n***	***M***	**SD**
Body mass index (percentiles)	142	1.61	2.76	<	142	19.3	14.2	=	121	21.5	22.3
Eating Disorder Examination–Questionnaire (total scores)	119	3.58	1.54	>	117	2.02	1.33	=	115	1.83	1.35
Beck Depression Inventory–II (total scores)	117	28.5	11.8	>	130	17.9	11.9	=	115	18.5	14.0
Commitment to Exercise Scale (total scores)	117	2.21	0.85	>	114	1.95	0.70	>	115	1.76	0.67
Satisfaction With Life Scale (total scores)	126	14.6	6.55	<	139	17.6	6.50	<	112	19.4	7.28

Note: The equal, smaller-than, and greater-than signs refer to paired *t*-tests for which "<" and ">" reflect significant differences between measurements with all $ps < 0.043$ and all $ds > 0.20$ and " = " reflects no significant differences between measurements with all $ps > 0.124$ and all $ds < 0.11$. Note, however, that this is only displayed here to provide further information for interested readers as the main analyses (growth curve analysis) did not exclude cases with missing data and should be interpreted in terms of slopes across the three time points instead of comparing the single timepoints. Nonetheless, the single comparisons presented here are in line with the main analyses that indicated non-linear changes in body weight, eating disorder symptoms and depressive symptoms and linear changes in compulsive exercise and life satisfaction.

Similarly, the quadratic time term was a significant predictor of EDE–Q scores (estimate = 0.57, SE = 0.08, $p < 0.001$), indicating that eating disorder symptoms changed non-linearly from admission to follow up. For the final model, R^2s were 0.237 (marginal) and 0.762 (conditional). As can be seen in Figure 1b and Table 1, EDE–Q scores decreased from admission to discharge and remained stable from discharge to follow up.

3.1.3 | Depressive symptoms

Adding the quadratic time term to the linear time significantly improved model fit ($\chi^2_{(4)} = 49.4$, $p < 0.001$). Similarly, the quadratic time term was a significant predictor of BDI–II scores (estimate = 5.09, SE = 0.66, $p < 0.001$), indicating that depressive symptoms changed non-linearly from admission to follow up. For the final model, R^2s were 0.128 (marginal) and 0.738 (conditional). As can be seen in Figure 1c and Table 1, BDI–II scores decreased from admission to discharge and remained stable from discharge to follow up.

3.1.4 | Compulsive exercise

Adding the quadratic time term to the linear time term did not improve model fit ($\chi^2_{(4)} = 3.99$, $p = 0.407$). Thus, only the linear time term was retained in the model and was a significant predictor of CES scores (estimate = –0.31, SE = 0.06, $p < 0.001$), indicating that compulsive exercise changed linearly from admission to follow up. For the final model, R^2s were 0.054 (marginal) and 0.684 (conditional). As can be seen in Figure 1d and Table 1, CES scores decreased from admission to discharge and further decreased from discharge to follow-up.

3.1.5 | Life satisfaction

Adding the quadratic time term to the linear time term did not improve model fit ($\chi^2_{(4)} = 4.22$, $p = 0.378$). Thus, only the linear time term was retained in the model and was a significant predictor of SWLS scores (estimate = 3.31, SE = 0.53, $p < 0.001$), indicating that life satisfaction changed linearly from admission to follow up. For the final model, R^2s were 0.071 (marginal) and 0.640 (conditional). As can be seen in Figure 1e and Table 1, SWLS scores increased from admission to discharge and further increased from discharge to follow up.

3.2 | Moderation analyses

3.2.1 | Age

When examining body weight, adding the effect of age on the intercept did not improve model fit ($\chi^2_{(1)} = 0.17$, $p = 0.680$), but adding the effect of age on the linear time term did ($\chi^2_{(1)} = 23.9$, $p < 0.001$). Similarly, the interaction between the linear time term and age was a significant predictor of BMI percentiles (estimate = –4.27, SE = 0.82, $p < 0.001$), indicating that changes in body weight differed as a function of age. Adding the effect of age on the quadratic term did not improve model fit ($\chi^2_{(1)} = 2.38$, $p = 0.123$) and, thus, this effect was not included in the final model (marginal $R^2 = 0.356$, conditional $R^2 = 0.982$). As can be seen in Figure 2a, younger patients showed a steeper, non-linear increase in body weight than older patients.

When examining depressive symptoms, adding the effect of age on the intercept did not improve model fit ($\chi^2_{(1)} = 2.76$, $p = 0.097$), but adding the effect of age on the linear time term did ($\chi^2_{(1)} = 4.73$, $p = 0.030$).

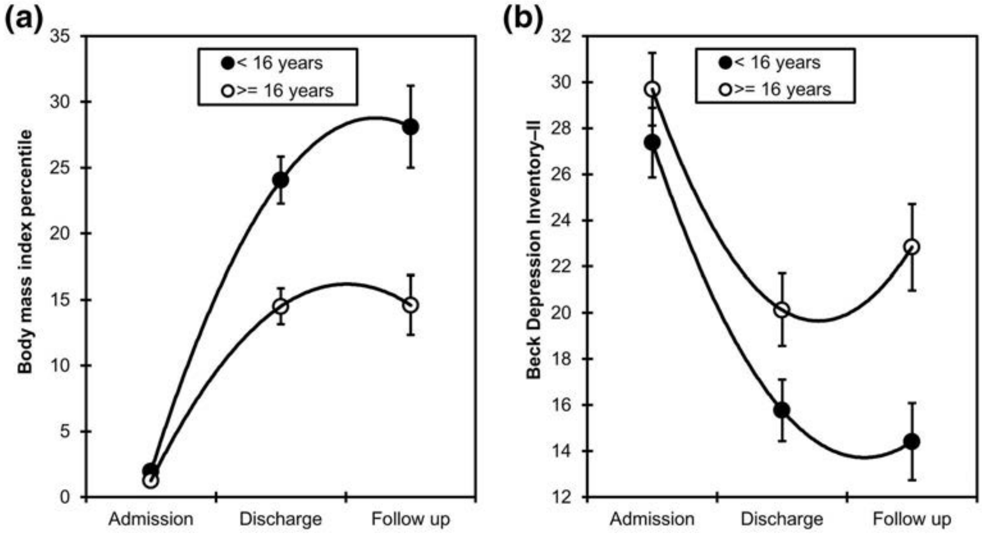

FIGURE 2 Mean body mass index percentiles (a) and mean total scores of the Beck Depression Inventory–II (b) with second-order polynomial fit lines as a function of age. Error bars represent the standard error of the mean. Younger patients had a steeper increase in body weight and steeper decrease in depressive symptoms than older patients. Note, however, that age was used as a continuous variable in all analyses. The differentiation between patients younger than 16 years and patients who were at least 16 years is based on a median split and only serves the purpose of visualising the interaction effect

Similarly, the interaction between the linear time term and age was a significant predictor of BDI–II scores (estimate = 1.41, SE = 0.64, p = 0.030), indicating that changes in depressive symptoms differed as a function of age. Adding the effect of age on the quadratic term did not improve model fit ($\chi^2_{(1)} = 0.41$, $p = 0.521$) and, thus, this effect was not included in the final model (marginal $R^2 = 0.153$, conditional $R^2 = 0.739$). As can be seen in Figure 2b, younger patients showed a steeper, non-linear decrease in depressive symptoms than older patients. Age did not moderate changes in eating disorder symptoms, compulsive exercise, or life satisfaction.

3.2.2 | Duration of illness

When examining body weight, adding the effect of duration of illness on the intercept did not improve model fit ($\chi^2_{(1)} = 0.13$, $p = 0.715$), but adding the effect of duration of illness on the linear time term did ($\chi^2_{(1)} = 4.46$, $p = 0.035$). Similarly, the interaction between the linear time term and duration of illness was a significant predictor of BMI percentiles (estimate = –0.12, SE = 0.05, p = 0.035), indicating that changes in body weight differed as a function of duration of illness. Adding the effect of duration of illness on the quadratic term did not improve model fit ($\chi^2_{(1)} = 0.11$, $p = 0.741$) and, thus, this effect was not included in the final model (marginal $R^2 = 0.283$, conditional $R^2 = 0.985$). As can be seen in Figure 3, patients with a shorter duration of illness showed a steeper, non-linear increase in body weight than patients with a longer duration of illness. Duration of illness did not moderate changes in eating disorder symptoms, depressive symptoms, compulsive exercise or life satisfaction.

3.2.3 | Previous inpatient treatment

When examining body weight, adding the effect of previous inpatient treatment on the intercept did not improve model fit ($\chi^2_{(2)} = 1.19$, $p = 0.552$), but adding the effect of previous inpatient treatment on the linear time term did ($\chi^2_{(2)} = 6.40$, $p = 0.041$). The interaction between the linear time term and the first dummy coded variable (no vs. one previous inpatient treatment) was not significant (estimate = –4.50, SE = 3.05, p = 0.143), but the interaction between the linear time term and the second dummy coded variable (no vs. at least two previous inpatient treatments) was significant (estimate = –8.03, SE = 3.13, p = 0.011), indicating that changes in body weight differed as a function of previous inpatient treatment (particularly between no vs. at least two previous inpatient treatments). Adding the effect of previous inpatient treatment on the quadratic term did not improve model fit ($\chi^2_{(2)} = 1.75$, $p = 0.418$) and, thus, this effect was not included in the final model (marginal $R^2 = 0.294$, conditional $R^2 = 0.982$). As can be seen in Figure 4, patients with no previous inpatient treatment showed a steeper, non-linear increase in body weight

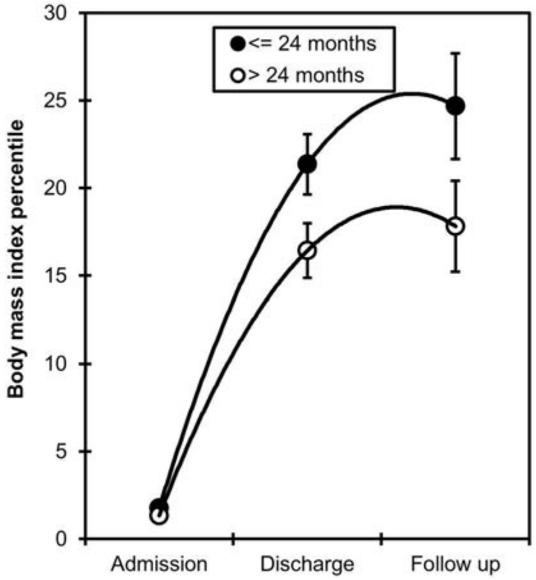

FIGURE 3 Mean body mass index percentiles with second-order polynomial fit lines as a function of duration of illness. Error bars represent the standard error of the mean. Patients with a shorter duration of illness had a steeper increase in body weight than patients with a longer duration of illness. Note, however, that duration of illness was used as a continuous variable in all analyses. The differentiation between patients with a duration of illness of 2 years or less and patients with a duration of illness longer than 2 years is based on a median split and only serves the purpose of visualising the interaction effect

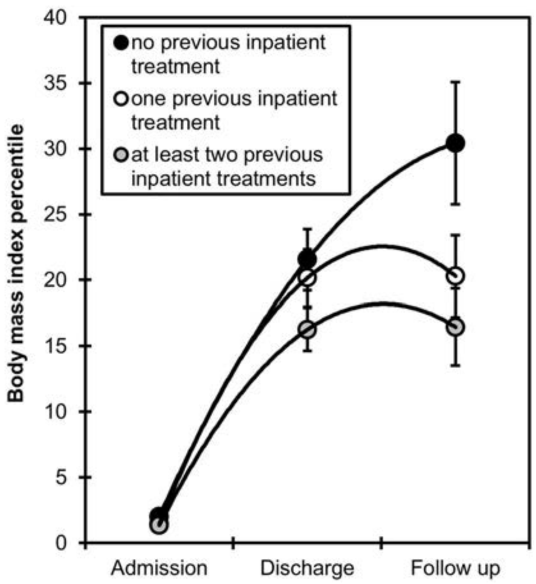

FIGURE 4 Mean body mass index percentiles with second-order polynomial fit lines as a function of previous inpatient treatments. Error bars represent the standard error of the mean. Patients with no previous inpatient treatments showed a steeper increase in body weight than patients with previous inpatient treatments

than patients with previous inpatient treatments. Previous inpatient treatment did not moderate changes in eating disorder symptoms, depressive symptoms, compulsive exercise or life satisfaction.

3.2.4 | Length of stay

When examining body weight, adding the effect of length of stay on the intercept improved model fit ($\chi^2_{(1)} = 11.4$, $p < 0.001$), but adding the effect of length of stay on the linear time term did not ($\chi^2_{(1)} = 0.002$, $p = 0.969$). However, adding the effect of length of stay on the quadratic term improved model fit ($\chi^2_{(1)} = 5.69$, $p = 0.017$). Similarly, the interaction between the quadratic time term and length of stay was a significant predictor of BMI percentiles (estimate = –0.05, SE = 0.02, $p = 0.017$), indicating that changes in body weight differed as a function of length of stay. For the final model, R^2s were 0.273 (marginal) and 0.980 (conditional). As can be seen in Figure 5a, patients with a shorter stay showed a nearly linear increase in body weight while patients with a longer stay showed a non-linear change in body weight (i.e., no further increase from discharge to follow up).

When examining compulsive exercise, adding the effect of length of stay on the intercept improved model fit ($\chi^2_{(1)} = 13.1$, $p < 0.001$) and adding the effect of length of stay on the linear time term improved model fit ($\chi^2_{(1)} = 5.36$, $p = 0.021$). Similarly, the interaction between the linear time term and length of stay was a significant predictor of CES scores (estimate = –0.003, SE = 0.001, $p = 0.024$), indicating that changes in compulsive exercise differed as a function of length of stay. For the final model, R^2s were 0.146 (marginal) and 0.683 (conditional). As can be seen in Figure 5b, patients with a longer stay showed a steeper, linear decrease in compulsive exercise than patients with a shorter stay. Length of stay did not moderate changes in eating disorder symptoms, depressive symptoms or life satisfaction.

3.2.5 | Readmission

When examining body weight, adding the effect of readmission on the intercept did not improve model fit ($\chi^2_{(1)} = 0.10$, $p = 0.759$), but adding the effect of readmission on the linear time term did ($\chi^2_{(1)} = 7.38$, $p = 0.007$). Similarly, the interaction between the linear time term and readmission was a significant predictor of BMI percentiles (estimate = –8.02, SE = 2.87, $p = 0.006$), indicating that changes in body weight differed as a

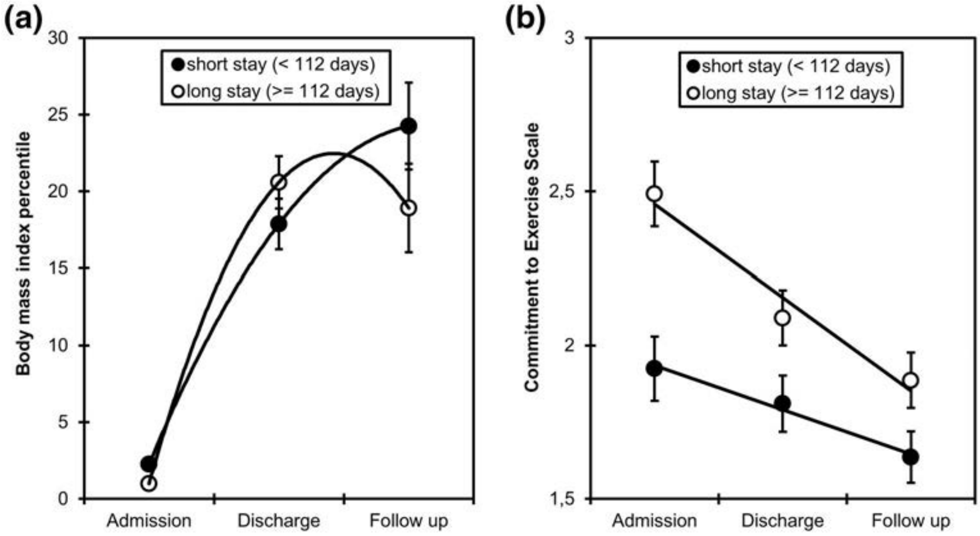

FIGURE 5 Mean body mass index percentiles with second-order polynomial fit lines (a) and mean total scores of the Commitment to Exercise Scale with linear fit lines (b) as a function of length of stay. Error bars represent the standard error of the mean. Patients with a shorter stay had a nearly linear increase in body weight from admission to follow up while patients with a longer stay had a non-linear change in body weight. Patients with a longer stay had a steeper, linear decrease in compulsive exercise than patients with a shorter stay. Note, however, that length of stay was used as a continuous variable in all analyses. The differentiation between patients with length of stay shorter than 112 days and patients with a length of stay at least 112 days is based on a median split and only serves the purpose of visualising the interaction effect

function of readmission. Adding the effect of readmission on the quadratic term did not improve model fit ($\chi^2_{(1)}$ = 2.82, p = 0.093) and, thus, this effect was not included in the final model (marginal R^2 = 0.292, conditional R^2 = 0.977). As can be seen in Figure 6a, both groups showed a non-linear change in body weight, but patients who were not readmitted to inpatient treatment showed a further increase in body weight from discharge to follow up while patients who were readmitted showed a decrease in body weight from discharge to follow up.

When examining depressive symptoms, adding the effect of readmission on the intercept did not improve model fit ($\chi^2_{(1)}$ = 1.70, p = 0.193), but adding the effect of readmission on the linear time term did ($\chi^2_{(1)}$ = 6.89, p = 0.009). Similarly, the interaction between the linear time term and readmission was a significant predictor of BDI–II scores (estimate = 5.74, SE = 2.14, p = 0.008), indicating that changes in depressive symptoms differed as a function of readmission. Adding the effect of readmission on the quadratic term did not improve model fit ($\chi^2_{(1)}$ = 0.12, p = 0.734) and, thus, this effect was not included in the final model (marginal R^2 = 0.150, conditional R^2 = 0.745). As can be seen in Figure 6b, both groups showed a non-linear change in depressive symptoms, but patients who were not readmitted to inpatient treatment showed a steeper decrease in depressive symptoms than patients who were readmitted.

When examining life satisfaction, adding the effect of readmission on the intercept improved model fit ($\chi^2_{(1)}$ = 5.36, p = 0.021) and adding the effect of readmission on the linear time term improved model fit ($\chi^2_{(1)}$ = 7.04, p = 0.008). Similarly, the interaction between the linear time term and readmission was a significant predictor of SWLS scores (estimate = −3.42, SE = 1.27, p = 0.008), indicating that changes in life satisfaction differed as a function of readmission. For the final model, R^2s were 0.106 (marginal) and 0.627 (conditional). As can be seen in Figure 6c, patients who were not readmitted to inpatient treatment showed a steeper, linear increase in life satisfaction than patients who were readmitted to inpatient treatment. Readmission did not moderate changes in eating disorder symptoms or compulsive exercise.

4 | DISCUSSION

4.1 | Overall changes

The current study examined treatment effects in 142 adolescent inpatients with AN. Eighty-five percent of the sample participated at follow up. Those who did not participate at follow up did not differ in important study variables from those who did participate, making dropout biases unlikely. On average, body weight increased and eating disorder symptoms and depressive symptoms decreased from admission to discharge and remained stable from discharge to follow up. Compulsive exercise

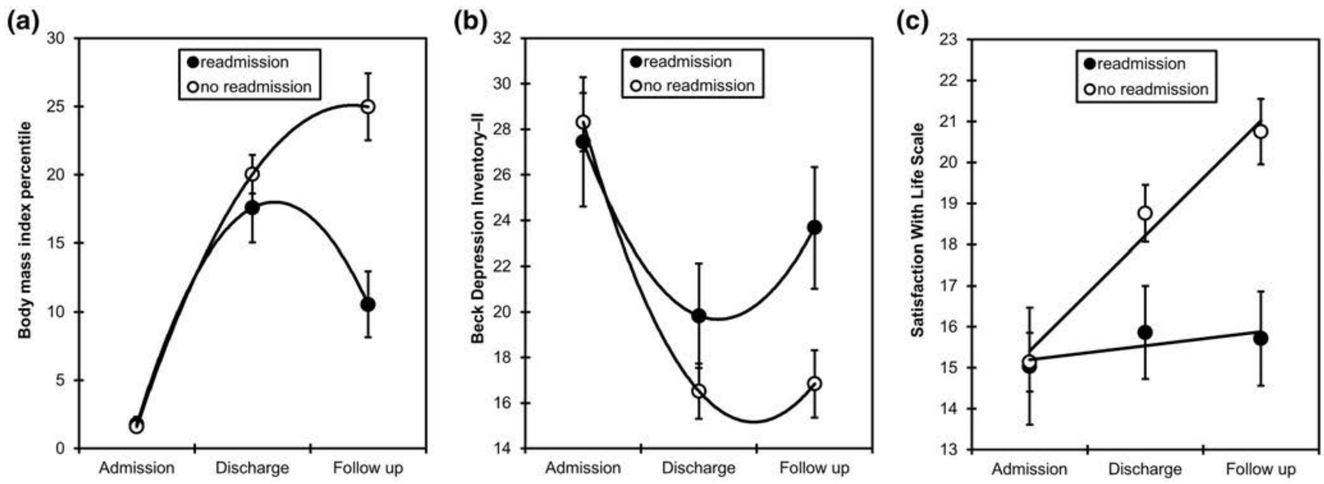

FIGURE 6 Mean body mass index percentiles (a) and mean total scores of the Beck Depression Inventory–II (b) and Satisfaction With Life Scale (c) as a function of readmission to inpatient treatment after discharge. Error bars represent the standard error of the mean. Panels (a) and (b) depict second-order polynomial fit lines. Panel (c) depicts linear fit lines as adding a second-order polynomial did not improve model fit. Patients who were not readmitted to inpatient treatment showed a steeper, non-linear increase in body weight, non-linear decrease in depressive symptoms, and linear increase in life satisfaction than patients who were readmitted to inpatient treatment after discharge

decreased and life satisfaction increased from admission to discharge and even showed a further decrease and increase, respectively, from discharge to follow up. Thus, these findings indicate that inpatient treatment of adolescent AN not only improves symptoms in the short term, but also results in long-term weight stabilisation after discharge and even contributes to further improvements in other aspects such as general satisfaction with life. Of note, more than 70% of our sample indicated that they had previously received inpatient treatment. Thus, the current sample was primarily comprised of patients that already had relapsed in the past.

Interpretation of these findings, however, needs to consider country-specific healthcare systems. In the current study, almost all participants (94%) indicated that they received outpatient treatment after discharge. It is likely that inpatient treatment of adolescent AN may not produce such long-lasting effects without this outpatient aftercare. Indeed, most patients in other studies that reported maintenance of weight and eating disorder symptom improvements after inpatient treatment also received subsequent outpatient treatment, which probably influenced long-term outcome (Dalle Grave et al., 2014; Herpertz-Dahlmann et al., 2014; Legenbauer & Meule, 2015; Madden et al., 2015). Moreover, it has been noted previously that inpatient treatment for AN in Germany is longer and more intensive than most of the structured treatments in many parts of the world, including the United States (Attia, 2014). For example, German treatment guidelines (Herpertz et al., 2018) recommend that treatment of AN is continued until a normal weight has been reached (ideally the 25th and at least the 10th age- and sex-specific BMI percentile) and aftercare is already organised during the inpatient stay. Thus, long-term effects of inpatient treatment for AN in adolescents may be smaller or risk of relapse may be higher in countries that do not provide this intensive healthcare.

4.2 | Moderation analyses

Several moderators of treatment effects were identified in the current study. When examining body weight, a better outcome (i.e., further increases in body weight from discharge to follow up) was found in patients with younger age, shorter duration of illness, no previous inpatient treatment, shorter stay, and no readmission after discharge. The moderating role of age, duration of illness, and previous inpatient treatments is in line with previous studies, which indicated that there is a subgroup of patients with a chronic course that is predictive of poorer outcomes (Agras et al., 2014; Berends et al., 2018; Bulik et al., 2007; Schlegl et al., 2016; Vall & Wade, 2015). The current study also found that younger patients showed a better long-term outcome in terms of depressive symptoms. In older patients, depressive symptoms increased again after discharge (Figure 2b). Future studies need to determine whether these changes in depressive symptoms occur before—and, thus, foster—renewed weight loss or whether renewed weight loss results in increased depressive symptoms.

The moderating role of length of stay is in contrast to previous findings that reported larger weight gain with a longer stay from pre- to post-treatment (e.g., Hiney-Saunders et al., in press; Schlegl et al., 2016). Yet, this may likely be explained by the fact that those with a lower body weight at admission need to gain more weight than those with a higher body weight at admission and, thus, need to stay longer in the hospital to achieve the target weight. Accordingly, a longer stay is associated with larger weight gain from admission to discharge. However, those with a low body weight at admission—thus, those with a larger weight gain during treatment and a longer stay—are likely those with a higher disorder severity and, thus, are more likely to relapse after discharge. Indeed, previous studies indicate that patients who need a longer duration of treatment have a higher risk of relapse after discharge (Berends et al., 2018). This can explain why a longer stay was associated with poorer long-term weight outcome in the current study. In addition, a longer stay was also associated with larger decreases in compulsive exercise due to elevated levels of compulsive exercise at admission (Figure 5b), which further suggests that those patients with a longer stay were those with a higher disorder severity.

The moderating role of readmission after discharge further shows that—while the patients maintained their weight on average after discharge—this effect can actually be decomposed into a subgroup of patients who were not readmitted and showed a further increase in body weight and a subgroup of patients who were readmitted and showed a decrease in body weight (i.e., relapse). In addition to this, patients who were readmitted after discharge also showed a renewed increase in depressive symptoms (Figure 6b) and hardly showed an increase in life satisfaction overall (Figure 6c). In contrast, patients who were not readmitted maintained their decreased levels of depressive symptoms after discharge (Figure 6b) and showed a linear increase in life satisfaction from admission to follow up (Figure 6c). These findings are in line with a recent study in adolescents with AN that found that a lack of early changes in depressive symptoms during inpatient treatment was associated with later rehospitalisation (Kahn, Brunstein-Klomek, Hadas, Snir, & Fennig, 2020). In sum, the current results are in line with the finding that patients have a high risk of relapse within the first year after discharge (Berends et al., 2018; Carter et al., 2004, 2012) and suggest that patients who are not readmitted within the first year after inpatient treatment may have a favourable long-term prognosis.

4.3 | Limitations

A limitation of the current study is that body weight at follow up was based on self-report, which may be biased. Yet, women with AN are extremely accurate when self-reporting their own weight. For example, self-reported weight has been found to be more accurate in women with AN than in normal-weight and overweight women (Engstrom, Paterson, Doherty, Trabulsi, & Speer, 2003). Although it has been found that they slightly overestimate their weight, this overestimation is on average less than 1 kg (Ciarapica, Mauro, Zaccaria, Cannella, & Polito, 2010; McCabe, McFarlane, Polivy, & Olmsted, 2001; Meyer, Arcelus, & Wright, 2009). Thus, it is unlikely that using self-report of current weight at follow up substantially affected results of the current study. Yet, other variables such as compulsive exercise were also based on self-report and, thus, biases cannot be excluded. Therefore, including objective measures of these variables would be desirable in future studies. Finally, interpretation of results is restricted to the current sample of female adolescents with AN in Germany and, thus, may not apply to males or to other countries (e.g., those with a substantially different health care system).

4.4 | Conclusion

In conclusion, the current study showed that inpatient treatment of adolescents with AN not only produces increases in body weight and decreases in eating disorder symptoms from admission to discharge, but also that these changes are maintained after 1 year and other aspects such as life satisfaction even show a further increase. However, several variables moderate these effects, indicating that a subgroup of patients (e.g., those with a higher age, longer duration of illness, and previous inpatient treatments) need to receive special attention during and after treatment to ensure long-lasting weight stabilisation and remission of eating disorder symptoms.

CONFLICT OF INTEREST

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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BRIEF REPORT

Distance to home does not influence treatment success during and after inpatient treatment in adolescents with anorexia nervosa

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Abstract
Current treatment guidelines recommend that inpatients with eating disorders—particularly adolescents with anorexia nervosa—should receive treatment at facilities within close distance to their home. However, whether distance to home actually influences short- and long-term treatment outcome in adolescents with anorexia nervosa has not been investigated yet. We re-analyzed data at admission, discharge, and 1-year follow up from a recent study with $N = 142$ female, adolescent inpatients with anorexia nervosa. Distance to home did not moderate changes in body weight, eating disorder symptoms, depressive symptoms, compulsive exercise, and life satisfaction. This is the first analysis that indicates that specialized inpatient treatment for adolescents with anorexia nervosa is effective both close to and away from home.

Keywords Anorexia nervosa · Adolescents · Inpatient treatment · Distance to home · Treatment outcome

Introduction

Current treatment guidelines (e.g., by the National Institute for Health and Care Excellence and the American Psychiatric Association) recommend that inpatients with eating disorders—particularly adolescents with anorexia nervosa (AN)—should receive treatment at facilities within close distance to their home [1, 2]. Being an inpatient may carry with it a pervasive sense of being removed from the outside world and the normality of adolescent life [3], which may be exacerbated when the treatment facility is located far from home. Other considerations for preferring facilities close to home include caregiver costs such as travel expenses [4]. However, empirical evidence for preferring inpatient treatment close to home is virtually non-existent. For example, longer distance to home related to longer length of stay in inpatients with AN in one study [5] but was unrelated to length of stay in another [6]. Furthermore, it seems that the influence of distance to home on actual treatment success during and after inpatient treatment has not been examined yet.

Methods

We re-analyzed data from a recently published study that investigated changes in body weight, eating disorder symptoms and other variables during and after inpatient treatment in adolescents with AN across admission, discharge, and one-year follow up. The study was approved by the institutional review board of the LMU Munich. One-hundred and forty-two female adolescents with AN who received inpatient treatment at the Schoen Clinic Roseneck (Prien am Chiemsee, Germany) between 2016 and 2018 were included in this study, 121 of which participated at follow up. Dependent variables were age- and sex-specific body mass index (BMI) percentiles and total scores of the Eating Disorder Examination–Questionnaire, Beck Depression Inventory–II, Commitment to Exercise Scale, and Satisfaction With Life Scale. A detailed description of the sample,

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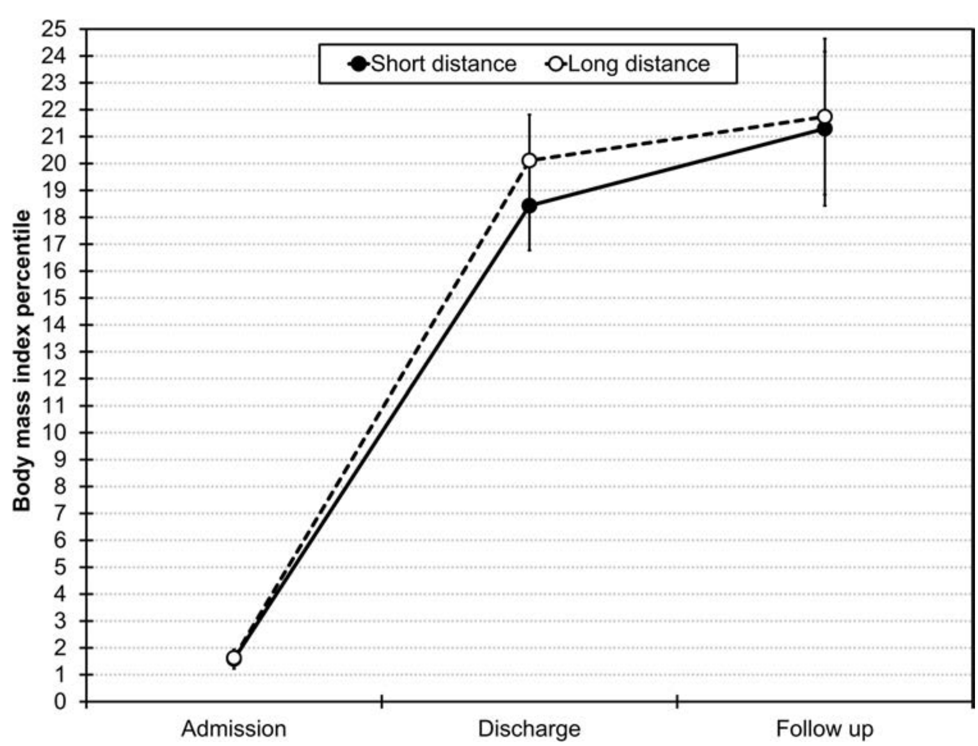
treatment elements, and measures can be found in the article by Meule et al. [7], which is openly accessible.

The Schoen Clinic Roseneck treats patients that reside all over Germany and Austria, that is, there is a large diversity in terms of distance to home. Treatment of adolescents includes family therapy sessions both in person and by phone or video calls. Patients are allowed to receive visitors, ideally on weekends. If appropriate for the current treatment stage, patients are also allowed to leave the hospital at weekends, including home visits overnight that are previewed before and reviewed afterwards with the patients' therapists. These treatment elements are integrated depending on the current treatment stage and the patients' physical and mental conditions but irrespective of distance to home. If a long distance to home poses a challenge, alternative solutions are sought (e.g., instead of traveling home, parents may come to visit and the patient is allowed an overnight stay at the hotel). The hospital does not offer subsequent outpatient treatment after completion of inpatient treatment but aims to organize outpatient treatment with a local practitioner at or near the patients' place of residence. Ideally, patients should receive their outpatient treatment from the therapist who provided therapy before the inpatient stay.

In the original report [7], data were analyzed with mixed-effects models [8]. This analytic strategy has multiple advantages as compared to, for example, analysis of variance. For instance, it can handle missing data better (i.e., cases with missing data are not excluded), both categorical and continuous predictor variables can be used, random effects can be specified, and both linear and non-linear trajectories can be modeled. Compulsive exercise and life satisfaction changed linearly across the three measurements, which is why these variables were predicted by a linear time term only. Changes in BMI percentiles, eating disorder symptoms, and depressive symptoms changed non-linearly across the three measurements (cf. Figure 1), which is why a second-order orthogonal polynomial of the time term (i.e., time^2) was added as predictor variable. The models also included random intercepts of patients. For the current analyses, we determined the linear distance between the hospital and each patient's place of residence with Google Maps (https://www.google.com/maps). To test whether distance to home moderated changes across the three measurements, we added the fixed effect of distance to home on all time terms. For these analyses, we report unstandardized regression coefficients, standard errors, and *p* values for the highest-order interactions. As there were five dependent variables (i.e., five models were calculated), we set the level of significance to $0.05/5 = 0.01$. At this level, the minimal detectable unstandardized regression coefficient with more than 80% power was 0.025 for the time$^2 \times$ distance interaction. This corresponds to a detectable difference of 2.44 BMI percentile points due to this interaction for an individual with a distance of 238.67 km (mean distance across participants) at follow up, compared to an individual living in close vicinity of the treatment center. The data and code for all analyses can be accessed at https://osf.io/qvmwr.

Fig. 1 Body mass index percentiles across measurements as a function of short (< 239.90 km) and long (> 239.90 km) distance to home. Error bars represent the standard error of the mean



Results

Distance to home ranged between 4.13 and 697.49 km ($M=238.67$, $SD=153.49$, $SE=12.88$, percentiles: 25th = 104.76, 50th = 239.90, 75th = 329.58) and was unrelated to length of stay ($r=0.042$, $p=0.621$). The interaction of the quadratic time term and distance to home (i.e., time^2 × distance) for predicting changes in BMI percentiles was not significant (estimate = − 0.0002, $SE=0.01$, $p=0.977$). As is depicted in Fig. 1, changes in BMI percentiles across the three measurements were similar for patients with a long and short distance to home (based on a median split). Note, however, that this graphical depiction merely serves the purpose of visualizing the non-significant interaction effect time^2 × distance, that is, distance to home was used as a continuous variable in all models and was not categorized into groups. The interaction time^2 × distance was also not significant when examining changes in eating disorder symptoms (estimate = 0.0003, $SE=0.001$, $p=0.690$) and depressive symptoms (estimate = 0.01, $SE=0.01$, $p=0.168$). Finally, the interaction between the linear time term and distance to home (time × distance) was also not significant when examining changes in compulsive exercise (estimate = 0.001, $SE=0.0003$, $p=0.012$) and life satisfaction (estimate = − 0.004, $SE=0.003$, $p=0.206$).

Discussion

In the current study, distance to home did not moderate treatment success during and after inpatient treatment in adolescents with AN. This finding resonates with reports from Germany that examined patients with depression [9] and substance use disorders [10], in which distance to home did not influence treatment success either. An auxiliary finding was that distance to home was unrelated to length of stay, thus contrasting results reported by Maguire et al. [5] but corroborating those by Strik Lievers et al. [6]. Yet, studies that replicate our findings—particularly outside of Germany—are urgently needed. For example, 94% of patients who participated at follow up in the current study indicated that they received outpatient psychotherapy after discharge (cf. [7]). This may have attenuated any influence of distance to home as psychotherapeutic aftercare was provided for almost all patients irrespective of their place of residence, which may not be the case in countries with other healthcare systems. Yet, while the current data were collected before the COVID pandemic, we expect that remote post-inpatient aftercare interventions (e.g., delivered via videoconference [11]) will increase in the years to come, which may further reduce the importance of distance to home on treatment outcome after discharge as provision of psychotherapeutic aftercare by the hospital is no longer dependent on place of residence.

Strengths of the current study include the large sample size, repeated measurements, and large range of distance to home, which allowed us to test meaningful effects that distance to home might have on short- and long-term treatment success in adolescents with AN. As this was a re-analysis of existing data, however, we could not take important variables into account that may influence effects of distance to home on treatment outcome. These may include health economic variables (e.g., loss of earning for family members secondary to increased travel time or travel expenses) and social factors (e.g., not being able to attend school or work or see family and friends when on leave from the inpatient unit). As effects of distance to home on treatment outcome appears to be such an under-researched topic, future studies may also consider applying qualitative research designs to gain further insights into the experiences by both patients and their relatives during and after treatment.

Both inpatient treatment far away from and close to home have advantages and disadvantages. For example, advantages of inpatient treatment far away from home include keeping distance to a potentially harmful social environment and having more discretion during treatment. Moreover, German treatment guidelines recommend that inpatient treatment of AN should take place in facilities that offer a specialized, multimodal treatment program [2], which may not be feasible if there is no such specialized facility near patients' homes. In contrast, centers with both in- and outpatient units can ensure continuity from inpatient to outpatient treatment by the same practitioners, which is not feasible when patients receive inpatient treatment far from home and need to return after inpatient treatment. As of yet, however, there have been no studies examining whether distance to home actually influences short- and long-term treatment outcome in adolescents with AN. This analysis is the first to indicate that specialized inpatient treatment for adolescents with AN is effective both close to and away from home.

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Declarations

Conflict of interest All authors declare that there is no conflict of interest.

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BRIEF REPORT

Adolescent inpatients with anorexia nervosa can roughly predict their own weight trajectories after discharge

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ABSTRACT

Most adolescents with anorexia nervosa (AN) gain a substantial amount of weight during inpatient treatment, but many relapse after discharge. Therefore, there is a need to identify variables that predict weight changes after treatment. The current study tested whether such a variable may be patients' own predictions about their future weight. Data of 120 female adolescent inpatients with AN were available at discharge and one-year follow-up. Patients' own predictions about their future weight trajectories predicted their actual weight change after discharge: those who indicated that they would gain weight, gained weight, those who indicated that they would lose weight, lost weight, and those who indicated to maintain their weight, had no weight change on average. Similarly, expected weight change in kilograms correlated positively with actual weight change after discharge. Thus, patients who expect that they will lose weight again should receive intensified aftercare that fosters motivation to change.

Clinical implications

- Relapse rates are high after inpatient treatment for anorexia nervosa
- Patients' own expectations about their future weight predicted actual weight changes
- Patients' own expectations should be considered in relapse prevention approaches

Introduction

During inpatient treatment for anorexia nervosa (AN), body weight and eating disorder symptomatology improve substantially (e.g., Dalle Grave et al., 2014;

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Supplemental data for this article can be accessed on the publisher's website.

Herpertz-Dahlmann et al., 2014; Hiney-Saunders et al., 2021; Isserlin et al., 2020; Jaite et al., 2019; Schlegl et al., 2016, 2014). After inpatient treatment, however, there is a high risk of relapse, particularly between 4 and 12 months after discharge (Carter et al., 2012; Berends et al., 2018; Carter et al., 2004). Thus, it is important to examine factors that predict changes in body weight and eating disorder symptoms after discharge that may help therapists to evaluate which patients are at risk for relapse. Factors that have been previously associated with relapse include eating disorder-related variables (e.g., increase in weight and shape concerns during treatment), comorbidity symptoms (e.g., history of childhood physical abuse), process treatment variables (e.g., longer duration of treatment and previous inpatient treatments), and demographic variables (e.g., higher age and longer duration of illness; Berends et al., 2018). However, many of these factors require rather effortful assessments (e.g., questionnaire measures that require data entry and scoring or time-consuming structured clinical interviews). Thus, it would be valuable to have easily measurable and easily interpretable variables available that can be used for determining risk of relapse after treatment. For example, no study has examined yet whether patients may simply be asked about their own expectations of whether their AN symptoms will recur or not. As weight loss is a key symptom of relapse in AN (Khalsa et al., 2017), we asked female, adolescent inpatients with AN at discharge whether they think that they will gain, lose, or maintain their weight and tested whether these expectations were predictive of their actual weight changes after discharge. As there are no similar studies of such effects, these analyses should be considered as exploratory.

Method

The data presented in this report are part of a larger study on effects of inpatient treatment in adolescents with AN. A detailed description of the study sample and the inpatient treatment can be found in Meule et al. (2021). This study was approved by the review board of the LMU Munich and all patients provided assent for participation in addition to their parent's or guardian's consent. Initially, 142 female, consecutively admitted adolescents with AN who received inpatient treatment at the Schoen Clinic Roseneck (Prien am Chiemsee, Germany), participated in this study. At discharge, they completed a set of questions that included the question "What is your estimation regarding your weight development after discharge from the hospital?", which had three response options: "I will maintain my weight", "I will continue to gain weight", and "I will lose weight again". In addition, participants were asked to indicate how many kilograms they would expect to gain or lose. If participants indicated that they would maintain their weight, this was coded with zero kilogram. One year after discharge, patients were contacted again and asked to indicate their current weight. Weight change was then calculated by subtracting weight in kilograms at discharge from weight in kilograms at one-year follow-up.

One-hundred and twenty-one patients participated at follow-up (85.2%). Those who participated at follow-up did not differ from those who did not differ at follow-up in key variables, such as age, illness duration, treatment duration, or body mass index (BMI) at admission and discharge (cf. Meule et al., 2021). One patient did not answer the question on weight prediction, leaving a final sample size of n = 120 for the categorical weight prediction variable. Three participants did not provide an estimate in kilograms, which is why sample size is n = 117 for the continuous weight prediction variable. Patients' mean age was 15.6 years (SD = 1.40), mean BMI was 18.2 kg/m^2 (SD = 1.21), and mean age- and sex-specific BMI percentile (according to German reference values; Kromeyer-Hauschild et al., 2001)) was 19.4 (SD = 13.6) at discharge.

As the expected weight change was assessed categorically (based on the three response options representing weight maintenance, weight gain, and weight loss) and continuously (based on expected weight change in kg), two different analyses were run. First, a Kruskal–Wallis test was run with IBM SPSS Statistics Version 24, entering weight change group as between-subjects factor and actual weight change as dependent variable. A significant effect of group ($p < .05$) was followed up with independent samples Mann–Whitney U-tests. Second, for the continuous variable of the expected weight change in kilograms, a Spearman's ρ correlation coefficient was calculated to examine the association with actual weight change. The data that support the findings of this study are available as online supplementary material.

Results

When examining expected weight change categorically, 45 patients (37.5%) indicated that they expected to gain further weight, 65 patients (54.2%) indicated that they expected to maintain their weight, and 10 patients (8.3%) indicated that they expected to lose weight again. Weight change significantly differed between these groups ($H_{(2)} = 7.72$, $p = .021$). Follow-up tests indicated that weight change was significantly larger in the weight gain group (M = 2.63 kg, SD = 5.43, 95%CI [1.15,4.13]) than in the weight maintenance group (M = 0.23 kg, SD = 6.19, 95%CI [−1.21,1.69]; U = 1879, p = .011; Figure 1A). The weight loss group (M = —1.64, SD = 5.87, 95%CI [−5.42,1.72]) did not differ significantly from the weight maintenance (U = 289, p = .575) and weight gain group (U = 139, p = .059). When examining expected weight change continuously, patients' expected weight change in kilograms correlated positively with the actual weight change after discharge (ρ = .279, p = .002; Figure 1B).

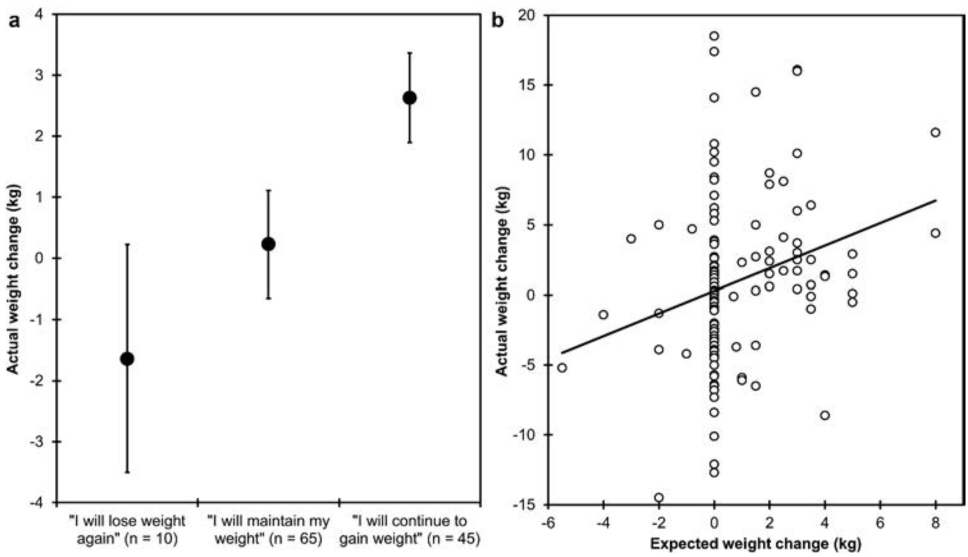

Figure 1. (A) Mean actual weight change in kilograms from discharge to one-year follow-up as a function of expected weight change group. Error bars represent the standard error of the mean. (B) Scatterplot with linear trend line depicting the association between patients' expected weight change in kilograms at discharge and actual weight change in kilograms from discharge to one-year follow-up.

Discussion

Results of the current study indicate that adolescent, female inpatients with AN are able to predict their own weight development after discharge. Those who expected to gain more weight after treatment actually gained more weight on average in the year after discharge, while those who expected to maintain their weight largely maintained it. Although those who expected to lose weight actually lost weight descriptively, weight change did not differ significantly from the other groups. This lack of difference may be due to low statistical power because of the small group size. Specifically, only ten patients indicated that they expected weight loss, leading to wide confidence intervals. While this is encouraging from a clinical perspective (as more than 90% of patients expected that they, at least, keep their weight that they gained during treatment), it may also have been influenced by social desirability. That is, some patients may have felt pressured into choosing the other response options in order to make a good impression towards their therapist.[1]

When asked about a precise estimate of future weight change, this estimate significantly correlated positively with actual weight change. While this correlation was of small magnitude, we would argue that it is

[1]Of note is that both higher expected weight change and higher actual weight change related to lower eating disorder symptomatology at follow-up, indicating that weight gain after discharge is associated with a general improvement in eating disorder symptoms (cf. supplementary material).

nonetheless a remarkable finding that AN patients are able to predict their weight one year later, though with slight precision. We are not aware of any study that investigated such an effect in the general population but, presumably, individuals without eating disorders are rarely able to predict their own weight in the following year (unless maybe individuals participating in weight loss programs). Future research may examine mediators and moderators of this relationship. For example, factors such as motivation may act as both a mediator (i.e., patients who expect to gain further weight may be more motivated at discharge, which in turn translates to higher actual weight gain) and moderator (i.e., the relationship between higher expected and higher actual weight change may be particularly strong among highly motivated patients). However, several factors other than motivation may also be relevant here (e.g., self-efficacy or social support).

A limitation of the current study is that body weight at follow-up was based on self-report, which may be biased. Yet, women with AN are extremely accurate when self-reporting their own weight. For example, self-reported weight has been found to be more accurate in women with AN than in normal-weight and overweight women (Engstrom et al., 2003). Although it has been found that they slightly overestimate their weight, this overestimation is, on average, less than one kilogram (Ciarapica et al., 2010; McCabe et al., 2001; Meyer et al., 2009). Thus, it is unlikely that using self-report of current weight at follow-up substantially affected results of the current study.

Given the prognostic value of self-predicted weight in the current study, such questions may be of use in clinical practice. Specifically, patients who expect to maintain or even increase their weight after inpatient treatment seem to have a higher likelihood of actual weight maintenance. This information alone is surely not sufficient to reliably predict patients' long-term weight outcome (e.g., as weight gain may also reflect a transition into binge eating-related disorders) but—on average—weight gain also seems to be related to general improvements in eating disorder symptoms (cf. supplementary material). Conversely, patients who already expect at discharge to lose weight again should receive intensified aftercare that fosters motivation to change to facilitate long-term weight stabilization.

Cnflicts of interest

The authors declare that there is no conflict of interest.

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Life satisfaction in persons with mental disorders

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Abstract

Purpose Life satisfaction refers to a cognitive and global evaluation of the quality of one's life as a whole. The arguably most often used measure of life satisfaction is the Satisfaction With Life Scale (SWLS). Persons with mental disorders generally report lower SWLS scores than healthy controls, yet there is a lack of studies that have compared different diagnostic groups, tested measurement invariance of the SWLS across these groups, and examined effects of treatment on life satisfaction.

Methods Data of 9649 inpatients of seven diagnostic categories were analyzed: depressive episode, recurrent depressive disorder, phobic disorders, obsessive-compulsive disorder, trauma-related disorders, somatoform disorders, and eating disorders.

Results The one-factor structure of the SWLS was replicated and full measurement invariance was demonstrated across groups. Patients with trauma-related disorders reported the lowest life satisfaction. Life satisfaction significantly increased during treatment across all groups and these changes were moderately related to changes in depressive symptoms.

Conclusions Results support the excellent psychometric properties of the SWLS. They also demonstrate that although persons with mental disorder generally report lower life satisfaction than persons without mental disorders, life satisfaction also varies considerably between different diagnostic groups. Finally, results show that life satisfaction increases during inpatient treatment, although at discharge most patients have rarely reached levels of life satisfaction reported in non-clinical samples.

Keywords Satisfaction With Life Scale · Life satisfaction · Measurement invariance · Mental disorders · Inpatient treatment

Introduction

Life satisfaction can be defined as a cognitive and global evaluation of the quality of one's life as a whole [1]. The Satisfaction With Life Scale (SWLS [2]) is arguably the most often used instrument for measuring life satisfaction. As of January 2020, using the search term "Satisfaction With Life Scale" resulted in more than 43,000 hits in Google Scholar and the article by Diener and colleagues [2] has been cited—according to Google Scholar—more than 25,000 times. The SWLS consists of five items and responses are recorded on a seven-point scale ranging from 1 = *strongly disagree* to 7 = *strongly agree*. Thus, sum scores can range between five and 35 and higher scores represent higher life satisfaction.

Internal reliability of the SWLS has been found to be good (around $\alpha = 0.80$) across several studies and samples [3]. Similarly, the SWLS has been found to have a one-factor structure, which has been replicated numerous times [1, 4, 5]. Another important aspect of the psychometric properties of a test, however, is measurement invariance, which indicates that the same construct is being measured across different groups or points in time. Although a large amount of studies have examined measurement invariance of the SWLS across sex, age, different countries, or points in time (for overviews see [1, 5, 6]), results have been mixed. For example, while measurement invariance has been fairly well established across men and women, this has rarely been found for different age or cultural groups [7]. Furthermore, measurement invariance has not been tested across other groups, for example, across different groups of persons with mental disorders. However, establishing measurement invariance of the SWLS across these groups is important as it is a prerequisite for comparing scores between these groups.

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That is, violations of measurement invariance may preclude meaningful interpretations of group differences in SWLS scores.

In unselected or healthy samples, mean sum scores of the SWLS roughly range between 20 and 30, indicating that participants are slightly or largely satisfied with their lives [1, 4]. In persons with physical diseases or other health concerns, scores are usually lower than 20, although there is considerable variation between such groups [1, 4]. To date, the lowest scores—thus, the lowest life satisfaction—have been reported in individuals with traumatic brain injury and post-traumatic stress disorder, in male prison inmates and in sex workers, with mean sum scores of about 13, 12, and 10, respectively [1, 4].

Studies that examined persons with mental disorders have largely reported lower SWLS scores than in participants without mental disorders. For example, lower scores have been reported in heterogeneous samples of persons with mental disorders [8, 9], in obese women with binge eating disorder [10], or in persons with obsessive–compulsive disorder [11] than in healthy control participants. In a study that compared several diagnostic groups, lower SWLS scores were found in all groups except persons with hypomania and bipolar disorder compared to persons without mental disorders [12].

As persons with mental disorders report reduced life satisfaction, the question arises whether and to which extent life satisfaction can be improved. While evidence-based treatments lead to symptom reductions, "clinical practice should not just endeavor to alleviate misery, but should also strive to build rewarding lives" ([1], p. 146). While previous studies suggest that scores on the SWLS have moderate temporal stability, they are also subject to change over time [1, 4]. Indeed, preliminary evidence from a study in 25 patients suggests that life satisfaction as measured with the SWLS increases during psychotherapeutic treatment [13].

The current study examined life satisfaction as measured with the SWLS in different diagnostic groups of persons with mental disorders who received inpatient treatment. A first aim was to examine the factor structure of the SWLS and to test measurement invariance across the different diagnostic groups. A second aim was to examine group differences in SWLS scores as well as changes over time (that is, from admission to discharge). A third aim was to explore whether such effects related to sex, age, and length of stay at the hospital. Finally, as the SWLS negatively correlates with affective aspects of subjective well-being such as depression [1, 4], we also examined whether group differences and changes in life satisfaction parallel those in depressive symptoms or whether they are partially independent from depressive symptoms.

Methods

Sample

Clinical records of inpatients treated at the Schoen Clinic Roseneck (Prien am Chiemsee, Germany) between 2014 and 2019 were analyzed. The German version of the SWLS [5] and the depression scale of the Patient Health Questionnaire (PHQ–9 [14–16]) are part of the routine diagnostic assessment at the hospital and are completed by the patients both at admission and at discharge. Only patients without missing SWLS data at admission and discharge were included in the current analyses. Moreover, only data from diagnostic groups with $n > 300$ were included as smaller group sizes are generally considered as not appropriate for confirmatory factor analysis ([17]; the largest group of patients that was excluded because of this procedure was other anxiety disorders [F41; $n = 164$]). The final sample with complete SWLS data at both admission and discharge was $N = 9649$ patients ($n = 9610$ for PHQ–9 data) and included patients of seven diagnostic categories (based on ICD–10 classification): depressive episode, recurrent depressive disorder, phobic disorders, obsessive–compulsive disorder, trauma-related disorders, somatoform disorders, and eating disorders (Table 1).

Data analyses

Sample characteristics. Groups were compared regarding sex distribution with a χ^2-test and regarding age and length of stay with univariate analyses of variance using IBM SPSS Statistics version 24.

Internal reliability, factor structure, and measurement invariance. Internal reliability of the SWLS was evaluated with McDonald's ω (as has been recommended [18–21]), which was calculated with JASP version 0.11.1 (https://jasp-stats.org [22]). Confirmatory factor analysis was conducted with the structural equation modeling module of JASP, which is based on the R-package lavaan (https://lavaan.ugent.be). Diagonally Weighted Least Squares was chosen as estimation method because of the ordinal scale structure [23]. In line with previous studies [4, 5], a one-factor model was specified. Model fit was considered as good according to the recommendations by Schermelleh-Engel et al. [17]: Comparative Fit Index (CFI) ≥ 0.97, Goodness of Fit Index (GFI) ≥ 0.95, Root Mean Square Error of Approximation (RMSEA) ≤ 0.05, and Standardized Root Mean Square Residual (SRMR) ≤ 0.05. Measurement invariance across groups was tested at four levels: configural invariance (tests if the configuration of the model is the same across groups), metric invariance (tests

Table 1 Sample characteristics

$N=9649$	Depressive episode (F32)	Recurrent depressive disorder (F33)	Phobic disorders (F40)	Obsessive–compulsive disorder (F42)	Trauma-related disorders (F43)	Somatoform disorders (F45)	Eating disorders (F50)
Group size	$n=1946$	$n=2697$	$n=465$	$n=909$	$n=538$	$n=340$	$n=2754$
Sex (female)	$n=1163$ (59.8%)	$n=1638$ (60.7%)	$n=258$ (55.5%)	$n=548$ (60.3%)	$n=461$ (85.7%)	$n=234$ (68.8%)	$n=2653$ (96.3%)
Age (years)	$M=41.6$ ($SD=16.6$)	$M=46.6$ ($SD=14.6$)	$M=30.2$ ($SD=14.5$)	$M=32.9$ ($SD=13.7$)	$M=41.0$ ($SD=13.7$)	$M=45.2$ ($SD=16.0$)	$M=23.5$ ($SD=10.5$)
Length of stay (days)	$M=54.6$ ($SD=24.5$)	$M=53.0$ ($SD=18.9$)	$M=60.7$ ($SD=21.6$)	$M=71.7$ ($SD=24.0$)	$M=71.5$ ($SD=23.8$)	$M=49.2$ ($SD=17.8$)	$M=93.5$ ($SD=43.2$)
Specific diagnoses	Mild depressive episode (F32.0, $n=4$, 0.2%) Moderate depressive episode (F32.1, $n=1257$, 64.6%) Severe depressive episode without psychotic symptoms (F32.2, $n=677$, 34.8%) Severe depressive episode with psychotic symptoms (F32.3, $n=6$, 0.3%) Depressive episode, unspecified (F32.9, $n=2$, 0.1%)	Recurrent depressive disorder, current episode mild (F33.0, $n=4$, 0.1%) Recurrent depressive disorder, current episode moderate (F33.1, $n=1426$, 52.9%) Recurrent depressive disorder, current episode severe without psychotic symptoms (F33.2, $n=1253$, 46.5%) Recurrent depressive disorder, current episode severe with psychotic symptoms (F33.3, $n=12$, 0.4%) Other recurrent depressive disorders (F33.8, $n=1$, 0.04%) Recurrent depressive disorder, unspecified (F33.9, $n=1$, 0.04%)	Agoraphobia (F40.0, $n=183$, 39.4%) Social phobias (F40.1, $n=248$, 53.3%) Specific phobias (F40.2, $n=30$, 6.5%) Other phobic anxiety disorders (F40.8, $n=3$, 0.6%) Phobic anxiety disorder, unspecified (F40.9, $n=1$, 0.2%)	Predominantly obsessional thoughts or ruminations (F42.0, $n=51$, 5.6%) Predominantly compulsive acts (F42.1, $n=171$, 18.8%) Mixed obsessional thoughts and acts (F42.2, $n=683$, 75.1%) Obsessive–compulsive disorder, unspecified (F42.9, $n=4$, 0.4%)	Post-traumatic stress disorder (F43.1, $n=531$, 98.7%) Other reactions to severe stress (F43.8, $n=7$, 1.3%)	Somatization disorder (F45.0, $n=58$, 17.1%) Undifferentiated somatoform disorder (F45.1, $n=41$, 12.1%) Hypochondriacal disorder (F45.2, $n=2$, 0.6%) Somatoform autonomic dysfunction (F45.3, $n=56$, 16.5%) Persistent somatoform pain disorder (F45.4, $n=168$, 49.4%) Other somatoform disorders (F45.8, $n=12$, 3.5%) Somatoform disorder, unspecified (F45.9, $n=3$, 0.9%)	Anorexia nervosa (F50.0, $n=1736$, 60.0%) Atypical anorexia nervosa (F50.1, $n=210$, 7.6%) Bulimia nervosa (F50.2, $n=606$, 22.0%) Atypical bulimia nervosa (F50.3, $n=97$, 3.5%) Other eating disorders (F50.8, $n=64$, 2.3%) Eating disorder, unspecified (F50.9, $n=41$, 1.5%)

if the factor loadings are the same across groups), scalar invariance (tests if the intercepts are the same across groups), and strict invariance (tests if the residual variances are the same across groups). There are different recommendations of how to evaluate measurement invariance but a fairly well established guideline is that model fit changes of $\Delta CFI \leq 0.01$ indicate invariance [24, 25]. We do not report the χ^2-test of exact fit or χ^2-difference tests between models because these are usually significant in large samples and, therefore, uninformative in the current sample. All analyses on internal reliability, factor structure, and measurement invariance were run separately for SWLS scores at admission and discharge.

Life satisfaction as a function of group and time. An analysis of variance for repeated measures was calculated using IBM SPSS Statistics version 24 with group (depressive episode vs. recurrent depressive disorder vs. phobic disorders vs. obsessive–compulsive disorder vs. trauma-related disorders vs. somatoform disorders vs. eating disorders) as between-subjects factor, time (admission vs. discharge) as within-subjects factor and SWLS scores as dependent variable.

Changes in life satisfaction as a function of sex, age, and length of stay. Three linear regression analyses were calculated separately with sex, age, and length of stay as independent variable with PROCESS version 3.4 (https://processmacro.org [26]). Group was entered as multicategorical moderator variable using indicator coding [27] and changes in SWLS scores (SWLS scores at discharge minus SWLS scores at admission) were entered as dependent variable.

Depressive symptoms as a function of group and time. An analysis of variance for repeated measures was calculated using IBM SPSS Statistics version 24 with group (depressive episode vs. recurrent depressive disorder vs. phobic disorders vs. obsessive–compulsive disorder vs. trauma-related disorders vs. somatoform disorders vs. eating disorders) as between-subjects factor, time (admission vs. discharge) as within-subjects factor and PHQ–9 scores as dependent variable.

Associations between life satisfaction and depressive symptoms. Pearson correlation coefficients were calculated using IBM SPSS Statistics version 24 to examine associations between SWLS and PHQ–9 scores at admission and discharge. To examine the relationship between changes in SWLS scores from admission to discharge and changes in PHQ–9 scores from admission to discharge, a repeated measures correlation was calculated with the R-package rmcorr [28].

Results

Sample characteristics

Groups differed in sex distribution ($\chi^2_{(6)} = 1302$, $p < 0.001$, $\phi = 0.367$) with patients with phobic disorders having the highest percentage of males and patients with eating disorders having the lowest percentage of males (Table 1). Groups also differed in age ($F_{(6,9642)} = 744$, $p < 0.001$, $\eta^2_p = 0.316$) with patients with recurrent depressive disorder having the oldest age and patients with eating disorders having the youngest age (Table 1). They also differed in length of stay ($F_{(6,9642)} = 556$, $p < 0.001$, $\eta^2_p = 0.257$) with patients with somatoform disorders staying the shortest and patients with eating disorders staying the longest (Table 1).

Internal reliability, factor structure, and measurement invariance

Admission. Internal reliability was good (McDonald's $\omega = 0.861$). The one-factor model showed a good fit (CFI = 0.997, GFI = 1.00, RMSEA = 0.043, SRMR = 0.023). Factor loadings are displayed in Fig. 1a. Examination of model fit changes indicated configural invariance ($\Delta CFI = 0.000$ compared to the baseline model), metric invariance ($\Delta CFI = 0.001$ compared to the configural model), scalar invariance ($\Delta CFI = 0.004$ compared to the metric model), and strict invariance ($\Delta CFI = 0.002$ compared to the scalar model). Accordingly, the strict invariance model still showed good model fit (CFI = 0.990, GFI = 0.998, RMSEA = 0.041, SRMR = 0.044).

Discharge. Internal reliability was good (McDonald's $\omega = 0.897$). The one-factor model showed a good fit (CFI = 0.999, GFI = 0.999, RMSEA = 0.031, SRMR = 0.019). Factor loadings are displayed in Fig. 1b. Examination of model fit changes indicated configural invariance ($\Delta CFI = 0.001$ compared to the baseline model), metric invariance ($\Delta CFI = 0.002$ compared to the configural model), scalar invariance ($\Delta CFI = 0.004$ compared to the metric model), and strict invariance ($\Delta CFI = 0.001$ compared to the scalar model). Accordingly, the strict invariance model still showed good model fit (CFI = 0.993, GFI = 0.999, RMSEA = 0.043, SRMR = 0.045).

Life satisfaction as a function of group and time

A main effect of group ($F_{(6,9642)} = 55.2$, $p < 0.001$, $\eta^2_p = 0.033$) indicated that diagnostic groups differed in life satisfaction. Patients with somatoform disorders reported the highest life satisfaction ($M = 19.4$, $SE = 0.34$) and patients with trauma-related disorders reported the lowest life satisfaction ($M = 14.4$, $SE = 0.27$; Fig. 2). A main effect of time ($F_{(1,9642)} = 1388$, $p < 0.001$, $\eta^2_p = 0.126$) indicated that life satisfaction increased from admission ($M = 15.9$, $SE = 0.09$) to discharge ($M = 18.5$, $SE = 0.10$) across diagnostic groups (Fig. 2). These main effects, however, were qualified by a significant interaction of group × time ($F_{(6,9642)} = 8.33$, $p < 0.001$, $\eta^2_p = 0.005$). Patients with somatoform disorders had the

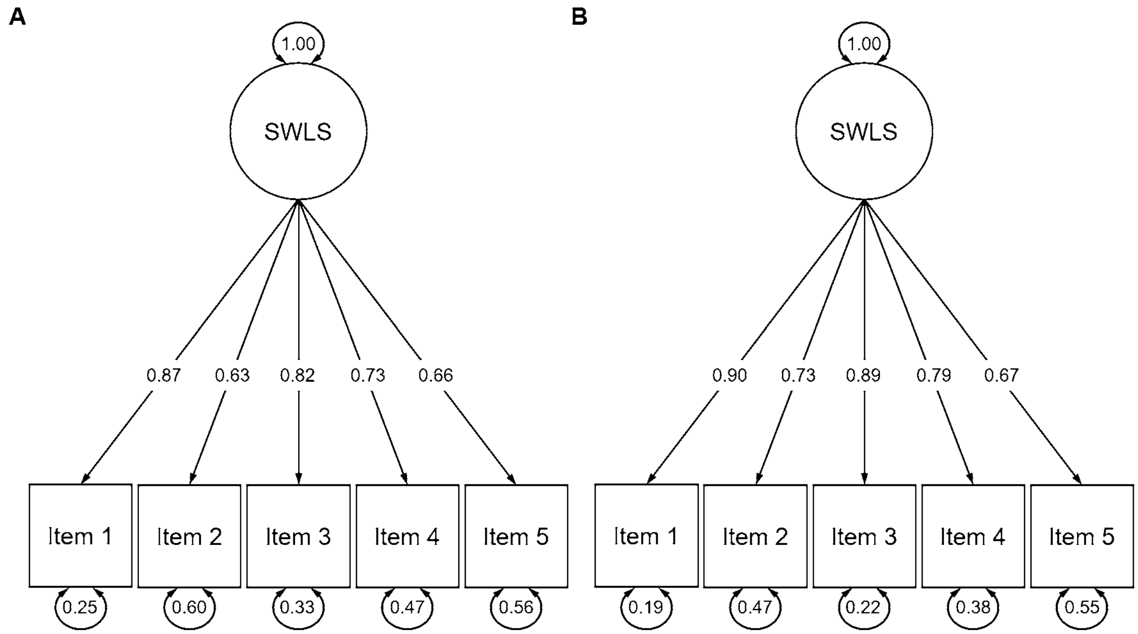

Fig. 1 Standardized factor loadings (straight arrows) and error variances (circular arrows) of the Satisfaction With Life Scale (SWLS) items at admission (**a**) and discharge (**b**)

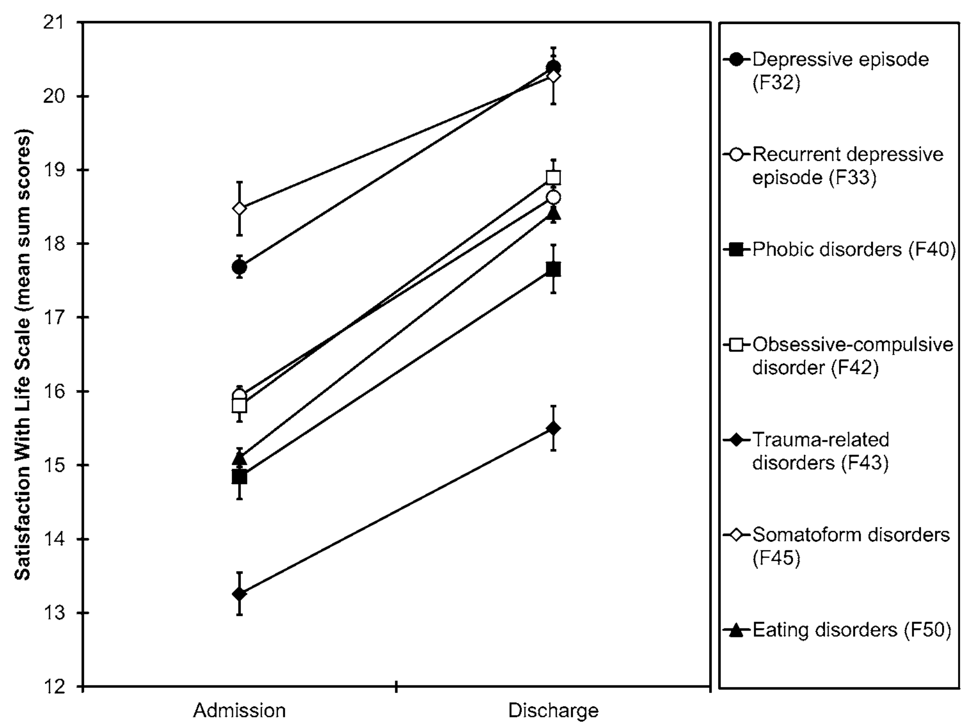

Fig. 2 Mean sum scores of the Satisfaction With Life Scale at admission and discharge as a function of group. Error bars represent the standard error of the mean

smallest increase in life satisfaction ($M = 1.80$, $SE = 0.27$) and patients with eating disorders had the largest increase in life satisfaction ($M = 3.32$, $SE = 0.10$). At admission, mean SWLS scores were below the neutral score of 20 [1, 4] in all groups. At discharge, mean SWLS scores were above a score of 20 only in patients with a depressive episode ($M = 20.4$, $SE = 0.16$) and patients with somatoform disorders ($M = 20.3$, $SE = 0.38$).

Changes in life satisfaction as a function of sex, age, and length of stay

Sex. The interaction of sex × group was not significant (R^2 change = 0.001, $F_{(6,9635)} = 1.00$, $p = 0.425$).

Age. The interaction of age × group was significant (R^2 change = 0.002, $F_{(6,9635)} = 3.32$, $p = 0.003$). A younger age was significantly related to larger increases in life satisfaction in patients with a depressive episode ($b = -0.02$, $SE = 0.01$, $p = 0.005$, $r = -0.064$), recurrent depressive disorder ($b = -0.03$, $SE = 0.01$, $p < 0.001$; $r = -0.075$), and trauma-related disorders ($b = -0.04$, $SE = 0.02$, $p = 0.007$; $r = -0.110$), and marginal significantly related to larger increases in life satisfaction in patients with obsessive–compulsive disorder ($b = -0.02$, $SE = 0.01$, $p = 0.054$; $r = -0.065$) and somatoform disorders ($b = -0.03$, $SE = 0.02$, $p = 0.084$; $r = -0.098$). Age was not associated with changes in life satisfaction in patients with phobic disorders and eating disorders (both $ps > 0.147$; Fig. 3).

Length of stay. The interaction of length of stay × group was significant (R^2 change = 0.002, $F_{(6,9635)} = 3.77$, $p = 0.001$). A longer stay was significantly related to larger increases in life satisfaction in patients with trauma-related disorders ($b = 0.02$, $SE = 0.01$, $p = 0.014$, $r = 0.102$) and marginal significantly related to larger increases in life satisfaction in patients with somatoform disorders ($b = 0.03$, $SE = 0.02$, $p = 0.079$, $r = 0.100$). A longer stay was significantly related to smaller increases in life satisfaction in patients with recurrent depressive disorder ($b = -0.01$, $SE = 0.01$, $p = 0.016$, $r = -0.048$) and phobic disorders ($b = -0.03$, $SE = 0.01$, $p = 0.015$, $r = -0.118$). Length of stay was not associated with changes in life satisfaction in the other groups (all $ps > 0.228$; Fig. 4).

Depressive symptoms as a function of group and time

A main effect of group ($F_{(6,9603)} = 61.2$, $p < 0.001$, $\eta^2_p = 0.037$) indicated that diagnostic groups differed in depressive symptoms. Patients with obsessive–compulsive disorder had the lowest depression scores ($M = 9.60$, $SE = 0.17$) and patients with trauma-related disorders had the highest depression scores ($M = 13.8$, $SE = 0.22$). A main effect of time ($F_{(1,9603)} = 4074$, $p < 0.001$, $\eta^2_p = 0.298$) indicated that depressive symptoms decreased from admission ($M = 13.4$, $SE = 0.08$) to discharge ($M = 8.60$, $SE = 0.08$) across diagnostic groups. These main effects, however, were qualified by a significant interaction of group × time ($F_{(6,9603)} = 33.7$, $p < 0.001$, $\eta^2_p = 0.021$). Patients with somatoform disorders had the smallest decrease in depressive symptoms ($M = -3.78$, $SE = 0.27$) and patients with eating disorders had the largest decrease in depressive symptoms ($M = -6.19$, $SE = 0.11$). At admission, mean PHQ–9 scores were above the cut-off score of 10 [29] in all groups. At discharge, mean PHQ–9 scores were below the cut-off score of 10 in all groups except in the patients with trauma-related disorders ($M = 11.6$, $SE = 0.24$).

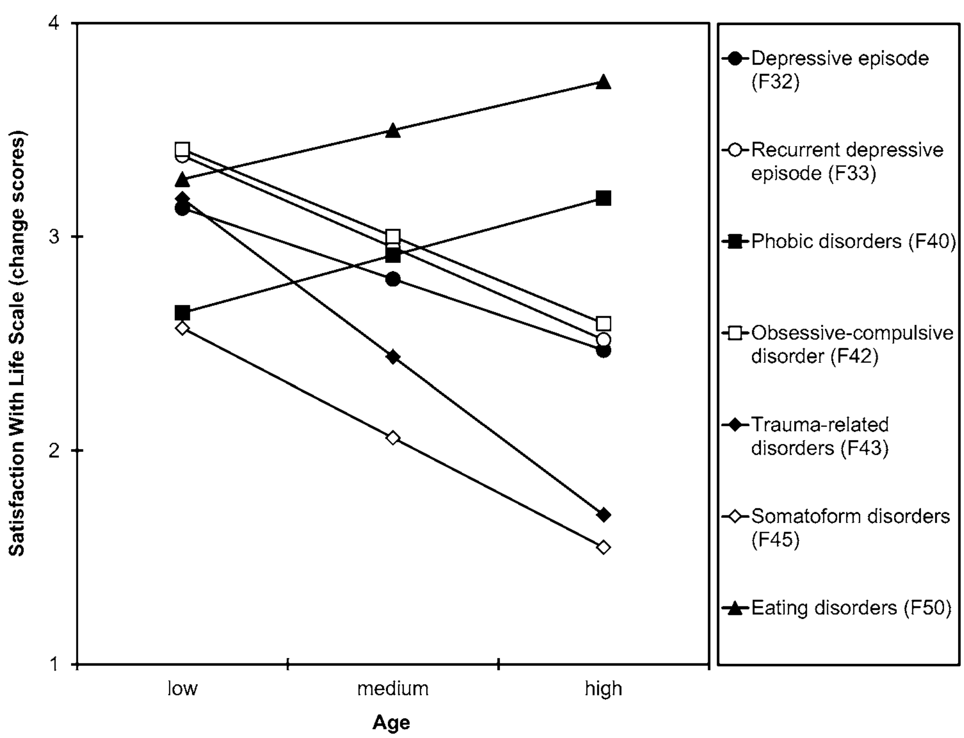

Fig. 3 Simple slopes probing the interaction between group and age when predicting change scores of the Satisfaction With Life Scale. Higher change scores indicate larger increases in life satisfaction from admission to discharge. Low, medium, and high values for age represent 19.7 years (–1 *SD*), 36.5 years (*M*), and 53.4 years (+ 1 *SD*)

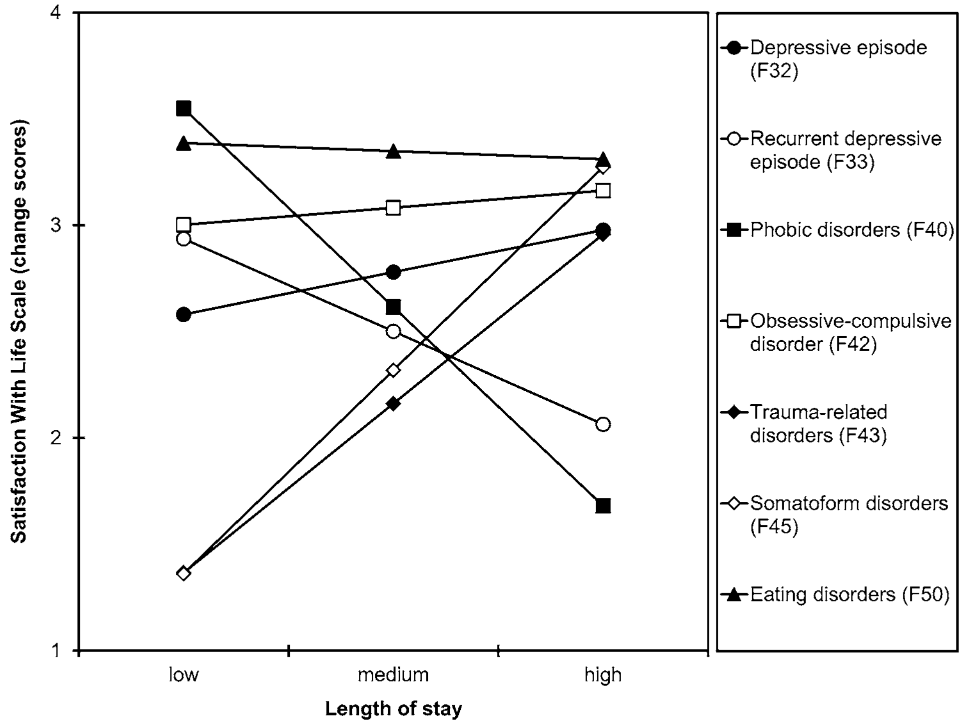

Fig. 4 Simple slopes probing the interaction between group and length of stay when predicting change scores of the Satisfaction With Life Scale. Higher change scores indicate larger increases in life satisfaction from admission to discharge. Low, medium, and high values for length of stay represent 33.6 days (–1 *SD*), 67.9 days (*M*), and 102 days (+ 1 *SD*)

Associations between life satisfaction and depressive symptoms

At admission, SWLS and PHQ–9 scores were moderately, negatively correlated ($r = –0.495$, $p < 0.001$). At discharge, SWLS and PHQ–9 scores were highly, negatively correlated ($r = –0.610$, $p < 0.001$). The repeated measures correlation between SWLS and PHQ–9 scores within individuals across admission and discharge was $r = –0.601$ ($p < 0.001$).

Discussion

The current study reports the largest sample of persons with mental disorders in which life satisfaction was assessed with the SWLS to date. Previous studies in this field have been limited as they mostly examined heterogeneous clinical samples (i.e., did not differentiate between different diagnostic groups), were cross-sectional (i.e., did not examined treatment changes in life satisfaction), and tested only small samples [8, 9, 12, 13]. In line with previous findings [1, 3–5, 9], the scale's good internal reliability and one-factor structure was replicated in the current sample. Moreover, this is the first study that tested measurement invariance of the SWLS across different diagnostic groups and full measurement invariance was demonstrated. This indicates that the SWLS measures the same construct—life satisfaction—in different groups of persons with mental disorders.

Group differences in life satisfaction

Groups significantly differed in SWLS scores. Patients with trauma-related disorders showed the lowest scores of all groups, starting at 13.3 at admission and increasing to 15.5 at discharge. In line with this, similar scores of 12.9 have been previously reported in a group of individuals with traumatic brain injury and post-traumatic stress disorder [1]. Thus, patients with trauma-related disorders are among the groups with the lowest life satisfaction, with lower scores having only been reported in the literature for male prison inmates and sex workers [1, 4]. Patients with somatoform disorders had the highest scores of 18.5 at admission. Thus, although patients with mental disorders generally report lower life satisfaction than persons without mental disorders, life satisfaction also varies considerably between different diagnostic groups.

Treatment changes in life satisfaction

Life satisfaction increased during treatment across diagnostic groups. Patients with somatoform disorders showed the smallest increases, which may be explained by the fact that they also had the shortest stay. In line with this, a longer stay (weakly) related to larger increases in life satisfaction in this group. While each group showed a statistically significant increase in life satisfaction during inpatient treatment, only two groups increased beyond the neutral point of 20 of the SWLS [1, 4]: patients with a depressive episode (score of 20.4 at discharge) and somatoform disorders (score of 20.3 at discharge). All other groups still had mean sum scores below 20 at discharge. Thus, although life satisfaction increases during inpatient treatment, most patients are still slightly dissatisfied with their life. However, preliminary data in adolescents with anorexia nervosa from our hospital suggest that life satisfaction actually shows a further increase in the year after discharge [30]. Yet, further studies that examine long-term changes in life satisfaction after inpatient treatment in other patient groups are necessary to corroborate such an effect.

Relationships of age and length of stay with changes in life satisfaction differed across groups. A younger age was predictive of larger increases in life satisfaction, but only in some diagnostic groups such as those with a depressive episode or with recurrent depressive disorder. This is in line with the findings by Meyer et al. [12] who found a negative relationship between the duration of the disorder and life satisfaction in major depression. That is, an older age and a longer duration of the disorder seems to relate to a higher symptom severity and, similarly, to smaller changes in life satisfaction during treatment in depressive disorders. Relationships between length of stay and changes in life satisfaction even showed opposite patterns across groups: A longer stay was associated with larger increases in life satisfaction in some groups while it was inversely (or unrelated) to changes in life satisfaction in other groups. This may suggest that some patients (e.g., those with trauma-related disorders) profit from a longer treatment while in other groups (e.g., those with recurrent depressive disorder) a longer stay may reflect a therapy-resistant course.

Differentiation between depression and life satisfaction

In line with previous findings [1, 4], depressive symptoms were negatively correlated with life satisfaction cross-sectionally. In addition, within-person correlational analyses showed that increases in life satisfaction were strongly related to decreases in depressive symptoms. Accordingly, group differences and changes in life satisfaction and depressive symptoms were largely similar. However, they were not identical. For example, the patients with obsessive–compulsive disorder had the lowest depressive symptoms although they did not report the highest life satisfaction. In addition, depressive symptoms showed a clinically significant reduction (i.e., a score lower than 10 on the PHQ–9) in almost all groups while life satisfaction showed an increase above the neutral point of the SWLS in only two groups. That is, a low depression severity is not equivalent to a high life satisfaction and a clinically significant reduction in depression severity does not necessarily imply that one is satisfied with his or her life. Together, these results corroborate that life satisfaction is related to the affective aspects of subjective well-being, but that it is also partially independent from them [1, 4, 31].

Clinical implications

Several clinical implications can be derived from the current study. First, this study showed that inpatient treatment of mental disorders not only decreases symptoms such as depression, but also increases life satisfaction. In terms of clinical significance, however, results suggested that treatment reduced depressive symptoms more than it increased life satisfaction. This highlights the need for incorporating other therapy elements in inpatient treatment or in aftercare that are specifically designed to enhance life satisfaction (e.g., [32].). Second, the current study identified subgroups of individuals with mental disorders that may need special attention and in which such targeted interventions for improving life satisfaction might be particularly effective. For example, patients with trauma-related disorders showed the lowest life satisfaction at both admission and discharge and patients with somatoform disorders showed the smallest increase in life satisfaction from admission to discharge. Thus, these diagnostic groups may require a more intensive treatment program that focuses on life satisfaction. Third, the current study also identified moderators of treatment changes in life satisfaction. For example, in both patient groups with trauma-related and somatoform disorders, a longer stay at the hospital related to larger improvements in life satisfaction. This implies that these patients may profit from time-extended treatment.

Limitations

The following limitations need to be considered when interpreting the current results. First, inpatients with mental disorders may not be representative of the entire population of persons with mental disorders. Specifically, inpatients usually have a higher clinical impairment and distress than outpatients or persons that do not receive treatment. Therefore, SWLS scores reported in the current study should not be treated as norm data for persons with mental disorders as these are likely lower than in persons with mental disorders who are not receiving inpatient treatment. As all patients were treated at the same hospital, site-specific effects can also not be excluded. Thus, the present findings may not be generalizable beyond the hospital, including nationally or cross-culturally. Second, in order for group sizes to be sufficiently large for performing confirmatory factor analysis, we restricted our analyses to large diagnostic groups using broad ICD–10 categories. Thus, while this study included large groups of patients with diverse mental disorders, future studies are needed that include diagnostic groups that are not part of the current sample and that differentiate between specific diagnoses within the broader diagnostic categories.

Conclusion

In conclusion, the current study supports the excellent psychometric properties of the SWLS. Compared with SWLS scores that have been reported in the literature, persons with mental disorders in the current study reported lower life satisfaction than persons without mental disorders. Yet, the current results demonstrate that life satisfaction also varies considerably between different diagnostic groups. Finally, results show that life satisfaction increases during inpatient treatment, although at discharge most patients have rarely reached levels of life satisfaction reported in non-clinical samples.

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Compliance with ethical standards

Conflict of interest Adrian Meule declares that he has no conflict of interest. Ulrich Voderholzer declares that he has no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional review board of the LMU Munich and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. According to the guidelines by the institutional review board of the LMU Munich, retrospective studies conducted on already available, anonymized data are exempt from requiring ethics approval.

Informed consent Informed consent was obtained from all individual participants included in the study.

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SHORT REPORT

Sleep quality in persons with mental disorders: Changes during inpatient treatment across 10 diagnostic groups

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Summary

Sleep disturbances have been documented across a range of mental disorders, particularly depression. However, studies that have examined sleep quality in large samples of different diagnostic groups and that report how sleep quality changes during inpatient treatment have been scarce. This retrospective, observational study examined changes in sleep quality during inpatient treatment at a psychosomatic hospital in Germany from admission to discharge as a function of 10 diagnostic groups. Data of 11,226 inpatients were analysed who completed the Pittsburgh Sleep Quality Index as part of the routine diagnostic assessment at admission and discharge. All diagnostic groups showed impaired sleep quality (Pittsburgh Sleep Quality Index score > 5). Patients with trauma-related disorders had the lowest sleep quality and patients with obsessive–compulsive disorder had the highest sleep quality. While sleep quality significantly improved in each diagnostic group, changes differed in size, with patients with trauma-related disorders showing the smallest improvement and patients with eating disorders showing the largest improvement. The current study documents impaired sleep quality in inpatients with mental disorders and shows that sleep problems are a transdiagnostic feature in this population. Results also resonate with earlier suggestions that sleep disturbances represent a key feature of trauma-related disorders in particular and the need for trauma-specific sleep interventions. Although sleep quality significantly improved during disorder-specific inpatient treatment in all diagnostic groups, average scores were still clinically elevated at discharge. Thus, a future avenue would be to examine whether adding sleep-specific treatment elements fosters both short- and long-term success in the treatment of mental disorders.

KEYWORDS
depression, inpatient treatment, mental disorders, sleep quality, trauma-related disorders

1 | INTRODUCTION

Sleep disturbances have been documented across a range of mental disorders, particularly depression (Baglioni et al., 2016; Lijun et al., 2012). However, studies that have examined sleep quality in large samples of different diagnostic groups and that report how sleep quality changes during psychotherapeutic treatment have been scarce (Schennach, Feige, Riemann, Heuser, & Voderholzer, 2019). Therefore, this report examines

TABLE 1 Sample characteristics

N = 11,226	Depressive episode (F32)	Recurrent depressive disorder (F33)	Phobic anxiety disorders (F40)	Other anxiety disorders (F41)	Obsessive-compulsive disorder (F42)	Reaction to severe stress, and adjustment disorders (F43)	Somatoform disorders (F45)	Eating disorders (F50)	Specific personality disorders (F60)	Other mental disorders
Group size	$n = 2128$	$n = 2961$	$n = 505$	$n = 183$	$n = 970$	$n = 630$	$n = 423$	$n = 3126$	$n = 124$	$n = 176$
Sex (female)	$n = 1272$ (59.8%)	$n = 1803$ (60.9%)	$n = 286$ (56.6%)	$n = 107$ (58.5%)	$n = 587$ (60.5%)	$n = 530$ (84.1%)	$n = 281$ (66.4%)	$n = 3005$ (96.1%)	$n = 88$ (71.0%)	$n = 100$ (56.8%)
Age (years)	$M = 41.7$ ($SD = 16.8$)	$M = 46.7$ ($SD = 14.7$)	$M = 30.1$ ($SD = 15.0$)	$M = 42.1$ ($SD = 15.7$)	$M = 33.1$ ($SD = 13.9$)	$M = 41.3$ ($SD = 14.1$)	$M = 44.8$ ($SD = 16.2$)	$M = 23.5$ ($SD = 10.6$)	$M = 30.8$ ($SD = 13.3$)	$M = 44.3$ ($SD = 16.9$)
Treatment duration (days)	$M = 54.5$ ($SD = 25.2$)	$M = 52.9$ ($SD = 19.4$)	$M = 59.8$ ($SD = 23.7$)	$M = 53.3$ ($SD = 19.3$)	$M = 72.5$ ($SD = 24.5$)	$M = 69.1$ ($SD = 26.1$)	$M = 49.7$ ($SD = 18.7$)	$M = 91.6$ ($SD = 44.6$)	$M = 57.4$ ($SD = 19.7$)	$M = 48.1$ ($SD = 20.9$)
PSQI at admission	$M = 10.1$ ($SD = 4.1$)	$M = 10.6$ ($SD = 4.3$)	$M = 8.4$ ($SD = 4.0$)	$M = 9.1$ ($SD = 4.3$)	$M = 8.0$ ($SD = 4.0$)	$M = 11.6$ ($SD = 4.3$)	$M = 10.2$ ($SD = 4.5$)	$M = 9.0$ ($SD = 4.3$)	$M = 9.9$ ($SD = 4.0$)	$M = 9.2$ ($SD = 4.7$)
PSQI at discharge	$M = 8.1$ ($SD = 4.2$)	$M = 8.7$ ($SD = 4.3$)	$M = 7.1$ ($SD = 3.9$)	$M = 7.7$ ($SD = 4.1$)	$M = 6.8$ ($SD = 3.9$)	$M = 10.6$ ($SD = 4.7$)	$M = 8.9$ ($SD = 4.6$)	$M = 6.9$ ($SD = 3.9$)	$M = 8.6$ ($SD = 4.2$)	$M = 7.8$ ($SD = 4.4$)
Specific diagnoses	Mild depressive episode (F32.0, $n = 10$, 0.5%) Moderate depressive episode (F32.1, $n = 1367$, 64.2%) Severe depressive episode without psychotic symptoms (F32.2, $n = 740$, 34.8%) Severe depressive episode with psychotic symptoms (F32.3, $n = 8$, 0.4%) Other depressive episodes (F32.8, $n = 1$, < 0.1%) Unspecified depressive episode (F32.9, $n = 2$, 0.1%)	Recurrent depressive disorder, current episode mild (F33.0, $n = 5$, 0.2%) Recurrent depressive disorder, current episode moderate (F33.1, $n = 1549$, 52.3%) Recurrent depressive disorder, current episode severe without psychotic symptoms (F33.2, $n = 1391$, 47.0%) Recurrent depressive disorder, current episode severe with psychotic symptoms (F33.3, $n = 12$, 0.4%) Recurrent depressive disorder, currently in remission (F33.4, $n = 1$, < 0.1%) Other recurrent depressive disorders (F33.8, $n = 1$, < 0.1%) Unspecified recurrent depressive disorder (F33.9, $n = 2$, 0.1%)	Agoraphobia (F40.0, $n = 192$, 38.0%) Social phobias (F40.1, $n = 274$, 54.3%) Specific phobias (F40.2, $n = 34$, 6.7%) Other phobic anxiety disorders (F40.8, $n = 4$, 0.8%) Unspecified phobic anxiety disorders (F40.9, $n = 1$, 0.2%)	Panic disorder (F41.0, $n = 110$, 60.1%) Generalized anxiety disorder (F41.1, $n = 52$, 28.4%) Mixed anxiety and depressive disorder (F41.2, $n = 6$, 3.3%) Other mixed anxiety disorders (F41.3, $n = 4$, 2.2%) Other specified anxiety disorders (F41.8, $n = 4$, 2.2%) Unspecified anxiety disorder (F41.9, $n = 7$, 3.8%)	Predominantly obsessional thoughts or ruminations (F42.0, $n = 56$, 5.8%) Predominantly compulsive acts (F42.1, $n = 180$, 18.6%) Mixed obsessional thoughts and acts (F42.2, $n = 730$, 75.3%) Unspecified obsessive-compulsive disorder (F42.9, $n = 4$, 0.4%)	Acute stress reaction (F43.0, $n = 1$, 0.2%) Post-traumatic stress disorder (F43.1, $n = 589$, 93.5%) Adjustment disorders (F43.2, $n = 32$, 5.1%) Other reactions to severe stress (F43.8, $n = 7$, 1.1%) Unspecified reaction to severe stress (F43.9, $n = 1$, 0.2%)	Somatization disorder (F45.0, $n = 63$, 14.9%) Undifferentiated somatoform disorder (F45.1, $n = 46$, 10.9%) Hypochondriacal disorder (F45.2, $n = 54$, 12.8%) Somatoform autonomic dysfunction (F45.3, $n = 60$, 14.2%) Persistent somatoform pain disorder (F45.4, $n = 185$, 43.7%) Other somatoform disorders (F45.8, $n = 12$, 2.8%) Unspecified somatoform disorder (F45.9, $n = 3$, 0.7%)	Anorexia nervosa (F50.0, $n = 1880$, 60.1%) Atypical anorexia nervosa (F50.1, $n = 234$, 7.5%) Bulimia nervosa (F50.2, $n = 668$, 21.4%) Atypical bulimia nervosa (F50.3, $n = 105$, 3.4%) Overeating associated with other psychological disturbances (F50.4, $n = 10$, 0.3%) Vomiting associated with other psychological disturbances (F50.5, $n = 3$, 0.1%) Other eating disorders (F50.8, $n = 104$, 3.3%) Unspecified eating disorder (F50.9, $n = 122$, 3.9%)	Paranoid personality disorder (F60.0, $n = 1$, 0.8%) Emotionally unstable personality disorder (F60.3, $n = 102$, 82.3%) Histrionic personality disorder (F60.4, $n = 1$, 0.8%) Anankastic personality disorder (F60.5, $n = 3$, 2.4%) Anxious personality disorder (F60.6, $n = 7$, 5.6%) Dependent personality disorder (F60.7, $n = 1$, 0.8%) Other specific personality disorder (F60.8, $n = 8$, 6.5%) Unspecified personality disorder (F60.9, $n = 1$, 0.8%)	Bipolar affective disorder, current episode mild or moderate depression (F31.3, $n = 18$, 10.2%) Bipolar affective disorder, current episode severe depression without psychotic symptoms (F31.4, $n = 22$, 12.5%) Psychological and behavioural factors associated with disorders or diseases classified elsewhere (F54, $n = 16$, 9.1%) Mixed and other personality disorders (F61, $n = 30$, 17.0%) Other diagnoses, each with $n = 1$–10 ($n = 90$, 51.1%)

Note: PSQI, Pittsburgh Sleep Quality Index.

changes in sleep quality during inpatient treatment from admission to discharge as a function of 10 diagnostic groups in more than 11,000 patients with mental disorders.

2 | MATERIALS AND METHODS

Data of 11,226 inpatients were analysed who completed the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) as part of the routine diagnostic assessment at admission and discharge at the Schoen Clinic Roseneck (Prien am Chiemsee, Germany) between July 2014 and September 2020. At the Schoen Clinic Roseneck, data from the routine diagnostic assessment (e.g., age, sex, treatment duration, diagnoses, questionnaire scores) are automatically transferred to a database from which they can be exported without any identifying information (e.g., name, date of birth, place of residence) by authorized employees. Thus, accessing individual patient charts is not necessary. According to the guidelines by the institutional review board of the LMU Munich, retrospective studies conducted on already available, anonymized data are exempt from requiring ethics approval. The Schoen Clinic Roseneck is a psychosomatic hospital, that is, in contrast to psychiatric hospitals in Germany, it does not have involuntary admissions and does not treat patients with acute suicidality, substance use disorders or psychotic disorders (for a general description of the term psychosomatic hospital in Germany, see Zipfel, Herzog, Kruse, & Henningsen, 2016). The hospital provides a multimodal inpatient treatment for persons with mental disorders (other than those mentioned above) that includes cognitive-behavioural individual and group therapy sessions and other treatment elements in line with national treatment guidelines. Only a minority of patients receive psychopharmacological medication: approximately three-quarters of the sample (73.2% at admission and 74.2% at discharge) indicated that they did not use any sleep medication in the past 4 weeks based on item #7 of the PSQI. The PSQI has 10 items with different response formats, which are converted to seven component scores, internal reliability of which was $\omega = 0.758$ at admission and $\omega = 0.783$ at discharge. Higher total scores represent lower sleep quality. Changes in PSQI total scores from admission to discharge as a function of diagnostic groups (based on ICD-10 categories; Table 1) were examined with analyses of variance and paired *t*-tests. The data that support the findings of this study are openly available at https://osf.io/82wmp.

3 | RESULTS

Groups differed in sex ($\chi_9 = 1447$, $p < 0.001$, $\varphi = 0.359$), age ($F_{9,11216} = 549$, $p < 0.001$, $\eta^2_p = 0.306$) and treatment duration ($F_{9,11216} = 549$, $p < 0.001$, $\eta^2_p = 0.306$; Table 1). Main effects of time ($F_{1,11216} = 528$, $p < 0.001$, $\eta^2_p = 0.045$) and group ($F_{9,11216} = 85.8$, $p < 0.001$, $\eta^2_p = 0.064$) indicated that sleep quality improved from admission to discharge, and that groups differed in sleep quality: descriptively, patients with reactions to severe stress, and adjustment disorders had the lowest sleep quality, and patients with obsessive–compulsive disorder had the highest sleep quality (Figure 1; Table 1). While sleep quality significantly improved in each diagnostic group (all $p < 0.001$), a significant time × group interaction ($F_{9,11216} = 10.7$, $p < 0.001$, $\eta^2_p = 0.008$) indicated that changes differed in size: descriptively, patients with reactions to severe stress, and adjustment disorders had the smallest changes ($M = -0.9$, $SD = 4.3$, $d = 0.212$), and patients with eating disorders had the largest changes ($M = -2.1$, $SD = 4.0$, $d = 0.518$; Figure 1; Table 1). Controlling for sex, age and treatment duration did not change this effect ($F_{9,11213} = 10.7$, $p < 0.001$, $\eta^2_p = 0.008$).

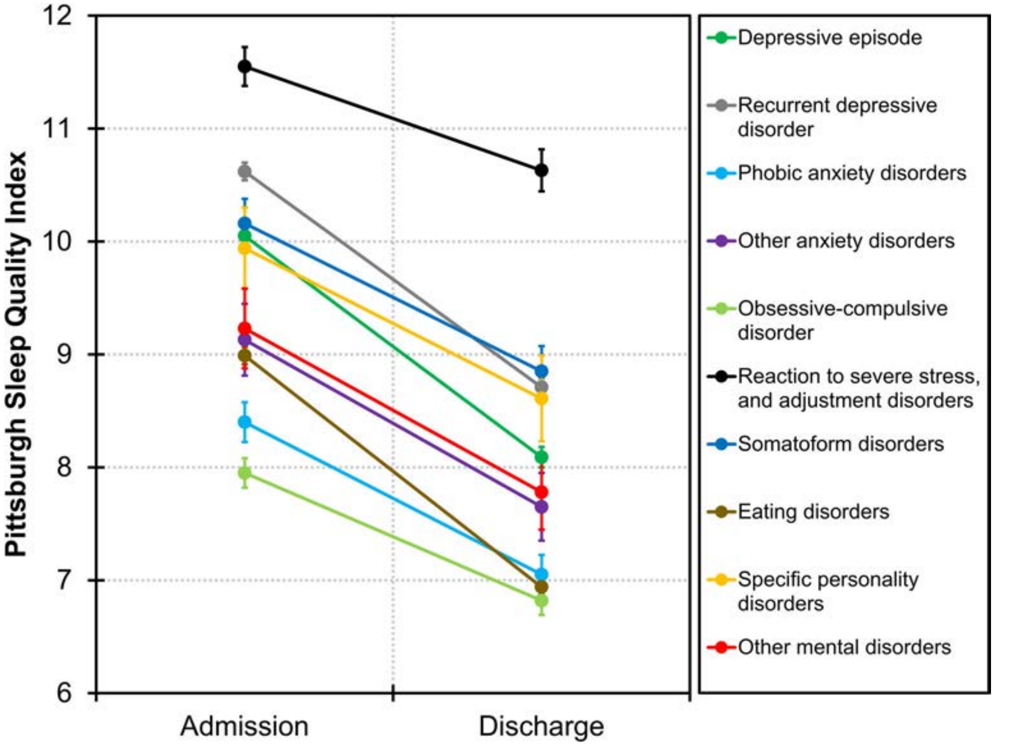

FIGURE 1 Mean sum scores of the Pittsburgh Sleep Quality Index at admission and discharge as a function of diagnostic groups. Error bars indicate the standard error of the mean. Note that higher scores represent lower sleep quality

4 | DISCUSSION

In line with previous findings, the current study documents impaired sleep quality in inpatients with mental disorders (Baglioni et al., 2016; Lijun et al., 2012; Schennach et al., 2019). Specifically, average PSQI scores were above the cut-off score of 5—indicating poor sleep quality (Buysse et al., 1989)—in all diagnostic groups, suggesting that sleep problems are a transdiagnostic feature in this population. Of note, however, is that results are limited to inpatients that are typically treated in psychosomatic hospitals in Germany and, thus, are not representative for the entire population of inpatients with mental disorders (including, e.g., psychiatric inpatients with substance use or psychotic disorders).

In contrast to previous reports, which found the lowest self-reported sleep quality and the most severe alterations in polysomnographic variables in patients with depression (Baglioni et al., 2016; Lijun et al., 2012), patients with trauma-related disorders showed the lowest sleep quality in our sample. However, this result is in line with previous findings from our hospital (Schennach et al., 2019), and with earlier suggestions that sleep disturbances represent a key feature of post-traumatic stress disorder (Germain, 2013). Furthermore, patients with trauma-related disorders showed the smallest improvements in sleep quality from admission to discharge. Thus, the current findings resonate with recent suggestions that highlight the need for trauma-specific sleep interventions in the treatment of trauma-related disorders (Miller, Brownlow, & Gehrman, 2020).

Finally, although disorder-specific inpatient treatment significantly improved sleep quality in all diagnostic groups in the current study, average scores were still clinically elevated at discharge. Thus, a future avenue would be to examine whether low sleep quality at discharge is predictive of poorer long-term treatment outcome, and whether adding sleep-specific treatment elements fosters both short- and long-term success in the treatment of mental disorders. Such transdiagnostic, sleep-specific treatment programs for inpatients with mental disorders are currently under development (Sheaves et al., 2018), and preliminary feasibility trials suggest that they have the potential to improve sleep quality and possibly other health outcomes as well (Schneider et al., 2020).

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CONFLICT OF INTEREST

The authors declare that none of them has a conflict of interest.

AUTHOR CONTRIBUTIONS

UV conceived the study. AM conducted the statistical analyses and wrote the first draft. DR and UV contributed to interpretation of the data and revised the manuscript for content.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available at https://osf.io/82wmp.

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RESEARCH

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Changes in obsessive–compulsive symptoms during inpatient treatment of anorexia nervosa

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Abstract

Background: Obsessive–compulsive disorder (OCD) is one of the most prevalent comorbidities in anorexia nervosa (AN). As AN is a severe, life-threatening condition, reducing obsessive–compulsive symptomatology is not the primary objective during treatment of AN and, thus, these symptoms may remain unchanged or may even increase in terms of a "symptom shift".

Methods: In this retrospective analysis, we examined clinical records of 149 adolescents ($n = 96$, 64%) and adults ($n = 53$, 36%) with AN (6 males, 4%) who received inpatient treatment and completed the Obsessive–Compulsive Inventory–Revised at admission and discharge.

Results: Obsessive–compulsive symptoms decreased from admission to discharge, irrespective of whether patients had comorbid OCD or not. Within-person decreases in obsessive–compulsive symptoms weakly correlated with increases in body weight.

Conclusions: These results indicate that obsessive–compulsive symptoms decrease during inpatient treatment of AN although they are not primarily targeted during treatment. Furthermore, these improvements seem to be associated with general improvements in AN symptomatology, suggesting the absence of a "symptom shift". Yet, effect sizes were small and obsessive–compulsive symptoms were still clinically elevated in patients with comorbid OCD at discharge, suggesting that these patients need OCD-specific, psychotherapeutic aftercare.

Keywords: Anorexia nervosa, Obsessive–compulsive disorder, Comorbidity, Body mass index, Inpatient treatment

Plain English summary

This study shows that obsessive–compulsive symptoms decrease during inpatient treatment of anorexia nervosa. That is, there is no "symptom shift", which refers to the idea that a reduction of anorexia nervosa symptoms may result in an increase in other symptoms. However, obsessive–compulsive symptoms should still be targeted during psychotherapeutic aftercare in patients who show obsessive–compulsive tendencies.

Introduction

With a prevalence of about 10–20%, obsessive–compulsive disorder (OCD) is one of the most prevalent comorbidities in anorexia nervosa (AN; [1]). Besides phenomenological overlaps between the two conditions (e.g., ritualized behavior, cognitive rigidity), there is also a substantial shared genetic basis [2, 3]. Yet, as AN is a

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severe, life-threatening condition, reducing obsessive–compulsive symptomatology is not the primary objective during treatment of AN. Specifically, treatment of AN focuses on weight restoration along with addressing AN symptoms such as restrictive eating, weight and shape concerns, or compulsive exercise [4]. Although less severe cases of AN are treated in out patient or day-patient settings, more severe cases or those who do not respond to these treatments require inpatient treatment [5, 6]. There is a plethora of studies showing that inpatient treatment leads to a substantial gain in body weight and reductions in other AN symptoms in both adolescents and adults (e.g., [7–11]). However, few studies have examined if inpatient treatment also leads to decreases in obsessive–compulsive symptoms, if these symptoms remain unchanged or if they even increase in terms of a "symptom shift" [12].

In a sample with mixed eating disorder diagnoses (that only included 10 AN patients with and 17 AN patients without comorbid OCD), Thiel and colleagues [13] reported that obsessive–compulsive symptoms decreased from psychodynamic inpatient treatment to 30-months follow up only in those with comorbid OCD but not in those without comorbid OCD. The absence of changes in obsessive–compulsive symptoms in the latter group may be explained by the fact that they already had relatively low scores at admission. Furthermore, larger improvements in eating disorder symptoms related to larger improvements in obsessive–compulsive symptoms in this study. In contrast, Mattar and colleagues [14] reported no significant changes in obsessive–compulsive symptoms from admission to discharge in a sample of 24 inpatients with AN. Yet, Lee and colleagues [15] reported significant decreases in obsessive–compulsive symptoms from pre- to post-treatment in a sample with mixed eating disorder diagnoses at a residential treatment facility. Most recently, Pleplé and colleagues [16] reported significant decreases in obsessive–compulsive symptoms from admission to discharge in a large sample ($n = 167$) of inpatients with AN.

To summarize these four studies, two found that obsessive–compulsive symptoms decreased during treatment, one did not find that obsessive–compulsive symptoms decreased during treatment, and one found that obsessive–compulsive symptoms only decreased in those with comorbid OCD. Thus, although there is some evidence suggesting that obsessive–compulsive symptoms decrease during eating disorder treatment, findings are rather inconsistent. In addition, these findings were derived from different samples (two with AN patients and two with mixed eating disorder diagnoses) and involved different treatments. Furthermore, only one study in a sample with mixed eating diagnoses examined whether changes in obsessive–compulsive symptoms related to changes in eating disorder symptoms. Thus, it is currently unclear if obsessive–compulsive symptoms decrease during inpatient AN treatment, whether they only (or more strongly) change in those with comorbid OCD, and whether changes in obsessive–compulsive symptoms relate to changes in AN symptomatology.

In this retrospective analysis, we analyzed clinical records from 149 inpatients with AN and examined three research questions. First, based on the findings by Pleplé and colleagues [16], we expected that obsessive–compulsive symptoms would decrease from admission to discharge. Second, based on the findings by Thiel and colleagues [13], we hypothesized that decreases in obsessive–compulsive symptoms would be larger in patients with comorbid OCD than in patients without comorbid OCD. Third, based on the findings by Thiel and colleagues [13] who found that larger reductions in obsessive–compulsive symptoms related to related to larger decreases in eating disorder symptoms, we hypothesized that larger reductions in obsessive–compulsive symptoms would also relate to larger weight gain.

Methods

General study description

In this retrospective study, data from patients with AN who received inpatient treatment at the Schoen Clinic Roseneck (Prien am Chiemsee, Germany) between January 2015 and September 2021 and who completed the German version [17] of the Obsessive–Compulsive Inventory–Revised (OCI–R; [18]) at admission and discharge were analyzed. The OCI–R is not part of the routine diagnostic assessment for AN patients but is completed by patients upon request by their therapists if exploratory questions suggest that there might be an obsessive–compulsive symptomatology and, therefore, further evaluation of obsessive–compulsive symptoms is deemed necessary. At the Schoen Clinic Roseneck, data from the diagnostic assessments (e.g., age, sex, body weight and height, length of stay, diagnoses, questionnaire scores) are automatically transferred to a database from which they can be exported without any identifying information (e.g., name, date of birth, place of residence) by authorized employees. Thus, accessing individual patient charts is not necessary. According to the guidelines by the institutional review board of the LMU Munich, retrospective studies conducted on already available, anonymized data are exempt from requiring ethics approval. The data of this study are available at https://osf.io/k2g95.

Treatment description

The inpatient treatment offered at the hospital adheres to the German S3-guidelines for the treatment of AN [5, 19] in terms of admission criteria, treatment elements, and therapy goals. Thus, patients received a cognitive-behavioral therapy-oriented, multimodal AN treatment that included several treatment elements such as individual psychotherapy sessions, group therapy sessions, exercise therapy, meal preparation classes, body image exposure, nutrition counseling, and food intake protocols as well as clinical management of medical complications. The treatment includes a high-calorie refeeding schedule (starting on the first day of treatment) that aims at a weight gain of 0.7–1.0 kg per week for all underweight AN patients. This schedule includes three meals per day, each having approximately 700 kcal and, thus, totaling to a daily caloric intake of approximately 2100 kcal. Meals are supervised by a nurse or therapist in earlier treatment stages. The schedule is individually tailored if patients do not finish their meals or do not show the expected weight gain by increasing portion size, adding snacks between meals, or offering sip feeds. As normalization of eating behavior is one of the therapeutic goals, patients do not receive nasogastric feeding. Patients can choose between vegetarian and non-vegetarian menus; vegan menus are not offered.

Sample description

Between January 2015 and September 2021, 4350 cases with a primary diagnosis of full syndrome AN (ICD–10 code F50.0; $n=3808$, 87.5%) or atypical AN (ICD–10 code F50.1; $n=542$, 12.5%) were treated at the hospital. Of these, 486 patients (11.2%) were diagnosed with comorbid OCD (ICD–10 code F42) and 3864 patients (88.8%) had no comorbid OCD. For a subset of 149 patients, OCI–R scores were available both at admission and discharge. Of these, 132 patients (88.6%) were diagnosed with full syndrome AN and 17 had atypical AN (11.4%). One-hundred and one patients (67.8%) were diagnosed with comorbid OCD and 48 patients (32.2%) had no comorbid OCD.[1] Six patients (4.0%) were male. Mean age was 18.6 years ($SD=5.88$; 96 adolescents, 64.4%; 53 adults, 35.6%).[2] Mean body mass index (BMI) was 15.2 kg/m^2 ($SD=2.05$) at admission and 18.0 kg/m^2 ($SD=1.68$) at discharge. Mean length of stay was 124 days ($SD=48.5$).

OCI–R

The OCI–R assesses obsessive–compulsive symptoms with 18 items. Responses are recorded on a five-point scale from 0 = *not at all* to 4 = *extremely*. Higher sum scores indicate higher obsessive–compulsive symptomatology. A score of 21 has been found to optimally discriminate between patients with OCD and persons without OCD [18]. Internal reliability (McDonald's omega; cf. [20]) was $\omega=0.864$ at admission and $\omega=0.891$ at discharge in the current study.

Data analyses

Changes in OCI–R scores from admission to discharge were tested with a paired samples *t*-test. Changes in OCI–R scores from admission to discharge as a function of comorbid OCD were tested with analysis of variance for repeated measures with the factors *time* (admission vs. discharge) and *group* (comorbid vs. no comorbid OCD). The within-person association between changes in OCI–R scores from admission to discharge and changes in BMI from admission to discharge was tested by computing a repeated measures correlation coefficient with the R-package *rmcorr* [21].

Results

Changes in obsessive–compulsive symptoms from admission to discharge

OCI–R scores decreased from admission ($M=26.4$, $SD=13.5$) to discharge ($M=24.4$, $SD=14.1$; $t_{(148)}=3.20$, $p=0.002$, $d=0.26$; Fig. 1).

Changes in obsessive–compulsive symptoms from admission to discharge as a function of comorbid OCD

The interaction group × time was not significant ($F_{(1,147)}=0.72$, $p=0.397$, $\eta_p^2=0.005$), indicating that the size of changes in OCI–R scores from admission to discharge did not differ between groups (Fig. 1). Of note, although scores decreased in both groups, they were still above the cut-off score of 21 in those with comorbid OCD at discharge (Fig. 1).

Within-person association between body weight and obsessive–compulsive symptoms across admission and discharge

The repeated measures correlation between BMI and OCI–R scores was $r_{rm}=-0.266$ ($p=0.001$, 95%CI[-0.109; -0.410]; Fig. 2), indicating that

[1] Note that patients with and without comorbid OCD did not differ in age ($t_{(147)}=1.16$, $p=.246$, $d=0.20$) and length of stay ($t_{(147)}=0.55$, $p=.585$, $d=0.10$). Groups also did not differ in BMI (main effect of group: $F_{(1,147)}=0.03$, $p=.866$, $\eta_p^2<.001$) and changes in BMI from admission to discharge (group × time interaction: $F_{(1,147)}=0.04$, $p=.835$, $\eta_p^2<.001$). Similarly, BMI was uncorrelated with OCI–R scores at admission ($r=.076$, $p=.357$).

[2] Note that adolescents and adults did not differ in OCI–R scores (main effect of group: $F_{(1,147)}=0.72$, $p=.396$, $\eta_p^2=.005$) and changes of OCI–R scores from admission to discharge (group × time interaction: $F_{(1,147)}<0.01$, $p=.963$, $\eta_p^2<.001$). Similarly, age was uncorrelated with OCI–R scores at admission ($r=.055$, $p=.504$).

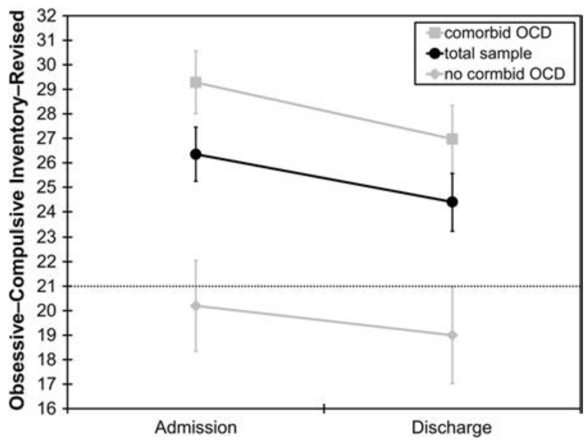

Fig. 1 Mean sum scores of the Obsessive–Compulsive Inventory–Revised at admission and discharge in the total sample and as a function of comorbid and no comorbid obsessive–compulsive disorder (OCD). Error bars indicate standard errors of the mean. The black dotted line indicates the cut-off score of 21 that has been found to optimally discriminate between persons with and without obsessive–compulsive disorder in the study by Foa and colleagues [18]

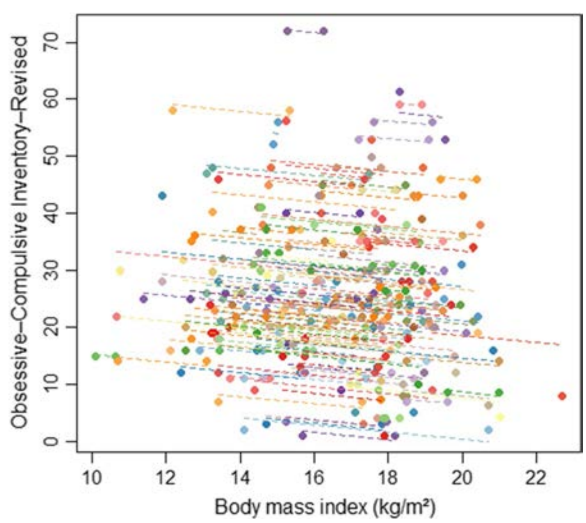

Fig. 2 *Rmcorr* plot depicting within-person associations across admission and discharge between body mass index and scores of the Obsessive–Compulsive Inventory–Revised. Note that, in *rmcorr*, separate parallel lines are fit to the data from each person and the sign of the *rmcorr* coefficient is indicated by the direction of the common regression slope. In the rmcorr plot, each patient's data and corresponding line are shown in different color. This is done because *rmcorr* can capture strong intra-individual relationships (here: between body weight and obsessive–compulsive symptoms across the two measurement time points) that are missed by using averaged data. As can be seen by the negative *rmcorr* coefficient ($r_{rm} = -.27$) and the negative slopes of the individual fit lines, larger weight gain was associated with decreases in obsessive–compulsive symptoms

within-person weight gain was associated with decreases in obsessive–compulsive symptoms.

Discussion

Summary of findings

In this retrospective analysis, obsessive–compulsive symptoms significantly decreased during inpatient treatment of AN. The magnitude of this decrease was small and was similar in patients with and without comorbid OCD. Although obsessive–compulsive symptoms decreased, average scores were still clinically elevated in those with comorbid OCD at discharge. Larger decreases in obsessive–compulsive symptoms related to larger weight gain with a small effect size, suggesting that decreases in AN symptomatology do not result in a "symptom shift", that is, do not facilitate obsessive–compulsive symptomatology.

Clinical implications

The finding that obsessive–compulsive symptoms decrease during AN treatment and relate to general changes in AN symptoms may be partially explained by overlapping features of both conditions. For example, both AN and OCD share several phenotypic, epidemiological, and neuropsychological characteristics such as excessive habit formation, cognitive rigidity, and repetitive and ritualistic behaviors [22, 23]. Thus, treating AN symptoms may also generalize to alter obsessive–compulsive symptoms that are not related to food, eating, and body weight because of their close phenomenological—but maybe also etiological—connection [2, 3].

Intervention techniques that target these central, overlapping features of both conditions may be particularly effective in the treatment of AN. Indeed, cognitive remediation therapy—originally developed as a treatment for schizophrenia—has been adapted for eating disorders as an add-on treatment element [24]. Amongst others, it addresses cognitive rigidity by using cognitive exercises to increase set-shifting abilities (i.e., increase cognitive flexibility) and to promote a more global information processing (i.e., decrease extreme attention to details). While some pilot studies found beneficial effects of cognitive remediation therapy in patients with AN, however, overall findings have been mixed [25]. In fact, two recent randomized controlled trials did not find that cognitive remediation therapy as an add-on to treatment as usual improved clinical and cognitive outcomes when compared to an active control condition [22, 26]. Thus, further research is necessary that examines if targeting obsessive–compulsive features of AN with cognitive remediation therapy has actual benefits over and above traditional psychotherapeutic approaches such as cognitive-behavioral therapy.

Limitations

Several factors limit interpretation of the current findings. As this was a retrospective analysis of clinical records, diagnoses were not confirmed by a structured clinical interview, which may be more precise than clinical diagnoses. However, the prevalence of comorbid OCD diagnoses (11%) matches well with prevalence rates that have been recently reported in a recent meta-analytic investigation [1], suggesting that OCD diagnoses were not under- or overestimated in the current study. Further, OCI–R scores were primarily available for those with comorbid OCD, which may have introduced a bias as the current sample was not representative of all treated cases with AN (i.e., although only 11% of all AN cases had comorbid OCD, 68% of all analyzed cases with available OCI–R scores had comorbid OCD). Finally, the current sample included both full syndrome and atypical AN patients as well as both males and females but the subgroups of atypical AN patients and males were too small to allow for testing whether changes in obsessive–compulsive symptoms differed between these groups. Yet, at least for the differentiation between full syndrome and atypical AN, it has been previously been reported that these groups do not show substantial differences in obsessive–compulsive symptoms [27].

Conclusion

The current study shows that obsessive–compulsive symptoms decrease during inpatient treatment of AN (although these are not a primary treatment target) and these decreases are associated with increases in body weight. Of note, effect sizes were small and patients with comorbid OCD still had clinically elevated obsessive–compulsive symptomatology at discharge, suggesting that obsessive–compulsive symptoms should be targeted with OCD-specific treatment elements in psychotherapeutic aftercare.

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Author contributions
AM prepared and analyzed the data and wrote the first draft of the manuscript. UV conceptualized the study and revised the manuscript for content. All authors read and approved the final manuscript.

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Availability of data and materials
The data of this study are available at https://osf.io/k2g95.

Declarations

Ethics approval and consent to participate
According to the guidelines by the institutional review board of the LMU Munich, retrospective studies conducted on already available, anonymized data are exempt from requiring ethics approval.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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