Title

Greater rate of weight loss predicts paediatric hospital admission in adolescent typical and atypical anorexia nervosa.

Corresponding author

Cliona Brennan
The Michael Rutter Centre, De Crespigny Park, Camberwell, London, SE5 8az
+447365135264
cliona.brennan@slam.nhs.uk

Short Title

Predictors of paediatric admissions in anorexia nervosa

Authors

1. Cliona Brennan (MSc) South London and Maudsley NHS Trust, London Metropolitan University
2. Erica Cini (MRCPsych) East London NHS Foundation Trust, Kings College London, University College London
3. Sarah Illingworth (MSc) London Metropolitan University
4. Simon Chapman (MD) South London and Maudsley NHS Trust, Kings College Hospital London
5. Mima Simic (MRCPsych) South London and Maudsley NHS Trust
6. Nicholls, Dasha (MRCPsych) Central North West London NHS Trust, Imperial College London
7. Victoria Chapman (MRCPsych) Royal Free Hospital NHS Trust
8. Conor Simms (MSc) West London NHS Trust
9. Ellen Hayes (MSc) Royal Free Hospital NHS Trust
10. Sarah Fuller (MSc) East London Foundation Trust
11. Jade Orpwood (MSc)Northeast London Foundation Trust
12. Nicola Tweedy (MSc) Royal Free Hospital NHS Trust
13. Tahmida Baksh (MSc) East London NHS Foundation Trust
14. Emma Astaire (MD) Central Northwest London NHS Trust
15. Dee Bhakta (PhD) London Metropolitan University

Declarations

Cliona Brennan wrote the first draft of the manuscript.

Statement of Authorship

CB was responsible for conception and design of the study, recruitment of participants, data collection and analysis and preparation of drafts and final versions of the manuscript and associated tables and documents. DB contributed to the conception, design, and supervision of the study, and

editing of the draft and final manuscript and tables. MS, SI, EC, SC, DN and VC contributed to the design and supervision of the study, and the editing of the final manuscript. CS, EH, SF, JO, NC, TB and EA were responsible for the recruitment of participants, collection of study data and editing the final draft of the manuscript.

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Key words

Eating disorders

Mental health

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Abstract

Purpose: Hospital admissions for eating disorders (ED) are rapidly increasing. Limited research exists evidencing the factors that lead to hospital admissions, or their outcomes. The current study aimed to identify predictors of hospital admission in adolescents with anorexia nervosa (AN) or atypical anorexia nervosa (AAN).

Methods: Prospective observational study including participants (n=205) aged 11-18 and diagnosed with AN or AAN at initial ED assessment, across eight London clinics. Physical health parameters at assessment, including heart rate, blood pressure, temperature, and rate of weight loss, were compared between adolescents who were admitted to a paediatric ward following assessment and those who were not admitted.

Results: Mean rate of weight loss prior to assessment was significantly higher, and mean energy intake significantly lower, in the admitted vs not admitted groups (1.2 vs 0.6kg/week, $p<0.001$ and 565kcal/d vs 857kcal/d, $p < 0.001$), independent of degree of underweight. No significant differences were identified between groups in all other parameters of physical risk. Underweight adolescents with AN were equally likely to be admitted as non-underweight adolescents with AAN.

Conclusion: This study provides evidence on predictors of hospital admission, from a sample representing the London area. Assessment of weight loss speed, duration, and magnitude are recommended as priority parameters that inform risk of deterioration and likelihood of hospital admission in adolescent AN and AAN. Further research investigating outcomes of these hospital admission is needed.

Keywords

Eating disorders

Anorexia nervosa

Medical admission

Medical risk

Abbreviations

AN – Anorexia Nervosa

AAN – Atypical Anorexia Nervosa

ANOVA – Analysis of Variance

ED – Eating disorders.

NHS – National Health Service

MDT – Multidisciplinary team

MEED – Managements of Emergencies in Eating Disorders

NICE - National Institute for Clinical and care Excellence

%mBMI – Percentage median body mass index

Introduction

Hospital admissions in adolescent eating disorders are increasing, with a rapid increase occurring during the Coronavirus 2019 (COVID-19) pandemic [1–3]. Limited research exists evidencing the factors that lead to these admissions, or their outcomes [4]. Despite recent updates to national guidance on eating disorders supporting improved recognition and management of emergencies, there remains a lack of high quality research studies exploring these areas [5]. Evidence supporting rapid weight loss as a key marker of medical instability and hospital admission in adolescent eating disorders, independent of degree of underweight, is growing [6–8].

Recent figures from the National Health Service (NHS) digital and the Royal College of Psychiatrists state that hospital admissions for eating disorders in the UK have increased on average by 84% over a five-year period, between 2015-2021 [1,9]. Children and adolescents were found to be the worst affected, with admissions increasing by 90% in five years, whilst admissions in adults rose 79% in five years [9]. Despite the rise in admissions in adolescent eating disorders, little is known about predictors of admissions or their outcomes [10].

Variation in admission practices and procedures exists between different institutions, and has been highlighted as a concern in research available on this topic [10]. Key risk parameters that guide level of clinician concern in eating disorders are identified in the MEED (Medical Emergencies in Eating Disorders) UK national eating disorders guidance report *(Figure 1),* alongside guidance on recommended management [5]. These parameters are based on the physical complications associated with restrictive eating disorders, including anorexia nervosa (AN), atypical anorexia nervosa (AAN) and Avoidant restrictive food intake disorder (ARFID), that are described across many research

studies [11–13]. Bradycardia, hypotension, hypothermia, refeeding hypophosphatemia, electrolyte disturbances and dehydration are consequences of these illnesses most commonly reported as causes for medical instability and hospitalisation in this group [13–15] and decisions regarding admissions are typically based on clinical opinion and guidance reports [4,5].

Insert Figure 1.

Recommendations for future research from the MEED report focus on the acquisition of quantitative data on admissions and management of physical health in eating disorders. Two recommendations in particular suggest a) validation of the risk assessment framework and b) an audit of admissions to acute medical and paediatric units of patients with eating disorders [5]. Although the MEED risk assessment tool is widely used in the UK to guide clinicians' level of concern, limited research exists identifying parameters that may be indicative of a hospitalisation being required. Further research describing the factors that lead to hospital admissions across adolescents with restrictive eating disorders is urgently needed.

It has been established that there is a lack of data on admission practices and outcomes in adolescent eating disorders [1,10]. Advancements in research indicates rapid weight loss as a key risk marker, irrespective of whether actual weight is classified as underweight, healthy weight or overweight [6,16,17]. Historically, individuals presenting with rapid weight loss, but in the absence of underweight, were overlooked resulting in diagnosis and treatment being delayed [18,19]. We aim to identify parameters of physical risk that are associated with pediatric hospital admission in young people with AN and AAN. The hypothesis that certain parameters of physical risk, such as rapid rate of weight loss, bradycardia and/or hypotension, increase the likelihood of paediatric admission in adolescents with AN and AAN, independent of degree of underweight will be tested. The primary outcome of the study will be pediatric hospital admission.

Methods

Ethics

NHS ethics approval was sought through the Integrated Research Application System. The study was approved by the Health Research Authority following successful Research Ethics Committee review.

Sample and Participants

Participants were recruited from NHS child and adolescent specialist eating disorders services located in the greater London area. Eight study sites were recruited. The research and development review boards at each site reviewed and provided local approval for the study. Participants meeting inclusion criteria for the study and being assessed at one of the study sites, were automatically entered into the study and had their data collected whilst undergoing treatment as standard. Participant data was anonymised by members of the direct clinical care team, prior to being used for research purposes.

Inclusion criteria were age 11 to 18 years, diagnosis of AN or AAN and first episode of eating disorder treatment. Patients meeting full criteria as per the Diagnostic and Statistical Manual version 5 or the International Classification of Diseases Manual version 10 were diagnosed with AN, and those meeting criteria but in the absence of underweight, were diagnosed with Otherwise Specified Feeding and Eating Disorder and classified as AAN.

Percentage median BMI between 95 and 105% is the expected normal weight range for children and adolescents, below this range is classed as underweight and above typically being classed as overweight. In the previous DSM-IV, AN diagnosis in those under 18 years of age, was limited to those considered to be significantly underweight, with a median BMI of <85% being listed as an example of this (29). The DSM-5 does not identify a weight threshold for AAN, as such, median BMI > 85% was used in this study. Patients were excluded if they had a comorbid physical health condition, were presenting for a subsequent episode of treatment, or did not receive a diagnosis of AN or AAN. Patients admitted to eating disorder units within the study period were excluded.

Data Collection

Patients assessed between January 2022 and December 2022, and meeting inclusion criteria were recruited to the study. Patients were assessed by specialist outpatient eating disorder services. All assessments were standard outpatient assessments, rather than urgent or non-routine assessments. Adolescents requiring a medical hospital admission were admitted to their local paediatric ward. Two clinicians on each site collected data and recorded this on standardised proformas. Clinicians were trained by the lead researcher and regular meetings and data checks for quality assurance between study sites. The physical risk assessment, for which data used in this study is derived, was based on a standardised proforma provided in the MEED national eating disorder guidance. Clinicians at each site removed any identifiable participant information prior to adding this routinely collected data to the research data base. Data collected were parameters included within the MEED national guidance document risk screening tool. These parameters included gender, age and gender adjusted body mass index (BMI) in the form of percentage median BMI, disordered eating behaviours, rate of weight loss (in kilograms per week), energy intake per day (kcal per day) , fluid intake (mls per day), temperature (degrees Celsius), heart rate (beats per minute), systolic sitting blood pressure, electrocardiogram reading (QTc in milliseconds), biochemical parameters (glucose, serum phosphorous, magnesium, calcium, potassium, white blood cell count), exercise rating, self-harm and suicide rating, muscular strength test (SUSS) and other mental health diagnosis.

Weight loss rate (kg/per week) was defined as average weight lost per week in kg in the months (i.e., for all participants this was a minimum of one month and maximum of three months) leading up to the eating disorder assessment. Weights that were reported from parents/carers were derived from measurements taken on home weighing scales or at GP visits where weight was checked and recorded. No self-reported weights were collected from patients. Total weight loss could not be consistently recorded due this not being collected as standard at the initial assessment. Daily energy and fluid intake was assessed by a registered dietitian by inputting data on diet history (collected at

the initial eating disorder assessment by the assessing clinician) into nutritional analysis software and calculating mean daily values. Data on wait time between referral and assessment, profession of the assessor, diagnosis and initial treatment setting were collected in addition to the MEED risk parameters. Data were collected at initial assessment with the specialist eating disorders team. Missing data were recorded and excluded from final analysis.

Statistical analysis

Data were added to IBM SPSS statistics software version 28. Descriptive statistics were used to determine means and standard deviations for all parameters. Data were cleaned and coded. Participants with missing data were excluded from statistical tests.

Shapiro-Wilk test was used to determine if data was normally distributed and Levene's test for homogeneity of variance was used to identify if normally distributed variables had equal variance across groups. Independent samples t-tests were used to compare mean differences between groups for those normally distributed variables, whilst the Mann Whitney U test compared variables that did not follow normal distribution. Binomial logistic regression models were used to analyse parameters with significant differences between groups. Chi squared analysis and post hoc testing were used to compare categorical variables. Characteristics of participants, including demographic and clinical parameters, were compared between eating disorder services, and a Kruskal Wallis one-way ANOVA was performed to explore differences between participants from each of the eight services. Significance was determined by a *p* value, corrected for all ties, of less than 0.05 for all tests.

Results

Characteristics of participants.

Data were available from 205 participants at first presentation to their local eating disorder services. Descriptive data for all participants are displayed in table 1, summarising sample size, means and standard deviations for each parameter. Data on the engagement with the treatment plan, listed as a

parameter within the MEED tool, could not be collected as there was no consistent method used to record this across services and most participants had no data recorded on this at all.

Insert table 1

Physical risk parameters associated with hospital admission.

Characteristics of adolescents requiring an acute paediatric admission (n = 41) were compared to those who did not require admission (n = 164) *(Tables 2 and 3)*. Wait time, between referral and assessment, was significantly lower in the admitted group compared with the non-admitted group (12.8 days vs 27.1 days, $p < 0.001$). Adolescents diagnosed with AN were equally likely to be admitted as those diagnosed with AAN. Nurses assessed 73% of adolescents (n = 30) that were admitted, and this was significantly higher than admissions by other assessing professions (n = 11, 27% of admitted adolescents) ($p < 0.001$). Mean age was significantly lower for the admitted group (14.3 vs 14.9 years, $p = 0.045$, respectively).

Mean weight loss rate prior to assessment was significantly higher for admitted adolescents (1.2kg/week vs 0.6kg/week, $p < 0.001$, respectively). Percentage median body mass index (%mBMI) was similar across groups (81.2% vs 85.1%, $p = 0.054$, respectively). Mean energy intake at assessment was significantly lower for admitted adolescents compared with adolescents that were not admitted (565kcal/d vs 857kcal/d, $p < 0.001$). Fluid intake was similar across groups.

No significant differences were found between groups in clinical parameters (temperature, QTc, heart rate and blood pressure) or biochemical parameters. Rates of eating disorder-related behaviours, exercise ratings, and self-harm and suicidality rates were similar across adolescents that were admitted and not admitted, without any significant differences between groups.

Insert table 2 and 3

A logistic regression was performed to identify effects of daily energy intake, rate of weight loss, wait time and age, on the likelihood that participants would be admitted to hospital (table 4). The logistic

regression model was statistically significant, $\chi^2(1) = 20.343$, $p < 0.001$. The model explained 48.2% (Nagelkerke R^2) of the variance in admission and correctly classified 87.7% of cases. Increasing rate of weight loss was associated with an increased likelihood of being admitted (p<0.001). Daily energy intake, age and wait time did not significantly affect the likelihood of admission (p = 0.341, p = 0.434, p = 0.247 respectively).

Insert table 4

Variations between assessment and admissions between services

Analysis of variance (ANOVA) was used to compare data from the eight services included in the study, results are displayed in tables 5 and 6. The Kruskal Wallis *H* test showed that there was a statistically significant difference in wait time (days between referral and assessment), %mBMI, rate of weight loss (kg/week), fluid intake (ml/day), temperature and blood parameters (calcium and WBC count) between at least two sites [wait time: X^2 (7) = 44.167, $p < 0.001$, %mBMI: X^2 (7) = 14.466, $p = 0.043$, rate of weight loss: X^2 (7) = 17.419, $p = 0.015$, fluid intake: X^2 (7) = 19.459, $p < 0.001$, temperature = X^2 (6) = 19.167, $p = 0.004$, serum calcium = X^2 (7) = 43.542, $p < 0.001$, WBC = X^2 (4) = 14.684, $p = 0.005$].

Insert table 5 and 6

Discussion

Rapid rate of weight loss and hospital admission.

In the current study, greater rate of weight loss (1.2kg/week vs 0.6kg/week, p < 0.001) and lower daily energy intake (565kcal/d vs 857kcal/d, p < 0.001) were associated with medical paediatric admission in adolescents with both AN and AAN. The likelihood of an admission occurring increased with increasing rate of weight loss [$\chi^2(1) = 20.343$, $p < 0.001$]. There were no significant differences identified in other parameters of physical risk between admitted and non-admitted adolescents.

Whilst rapid weight loss, hypothermia, bradycardia, hypotension, electrolyte disturbances and refeeding hypophosphatemia are recommended indicators for hospitalisation in adolescents with AN [5], the thresholds for these parameters are mostly based on expert opinion, and recommended guidelines (which varies in different countries) in the absence of clear evidence for the threshold values [4]. Medical complications that have been shown to occur as a result of rapid weight loss include electrolyte abnormalities, dehydration, cardiovascular complications (such as bradycardia) and endocrine disturbances [7,8,20,21].

In the UK, the MEED national eating disorder guidance uses a traffic light stratification system to differentiate between high, moderate of low risks to life. To ensure that risks are assessed and managed safely, the MEED advises that medical admission should be considered for those that present with one or more high risk alerts, or two or more moderate risk alerts, and supports a low threshold for medical admission. Although we found no significant differences in rates of medical instability based on these parameters between admitted and not-admitted groups, all admissions occurred based on participants being deemed by the assessing clinician to be at high risk of physical deterioration, albeit not medically unstable at the time of admission. Wait time between referral and assessment was significantly shorter for the admitted group, and admission may have taken place prior to medical instability occurring, considering the rapid rate of physical decline leading up to the assessment.

Findings of this study highlighting greater weight loss rate as a key indicator of risk, build on the results from a small number of studies that have also identified greater weight loss as an important marker in guiding level of concern regarding risk when assessing patients with AN and AAN [7,8,22]. One of these studies, an RCT conducted by Garber and colleagues in 2019, identified weight loss as an independent marker of malnutrition and medical instability [7]. Similarly, Whitelaw et al. (2018) found that recent weight loss was a better predictor of medical instability than admission weight [8].

We conducted a systematic review and meta-analysis highlighting rate of weight loss as a key marker of risk [6]. In this review, we concluded that medical instability may occur across a range of weights in adolescent eating disorders, with rapid weight loss being an important indicator of increasing medical risk. Rapid weight loss was recommended as an indicator of medical instability and hospitalisation in adolescents presenting with AN and AAN [6].

Medical instability assessed by the MEED risk assessment tool.

Assessment of physical risk is advised for all young people presenting with suspected eating disorders. Paediatric admissions for stabilisation are recommended for those at highest risk of rapid deterioration [5]. All services included in the study used the MEED National guidance tool to assess physical risk of patients. Overall rates of medical instability were low, participants had modest rates of hypotension (8%, n = 12) and bradycardia (24%, n = 33) and no incidences of hypophosphatemia or hypothermia were identified. Markers of medical instability were not significantly associated with admission in this sample.

Decisions to admit patients to hospital encompass a range of factors relating to physical, as well as mental health. Factors such as motivation, readiness to change and engagement, could not be assessed by this study, and may have played a key role, in addition to rapid weight loss, in the admissions recorded within this sample [4,23,24]. Hospital admissions can serve secondary purposes in improving therapeutic engagement [24]. In this study, engagement was rarely reported by services, and thus could not be analysed. Research studies that have explored this the role of hospital admission in therapeutic engagement have found that admissions, that included elements of therapeutic support, had positive effects on clinical outcomes [25–27].

Freizinger et al. (2021) found that a partial hospitalisation program, which integrated principles of family therapy – including therapeutic engagement, improved patient outcomes (number of admissions, length of admissions, weight trajectory) during hospitalisation [26]. Matthews et al. (2019) also found that admissions, that included aspects of family therapy such as psychoeducation,

parental meal coaching, and behavioural contracting, improved parental self-efficacy and treatment outcomes [27]. Future research should focus on the development of a validated measure of engagement, and the role of hospital admission in engagement of the family with the treatment plan.

Location of treatment and purpose of hospital admissions

Comparison of hospital admissions across eating disorder services identified significant differences in admission rates between sites. Mean rates of weight loss were significantly greater within sites with higher admission rates. Nurses were the predominant profession of assessing clinician in sites with higher admission rates, and involvement of psychologists and psychiatrists at assessment in these sites was less. Variation in admission rates and practices is reported previously in the literature [4] with factors indicating the need for admission including medical instability, rapid weight loss, suicidality risk as well as poor engagement with the treatment plan [5]. Potential factors leading to differing rates of admissions between services in this study likely included differing levels of psychiatry leadership and expertise, collaborative working amongst paediatric and psychiatric networks and differences in system containment.

Family therapy for anorexia nervosa (FT-AN) is the first line treatment, recommended by the National Institute for Clinical and care Excellence (NICE), for adolescents with AN and AAN [28]. Within the FT-AN model, the role of hospital admission is primarily to manage physical risk and begin safe refeeding with maximum support and monitoring for severely malnourished young people. Hospital admission is also framed as an important engagement tool within this therapy model [24]. Fidelity to the treatment model, and expertise in its delivery are important in providing effective treatment [29]. Clinicians require specific training and ongoing supervision to ensure that the delivery of FT-AN is in keeping with treatment modality. A multidisciplinary team (MDT) approach is paramount to ensure that a holistic care plan (including, nutritional, physical monitoring, medication, and psychiatric assessment) is offered.

Findings from this study indicate that system issues, including a lack of senior medical and psychiatry staff to assess and manage physical and mental health risk in the community, may influence admission rates. Differences in services related to factors not fully captured by this data set (such as members within the multidisciplinary team make up and expertise of the team), likely affected admission rates in addition to those parameters identified in the study. Further studies should investigate these wider factors that influence both admission and treatment in this population group.

Strengths

The key strength of this study lies in it being one of the first study's investigating predictors of acute hospital admission in adolescents diagnosed with AN and AAN. Another strength of the study is the inclusion of multiple centres in its data collection, and a relatively large sample size.

Limitations

Due to the nature of the protocol, whereby there was no change to assessment and treatment as usual, many participants had missing data for various parameters. Weight loss rate was reported from parents/carers and GP measures rather than researchers or clinicians being able to collect this in a consistent manner, which may limit the strength and reliability of the results of the study. The data collection also did not include ethnicity of participants and thus this was not factored into analysis. Data on psychological morbidity of participants was not collected, future work should collect results from intake questionnaires to identify associations with physical risk that may be present. Longer term follow-up data would be useful for looking at the overall outcome of the medical admissions.

Conclusion

Findings from our study highlighted that adolescents with both AN and AAN who are losing weight rapidly are more likely to be admitted to paediatric hospital wards, without necessarily being medically unstable. Assessment of weight loss speed, duration, and magnitude is recommended as a

priority in assessing risk of deterioration in AN and AAN, irrespective of absolute weight at presentation. Differences between services (such as therapeutic skill and service organisation) likely influence decisions regarding hospital admission. Factors including family engagement and characterises of services (including multidisciplinary team set up and level of expertise in therapy models for eating disorders) need to be investigated further to fully understand their influence on admission rates. Further research on the duration and the impact of these hospital admissions on clinical outcomes is essential.

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