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Authors

Nagata, Jason
Vargas, Ruben
Sanders, Austin
et al.

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Clinical Characteristics of Hospitalized Male Adolescents and Young Adults with Atypical Anorexia Nervosa

Jason M. Nagata[1], **Ruben Vargas**[1], **Austin E. Sanders**[1], **Elena Stuart**[1], **Amanda E. Downey**[1,2], **Anita V. Chaphekar**[1], **Anthony Nguyen**[1], **Kyle T. Ganson**[3], **Sara M. Buckelew**[1], **Andrea K. Garber**[1]

[1]Department of Pediatrics, University of California, San Francisco, 550 16th Street, Box 0503 San Francisco, CA 94143, USA

[2]Department of Psychiatry and Behavioral Sciences, University of California, San Francisco, 550 16th Street, Box 0503 San Francisco, CA 94143, USA

[3]Factor-Inwentash Faculty of Social Work, University of Toronto, Toronto, ON, Canada

Abstract

Objective: To describe the clinical characteristics of male adolescents and young adults hospitalized for medical complications of atypical anorexia nervosa (atypical AN) and to compare their clinical characteristics with females with atypical AN and males with anorexia nervosa (AN).

Method: A retrospective review of electronic medical records for patients with atypical AN and AN aged 9–25 admitted to the UCSF Eating Disorders Program from May 2012 to August 2020 was conducted.

Results: Among 21 males with atypical AN (mean age 15.1±2.7, mean %mBMI 102.0±11.8), medical complications evidenced by admission laboratory values included anemia (52.9%), vitamin D insufficiency/deficiency (52.6%), and zinc deficiency (31.6%). Compared with females with atypical AN (n=69), males with atypical AN had longer length of stay (11.4 vs 8.4 days, p=.004), higher prescribed kcal at discharge (4114 vs 3045 kcal, p<.001), lower heart rate nadir (40.0 vs 45.8, p=.038), higher aspartate transaminase (AST, 37.9 vs 26.2 U/L, p=.032), higher alanine transaminase (ALT, 30.6 vs 18.3 U/L, p=.005), and higher rates of anemia (52.9% vs 19.4%, p=.005), with no differences in vitamin D, zinc, and vital signs. Compared with males

Corresponding Author: Jason M. Nagata, 550 16th Street, 4th Floor, Box 0503, San Francisco, California 94143, jason.nagata@ucsf.edu.

Contributor roles:

J.N. conceptualized and designed the study, developed the methodology, drafted the initial manuscript, and reviewed and revised the manuscript. R.V. performed statistical analysis and reviewed and revised the manuscript. A.S., E.S. drafted the initial manuscript and reviewed and revised the manuscript. A.N. contributed to the data extraction, conducted the literature review, and reviewed and revised the manuscript. A.D., A.C., K.G., and S.B. critically reviewed and revised the manuscript. A.G. helped conceptualize the study and reviewed and revised the manuscript.

Conflicts of interest: The authors have no conflicts to disclose.

Ethics approval: This retrospective chart review study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The Institutional Review Board (IRB) of the University of California, San Francisco approved this study.

Consent to participate: This research study was conducted retrospectively from data obtained for clinical purposes. We consulted extensively with the IRB of the University of California, San Francisco who determined that our study did not need informed consent.

with AN (n=40), males with atypical AN had no significant differences in vital signs or laboratory assessments during the hospitalization.

Discussion: Atypical AN in males leads to significant medical comorbidity, and males with atypical AN require longer hospital stays compared to females with atypical AN. Rates of abnormal vital signs and abnormal serum laboratory values during hospital admissions do not differ in males with atypical AN compared to AN.

Keywords

Atypical anorexia nervosa; anorexia nervosa; feeding and eating disorders; female; male; refeeding

Introduction

Until 2013, the Diagnostic and Statistical Manual, fourth edition (DSM-IV) only contained diagnostic criteria for anorexia nervosa (AN) and bulimia nervosa. As a result, many patients who did not fall squarely within these diagnostic criteria were labeled as “eating disorder not otherwise specified” (Walsh et al., 2023; Walsh & Sysko, 2009). With the release of the DSM-5, atypical anorexia nervosa (atypical AN) was included to account for patients who meet all psychological criteria for AN, yet have a weight within or above the normal range (American Psychiatric Association, 2013).

Over the last decade, research comparing atypical AN and AN has increased. Compared to individuals with AN, adolescents with atypical AN experience more distress with eating and body image (Johnson-Munguia et al., 2023) and have higher bone mineral density Z-scores (Nagata et al., 2019). When hospitalized, individuals with atypical AN exhibit vital sign instability, including hypotension and bradycardia, at similar rates to those with AN, suggesting they are just as medically ill (Garber et al., 2019; Sawyer et al., 2016; Walsh et al., 2023; Zanna et al., 2021). While a recent systematic review found that males comprise a greater proportion of individuals with atypical AN compared to AN (Walsh et al., 2023), sex-specific differences among those with atypical AN have not been explored.

Sex differences in eating disorder behaviors (e.g., exercising behaviors, muscularity-oriented eating) and medical complications highlight the need for sex-specific research examining males with atypical AN. Lengths of stay among hospitalized patients with eating disorders are prolonged for males compared to females, in part due to higher estimated energy requirements and the need for higher caloric intake to achieve medical stability (Nagata, Bojorquez-Ramirez, Nguyen, Ganson, Machen, et al., 2022). Further, males with eating disorders are more likely to be anemic compared to females (Nagata, Bojorquez-Ramirez, Nguyen, Ganson, McDonald, et al., 2022). Males with AN have distinct changes in body composition compared to females with AN, which may highlight the unique psychopathology of males with eating disorders as it relates to muscularity-oriented goals (Nagata et al., 2017). Prior studies have reported presenting clinical characteristics of males with eating disorders in general, but have not focused on those with atypical AN (Coelho et al., 2018; Vo et al., 2016). Altogether, the interplay between sex and eating disorder

pathology influences sex-specific clinical care for individuals with eating disorders, allowing for effective and individualized treatment.

To our knowledge, no studies have described the clinical characteristics of hospitalized males with atypical AN. Therefore, the objectives of this study are to 1) describe the clinical characteristics of hospitalized males with atypical AN, 2) compare their clinical characteristics to females with atypical AN, and 3) compare their clinical characteristics to males with AN. Building on the growing body of literature describing sex differences in eating disorders more broadly, we hypothesize that males with atypical AN will have longer medical hospitalizations than females with atypical AN due to the differences in estimated energy requirements and similar vital sign instability on admission. We also hypothesize that clinical characteristics of males with atypical AN will be similar to those of males with AN.

Method

Study population

We conducted a chart review of 601 patients, aged 9–25, admitted to the Eating Disorders Program at the University of California, San Francisco (UCSF) between May 2012 and August 2020. The UCSF Inpatient Eating Disorders Program offers medical stabilization and diagnostic assessments by specialists. Indications for medical hospitalization are based on the Position Papers of the Society for Adolescent Health and Medicine (see Appendix A for full list of indications for hospitalization) (Golden et al., 2003; Society for Adolescent Health and Medicine et al., 2015). Patients diagnosed under DSM-IV criteria (8%) were reclassified to DSM-5 by our study team.

The criteria for inclusion were patients aged 9 to 25 years initially hospitalized for the medical management of atypical AN (n=90) and AN (n=355) through nutritional rehabilitation between May 2012 and August 2020. Exclusion criteria encompassed patients who did not meet DSM-5 diagnostic criteria for atypical AN or AN. The final sample included 445 participants.

Study design

We sourced data from electronic medical records to characterize demographic and physiologic characteristics of our study participants. This data spanned demographics, illness duration, anthropometric measures, vital signs, and laboratory analyses from standard clinical documentation.

Measurements

All measurements and evaluations followed established clinical protocols. At admission, vital signs and laboratory assessment were obtained per the standard admission protocol. All analyses were conducted at a Clinical Laboratory Improvement Amendments (CLIA)-certified laboratory, adhering to federal standards. Our study adhered to the UCSF clinical laboratory's reference ranges. Height measurements were performed using a wall-mounted stadiometer while patients were weighed in a hospital gown without undergarments on a standing scale before morning intake and post-voiding. Body mass index (BMI), presented

as kg/m², was derived from initial weight and height measurements taken at admission. The percent median BMI (%mBMI) was calculated from the median BMI for age and sex using the Center for Disease Control growth charts as a reference (Centers for Disease Control, 2022). Licensed psychologists or psychiatrists made AN and atypical AN diagnoses based on clinical assessments during the hospital admission. For the weight criteria, atypical AN was defined as %mBMI >85% as has been defined in previous research (Garber et al., 2019, 2021; Golden et al., 2023). The severity of weight suppression at admission was assessed by subtracting the admission weight from the patient's highest recorded weight, then dividing by the highest recorded weight, from chart reviews. Duration of illness, length of hospital stay, and prescribed calories at admission and discharge were extracted by chart review. Per the UCSF inpatient admission protocol and the American Psychiatric Association's clinical practice guidelines (American Psychiatric Association, 2023), zinc levels were obtained to monitor for deficiencies in individuals with AN or atypical AN. Prior studies have found the prevalence of zinc deficiency to range from 24.8% to 64.3% during inpatient medical admissions (Hanachi et al., 2019; Nagata, Bojorquez-Ramirez, Nguyen, Ganson, McDonald, et al., 2022). Refeeding hypophosphatemia, hypokalemia, or hypomagnesemia were defined as individuals with low phosphorous (<3.0 mg/dL), potassium (<3.5 mmol/L), or magnesium (<1.8 mg/dL), respectively, after 24 hours of hospitalization (hospital day 2) and the initiation of nutritional refeeding. Refeeding hypophosphatemia was defined by the Society for Adolescent Health and Medicine as serum phosphorus < 3.0 mg/dL, given that this threshold is associated with the development of other medical complications associated with refeeding syndrome (Society for Adolescent Health and Medicine, 2022b).

Ethics

This retrospective chart review study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The Institutional Review Board of the UCSF approved this study (20–30323). A waiver of informed consent was granted given no more than minimal risk to participants, the study will not adversely affect the rights and welfare of participants, the retrospective chart review could not practicably be done without the waiver, and an adequate plan to protect the identifiers from improper use and disclosure.

Statistical analysis

Using Stata 18.0 (StataCorp LP, College Station, TX), we report descriptive statistics of the demographic and clinical factors for males with atypical AN, females with atypical AN, males with AN, and females with AN. We then compared groups using independent samples t-tests (continuous variables) and chi-squared or Fisher's exact tests (categorical variables). Group comparisons were for males with atypical AN vs females with atypical AN, males with atypical AN vs males with AN, and females with atypical AN vs females with AN. For the comparisons of liver function tests among males with atypical AN vs females with atypical AN, we conducted additional regression analysis to adjust for %mBMI. We conducted linear regression analyses with sex (independent variable) and liver function tests (aspartate transaminase [AST] and alanine transaminase [ALT], dependent variables, adjusted for %mBMI. In a sensitivity analysis, we limited the sample to participants

who presented prior to the COVID-19 pandemic (prior to March 13, 2020). Statistical significance was evaluated after employing the Benjamini-Hochberg Procedure to adjust for a false discovery rate.

Results

Table 1 presents the demographic and clinical characteristics of hospitalized adolescents and young adults with atypical AN and AN by sex. Among males with atypical AN (n=21), average (SD) age was 15.1 (2.7), BMI was 20.6 (3.3), and %mBMI was 102.0% (11.8%). The average prescribed daily calorie intake was 2095 (531) kcal at admission and increased to 4114 (674) kcal at discharge. Average duration of illness prior to hospitalization was 15.0 (22.8) months and length of hospital stay was 11.4 (4.2) days. The most common serum laboratory abnormalities in males with atypical AN included anemia (52.9%), vitamin D insufficiency or deficiency (52.6%), elevated alanine transaminase (ALT, 37.5%), elevated aspartate transaminase (AST, 25.0%), and zinc deficiency (31.6%).

Compared with females with atypical AN, males with atypical AN had longer length of stay (11.4 vs 8.4 days, p=.004), higher prescribed kcal at discharge (4114 vs 3045 kcal, p<.001), lower heart rate nadir (40.0 vs 45.8, p=.038), higher AST (37.9 vs 26.2 U/L, p=.032), higher ALT (30.6 vs 18.3 U/L, p=.005), and greater rates of anemia (52.9% vs 19.4%, p=.005). In linear regression models adjusted for %mBMI, male sex remained associated with higher AST (B=11.5, 95% CI 0.8–22.3, R^2=0.06) and higher ALT (B=12.1, 95% CI 3.6–20.6, R^2=0.11).

Compared with males with AN, males with atypical AN showed no significant differences in prevalence of vital sign instability or laboratory assessments during the hospitalization. Males with atypical AN did have higher BMI (20.6 vs 17.3, p<.001) and %mBMI (102.0 vs 83.5, p<.001), concurrent with the diagnostic criteria for atypical AN. Sensitivity analyses of participants who presented prior to the COVID-19 pandemic are shown in Appendix B.

Discussion

The presenting clinical characteristics of male adolescents and young adults hospitalized for medical complications of atypical AN are described for the first time in this retrospective chart review. Despite a higher weight and %mBMI, significant medical complications were noted in males with atypical AN including anemia, vitamin D insufficiency or deficiency, elevated ALT, elevated AST, and zinc deficiency. Atypical AN can lead to significant medical consequences in male adolescents and young adults.

The analysis of sex differences among those hospitalized with atypical AN revealed unique clinical considerations for males with atypical AN, notably longer hospitalizations and higher prescribed calorie requirements to restore medical stability compared to females with atypical AN. Adolescent males have greater energy requirements than females due to the interplay between height, weight, metabolic demands, and physical activity (Whitelaw & Nagata, 2021). Higher nutritional requirements for males coupled with lack of sex- or weight-specific refeeding protocols could lead to longer hospital stays for males and a higher cost burden (Nagata, Bojorquez-Ramirez, Nguyen, Ganson, Machen, et al., 2022).

Prior studies in patients with AN (Garber et al., 2013; Golden et al., 2013) identified protracted length of stay as part of the so-called “underfeeding syndrome.” Further, a recent randomized controlled trial in patients with atypical AN and AN demonstrated that higher calorie refeeding restored medical stability three days faster and shortened hospital stay by four days, as compared to the lower calorie standard of care (Garber et al., 2021). These findings support future research examining higher caloric loads and/or faster caloric advancement in males with AAN.

Males with atypical AN had higher rates of anemia than females with atypical AN, similar to findings across eating disorder samples (Nagata, Bojorquez-Ramirez, Nguyen, Ganson, McDonald, et al., 2022), likely due to the sex-specific cutoffs for anemia. Males with atypical AN had higher liver enzymes than females with atypical AN, consistent with prior research in AN (Nagata et al., 2015). In a nationally representative sample of US adolescents, male sex has been found to be associated with a 7.7 times higher odds of elevated ALT than female sex (Fraser et al., 2007). Male sex was associated with higher ALT and AST even after adjusting for %mBMI. ALT and AST are markers of malnutrition in patients with eating disorders, as indicators of hepatic cell damage and muscle injury, respectively. About one-third of patients with AN have elevated ALT or AST (Fong et al., 2008; Garber et al., 2019). ALT is increased in patients with lower weight (Nagata et al., 2015), lower fat mass (Fong et al., 2008), and amenorrhea (Singhal et al., 2014). AST is elevated in proportion to greater lean mass, longer duration of illness, and amenorrhea (Garber et al., 2019; Singhal et al., 2014). In contrast, elevated BMI could lead to elevated liver function tests secondary to steatosis (Milić et al., 2014); however, mean BMI in our sample with atypical AN was within the normal range. There were not significant sex differences in vital signs or electrolytes at admission for males and females with atypical AN except the lowest heart rate was lower for males compared to females with atypical AN.

In comparisons of males with atypical AN vs AN, there were no significant differences in presenting vital signs or admission laboratory values, indicating that males hospitalized with atypical AN present with similar rates of medical complications as males hospitalized with AN. Consistent with prior research showing similar rates of medical complications of atypical AN compared to AN (Garber et al., 2019; Sawyer et al., 2016), our findings support these conclusions even when limited to males with atypical AN and AN.

Limitations/strengths

Limitations of this study include the relatively small sample size of males with atypical AN; however, prior studies have not specifically focused on males with atypical AN. Additionally, the retrospective and observational nature of the chart review precludes causal inferences and introduces the potential for incomplete documentation. Eating disorder diagnosis was ascertained by clinical interview rather than structured/semi-structured rating instruments during medical hospitalization. Findings were from a tertiary care hospital in Northern California and therefore may not be generalizable to other populations. Future research endeavors could involve larger, multicenter studies to validate these findings across diverse populations and healthcare settings.

Conclusion

We report clinical characteristics of male adolescents and young adults hospitalized for medical complications of atypical AN, noting important medical consequences including anemia, vitamin D insufficiency, zinc deficiency, and elevated liver enzymes. It is noteworthy that the rates of abnormal admission vital signs and abnormal laboratory evaluations in males with atypical AN were not less common than in males with AN, despite a higher %mBMI, indicating that higher admission weight is not protective. Eating disorders in male populations remain under-researched and underdiagnosed, and this is particularly the case for males with atypical AN. Findings from this study can contribute to the limited but growing body of literature informing sex-specific medical management of eating disorders in male populations (Society for Adolescent Health and Medicine, 2022a). Future research should investigate sex-specific screening, prevention, and treatment for males with atypical AN.

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Availability of Data, Materials and Code

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author, JN. The data are not publicly available due to confidentiality restrictions; e.g., they contain information that could compromise the privacy of research participants.

Appendix A.: Indications for medical hospitalization at UCSF.

The UCSF Eating Disorders Program follows the indications supporting hospitalization published by the Society for Adolescent Health and Medicine Position Paper.

Indications supporting hospitalization in an adolescent with an eating disorder for patients admitted to UCSF in 2015–2020

One or more of the following justify hospitalization:

1. ≤75% Median body mass index for age and sex
2. Dehydration
3. Electrolyte disturbance (hypokalemia, hyponatremia, hypophosphatemia)
4. EKG abnormalities (e.g., prolonged QTc or severe bradycardia)
5. Physiological instability

Severe bradycardia (heart rate <50 beats/min daytime; <45 beats/min at night)

Hypotension (<90/45 mm Hg)

Hypothermia (body temperature <96°F, 35.6°C)

Orthostatic increase in pulse (>20 beats/min) or decrease in blood pressure (>20 mm Hg systolic or >10 mm Hg diastolic)

6. Arrested growth and development
7. Failure of outpatient treatment
8. Acute food refusal
9. Uncontrollable bingeing and purging
10. Acute medical complications of malnutrition (e.g., syncope, seizures, cardiac failure, pancreatitis, and so forth)
11. Comorbid psychiatric or medical condition that prohibits or limits appropriate outpatient treatment (e.g., severe depression, suicidal ideation, obsessive compulsive disorder, type 1 diabetes mellitus)

EKG = Electrocardiogram; QTc = Corrected QT interval

Society for Adolescent Health and Medicine, Golden, N. H., Katzman, D. K., Sawyer, S. M., Ornstein, R. M., Rome, E. S., Garber, A. K., Kohn, M., & Kreipe, R. E. (2015). Position Paper of the Society for Adolescent Health and Medicine: medical management of restrictive eating disorders in adolescents and young adults. The Journal of adolescent health : official publication of the Society for Adolescent Medicine, 56(1), 121–125.

Indications supporting hospitalization in an adolescent with an eating disorder for patients admitted to UCSF in 2012–2014

One or more of the following justify hospitalization:

1. Severe malnutrition (weight ≤75% average body weight for age, sex, and height)
2. Dehydration
3. Electrolyte disturbances (hypokalemia, hyponatremia, hypophosphatemia)
4. Cardiac dysrhythmia
5. Physiological instability Severe bradycardia (heart rate < 50 beats/minute daytime; <45 beats/minute at night)

   Hypotension (< 80/50 mm Hg)

   Hypothermia (body temperature < 96° F)

   Orthostatic changes in pulse (> 20 beats per minute) or blood pressure (>10 mm Hg)
6. Arrested growth and development

7. Failure of outpatient treatment
8. Acute food refusal
9. Uncontrollable binging and purging
10. Acute medical complications of malnutrition (e.g., syncope, seizures, cardiac failure, pancreatitis, etc.)
11. Acute psychiatric emergencies (e.g., suicidal ideation, acute psychosis)
12. Comorbid diagnosis that interferes with the treatment of the eating disorder (e.g., severe depression, obsessive compulsive disorder, severe family dysfunction)

Golden, N. H., Katzman, D. K., Kreipe, R. E., Stevens, S. L., Sawyer, S. M., Rees, J., Nicholls, D., Rome, E. S., & Society For Adolescent Medicine (2003). Eating disorders in adolescents: position paper of the Society for Adolescent Medicine. The Journal of adolescent health : official publication of the Society for Adolescent Medicine, 33(6), 496–503.

Appendix B.: Demographic characteristics and nutritional status of adolescents and young adults hospitalized with atypical anorexia nervosa and anorexia nervosa by sex (prior to COVID-19 pandemic)

Characteristic	Atypical Anorexia Nervosa				Anorexia Nervosa					
	Male (n = 16)	Female (n = 56)	p *a*	Effect size*b*	Male (n = 35)	p *c*	Effect size*b*	Female (n = 287)	p *d*	Effect size*b*
Age, years, mean (SD)	15.1 ± 2.9	15.3 ± 2.6	.870	0.047	16.3 ± 2.6	.141	0.452	15.7 ± 2.9	.279	0.158
Race/ethnicity, n (%)			.129	0.179		.461	0.103		.374	0.048
Asian or NHOPI*e*	0 (0)	3 (5.4)			3 (8.6)			21 (7.3)		
Hispanic	7 (43.8)	7 (12.5)			11 (31.4)			41 (14.3)		
Multiracial	2 (12.5)	5 (8.9)			1 (2.9)			10 (3.5)		
Non-Hispanic Black or African American	1 (6.3)	0 (0)	`		1 (2.9)	`		3 (1.1)		
Non-Hispanic White	6 (37.5)	33 (58.9)			17 (48.6)			187 (65.2)		
Other	0 (0)	7 (12.5)			2 (5.7)			15 (5.2)		
Unknown/ Declined	0 (0)	1 (1.8)			0 (0)			10 (3.5)		
BMI, kg/m^2, mean (SD)	20.5 ± 3.5	20.3 ± 2.4	.747	0.092	17.5 ± 2.4	< **.001**	1.097	17.0 ± 2.3	< **.001**	1.396
% median BMI, mean (SD)	101.7 ± 11.8	101.0 ± 11.8	.837	0.059	83.9 ± 12.3	< **.001**	1.439	83.9 ± 10.9	< **.001**	1.537
Percent weight suppression at	19.6 ± 11.9	17.0 ± 8.5	.347	0.284	22.5 ± 12.2	.454	0.245	20.1 ± 10.5	.042	0.307

Characteristic	Atypical Anorexia Nervosa				Anorexia Nervosa					
	Male (n = 16)	Female (n = 56)	p [a]	Effect size[b]	Male (n = 35)	p [c]	Effect size[b]	Female (n = 287)	p [d]	Effect size[b]
admission, mean (SD)[f]										
Duration of illness in months, mean (SD)[g]	18.3 ± 25.6	14.6 ± 19.1	.538	0.181	14.7 ± 13.9	.527	0.198	16.0 ± 19.5	.643	0.069
Lowest vital signs during hospitalization										
Pulse (beats per minute)	41.4 ± 10.6	45.2 ± 11.1	.223	0.348	42.0 ± 10.0	.847	0.059	44.8 ± 10.0	.778	0.041
Pulse <50 beats per minute	12 (75.0)	42 (75.0)	1.000	0.000	30 (85.7)	.352	0.130	212 (73.9)	.860	0.010
Systolic blood pressure (mmHg)	92.0 ± 11.1	87.3 ± 11.2	.143	0.420	81.7 ± 12.5	**.007**	0.849	82.3 ± 8.9	< **.001**	0.539
Systolic blood pressure <90 mmHg	7 (43.8)	37 (66.1)	.106	0.190	24 (68.6)	.092	0.236	230 (80.1)	**.020**	0.125
Diastolic blood pressure (mmHg)	46.7 ± 5.3	47.2 ± 8.4	.808	0.069	42.4 ± 8.2	.062	0.576	44.8 ± 6.6	**.016**	0.355
Diastolic blood pressure <45 mmHg	6 (37.5)	17 (30.4)	.589	0.064	18 (51.4)	.355	0.130	127 (44.3)	.054	0.104
Admission electrolyte laboratory values, mean (SD)										
Magnesium	2.1 ± 0.2	2.1 ± 0.2	.424	0.228	2.1 ± 0.1	.486	0.212	2.1 ± 0.2	.883	0.022
Hypomagnesemia (<1.8 mg/dL)	0 (0)	0 (0)	--	--	0 (0)	--	--	4 (1.4)	.374	0.048
Phosphorus	4.2 ± 0.6	3.9 ± 0.6	.070	0.522	3.9 ± 0.8	.226	0.370	3.9 ± 0.6	.912	0.016
Hypophosphatemia (<3.0 mg/dL)	0 (0)	1 (1.8)	.590	0.063	3 (8.6)	.227	0.169	16 (5.6)	.232	0.065
Potassium	3.9 ± 0.5	3.9 ± 0.8	.923	0.027	3.8 ± 0.4	.380	0.267	3.9 ± 0.5	.385	0.127
Hypokalemia (<3.5 mmol/L)	4 (25.0)	6 (10.7)	.145	0.172	4 (11.4)	.216	0.173	46 (16.0)	.310	0.055
Refeeding electrolyte laboratory values, n (%)										
Refeeding hypomagnesemia (<1.8 mg/dL)	0 (0)	9 (16.1)	.086	0.202	7 (20.0)	.054	0.270	61 (21.3)	.379	0.048
Refeeding hypophosphatemia (<3.5 mmol/L)	1 (6.3)	5 (8.9)	.732	0.040	1 (2.9)	.562	0.081	25 (8.7)	.958	0.003
Refeeding hypokalemia (low potassium)	0 (0)	4 (7.1)	.271	0.130	3 (8.6)	.227	0.169	38 (13.2)	.203	0.069

Characteristic	Atypical Anorexia Nervosa				Anorexia Nervosa					
	Male (n = 16)	Female (n = 56)	p [a]	Effect size[b]	Male (n = 35)	p [c]	Effect size[b]	Female (n = 287)	p [d]	Effect size[b]
Combined refeeding electrolyte deficiencies[h]	1 (6.3)	12 (21.4)	.164	0.164	9 (25.7)	.104	0.228	81 (28.2)	.295	0.057
Other laboratory evaluation at admission (normal range)										
Total cholesterol[i]	152.8 ± 41.5	163.9 ± 34.4	.282	0.310	152.8 ± 34.7	.997	0.001	171.5 ± 44.4	.249	0.175
High total cholesterol (≥ 200 mg/dL)	2 (12.5)	9 (17.3)	.648	0.055	4 (12.1)	.970	0.005	52 (19.1)	.760	0.017
Triglycerides[j]	78.7 ± 67.3	67.3 ± 35.3	.283	0.309	69.5 ± 35.1	.422	0.247	68.7 ± 34.4	.791	0.040
High triglycerides (≥ 130 mg/dL)	2 (12.5)	5 (9.6)	.740	0.040	3 (9.1)	.712	0.053	16 (6.0)	.328	0.055
Hemoglobin[k]	13.8 ± 1.2	13.0 ± 1.2	**.012**	0.753	13.4 ± 1.2	.291	0.331	12.8 ± 1.1	.257	0.166
Hematocrit[k]	40.9 ± 3.3	38.4 ± 3.0	**.008**	0.797	39.0 ± 3.6	.089	0.538	37.7 ± 3.2	.105	0.238
Anemic (M: < 13.6 g/dL; F: < 11.8 g/dL)[k]	8 (53.3)	12 (21.4)	**.015**	0.290	20 (58.8)	.720	0.051	55 (19.6)	.760	0.017
Zinc (plasma), mcg/dL[l]	65.4 ± 13.9	63.2 ± 12.6	.584	0.167	66.9 ± 18.8	.781	0.089	63.5 ± 14.5	.893	0.021
Low Zinc (plasma) (<55 mcg/dL)[l]	5 (35.7)	14 (29.2)	.640	0.059	8 (25.0)	.458	0.110	61 (23.6)	.414	0.047
25-hydroxyvitamin D (ng/mL), mean (sd)[m]	29.6 ± 7.4	34.1 ± 10.7	.134	0.444	31.6 ± 12.1	.561	0.181	33.4 ± 12.2	.720	0.054
25-hydroxyvitamin D Insufficiency (20–29 ng/mL)[m]	6 (40.0)	17 (32.1)	.567	0.070	5 (14.3)	.044	0.285	83 (30.9)	.861	0.010
Deficiency (< 20 ng/mL)[m]	1 (6.7)	3 (5.7)	.884	0.018	7 (20.0)	.239	0.167	25 (9.3)	.391	0.048
Severe deficiency (< 12 ng/mL)[m]	0 (0)	0 (0)	.589	--	4 (11.4)	.172	0.193	4 (1.5)	.372	0.050
Creatinine (0.45–1.08 mg/dL)	0.7 ± 0.2	0.7 ± 0.1	.140	0.423	0.8 ± 0.2	.178	0.412	0.7 ± 0.1	.205	0.186
Blood urea nitrogen (7–21 mg/dL)[n]	14.8 ± 4.7	12.4 ± 4.0	.054	0.559	17.1 ± 12.1	.449	0.232	13.0 ± 4.7	.422	0.119
Thyroid stimulating hormone (0.45–4.33 mIU/L)[o]	1.9 ± 1.2	2.1 ± 1.4	.664	0.135	2.1 ± 1.3	.717	0.120	2.0 ± 1.4	.536	0.093
Abnormal TSH (<0.45 or >4.33 mIU/L)[o]	1 (7.7)	4 (7.6)	.986	0.002	3 (9.4)	.857	0.027	17 (6.2)	.720	0.020

Characteristic	Atypical Anorexia Nervosa				Anorexia Nervosa					
	Male (n = 16)	Female (n = 56)	p [a]	Effect size[b]	Male (n = 35)	p [c]	Effect size[b]	Female (n = 287)	p [d]	Effect size[b]
Free thyroxine (10–18 pmol/L)[p]	12.1 ± 1.6	12.2 ± 1.9	.786	0.087	11.9 ± 1.9	.814	0.080	11.7 ± 1.8	.039	0.308
Abnormal Free thyroxine (<10 or >18 pmol/L)[p]	0 (0)	2 (3.7)	.498	0.083	2 (6.5)	.368	0.137	19 (7.0)	.370	0.050
Aspartate transaminase, AST[q]	39.4 ± 41.6	27.2 ± 10.9	.055	0.587	56.2 ± 115.0	.599	0.167	26.8 ± 12.0	.848	0.028
Elevated aspartate transaminase (>35 U/L)[q]	4 (28.6)	7 (13.0)	.158	0.171	10 (28.6)	1.000	0.000	28 (10.1)	.539	0.034
Alanine transaminase, ALT[r]	31.6 ± 29.9	18.5 ± 10.8	**.010**	0.796	46.9 ± 85.8	.520	0.205	20.5 ± 14.8	.362	0.137
Elevated alanine transaminase (>24 U/L)[r]	6 (42.9)	12 (22.6)	.129	0.185	14 (40.0)	.854	0.026	59 (21.4)	.838	0.011
Albumin (3.5–5.0 g/dL)[s]	4.4 ± 0.4	4.3 ± 0.4	.542	0.179	4.3 ± 0.4	.276	0.344	4.3 ± 0.4	.874	0.024
Clinical and nutritional characteristics										
Length of stay in days, mean (SD)	11.4 ± 4.4	8.4 ± 4.4	**.016**	0.702	11.5 ± 6.0	.964	0.014	10.3 ± 7.0	.048	0.289
Prescribed kcal, mean (SD)										
Admission	2150 ± 596	2011 ± 207	.142	0.421	2011 ± 252	.245	0.355	1966 ± 230	.175	0.198
Discharge[t]	4113 ± 708	3027 ± 446	< **.001**	2.110	3794 ± 720	.148	0.444	3042 ± 442	.818	0.034

P-value is for t-tests for continuous variables or Pearson's chi square tests (or Fisher's exact test as appropriate) for categorical variables. **Bold** indicates statistical significance after the Benjamini-Hochberg procedure.

[a] P for comparison of males with atypical anorexia nervosa compared to females with atypical anorexia nervosa

[b] Cohen's d for continuous variables, Cramer's V for categorical variables.

[c] P for comparison of males with atypical anorexia nervosa compared to males with anorexia nervosa

[d] P for comparison of females with atypical anorexia nervosa compared to females with anorexia nervosa

[e] NHOPI = Native Hawaiian and Other Pacific Islanders

[f] Due to missing data for weight suppression rate at admission, a sample size of 68 was utilized for atypical anorexia nervosa (Male n = 14; Female n = 54) and 285 for anorexia nervosa (Male n = 30; Female n = 255)

[g] Due to missing data for duration of illness, a sample size of 69 was utilized for atypical anorexia nervosa (Male n = 15; Female n = 54) and 306 for anorexia nervosa (Male n = 33; Female n = 273)

[h] A variable indicating hypomagnesemia (low Mg) OR hypophosphatemia (low phos) OR hypokalemia (low K)

[i] Due to missing data for cholesterol, a sample size of 68 was utilized for atypical anorexia nervosa (Male n = 16; Female n = 52) and 305 for anorexia nervosa (Male n = 33; Female n = 272)

[j] Due to missing data for triglycerides, a sample size of 68 was utilized for atypical anorexia nervosa (Male n = 16; Female n = 52) and 302 for anorexia nervosa (Male n = 33; Female n = 269)

[k] Due to missing data for hemoglobin and hematocrit, a sample size of 71 was utilized for atypical anorexia nervosa (Male n = 15; Female n = 56) and 314 for anorexia nervosa (Male n = 34; Female n = 280)

[l] Due to missing data for zinc, a sample size of 62 was utilized for atypical anorexia nervosa (Male n = 14; Female n = 48) and 290 for anorexia nervosa (Male n = 32; Female n = 258)

[m] Due to missing data for 25-hydroxyvitamin D, a sample size of 68 was utilized for atypical anorexia nervosa (Male n = 15; Female n = 53) and 304 for anorexia nervosa (Male n = 35; Female n = 269)

[n] Due to missing data for blood urea nitrogen, a sample size of 70 was utilized for atypical anorexia nervosa (Male n = 16; Female n = 54) and 314 for anorexia nervosa (Male n = 34; Female n = 280)

[o] Due to missing data for thyroid stimulating hormone, a sample size of 66 was utilized for atypical anorexia nervosa (Male n = 13; Female n = 53) and 306 for anorexia nervosa (Male n = 33; Female n = 273)

[p] Due to missing data for free thyroxine, a sample size of 66 was utilized for atypical anorexia nervosa (Male n = 12; Female n = 54) and 303 for anorexia nervosa (Male n = 31; Female n = 272)

[q] Due to missing data for aspartate transaminase, a sample size of 68 was utilized for atypical anorexia nervosa (Male n = 14; Female n = 54) and 311 for anorexia nervosa (Male n = 35; Female n = 276)

[r] Due to missing data for alanine transaminase, a sample size of 67 was utilized for atypical anorexia nervosa (Male n = 14; Female n = 53) and 311 for anorexia nervosa (Male n = 35; Female n = 276)

[s] Due to missing data for albumin, a sample size of 69 was utilized for atypical anorexia nervosa (Male n = 15; Female n = 54) and 309 for anorexia nervosa (Male n = 33; Female n = 276)

[t] Due to missing data for prescribed kcal at discharge, a sample size of 71 was utilized for atypical anorexia nervosa (Male n = 16; Female n = 55)

References

American Psychiatric Association. (2013). American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders Fifth Edition. In Arlington. 10.1176/appi.books.9780890425596.744053

American Psychiatric Association. (2023). The American Psychiatric Association Practice Guideline for the Treatment of Patients With Eating Disorders. American Psychiatric Association Publishing. 10.1176/appi.books.9780890424865

Centers for Disease Control. (2022, December 12). Growth Charts—Clinical Growth Charts. https://www.cdc.gov/growthcharts/clinical_charts.htm

Coelho JS, Lee T, Karnabi P, Burns A, Marshall S, Geller J, & Lam P-Y (2018). Eating disorders in biological males: Clinical presentation and consideration of sex differences in a pediatric sample. Journal of Eating Disorders, 6, 40. 10.1186/s40337-018-0226-y [PubMed: 30534377]

Fong H, DiVasta AD, DiFabio D, Ringelheim J, Jonas MM, & Gordon CM (2008). Prevalence and Predictors of Abnormal Liver Enzymes in Young Women with Anorexia Nervosa. The Journal of Pediatrics, 153(2), 247–253. 10.1016/j.jpeds.2008.01.036 [PubMed: 18534220]

Fraser A, Longnecker MP, & Lawlor DA (2007). Prevalence of elevated alanine aminotransferase among US adolescents and associated factors: NHANES 1999–2004. Gastroenterology, 133(6), 1814–1820. https://doi.org/S0016-5085(07)01634-4 [pii] [PubMed: 18054554]

Garber AK, Cheng J, Accurso EC, Adams SH, Buckelew SM, Kapphahn CJ, Kreiter A, Le Grange D, Machen VI, Moscicki A-B, Saffran K, Sy AF, Wilson L, & Golden NH (2019). Weight Loss and Illness Severity in Adolescents With Atypical Anorexia Nervosa. Pediatrics, 144(6), e20192339. 10.1542/peds.2019-2339

Garber AK, Cheng J, Accurso EC, Adams SH, Buckelew SM, Kapphahn CJ, Kreiter A, Le Grange D, Machen VI, Moscicki A-B, Sy A, Wilson L, & Golden NH (2021). Short-term Outcomes of the Study of Refeeding to Optimize Inpatient Gains for Patients With Anorexia Nervosa. JAMA Pediatrics, 175(1). 10.1001/jamapediatrics.2020.3359

Garber AK, Mauldin K, Michihata N, Buckelew SM, Shafer M-A, & Moscicki A-B (2013). Higher Calorie Diets Increase Rate of Weight Gain and Shorten Hospital Stay in Hospitalized Adolescents With Anorexia Nervosa. Journal of Adolescent Health, 53(5). 10.1016/j.jadohealth.2013.07.014

Golden NH, Kapphahn CJ, Cheng J, Kreiter A, Downey AE, Accurso EC, Machen VI, Adams SH, Buckelew SM, Moscicki A-B, Le Grange D, & Garber AK (2023). Course and outcome in individuals with atypical anorexia nervosa: Findings from the Study of Refeeding to Optimize iNpatient Gains (StRONG). The International Journal of Eating Disorders. 10.1002/eat.24029

Golden NH, Katzman DK, Kreipe RE, Stevens SL, Sawyer SM, Rees J, Nicholls D, & Rome ES (2003). Eating disorders in adolescents: Position paper of the Society for Adolescent Medicine. Journal of Adolescent Health, 33(6), 496–503. 10.1016/j.jadohealth.2003.08.004

Golden NH, Keane-Miller C, Sainani KL, & Kapphahn CJ (2013). Higher Caloric Intake in Hospitalized Adolescents With Anorexia Nervosa Is Associated With Reduced Length of Stay and No Increased Rate of Refeeding Syndrome. Journal of Adolescent Health, 53(5), 573–578. 10.1016/j.jadohealth.2013.05.014

Hanachi M, Dicembre M, Rives-Lange C, Ropers J, Bemer P, Zazzo J, Poupon J, Dauvergne A, & Melchior J. (2019). Micronutrients Deficiencies in 374 Severely Malnourished Anorexia Nervosa Inpatients. Nutrients, 11(4), 792. 10.3390/NU11040792 [PubMed: 30959831]

Johnson-Munguia S, Negi S, Chen Y, Thomeczek ML, & Forbush KT (2023). Eating disorder psychopathology, psychiatric impairment, and symptom frequency of atypical anorexia nervosa versus anorexia nervosa: A systematic review and meta-analysis. The International Journal of Eating Disorders. 10.1002/eat.23989

Milić S, Lulić D, & Štimac D. (2014). Non-alcoholic fatty liver disease and obesity: Biochemical, metabolic and clinical presentations. World Journal of Gastroenterology : WJG, 20(28), 9330–9337. 10.3748/wjg.v20.i28.9330 [PubMed: 25071327]

Nagata JM, Bojorquez-Ramirez P, Nguyen A, Ganson KT, Machen VI, Cattle CJ, Buckelew SM, & Garber AK (2022). Sex differences in refeeding among hospitalized adolescents and young adults with eating disorders. The International Journal of Eating Disorders, 55(2), 247–253. 10.1002/EAT.23660 [PubMed: 34957571]

Nagata JM, Bojorquez-Ramirez P, Nguyen A, Ganson KT, McDonald CM, Machen VI, Downey A, Buckelew SM, & Garber AK (2022). Sex differences and associations between zinc deficiency and anemia among hospitalized adolescents and young adults with eating disorders. Eating and Weight Disorders : EWD. 10.1007/S40519-022-01396-5

Nagata JM, Carlson JL, Golden NH, Long J, Murray SB, & Peebles R. (2019). Comparisons of bone density and body composition among adolescents with anorexia nervosa and atypical anorexia nervosa. The International Journal of Eating Disorders, 52(5), 591–596. 10.1002/eat.23048 [PubMed: 30771231]

Nagata JM, Golden NH, Peebles R, Long J, Murray SB, Leonard MB, & Carlson JL (2017). Assessment of sex differences in body composition among adolescents With anorexia nervosa. Journal of Adolescent Health, 60(4), 455–459. 10.1016/j.jadohealth.2016.11.005

Nagata JM, Park KT, Colditz K, & Golden NH (2015). Associations of elevated liver enzymes among hospitalized adolescents with anorexia nervosa. Journal of Pediatrics, 166(2), 439–443.e1. 10.1016/j.jpeds.2014.10.048 [PubMed: 25477162]

Sawyer SM, Whitelaw M, Grange DL, Yeo M, & Hughes EK (2016). Physical and Psychological Morbidity in Adolescents With Atypical Anorexia Nervosa. Pediatrics, 137(4), 10.1542/peds.2015-4080. Epub 2016 Mar 29. 10.1542/peds.2015-4080 [doi]

Singhal V, de Lourdes Eguiguren M, Eisenbach L, Clarke H, Slattery M, Eddy K, Ackerman KE, & Misra M. (2014). Body composition, hemodynamic, and biochemical parameters of young female normal-weight oligo-amenorrheic and eumenorrheic athletes and nonathletes. Annals of Nutrition & Metabolism, 65(4), 264–271. 10.1159/000366024 [PubMed: 25376841]

Society for Adolescent Health and Medicine. (2022a). Medical management of restrictive eating disorders in adolescents and young adults. The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine, 71(5), 648–654. 10.1016/j.jadohealth.2022.08.006 [PubMed: 36058805]

Society for Adolescent Health and Medicine. (2022b). Refeeding Hypophosphatemia in Hospitalized Adolescents With Anorexia Nervosa. The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine, 71(4), 517–520. 10.1016/j.jadohealth.2022.06.025 [PubMed: 36123000]

Society for Adolescent Health and Medicine, Golden NH, Katzman DK, Sawyer SM, Ornstein RM, Rome ES, Garber AK, Kohn M, & Kreipe RE (2015). Position Paper of the Society for Adolescent Health and Medicine: Medical management of restrictive eating disorders in adolescents and young adults. The Journal of Adolescent Health, 56(1), 121–125. 10.1016/j.jadohealth.2014.10.259 [doi] [PubMed: 25530605]

Vo M, Lau J, & Rubinstein M. (2016). Eating Disorders in Adolescent and Young Adult Males: Presenting Characteristics. The Journal of Adolescent Health : Official Publication of the Society for Adolescent Medicine, 59(4), 397–400. https://doi.org/S1054-139X(16)30033-7 [pii] [PubMed: 27287963]

Walsh BT, Hagan KE, & Lockwood C. (2023). A systematic review comparing atypical anorexia nervosa and anorexia nervosa. The International Journal of Eating Disorders, 56(4), 798–820. 10.1002/eat.23856 [PubMed: 36508318]

Walsh BT, & Sysko R. (2009). Broad categories for the diagnosis of eating disorders (BCD-ED): An alternative system for classification. The International Journal of Eating Disorders, 42(8), 754–764. 10.1002/eat.20722 [PubMed: 19650083]

Whitelaw M, & Nagata JM (2021). Nutritional Considerations for Boys and Men with Eating Disorders. In Eating Disorders in Boys and Men. Springer International Publishing. 10.1007/978-3-030-67127-3_11

Zanna V, Criscuolo M, Mereu A, Cinelli G, Marchetto C, Pasqualetti P, Tozzi AE, Castiglioni MC, Chianello I, & Vicari S. (2021). Restrictive eating disorders in children and adolescents: A comparison between clinical and psychopathological profiles. Eating and Weight Disorders: EWD, 26(5), 1491–1501. 10.1007/s40519-020-00962-z [PubMed: 32720247]

Public significance statement

Adolescent and young adult males with atypical anorexia nervosa experience significant medical complications. Males with atypical anorexia nervosa had longer hospitalizations and higher prescribed nutrition at discharge than females. Medical complications of atypical anorexia nervosa in male adolescents and young adults were generally equal to those of male adolescents and young adults with anorexia nervosa. Clinicians should be aware of unique medical complications of males with atypical anorexia nervosa.

Table 1.

Demographic characteristics and nutritional status of adolescents and young adults hospitalized with atypical anorexia nervosa and anorexia nervosa by sex

Characteristic	Atypical Anorexia Nervosa				Anorexia Nervosa					
	Male (n = 21)	Female (n = 69)	p [a]	Effect size[b]	Male (n = 40)	p [c]	Effect size[b]	Female (n = 315)	p [d]	Effect size[b]
Age, years, mean (SD)	15.1 ± 2.7	15.3 ± 2.6	.783	0.069	16.2 ± 2.7	.142	0.401	15.6 ± 2.8	.343	0.126
Race/ethnicity, n (%)			.223	0.128		.120	0.044		.920	0.049
Asian or NHOPI[e]	1 (4.8)	5 (7.3)			4 (10.0)			28 (8.9)		
Hispanic	8 (38.1)	9 (13.0)			12 (30.0)			46 (14.6)		
Multiracial	2 (9.5)	5 (7.3)			1 (2.5)			10 (3.2)		
Non-Hispanic Black or African American	1 (4.8)	0 (0)	`		1 (2.5)	`		4 (1.3)	`	
Non-Hispanic White	9 (42.9)	40 (58.0)			19 (47.5)			202 (64.1)		
Other	0 (0)	8 (11.6)			2 (5.0)			15 (4.8)		
Unknown/Declined	0 (0)	2 (2.9)			1 (2.5)			10 (3.2)		
BMI, kg/m^2, mean (SD)	20.6 ± 3.3	20.2 ± 2.4	.546	0.151	17.3 ± 2.3	**< .001**	1.221	16.9 ± 2.3	**< .001**	1.418
% median BMI, mean (SD)	102.0 ± 11.8	100.8 ± 12.3	.705	0.095	83.5 ± 11.6	**< .001**	1.578	83.8 ± 10.8	**< .001**	1.529
Percent weight suppression at admission, mean (SD)[f]	20.5 ± 11.9	17.1 ± 8.2	.153	0.375	22.0 ± 11.4	.646	0.132	19.9 ± 10.2	**.038**	0.283
Duration of illness in months, mean (SD)[g]	15.0 ± 22.8	15.0 ± 19.7	.999	< 0.001	14.9 ± 13.6	.986	0.005	15.3 ± 19.2	.888	0.019
Lowest vital signs during hospitalization										
Pulse (beats per minute)	40.0 ± 10.0	45.8 ± 11.3	**.038**	0.525	42.3 ± 10.5	.423	0.218	44.7 ± 10.1	.429	0.105
Pulse <50 beats per minute	17 (81.0)	50 (72.5)	.435	0.082	33 (82.5)	.881	0.019	231 (73.3)	.883	0.008
Systolic blood pressure (mmHg)	88.2 ± 12.6	86.4 ± 11.6	.528	0.158	82.4 ± 12.1	.083	0.476	82.2 ± 8.9	**.001**	0.441
Systolic blood pressure <90 mmHg	12 (57.1)	46 (66.7)	.425	0.084	26 (65.0)	.547	0.077	253 (80.3)	**.013**	0.126
Diastolic blood pressure (mmHg)	46.5 ± 5.8	47.1 ± 8.4	.750	0.080	43.4 ± 8.2	.128	0.416	44.9 ± 6.6	**.020**	0.311
Diastolic blood pressure <45 mmHg	7 (33.3)	21 (30.4)	.802	0.027	19 (47.5)	.288	0.136	135 (42.9)	.057	0.097
Admission serum electrolyte laboratory values, mean (SD)										
Magnesium	2.1 ± 0.2	2.1 ± 0.2	.535	0.155	2.1 ± 0.2	.240	0.320	2.1 ± 0.2	.111	0.212
Hypomagnesemia (<1.8 mg/dL)	1 (4.8)	3 (4.4)	.936	0.009	0 (0)	.164	0.178	5 (1.6)	.146	0.074
Phosphorus	4.1 ± 0.6	3.9 ± 0.6	.145	0.367	3.9 ± 0.8	.289	0.289	3.9 ± 0.6	.628	0.064

Characteristic	Atypical Anorexia Nervosa				Anorexia Nervosa					
	Male (n = 21)	Female (n = 69)	p [a]	Effect size[b]	Male (n = 40)	p [c]	Effect size[b]	Female (n = 315)	p [d]	Effect size[b]
Hypophosphatemia (<3.0 mg/dL)	0 (0)	2 (2.9)	.430	0.083	3 (7.5)	.198	0.165	17 (5.4)	.386	0.044
Potassium	3.9 ± 0.5	3.9 ± 0.8	.934	0.021	3.9 ± 0.5	.747	0.087	3.9 ± 0.5	.477	0.095
Hypokalemia (<3.5 mmol/L)	6 (28.6)	8 (11.6)	.060	0.198	4 (10.0)	.063	0.238	50 (15.9)	.369	0.046
Refeeding electrolyte laboratory values, n (%)										
Refeeding hypomagnesemia (<1.8 mg/dL)	0 (0)	12 (17.4)	**.040**	0.216	7 (17.5)	.042	0.261	67 (21.3)	.470	0.037
Refeeding hypophosphatemia (<3.0 mg/dL)	1 (4.8)	6 (8.7)	.556	0.062	2 (5.0)	.967	0.005	29 (9.2)	.894	0.007
Refeeding hypokalemia (<3.5 mmol/L)	0 (0)	5 (5.6)	.204	0.134	4 (10.0)	.134	0.192	38 (12.1)	.250	0.059
Combined refeeding electrolyte deficiencies[h]	1 (4.8)	16 (23.2)	.059	0.188	10 (25.0)	.051	0.250	90 (28.6)	.249	0.059
Other laboratory evaluation at admission (normal range)										
Total cholesterol[i]	160.4 ± 48.7	162.7 ± 33.6	.808	0.062	161.3 ± 47.2	.942	0.020	171.9 ± 44.1	.116	0.216
High total cholesterol (≥ 200 mg/dL)	3 (15.0)	10 (15.4)	.967	0.005	6 (15.8)	.937	0.010	60 (20.1)	.379	0.046
Triglycerides[j]	82.2 ± 40.8	70.1 ± 34.0	.191	0.338	71.9 ± 34.9	.319	0.278	71.2 ± 37.1	.825	0.031
High triglycerides (≥ 130 mg/dL)	3 (15.0)	6 (9.4)	.478	0.078	4 (10.5)	.619	0.065	20 (6.8)	.477	0.038
Hemoglobin[k]	13.9 ± 1.2	12.9 ± 1.1	**.003**	0.820	13.4 ± 1.2	.240	0.347	12.8 ± 1.1	.249	0.156
Hematocrit[k]	40.8 ± 3.2	38.5 ± 2.8	**.004**	0.816	39.0 ± 3.5	.081	0.519	37.7 ± 3.2	.075	0.240
Anemic (M: < 13.6 g/dL; F: < 11.8 g/dL)[k]	9 (52.9)	13 (19.4)	**.005**	0.307	22 (57.9)	.732	0.046	59 (19.3)	.982	0.001
Zinc (plasma), mcg/dL[l]	64.7 ± 13.4	63.9 ± 12.5	.805	0.065	66.8 ± 18.3	.663	0.124	63.8 ± 14.7	.985	0.003
Low Zinc (plasma) (<55 mcg/dL)[l]	6 (31.6)	17 (28.3)	.786	0.031	9 (24.3)	.562	0.078	67 (23.6)	.437	0.042
25-hydroxyvitamin D (ng/mL), mean (sd)[m]	28.8 ± 7.4	33.5 ± 12.0	.109	0.422	31.4 ± 11.5	.367	0.253	33.3 ± 12.1	.888	0.019
25-hydroxyvitamin D Insufficiency (20–29 ng/mL)[m]	8 (42.1)	20 (30.3)	.335	0.105	6 (15.0)	.022	0.298	95 (32.3)	.752	0.017
Deficiency (< 20 ng/mL)[m]	2 (10.5)	6 (9.1)	.850	0.021	8 (20.0)	.365	0.118	27 (9.2)	.981	0.001
Severe deficiency (< 12 ng/mL)[m]	0 (0)	1 (1.5)	.589	0.059	4 (10.0)	.153	0.186	5 (1.7)	.915	0.006
Creatinine (0.45–1.08 mg/dL)	0.8 ± 0.2	0.7 ± 0.1	.057	0.480	0.8 ± 0.2	.263	0.305	0.7 ± 0.1	.296	0.139
Blood urea nitrogen (7–21 mg/dL)[n]	14.7 ± 4.4	12.4 ± 4.1	**.029**	0.557	17.3 ± 11.7	.333	0.264	13.0 ± 4.7	.343	0.128
Thyroid stimulating hormone (0.45–4.33 mIU/L)[o]	2.2 ± 1.3	2.3 ± 1.5	.808	0.062	2.2 ± 1.3	.974	0.010	2.0 ± 1.4	.167	0.192
Abnormal TSH (<0.45 or >4.33 mIU/L)[o]	2 (11.8)	6 (9.5)	.785	0.031	3 (8.1)	.667	0.059	18 (6.0)	.310	0.053

Characteristic	Atypical Anorexia Nervosa				Anorexia Nervosa					
	Male (n = 21)	Female (n = 69)	p [a]	Effect size[b]	Male (n = 40)	p [c]	Effect size[b]	Female (n = 315)	p [d]	Effect size[b]
Free thyroxine (10–18 pmol/L)[p]	12.1 ± 1.5	12.2 ± 1.8	.845	0.055	11.9 ± 1.9	.751	0.096	11.6 ± 1.8	**.028**	0.305
Abnormal Free thyroxine (<10 or >18 pmol/L)[p]	0 (0)	2 (3.1)	.474	0.080	2 (5.6)	.336	0.133	21 (7.1)	.243	0.061
Aspartate transaminase, AST[q]	37.9 ± 38.9	26.2 ± 10.4	**.032**	0.609	53.2 ± 107.8	.586	0.162	27.3 ± 25.5	.598	0.072
Elevated aspartate transaminase (>35 U/L)[q]	4 (25.0)	7 (10.6)	.130	0.167	11 (27.5)	.849	0.026	32 (10.7)	.988	0.001
Alanine transaminase, ALT[r]	30.6 ± 28.0	18.3 ± 10.3	**.005**	0.805	44.0 ± 80.6	.522	0.191	21.1 ± 18.2	.241	0.161
Elevated alanine transaminase (>24 U/L)[r]	6 (37.5)	14 (21.5)	.967	0.147	16 (40.0)	.863	0.023	65 (21.7)	.972	0.002
Albumin (3.5–5.0 g/dL)[s]	4.3 ± 0.5	4.3 ± 0.4	.932	0.023	4.3 ± 0.4	.888	0.041	4.3 ± 0.4	.844	0.027
Clinical and nutritional characteristics										
Length of stay in days, mean (SD)	11.4 ± 4.2	8.4 ± 4.2	**.004**	0.733	11.2 ± 5.7	.844	0.053	10.3 ± 6.8	**.030**	0.290
Prescribed kcal, mean (SD)										
Admission	2095 ± 531	2017 ± 199	.313	0.253	2010 ± 235	.388	0.234	1968 ± 220	.085	0.230
Discharge[t]	4114 ± 674	3045 ± 437	< **.001**	2.131	3785 ± 720	.088	0.467	3057 ± 443	.841	0.027

P-value is for t-tests for continuous variables or Pearson's chi square tests (or Fisher's exact test as appropriate) for categorical variables. **Bold** indicates statistical significance after the Benjamini-Hochberg procedure.

[a] P for comparison of males with atypical anorexia nervosa compared to females with atypical anorexia nervosa

[b] Cohen's d for continuous variables, Cramer's V for categorical variables.

[c] P for comparison of males with atypical anorexia nervosa compared to males with anorexia nervosa

[d] P for comparison of females with atypical anorexia nervosa compared to females with anorexia nervosa

[e] NHOPI = Native Hawaiian and Other Pacific Islanders

[f] Due to missing data for weight suppression rate at admission, a sample size of 86 was utilized for atypical anorexia nervosa (Male n = 19; Female n = 67) and 317 for anorexia nervosa (Male n = 35; Female n = 282)

[g] Due to missing data for duration of illness, a sample size of 87 was utilized for atypical anorexia nervosa (Male n = 20; Female n = 67) and 335 for anorexia nervosa (Male n = 37; Female n = 298)

[h] A variable indicating refeeding hypomagnesemia or hypophosphatemia or hypokalemia

[i] Due to missing data for cholesterol, a sample size of 85 was utilized for atypical anorexia nervosa (Male n = 20; Female n = 65) and 336 for anorexia nervosa (Male n = 38; Female n = 298)

[j] Due to missing data for triglycerides, a sample size of 84 was utilized for atypical anorexia nervosa (Male n = 20; Female n = 64) and 331 for anorexia nervosa (Male n = 38; Female n = 293)

[k] Due to missing data for hemoglobin and hematocrit, a sample size of 84 was utilized for atypical anorexia nervosa (Male n = 17; Female n = 67) and 344 for anorexia nervosa (Male n = 38; Female n = 306)

[l] Due to missing data for zinc, a sample size of 79 was utilized for atypical anorexia nervosa (Male n = 19; Female n = 60) and 321 for anorexia nervosa (Male n = 37; Female n = 284)

[m] Due to missing data for 25-hydroxyvitamin D, a sample size of 85 was utilized for atypical anorexia nervosa (Male n = 19; Female n = 66) and 334 for anorexia nervosa (Male n = 40; Female n = 294)

[n] Due to missing data for blood urea nitrogen, a sample size of 88 was utilized for atypical anorexia nervosa (Male n = 21; Female n = 67) and 347 for anorexia nervosa (Male n = 39; Female n = 308)

[o] Due to missing data for thyroid stimulating hormone, a sample size of 80 was utilized for atypical anorexia nervosa (Male n = 17; Female n = 63) and 336 for anorexia nervosa (Male n = 37; Female n = 299)

[p] Due to missing data for free thyroxine, a sample size of 80 was utilized for atypical anorexia nervosa (Male n = 16; Female n = 64) and 334 for anorexia nervosa (Male n = 36; Female n = 298)

[q] Due to missing data for aspartate transaminase, a sample size of 82 was utilized for atypical anorexia nervosa (Male n = 16; Female n = 66) and 340 for anorexia nervosa (Male n = 40; Female n = 300)

[r] Due to missing data for alanine transaminase, a sample size of 81 was utilized for atypical anorexia nervosa (Male n = 16; Female n = 65) and 339 for anorexia nervosa (Male n = 40; Female n = 299)

[s] Due to missing data for albumin, a sample size of 83 was utilized for atypical anorexia nervosa (Male n = 17; Female n = 66) and 337 for anorexia nervosa (Male n = 38; Female n = 299)

[t] Due to missing data for prescribed kcal at discharge, a sample size of 89 was utilized for atypical anorexia nervosa (Male n = 21; Female n = 68)