Treatment Goal Weight in Adolescents with Anorexia Nervosa: Use of BMI Percentiles

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ABSTRACT

Objective: There is a lack of consensus as to how to determine treatment goal weight in the growing adolescent with anorexia nervosa (AN). Resumption of menses (ROM) is an indicator of biological health and weight at ROM can be used as a treatment goal weight. This study determined the BMI percentile for age at which ROM occurs.

Method: A secondary analysis of a prospective cohort study examining 56 adolescent females with AN, aged 12–19 years, followed every 3 months until ROM. BMI percentiles for age and gender at ROM were determined using the nutrition module of Epi Info 2002.

Results: At 1-year follow-up, 36 participants (64.3%) resumed menses and 20 (35.7%) remained amenorrheic. Mean BMI percentile at ROM was 27.1 (95% CI = 20.0–34.2). Fifty percent of participants who resumed menses, did so at a BMI percentile between the 14th and 39th percentile.

Conclusion: A BMI percentile range of 14th–39th percentile can be used to assign a treatment goal weight, with adjustments for prior weight, stage of pubertal development, and anticipated growth. © 2008 by Wiley Periodicals, Inc.

Keywords: treatment goal weight; adolescent; anorexia nervosa

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Introduction

Anorexia nervosa (AN) usually has its onset during adolescence, a time characterized by marked changes in both height and body weight. Weight restoration is an important early goal in the treatment of AN. It is accompanied by reversal of the medical complications of the disease,[1] improved mood,[2] and is felt by many to be necessary for psychotherapy to be effective. There is a lack of consensus, however, as to how to determine treatment goal weight in the growing adolescent, when both height and weight are changing as part of normal development.

In adults with AN, some clinicians use premorbid weight while others use "ideal body weight" derived from tables such as those provided by the Metropolitan Life Insurance Company.[3] In an adolescent who is in a phase of growth, the clinician cannot use body weight just prior to the onset of weight loss as a treatment goal weight because both height and weight are expected to increase with time. Use of tables of adult normative data is also not appropriate. The pediatric growth curves represent separate percentile curves of height for age and weight for age, for children and adolescents to the age of 20 years, based on the National Center for Health Statistics (NCHS) datasets.[4,5] They do not however show weight for both age and height. It is a mistake to assume that a 16-year old who is on the 90th percentile for height (i.e., who is tall) should be on the 90th percentile for weight (i.e., overweight). In 2000, the Centers for Disease Control and Prevention (CDC) developed graphs plotting body mass index (BMI) for age.[5] Body mass index, defined as weight in kilograms divided by height in meters squared, takes into account both height and weight. Some groups have begun to use BMI for both the diagnosis of AN and for determining treatment goal weight.[6,7] Absolute BMI changes with age and caution should be used in the use of absolute BMI in children and adolescents.[8] For example, a BMI of 17.5 would be on the 3rd percentile for a 19-year old but on the 50th percentile for an 11-year old.

Resumption of menses (ROM) is an important indicator of biological health. We have previously shown that, in a cohort of 100 adolescent girls with AN, a weight ~90% of median weight for age and

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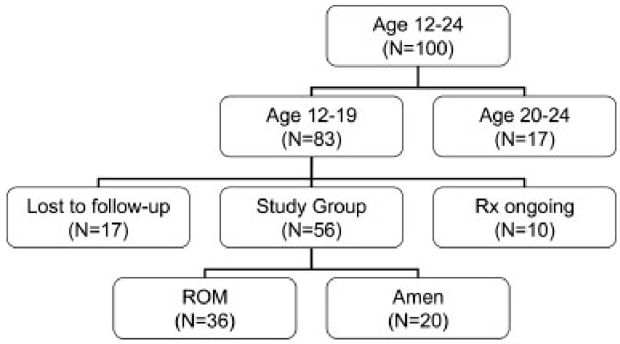
height (using the NCHS tables) is the average weight at ROM and 86% of participants who achieved this weight, resumed menses within 6 months of achieving this weight.[9] We suggested that this weight represents a reasonable treatment goal weight for postmenarcheal adolescent girls with AN. Most practitioners do not have access to the NCHS tables which are required to determine median weight for age and height, but the CDC BMI percentiles for age and sex are readily available (www.cdc.gov). The aim of the present study was to determine the BMI percentile for age at which ROM occurred, to facilitate determination of treatment goal weight in AN.

FIGURE 1. Study Design. The study group ($N = 56$) comprised adolescent females with anorexia nervosa between the ages of 12 and 19 years who were followed for at least 1 year. At 1-year follow-up, 36 participants (64.3%) resumed menses while 20 (35.7%) remained amenorrheic.



Method

We conducted a secondary analysis of a previously published prospective study that determined factors associated with ROM in a cohort of 100 adolescent females with anorexia nervosa, to determine the BMI percentile for age at which ROM occurred. Resumption of menses was defined as resumption of two or more consecutive spontaneous menstrual cycles.

Participants

Participants in the original study were adolescent females between the ages of 12 and 24 years who met DSM-IV diagnostic criteria for AN.[10] By definition, they all had secondary amenorrhea of greater than 3 months duration. We excluded those with primary amenorrhea, those who were receiving hormonal medication (e.g. steroids, oral or injectable contraception) at any visit, and those who did not return for follow-up visits. Because the CDC growth charts only go up to the age of 20 years, for the purposes of this study, we also excluded those 20 years of age and older.

Protocol

At baseline and every 3 months, height and weight were accurately measured as previously described.[9] Median body weight for age, height, and gender was obtained from the NCHS tables.[11] Percent of median body weight was defined as measured body weight divided by median body weight, multiplied by 100. BMI was calculated from height and weight (BMI = weight in kilograms divided by height in meters squared) and BMI percentiles for age and gender were obtained using the nutrition module of Epi- Info 2002 (available at CDC.gov). Blood was sent for leuteinizing hormone (LH), follicle-stimulating hormone (FSH), and estradiol levels. Written informed consent was obtained from all participants and in the case of a minor, a parent signed consent and the minor gave written assent. The study was approved by the Institutional Review Board of our medical center.

Statistics

The student's *t*-test was used to compare continuous variables between the two groups. Baseline and follow-up measurements were compared using the paired *t*-test. The box and whiskers plot was used to describe the distribution of BMI percentiles in those who resumed menses. All data are expressed as mean ± SD.

Results

As shown in **Figure 1**, of the original 100 participants, 56 met eligibility for this analysis. Seventeen participants were 20 years or older, 17 did not return for follow-up visits and 10 had not yet completed a year of treatment. Of the 56 participants, 36 (64.3%) resumed menses within the first year of follow-up and 20 (35.7%) remained amenorrheic at 1-year follow-up.

Mean age at enrollment was 16.0 ± 1.7 years (range 12–19) and 93% of the participants were Caucasian. In **Table 1**, at baseline, the group that subsequently resumed menses was similar to the group that remained amenorrheic with respect to weight, percent median body weight and BMI. However, at baseline, LH and FSH were significantly lower in those who subsequently remained amenorrheic 1 year later. Estradiol levels were low in both groups and were not significantly different from each other.

At 1-year follow up, both groups had gained weight. Weight increased from 44.3 ± 5.7 kg (97.5 ± 12.6 lbs.) to 49.5 ± 4.7 kg (109.0 ± 10.3 lbs.) in the

TABLE 1. Anthropometric and hormone values at baseline

	ROM (N = 36)	Amen (N = 20)	p
Weight (kg)	44.3 ± 5.7	41.3 ± 6.6	.08
% MBW	81.5 ± 7.1	77.5 ± 11.7	.12
BMI (kg/m2)	17.0 ± 1.5	16.2 ± 2.2	.12
LH (mIU/ml)	5.0 ± 4.0	2.0 ± 0.0	.001
FSH (mIU/ml)	6.7 ± 3.0	4.3 ± 3.3	.02
Estradiol (pg/ml)	28.3 ± 14.1	23.0 ± 12.1	.20

TABLE 2. Anthropometric and hormone values at resumption of menses or 1-year follow-up

	ROM (N = 36)	Amen (N = 20)	p
Weight (kg)	49.5 ± 4.7	47.7 ± 6.1	.25
% MBW	90.4 ± 8.4	88.6 ± 11.9	.51
BMI (kg/m2)	19.0 ± 1.6	18.7 ± 2.4	.66
LH (mIU/ml)	7.4 ± 5.1	3.7 ± 2.85	.007
FSH (mIU/ml)	8.2 ± 3.2	8.9 ± 3.9	.54
Estradiol (pg/ml)	49.5 ± 22.8	24.4 ± 11.9	<.001

group that resumed menses ($p < .001$) and from 41.3 ± 6.6 kg (90.8 ± 14.6 lbs.) to 47.7 ± 6.1 kg (104.9 ± 13.4 lbs.) in the group that remained amenorrheic ($p < .001$). At follow-up, there were no significant differences in weight, percent median body weight, amount of weight gained, or BMI between the groups. As expected, in the amenorrheic group at follow-up, LH and estradiol levels were significantly lower compared with those who resumed menses (**Table 2**).

Absolute BMI at ROM ranged from 16 to 23.8 kg/m^2 and varied by age (**Fig. 2**). Mean BMI percentile for age at ROM was 27.1 ± 20.9 (95% CI, 20.0–34.2). As shown in **Figure 3**, median BMI percentile for age at ROM was 20.6. Fifty percent of the participants who resumed menses, did so when they achieved a BMI between the 14th and 39th percentile and 75% did so at a BMI equivalent below the 39th percentile (note that these data are expressed as percentiles for age and sex and not absolute BMI).

FIGURE 2. Relationship between absolute BMI at resumption of menses and age.

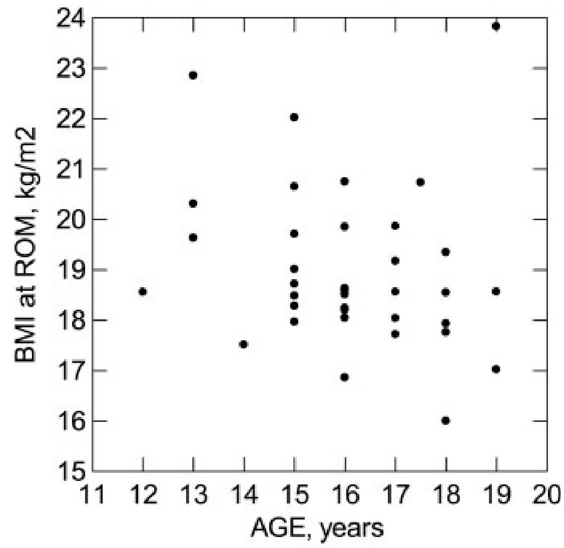
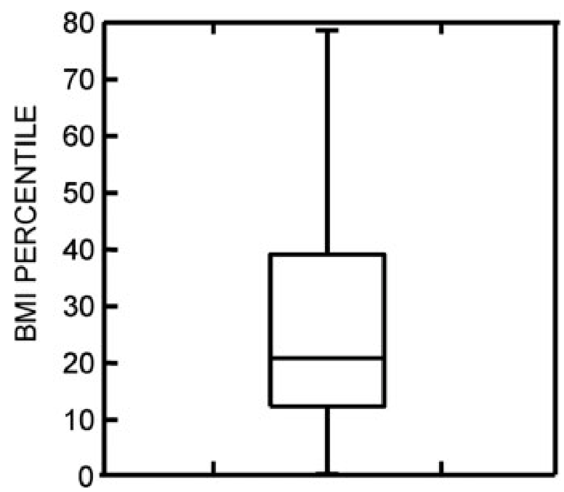


FIGURE 3. Distribution of BMI percentiles of participants who resumed menses. The horizontal line represents the median and the box includes the middle 50% of participants. The lower border of the box represents the first quartile and the upper border the third quartile. Seventy-five percent of participants resumed menses prior to achieving a BMI equivalent to the 39th BMI percentile.



Discussion

The concept of an ideal body weight for a particular patient is confusing for clinicians and patients alike. Different methods of determining ideal body weight give discrepant results, adding to the confusion.[12,13] The term ideal body weight implies a weight that will result in optimal health and lowest mortality. To our knowledge, there are no data in adolescents, which have demonstrated that a particular weight is associated with improved longevity. For most patients, there is a range of weights that is healthy. Terms such as ideal body weight are often mistakenly considered to be synonymous with "average body weight" or "median body weight." The term "treatment goal weight" refers to the individualized goal weight for that particular patient. In an adolescent, it should take into account age, height, premorbid weight, prior growth record (from the growth chart), stage of pubertal development, and growth potential. A number of different methods have been used to determine treatment goal weight.

In the 1940s the Metropolitan Life Company published tables of ideal body weight that were based on actuarial data of life expectancy in adult men and women between the ages of 25 and 59 years, who were seeking life insurance.[14,15] These tables were revised in 1959 and again in 1983.[3,16] However, heights and weights were not accurately measured. Height was determined wearing shoes and participants were weighed wearing clothes. A correction was made for height by subtracting 1 in. for heels in men and 2 in. in women, and for weight by subtracting 7 pounds for clothing in men and 4 pounds in women. Patients were divided into groups according to small, medium, and large frame size but the method of determining frame size was not defined. Nevertheless, despite the limitations of the methodology, these tables did represent a weight associated with improved outcome in adults. In the 1983 Metropolitan Life Insurance tables, weights for height were slightly higher than the 1959 tables, method of determining frame size was now defined based on measurements of elbow breadth, and the term ideal body weight was eliminated. Nevertheless, the term ideal body weight has persisted in the medical literature.

Population-based tables of normative data of height and weights of children and adolescents are readily available in a number of different countries. In the United States, the NCHS datasets provide an excellent resource of normative data of heights and weights of children and adolescents. In contrast to the Metropolitan Life Insurance Company tables, these data sets provide accurate measurements of a national probability sample of children and adolescents. For example, the National Health Examination Survey (NHES) Cycle III (1966–1970) accurately measured heights and weights of 6,768 US adolescents between the ages of 12 and 17 years. This sample was designed to accurately predict measurements from 22,692,000 US adolescents.[11] The CDC BMI charts were derived from data using NHES Cycle II (1963–1965), NHES Cycle III (1966–1970), National Health and Nutrition Survey (NHANES) I (1971–1974), NHANES II (1976–1980) and NHANES III (1988–1994). Because of the marked increase in obesity between NHANES II and NHANES III, the BMI charts for children older than 6 years of age deliberately excluded data from the NHANES III survey. Without this correction, the 85th and 95th percentiles would be much higher than they presently are.

Normative data do not provide information about the weight that will result in optimal health or lowest mortality. Median body weight or median BMI therefore is not synonymous with ideal body weight. In a population with a high prevalence of obesity, median body weight or median BMI will be higher than in a population where obesity is not so prevalent. Even despite the correction in BMI conferred by not using NHANES III data in adolescents, on the BMI charts there still is a greater splay of BMI above the 50th percentile than there is below the 50th percentile.

Further complicating the issue of assigning a treatment goal weight in adolescents is the fact that the rate and tempo of puberty varies for different individuals. During puberty, patients do not necessarily follow the cross-sectionally derived population-based growth curves. An early maturing girl will grow more rapidly and gain weight more rapidly than a late maturing girl of the same age. On the other hand, a late maturing girl will continue to grow and gain weight well after the early maturing girl. Neither of these girls will follow the smoothed, population-based growth curves. Furthermore, malnutrition associated with AN can cause growth retardation.[17–20] As part of the clinical assessment of an individual patient, the clinician should review the prior growth curve. In the presence of documented growth deceleration or arrest, projected height rather than measured height, should be used for determination of treatment goal weight.

Treatment goal weight is the weight at which the patient is functioning well both medically and psychologically. It is the weight at which most of the medical complications have resolved and the patient's bodily functions are restored to normal. Usually at such a weight, the obsessions and preoccupation with food, shape, and weight, though still present, are markedly improved. Determination of treatment goal weight is a complex clinical decision that should be carefully made taking into account a number of variables and needs to be recalculated every 3–6 months in adolescents. Treatment goal weight needs to be individualized and cannot simply be read off from generic charts. Resumption of menses is one indicator of return to biological health and we have suggested that weight at ROM is a reasonable treatment goal weight. We have shown that 86% of adolescent girls resume menses within 6 months of achieving a weight at or above 90% of median body weight for age and height,[9] which, using the results of this present study, translates to a BMI percentile of 27. Fifty percent of girls with AN who resumed menses, did so when they achieved a weight between the 14th and 39th BMI percentile for age and 75% did so at a BMI percentile below the 39th percentile. Most patients do not need to achieve the 50th percentile of BMI to resume menses, which makes sense, since the 50th percentile in a population that has become progressively more overweight over the past two decades, does not necessarily reflect a "healthy" BMI.

Clearly patients do not immediately resume regular menses once they achieve a certain weight. In addition, given that there is daily fluctuation of body weight and patients with eating disorders tend to focus on one particular number, it is preferable to give a range of weights (around the treatment goal weight). Restoration of normal hypothalamic–pituitary–ovarian function is necessary for ROM to occur. Caloric restriction even in the presence of a normal weight will inhibit ovulation and cause amenorrhea. Our data suggest that in postmenarcheal girls, a BMI at or above the 27th percentile is sufficient for ROM and, based on our prior findings, the majority of patients who achieve this BMI percentile will resume menses within 3–6 months.[9]

Resistance to weight gain is one of the core features of patients with eating disorders. Most patients with AN were not overweight before the onset of the eating disorder. For those who were previously overweight, the fear of weight gain is aggravated by fear of becoming overweight once more. In such situations, the knowledge that it is possible to achieve a healthy weight and resume regular menses without having to get back to premorbid body weight, can be very reassuring. Once a BMI at or above the 27th percentile has been maintained, the patient can be followed with serial estradiol levels every 3 months. We have previously shown that an estradiol level above 30 pg/mL (110 pmol/L) is predictive of ROM within 3–6 months (RR 4.6, 95% CI 1.9–11.2).[9] If after 6 months, estradiol levels still remain low, the individualized treatment goal weight needs to be higher.

The limitations of our study include the small sample size and the fact that we only studied postmenarcheal girls. The findings therefore cannot be generalized to boys or to premenarcheal girls. Future research should study treatment goal weight in boys, premenarcheal girls, and those who were previously overweight. Finally, we used ROM as one objective measure to help determine treatment goal weight, but this study did not address psychological variables associated with achieving such a weight. Nevertheless, for the practitioner faced with a malnourished patient with AN, in deciding whether an individual patients has to gain 10, 20, or 30 pounds, the results of our study can provide an evidence-based guideline as to a recommended starting point.

Conclusion

In summary, in adolescents, treatment goal weight needs to be individualized, taking into account pubertal stage, prior growth percentiles, growth potential as well as height and age. Average body weight or median body weight does not necessarily imply optimal nutrition or health. The term ideal body weight is misleading and confusing for clinicians and patients alike. In a growing adolescent, treatment goal weight is a "moving target" and should be recalculated every 3–6 months. Treatment goal weight is the weight at which the patient is functioning well medically and for girls, this is the weight at which menstruation and ovulation are restored. Usually, at a such a weight, the obsessions and preoccupations with food, shape and weight are decreased. This study demonstrates that ROM occurs at a mean BMI percentile of 27 and that 50% of participants who resume menses, do so when they achieve a BMI between the 14th and the 39th percentile for age. The results of this study provide objective data that can be helpful to the practitioner in deciding on treatment goal weight for a particular patient.

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