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# Aiming for healthy weight in wrestlers and other athletes

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Wrestlers and athletes in other “weight-sensitive” sports are at high risk of engaging in unhealthy weight-loss practices. Learning how to intervene effectively will help you deal better with weight issues in all your patients.

**U**nhealthy weight loss and suboptimal nutrition, along with disordered eating habits and eating disorders, are significant problems among adolescents. Seventy-five percent of patients with disordered eating develop the problem during adolescence.<sup>1</sup>

Because 90% of eating disorders occur in girls and women, most discussion in the literature focuses on this as a female problem. A 1995 study of middle schools in North Carolina, however, found that, in addition to the 10% of girls in the sixth to eighth grades who reported using vomiting and laxatives to lose weight, 4% of boys reported similar practices.<sup>2</sup> Among athletes, especially those participating in “weight-sensitive”

sports, unhealthy weight loss practices are prominent in both sexes, with reported prevalences of 10% to 15% in boys and 25% to 30% in girls.<sup>3,4</sup>

Weight-sensitive sports involve either a requirement to reach a specific weight or a perception that an advantage exists if the athlete performs at a lower weight. Sports often cited for having a high incidence of athletes engaging in unhealthy nutrition and weight loss practices include rowing, gymnastics, cross country, cheerleading, dancing, and wrestling. Although many of the same concerns apply to all of these sports, this review focuses on unhealthy weight loss practices in wrestling for several reasons:

- The magnitude of the weight loss problem in wrestling is great and has been well-documented, with studies reporting as many as 45% of wrestlers at risk for a major eating disorder.<sup>5,6</sup>

- Pediatricians are more likely to encounter patients experiencing weight loss problems in wrestling than in most other sports.

- Other health issues associated with wrestling, such as injury and spread of infection, put wrestling in the fish bowl of public scrutiny.

This year, the National Federation of State High School Associations, the governing body for high school athletics, recommended to the wrestling rules committee that all states have weight management programs in place for wrestling no later than 2004. Physicians across the country may therefore be called upon to certify the minimum appropriate weight for participation in wrestling, especially if a youngster's natural weight is below the recommended minimum. Physicians making these decisions for patients involved in wrestling and other weight-sensitive sports need to be familiar with techniques for determining body fat and appropriate

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weight management programs. This information also can provide a valuable tool for educating youngsters about nutrition, fitness, and healthy weight loss or gain, whether or not the youngster participates in sports.

### Health concerns in wrestling

Wrestling has a long and storied history. Drawings of wrestling holds have been found in Egyptian tombs from 2,500 BC, and wrestling was one of the five sports in the first Quadern Olympiad in 776 BC. Participation in wrestling has been shown to contribute positively to self-esteem, mental and physical toughness, self-discipline, and character. Despite these positive attributes, wrestling has suffered from the general perception that it is an unhealthy sport. The medical literature substantiates this perception to some extent.

Table 1 lists some of the medical concerns associated with wrestling.<sup>7</sup> In addition to a high injury rate, the spread of infectious diseases, highlighted by documented epidemics of herpes gladiatorum, has long concerned the wrestling community, and much work has been done on developing guidelines for wrestlers' return to participation after developing skin diseases.<sup>8,9</sup> Although the risk for spread of systemic contagious diseases such as HIV infection and

TABLE 1

## Medical concerns associated with wrestling

### Injuries

Wrestling ranks fourth in nonfatal catastrophic sports injury

Wrestling ranks first or second in overall sports injury rate

Three wrestlers died from wrestling-related causes in 1998

### Use of supplements

Alleged fat-burning supplements (more common in wrestling than in other sports)

Ephedrine (ma huang)

Chromium

Pyruvate

Androgenic supplements (less common in wrestling than in other sports)

Creatine

Androstenedione

### Spread of contagious disease

Viral illnesses (rhinovirus, influenza)

HIV infection/hepatitis (theoretical but not reported)

Skin disease (herpes gladiatorum, impetigo, tinea gladiatorum)

### Inappropriate weight loss

Excessive weight loss

Too rapid weight loss

Cycling of weight (repeated rapid loss and gain)

hepatitis B is not zero, it is extremely low, and no documented transmission in the course of sports participation has been reported.

The use of supplements in all sports is of concern to the sports medicine community. In contrast to athletes in many other sports, who take supplements such as creatine or androstenedione to gain weight and strength, wrestlers are

more likely to try diuretics, chromium, pyruvate, or ephedrine (ma huang) to lose weight. [Editor's note: For more on supplements, see "Nutritional supplements and the young athlete: What you need to know" in the July issue, also accessible at [www.contpeds.com](http://www.contpeds.com).]



These substances have not been shown to be effective, and their use presents significant risks to young athletes.

The greatest medical concern associated with wrestling is the dangerous weight loss methods used by many wrestlers. In 1998, these behaviors led to the deaths of three collegiate wrestlers that were directly attributed to excessive weight loss.<sup>10</sup>

### What is fighting weight?

For most young athletes in all sports, the best weight at which to compete is the athlete's natural weight, which is defined as out-of-season weight when eating and exercising in a healthy manner. Studies suggest that a body fat percentage of 7% to 9% is efficient metabolically for most males. For most females the most efficient and healthy percentage is 12% to 15% body fat.<sup>4,11</sup> Attempts to achieve body fat compositions below these percentages usually require unhealthy eating practices. No evidence exists to suggest any

additional benefit in metabolic efficiency or performance at lower levels. These percentages are considered the *minimum* for most persons and therefore are not necessarily the natural or ideal for a given youngster.

Because of ethnicity or genetics, some youngsters' natural weight may place them below the 7% minimum body fat for males and 12% minimum for females. A physician familiar with the youth may be asked to verify that he or she is healthy and fit and can safely participate at his or her present weight even though body fat is below the established minimum. The physician should feel comfortable certifying such a youngster for participation if medical records document a consistent pattern of weight and no evidence of malnutrition or pathologic eating or exercise behaviors.

### **Why do wrestlers want to lose weight?**

Most athletes who want to lose weight are motivated by a desire for improved appearance, better performance, or perceived competitive advantage. Sports such as wrestling, crew, and youth football require that teams or individuals meet specific weight targets to participate. The drive to compete can encourage athletes to lose weight, whether or not they have excessive body fat.

The major motivation for wrestlers to lose weight is the hope of achieving greater success by competing in a lower weight class. This perception may be based on the

myth that wrestling at a lower weight for the same height improves leverage and provides an advantage over one's opponent. Because it is difficult to demonstrate how an athlete would have performed at different weights, no convincing data are available to show whether performance is better or worse at lower weight classes. Wrestling at a lower weight class may also be motivated by the desire to avoid competing against a wrestler in the athlete's more natural weight class who is significantly better or to help the team fill an empty weight class slot. Last, many in the wrestling community have developed a mentality of commitment, sacrifice, and self-discipline that traditionally sees weight loss as a critical component of the "no pain, no gain" philosophy.

### **When is losing weight harmful?**

Obviously, not all weight loss is harmful. Anyone, including an athlete, can benefit from losing body fat in certain circumstances. Excessive fat does not enhance an athlete's performance, even in football where coaches often seek out heavy players. It can hamper heat acclimatization, speed, endurance, and work efficiency. Weight loss can be beneficial if it involves losing excessive body fat without reducing lean muscle mass or causing significant dehydration. Healthy weight loss requires eating a balanced diet that supplies adequate calories to support growth and daily activity and drinking enough fluid to maintain an appropriate state of hydration.

Losing weight too rapidly, losing an excessive amount of weight, and frequent "cycling" of weight (rapid, repeated loss and gain), on the other hand, can undermine health and well-being. Such unhealthy patterns generally occur only if water is lost—which can lead to dehydration—or "fat-free" tissue (such as muscle) is lost because of inadequate caloric intake. Neither type of weight loss benefits athletic performance and, when carried to extremes, can impair growth, strength, and endurance.

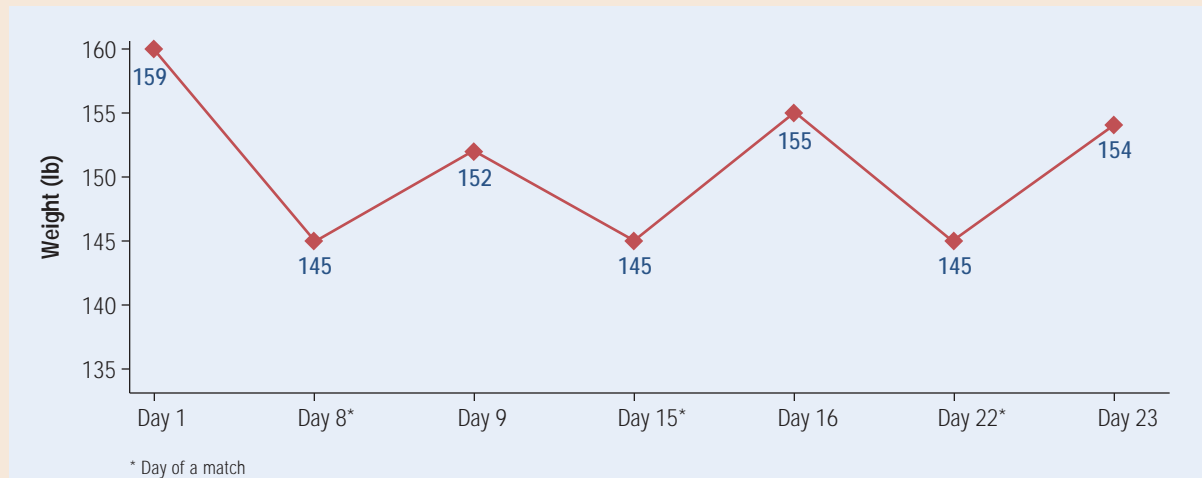
In female athletes, the triad of osteoporosis, amenorrhea, and eating disorders, along with delayed physical maturation, have been linked to excessive weight loss and sports participation at weights below minimum natural weight.

Weight loss in prepubertal children is an even greater concern if not undertaken cautiously. Excessive restriction of caloric intake and inadequate nutrition during growth can have an adverse effect on adult height and health.

Two kinds of weight-loss practices in wrestlers are cause for concern. One is loss of weight to a level below what is considered healthy and appropriate (less than 7% to 9% body fat for boys and 12% to 15% body fat for girls; weight loss at a rate faster than 1.5% of body weight or 2 lb per week is also considered unhealthy). The other is repeated cycling of weight throughout the wrestling season. Cycling involves losing weight rapidly to "make weight" at a weigh-in for a

FIGURE 1

### The ups and downs of weight cycling among wrestlers



“Cycles” of weight gain and loss during the wrestling season average 5 to 10 lb a week in many wrestlers, who lose weight rapidly to “make weight” for a match, then gain back the lost pounds within a day afterward. Data on the graph have been compiled from multiple studies.

match, then eating and drinking after the match to compensate for nutrition and fluid losses. Many wrestlers repeat this process for every match. Research has consistently reported an average of 5 to 10 pounds of weight loss and gain every week in such athletes.

The graph above summarizes the findings of a number of studies of average weekly weight loss among wrestlers.<sup>12</sup>

As many as 80% to 93% of wrestlers use one or more of the measures to lose weight that are outlined in Table 2.<sup>2,5,6,8,10,13,14</sup> Many of these practices also occur to some degree in other weight-sensitive sports.

#### Dehydration and other dangers

The major method of rapid weight loss for athletes attempting to make a target

weight is loss of body water by a combination of fluid restriction and excessive fluid loss. This method usually results in varying degrees of dehydration accompanied by the familiar physiologic changes: hypovolemia leading to decreased

renal blood flow, decreased glomerular filtration rate, electrolyte imbalance, and acidosis, which alters cellular function throughout the body.

In addition to the familiar physiologic problems associated with dehydration, athletes demonstrate two other worrisome abnormalities resulting from excessive weight loss and repeated cycling of weight: abnormal thermoregulatory capabilities and decreased cardiac output. Thermoregulatory abnormalities markedly increase the threat of heat injury and severe dehydration to poorly hydrated athletes who are performing strenuous workouts because they interfere with sweating and cooling of the body. The danger is actually greater during a long practice workout, which often occurs in a

TABLE 2

#### Weight loss methods used by wrestlers

Method	Percent of wrestlers using
Running, jogging	73%
Exercise using a device (bicycle, jump rope, etc.)	59%
Rubber suit, nylon top	34%
Sauna	14%
Vomiting	8%
Spitting (to get rid of the weight of the saliva)	5%
“Fat burner” devices (belts, etc.)	2%
Diuretics	2%

TABLE 3

### Reported harm to wrestlers from excessive weight loss

#### Academic performance

Lethargy, sleepiness, mood swings

Lower grades during wrestling season (compared to out of season)

Diminished short-term memory and cognition

#### Athletic performance

Lower testosterone level

Lower endurance

Decreased strength on ergometric testing

#### Altered body function

Decreased growth

Increased susceptibility to infection

Decreased serum protein level

Lowered glycogen stores

Decreased cardiac output and glomerular filtration rate

Poor temperature control with increased risk of heat injury

#### Disordered eating

Binge eating (6% of wrestlers meet criteria)<sup>1</sup>

Eating disorders (11% meet profile for eating disorders on eating attitudes test [EAT])<sup>2</sup>

#### REFERENCES

1. Oppliger RA, Landry GL, Foster SA, et al: Bulemic behaviors among interscholastic wrestlers: A statewide survey. *Pediatrics* 1993;91:826
2. Garner DM, Olmsted MP, Bohr Y, et al: The eating attitudes test: Psychometric features and clinical correlates. *Psychol Med* 1982;12(4):871

warm wrestling room, than in a match, which lasts six minutes or less.<sup>15</sup>

Another significant threat is decreased cardiac output, which can produce strain on the heart even with minimal exertion. Cardiac output drops when reduced blood volume from dehydration leads to

increased heart rate and decreased stroke volume. A high percentage of unhealthy weight loss occurs in smaller athletes and the lowest weight classes of wrestlers.<sup>6</sup> Weight loss in the average range of 5 to 10 lb per week could represent a 5% to 10% level of dehydration in many of these athletes. Low cardiac output and thermoregulatory abnormalities also pose a greater threat to younger and smaller athletes, who have greater body surface area for every kilogram of weight.

Although many reports about health issues related to severe weight loss in athletes are anecdotal, recent data increasingly document the adverse effects of excessive and frequent weight loss, especially among wrestlers (Table 3). Similar problems have been reported in nonathletes who experience frequent swings in body weight.<sup>16</sup>


An increase in academic difficulties has been noted among young athletes whose food and fluid consumption is inadequate. Unlike most athletes, who tend to earn better grades during sports participation, wrestlers are likely to experience poor focus and concentration, mood swings, and

lethargy, resulting in lower grades during wrestling season. Some of these symptoms appear to be caused by hypoglycemia from prolonged fasting as well as dehydration.

A lowered testosterone level, decreased growth, and an increased incidence of disordered eating and eating disorders all have been reported to result from the weight-loss practices of wrestlers and other youngsters. Horswell and colleagues have shown that a 3% to 6% level of dehydration decreases strength and endurance on ergometric muscle measurement.<sup>7,9,17</sup> Thus, besides being harmful to health, severe weight loss is detrimental to performance.

#### Effective weight management

Most effective and safe weight management programs, whether for wrestlers and other athletes in weight-sensitive sports or individuals attempting to lose weight for personal reasons, aim to minimize unhealthy weight loss. Such programs generally include a comprehensive nutrition and fitness component that attempts to educate athletes, parents, and coaches about the dietary requirements needed to support growth, activities of daily living, and the increased nutritional requirements of sports. Another important com-

The patient guide on the next pages about healthy weight loss can be photocopied and distributed to families in your practice without permission of the publisher. 



## GUIDE FOR PATIENTS

### Steps to healthy weight loss

**T**here are no short cuts to losing weight effectively and safely. Weight gain and loss are directly related to the balance between the calories you take in and the calories you burn through daily activity and specific exercise, such as sports.

A government-sponsored task force recently reviewed the multimillion-dollar industry of fad diets that guarantee quick weight loss using everything from vibrators to pills. The task force concluded that although some of the diets may contribute to weight loss, none maintains weight loss (keeps weight off once you lose it). Eating less fat (meat, cheese, and whole milk, for example) and more complex carbohydrates (bread, cereal, pasta), along with regular aerobic activity, appears to offer the best hope for losing weight and keeping it off.

Losing excess body fat should be your only goal in losing weight. Losing water or fat-free tissue, such as muscle, is not desirable or healthy and does not improve performance or appearance.

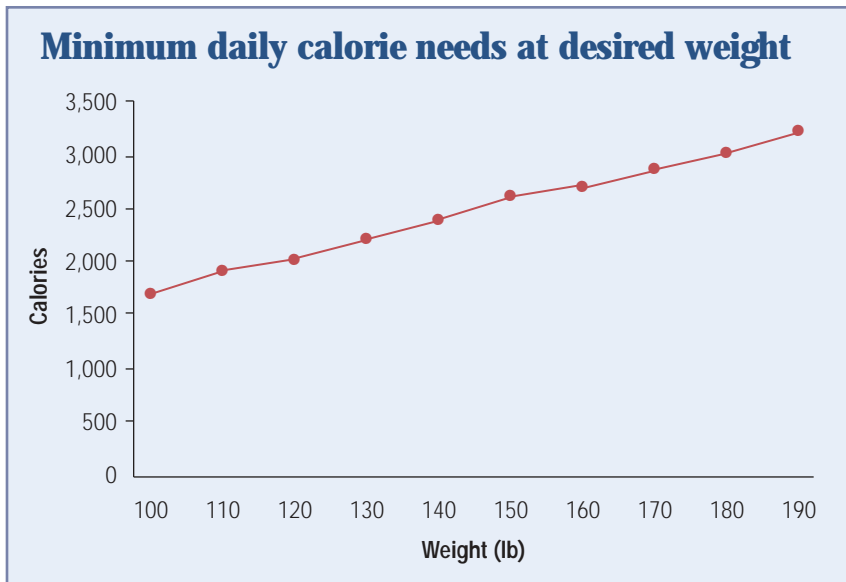
#### Eat right

Most adolescents need 1,700 to 3,000 calories a day just to meet physiologic needs and support growth and normal daily activities. The minimum number of calories varies somewhat based on size, as shown on the graph at right.

An average 30-minute period of aerobic exercise, such as jogging, burns about 350 calories; an intense two-hour sports practice can burn more than 1,000 calories. The table on the next page shows about how many calories various activities consume. The number

of calories burned can vary to some degree depending on your weight and how long and intensely you exercise. The minimum calorie requirements suggested here support only usual daily activities. You must consume additional calories if you participate in aerobic activities such as athletics, dancing, or strenuous work.

Teenagers need to eat a balanced diet that consists of carbohydrates (55%), fat (20% to 25%), and protein (15% to 20%). Teens who are healthy and eating a good diet do not need nutritional supplements. Eating a high-



carbohydrate meal four to six hours before a sports competition can improve performance and well-being.

Don't forget to drink enough water, which is the most important nutrient, making up 60% of the body. During exercise, you should drink  $\frac{1}{2}$  cup to 1 cup of water every 15 to 30 minutes depending on the heat index and the intensity of the exercise.

## Calories burned by various activities

Activity	Calories burned in 60 min*
Aerobic dancing	470
Backpacking (carrying a 40-lb pack)	670
Badminton	440
Basketball	630
Bicycling (10 mph)	450
Circuit weight training	420
Cross-country skiing	650
Racquetball	800
Rope jumping	775
Running (7 mph)	880
Swimming (slow crawl)	600
Volleyball	228
Walking	
3.5 mph	350
4 mph (with 5-lb hand-held weights)	590
4 mph (with 5-lb ankle weights)	540
Chores	
Digging ditches	660
Mowing (push or power mower)	510
Sawing with a hand saw	550
Weeding	330

\*Values vary based on intensity of activity and weight. Values shown here are for a 167-lb person.

Avoid “semistarvation” diets—those in which the number of calories you consume during a 24-hour period is more than 500 to 1,000 below the number of calories you burn. Deficits greater than 500 to 1,000 calories usually result in very limited additional loss of fat and promote loss of water and some fat-free tissue (muscle). Most people on such diets tend to regain weight quickly.

Severely reducing the number of calories you take in causes your body to lose large amounts of water, electrolytes (substances such as sodium and potassium), and minerals. In addition, the body looks for sources of energy other than fat and finds it in muscle and glycogen (carbohydrate stored mostly in the liver), which it then uses to

produce energy. This undermines strength and endurance.

### Get enough exercise

Adequate exercise, along with moderately reducing the number of calories you consume, promotes the most efficient loss of fat while preserving fat-free tissue. The minimum amount of aerobic activity necessary to benefit from this efficient fat loss is 30 minutes three times a week of an exercise that burns about 350 calories in one workout.

Studies suggest that you must burn 3,500 calories to lose one pound of fat. You can therefore lose 1 or 2 lbs of fat a week by burning 500 to 1,000 more calories a day than you take in. (Remember: Burning more than 500 to 1,000 calories beyond what you take in leads to loss of fat-free tissue and is undesirable.)

### Maintain your “natural weight”

You should strive to maintain a “natural weight.” Natural weight is your weight when you are eating a healthy, balanced diet with enough calories to sustain growth and usual daily activities and getting 30 minutes of aerobic exercise at least three times a week. Your doctor can help you determine your natural weight and body fat composition (what percentage of your weight consists of fat).

For most boys (with some variation), the normal range of body fat composition is 7% to 20%. A body fat composition of 10% to 15% is considered excellent. For most girls (again, with variation), the acceptable body fat range is 12% to 25%. A range of 15% to 20% is ideal. Abnormally high body fat composition can lead to health problems such as high blood pressure, a high cholesterol level, heart disease, diabetes, and gall bladder disease.

Too little body fat, like too much, can be bad for your health. Body fat below 7% for boys can interfere with growth, strength, and endurance. Body fat below 12% for girls can be associated with problems such as missed menstrual periods, weak bones, and eating disorders.

TABLE 4

**Measuring body fat**

Method	Comment
Underwater weighing	Expensive, limited access; gold standard
Skin-fold calipers (Lange/Harpender)	Closest to underwater weighing in accuracy; validated; reasonable cost
Dual energy X-ray absorptiometry (DEXA)	Expensive and not validated for youth
Bioimpedance (Tanita)	Expensive and not validated for youth; easy to use
Near-infrared photospectrometry (Futrex)	Expensive and not validated for youth; calculates many other body nutritional parameters
Computerized calipers (Skydex)	Contain the wrong formula for adolescents
Air displacement weighing (BOD-POD)	Not validated for youth
CT scans	Expensive method of measuring fat

ponent of proper weight management is determining body fat and calculating the *minimum* recommended participation weight, which is based on 7% body fat for most boys and 12% body fat for most girls. A third component involves educating the athlete about the *maximum* weight loss each week that can be achieved in a healthy manner.<sup>18</sup> (See the patient guide, “Steps to healthy weight loss,” pages 65 and 66.)

Discouraging wrestlers from bouncing from low weights for match weigh-ins to higher weights between matches has been the most difficult aspect of weight management. The 1996 American College of Sports Medicine (ACSM) position statement on weight loss in wrestlers and a subsequent resolution by the ACSM wrestling task force emphasize the importance of addressing this issue and outline desirable features of

weight management programs.<sup>19,20</sup> The task force also encourages an increase in the number of wrestling weight classes and/or participation by multiple wrestlers in the more popular weight classes as a means of addressing this issue nationwide.

**How can pediatricians help?**

One role of pediatricians and other primary care physicians is to monitor the health and nutrition of all our patients, especially during health maintenance or preparticipation sports physical examinations. That makes it important to be familiar with body fat measurements, minimum weight calculations, height-weight proportions, and normal growth curves.

Body fat measurements can be helpful in primary care practice for monitoring health and nutrition in patients with a significant change

in weight, history of poor eating habits, or concerns about weight. They can add credence and objectivity to discussions with youngsters and their parents about healthy weight management practices.

Many methods of determining body fat are available; underwater weighing is considered the gold standard. Table 4 lists a number of other techniques used to determine body density, percent body fat, and other body composition measurements (body density is part of the formula used to calculate percent body fat). The only method that has been validated for high-school-age youngsters, and the one that most closely reproduces the results of the expensive and fairly inaccessible method of underwater weighing, is measurement of skin-fold thickness with fat calipers.<sup>21</sup> For information on how to use this method and how to calculate minimum weight, see “How to measure body fat,” pages 72 and 73. With a little experience and the aid of precalculated charts kept on hand in your examining room, you can measure body fat using the skin-fold method in less than a minute.

In Virginia, body-fat measurements are now part of the standard preparticipation physical examination form, which has introduced the idea of fitness to athletes, parents, and physicians.<sup>22,23</sup> While I have been more reluctant to determine body fat routinely on female athletes than male athletes because of the potential for precipitating weight concerns and disordered eating, it can be a helpful and positive part of the physical evaluation



## How to measure body fat

**B**ody fat measurement is the best tool for establishing suitable weight targets. This is the case because fat is the most desirable body component to decrease to achieve weight loss. Studies have shown that, with a little practice, skin-fold measurement can be a very accurate technique for determining body fat and calculating a healthy weight goal. Good quality skin calipers, such as the Lange calipers, are inexpensive, durable, and easy to use. Once you are familiar with the methodology and have created a chart or computer program to calculate body fat from skin-fold measurement, the entire procedure can be done in one or two minutes.

Following are instructions for marking the three most commonly used sites for skin-fold measurement, some general rules for measuring skin folds, and formulas for calculating body density, body fat, and minimum weight at 7% and 12% body fat. The modified Lohman equation is the most accurate formula for high school boys. A modified Slaughter-Lohman-Boileau equation is used for girls.

### Marking skin folds

#### TRICEPS (boys and girls)

- Have the patient stand with the right arm flexed to 90° at the elbow and relaxed.



- Determine the midpoint between the acromial process of the shoulder and the olecranon of the elbow and make a horizontal mark there.
- Make a vertical mark to intersect this line over the triceps muscle in the midline of the posterior arm.
- For the actual caliper measurement, have the patient stand with the arm straightened and relaxed.

#### SUBSCAPULAR (boys and girls)

- Locate the inferior angle, lowest point of the scapula. If this is not palpable with the arms at the side, ask the patient to put the arm behind the back.

- Mark a diagonal line below the scapula that is an extension of the natural hollowing of the skin. This should be on an axis from the left shoulder to the right hip, which is approximately a 45° angle from the vertical. Draw a mark perpendicular to that line 1 cm below the inferior angle.



- When raising the skin fold for measurement have the patient stand with his arm hanging relaxed at his side.

#### ABDOMINAL (boys only)

- Have the patient stand relaxed on both feet and relax the abdominal muscles.
- Mark a vertical line 3 cm to the right of the midpoint of the umbilicus.



- Draw a horizontal line to intersect the vertical line 1 cm below the midpoint of the umbilicus.

### General rules for measuring skin folds

- Have the patient stand with weight evenly distributed on both feet and the arms relaxed and hanging down at his sides in the normal standing position. For the abdominal measurement, have the patient relax the abdominal muscles.
- For consistency, always take the measurement on the right side of the body.

- Make sure the skin is dry to facilitate accurate measurement.
- Do not take a measurement immediately after a workout or when the patient is overheated because elevated body temperature causes fluid shifts to the skin, resulting in a falsely elevated reading.
- Palpate the site to familiarize yourself and the youngster with what is to happen.
- “Pinch” the skin and subcutaneous tissue only (not muscle) between the finger and thumb firmly (but not firmly enough to cause pain) about 1 cm above the intersecting lines you have drawn as described above. The pinch should be parallel to the natural cleavage lines of the skin (the natural cleavage lines of the skin of the triceps, for example, would be vertical rather than horizontal across the arm).
- Apply the calipers at the intersecting marks perpendicular to the long axis of the skin folds and midway between the body skin surface and the bulbous crest of the skin fold.
- Allow the calipers to equilibrate for two to four seconds before taking the readings.
- When taking readings, be careful to look directly at the calipers to avoid parallax, resulting in an inaccurate reading.
- Record measurements on data sheets to the nearest 0.5 mm.
- Rotate measurements from one site to the next (triceps to subscapular to abdominal in boys) and then take a second round of measurements.

- If the first two measurements are not within 0.5 mm of each other, take a third measurement and average the two that are within 0.5 mm. If no two are within that range, average the three recorded measurements for that site.

### Calculating body fat

The formulas for calculating body density, body fat, and minimum weight at 7% body fat (boys) or 12% body fat (girls) are listed below. (Body density must be determined first because it is part of the formula for calculating body fat.) USA Wrestling is planning to post interactive spreadsheets on its Web site ([www.usawrestling.org](http://www.usawrestling.org)) that allow you to insert weights and skin-fold measurements to calculate all the desired information. To obtain your own Excel spreadsheet, contact Jon Almquist at [JLAAct@aol.com](mailto:JLAAct@aol.com).

For counseling about healthy weight gain and loss in general pediatric practice, using the patient’s measured weight in the equations below provides acceptable accuracy. To determine minimum weight for wrestling, where athletes often “push the envelope,” the NCAA and NFHS recommend documenting a urine specific gravity of 1.020 or less before weighing the athlete to ensure that he is adequately hydrated. Otherwise, the weight shown on the scale will represent a dehydrated weight that is lower than the athlete’s actual weight and allow a lower minimum weight determination than is considered appropriate and safe.

#### BOYS ONLY

##### Lohman equation for calculating body density (BD)

$$\text{Sum SF}^* = \text{Triceps SF} + \text{subscapular SF} + \text{abdominal SF}$$

$$\text{BD} = [1.0973 - (\text{sum SF} \times .000815)] + [(\text{sum SF})^2 \times .00000084]$$

##### Brozek equation for calculating % body fat (BF)

$$\% \text{ BF} = (4.57/\text{BD} - 4.142) \times 100$$

##### Calculating minimum weight at 7% BF

$$\text{Weight at 7\% BF} = \frac{[1 - (\% \text{ BF}/100)] \times \text{current weight}}{0.93}$$

\* SF = Skin-fold measurement

#### GIRLS ONLY

##### Slaughter-Lohman-Boileau equation for calculating % body fat (BF)

$$\text{Sum SF} = \text{Triceps SF} + \text{subscapular SF} =$$

$$\% \text{ BF} = [(\text{sum SF}) \times 1.33] - [(\text{sum SF})^2 \times .013] - 2.50 =$$

$$\% \text{ BF}$$

##### Calculating minimum weight at 12% BF

$$\text{Weight at 12\% BF} = \frac{[1 - (\% \text{ BF}/100)] \times \text{current weight}}{0.88}$$



if handled in a sensitive manner and presented in the proper context (for example, as part of weight management counseling for girls who express concerns about weight or girls with menstrual irregularities that appear to be caused by inappropriately low weight).

New growth curves are now available from the Centers for Disease Control and Prevention ([www.cdc.gov/growthcharts](http://www.cdc.gov/growthcharts)) or Ross Products Division of Abbott Laboratories (Columbus, OH 43215-1724). The new charts reflect present growth standards for youngsters in this country and include 3rd and 97th percentile lines. They also include directions for calculating body mass index, which makes them very useful for accurately determining whether a youngster is overweight or underweight. [Editor's note: For more on this topic, see "Understanding growth patterns in short stature" in the June issue, also accessible at [www.contpeds.com](http://www.contpeds.com).]

When monitoring weight and nutrition in young athletes, the pediatrician must know what sports the patient plays, understand the role of weight in sports, and be familiar with some of the myths and traditions regarding weight gain or loss in various sports. One of the biggest weight management problems occurs when, for example, a high school football coach sees a youngster as a 185-lb linebacker and only a few days after football season ends, the wrestling coach sees that same athlete as a 152-lb state wrestling champion.

Physicians must do a better job of educating parents and patients about

the risks and benefits of various weight loss methods practiced by young athletes and about how to achieve a safe rate and amount of weight loss. Regrettably, many surveys have shown that wrestlers and other athletes hardly ever consult physicians on these subjects. We need to take a more active role in discussing nutrition and fitness at check-ups and, especially, at the preparticipation sports physical examination.

### Toward sensible weight control

In our society, a significant number of adolescents attempt to lose weight for a variety of reasons. Many of these youths, whether they participate in sports or not,

use potentially harmful methods to achieve an excessive amount or rate of weight loss. In general, weight loss in adolescents and, especially, prepubertal youngsters is not advisable unless excessive body fat is documented.

Pediatricians have an important role to play in educating parents and youngsters about nutrition, body fat, and the role of exercise and diet in healthy weight loss and gain. Those who are familiar with quick, accurate methods of determining body fat and know how to prescribe a healthy weight management program for patients can provide valuable guidance at health maintenance check-ups and preparticipation physical evaluations. □

### REFERENCES

1. Kreipe RE: Eating disorders among children and adolescents. *Pediatr Rev* 1995;16:370
2. Krowchuk DP, Kreiter SR, Woods CR, et al: Problem dieting behaviors among young adolescents. *Arch Pediatr Adolesc Med* 1998;152:884
3. Perriello VA: Virginia High School League Training Workshop on Wrestling Weight Management for Master Testers, Fall 1999 (available from Vito A. Perriello, Jr., MD, c/o Larry Johnson, Virginia High School League 1642 State Farm Boulevard, Charlottesville, VA 22901)
4. Ashley CD, Smith JF, Robinson JB, et al: Disordered eating in female collegiate athletes and collegiate females in an advanced program of study. *Int J Sport Nutr* 1996;6:391
5. Steen SN, Brownell KD: Patterns of weight loss and regain in wrestlers: Has the tradition changed? *Med Sci Sports Exerc* 1990;22:762
6. Perriello VA, Almquist J, Conkwright D, et al: Health and weight control management among wrestlers. *Virginia Medical Quarterly* 1995;122:179
7. Cantu RC, Meller FO: Fatalities and catastrophic injuries in high school and college sports 1982-1995. *Physician and Sports Medicine* 1999;27:35
8. Anderson BJ: Effectiveness of valacyclovir in preventing reactivation of herpes gladiatorum in wrestling. *Clin J Sport Med* 1999;9:86
9. Medical Advisory Committee to National Federation of High School Associations: Physician release for wrestlers to participate with skin lesions. Indianapolis, NFHS (PO Box 690, Indianapolis, IN 46206), 1999
10. Three college wrestling deaths. *MMWR* 1998;47:105/*JAMA* 1998;279:824
11. Clark RR, Oppliger RA: Minimal weight standards in high school wrestling, the Wisconsin model. *Orthopedic Physical Therapy Clinics of North America* 1998;7:23
12. Perriello VA: *How Wrestlers can Achieve Victory and Enjoyment While Maintaining a Healthy Diet*. Virginia High School League Publication, October 1994
13. Oppliger RA, Harns RD, Herrmann DE, et al: Grappling with weight cutting. *Physician and Sports Medicine* 1995; 23:69
14. Parr RB: Exercise for overweight kids. *Physician and Sports Medicine* 1998;26:109
15. Montain S, Coyle E: Influence of the timing of fluid ingestion on temperature regulation during exercise. *J Appl Physiol* 1993;75:688
16. National Task Force on Prevention and Treatment of Obesity: Weight cycling. *JAMA* 1994;272:1196
17. Roemmich J, Sinning W: Weight loss and wrestling training: Effects on nutrition, growth, maturation, body composition, and strength. *J Appl Physiol* 1997;82:1751
18. Oppliger RA, Landry GL, Foster SW, et al: Wisconsin minimum weight program reduces weight-cutting practices of high school wrestlers. *Clin J Sport Med* 1999;9:929
19. Oppliger RA, Case S, Horswill CA, et al: American College of Sports Medicine position stand: Weight loss in wrestlers. *Med Sci Sports Exerc* 1990;22:110
20. Case HS, Horswill CA, Landry G, et al: Weight Loss in Wrestlers. *Current Comment from the American College of Sports Medicine*. January 1998
21. Kuta JM, Clark RR, Webber LM, et al: Inter- and intra-tester reliability of skin fold measurements in high school wrestlers. *Med Sci Sports Exerc* 1990;22:110
22. Perriello VA: Virginia's athletic exam form: Results and revisions. *Virginia Medical Quarterly* 1992 (summer); 119:159
23. Perriello VA, Almquist J, Pitrezzi M, et al: New medical standards for Virginia's high school athletes. *Virginia Medical Monthly* 1989;116:359