

# Overweight and Obesity among Youth Participants in American Football

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**Objective** To estimate the prevalence of overweight and obesity among participants in youth American football 9 to 14 years of age.

**Study design** Cross-sectional, 653 boys, 8.7 to 14.6 years. Height and weight were measured; body mass index (BMI) was calculated. Overweight and obesity were defined by international (International Obesity Task Force [IOTF]) and United States (Centers for Disease Control [CDC]) criteria. Prevalence and 95% confidence interval were calculated. Player age, height, and weight and midparent height were used to predict mature height; current height was expressed as a percentage of predicted mature height as an estimate of maturity status.

**Results** Overall 45.0% (41.2% to 48.9%) and 42.6% (38.8% to 46.5%) of players were overweight or obese by CDC and IOTF criteria, respectively. Prevalence was highest in early maturing boys. Based on position-activity at time of injury ( $n = 180$ ), overweight and obesity were more common among offensive and defensive linemen.

**Conclusion** Overweight and obesity were more prevalent in youth football players than in national samples of American boys. Allowing for limitations of the BMI and the relative stability of the BMI from adolescence into adulthood, a relatively large number of football participants may be at risk for later overweight or obesity, and the risk appears to be greater for offensive and defensive line positions. (*J Pediatr* 2007;151:378-82)

American football is a sport in which large body size is considered advantageous. It is no surprise therefore that football players tend to be taller and heavier and possess greater mass-for-height than non-players. The size advantage is evident at youth and scholastic levels.<sup>1-5</sup> The relatively large size of youth players may, in turn, have implications for overweight and obesity, and perhaps for the future health of the individual. Childhood and adolescent overweight and obesity persist into adulthood in many individuals.<sup>6-10</sup> Given the emphasis on body size and mass in football, the sport may place some youth at risk for later overweight or obesity. The purpose of this study was 2-fold: (1) to estimate the prevalence of overweight and obesity among participants in community-based youth American football programs, and (2) to evaluate the relationship between biologic maturity status and overweight and obesity.

## METHODS

Members of teams from 2 communities in the Mid-Michigan PONY (Protect Our Nation's Youth) Football League in 2000 and 2001 participated in the study. The project was approved by the University Committee for Research Involving Human Subjects at Michigan State University and by league officials in each community. Informed consent of parents and self-assent of players were obtained. The total sample was 653 boys (>96% of participants), 8.7 to 14.6 years of age. One girl (11.1 years, 6th grade) participated in 2001; she was excluded from analysis. Six players (<1%) were non-white.

Measurement protocol for height and weight and growth status of the players have been reported.<sup>5</sup> The body mass index (BMI,  $\text{kg}/\text{m}^2$ ) and decimal age were calculated. Players were classified as overweight or obese using the age-specific Centers for Disease Control (CDC) reference for American boys (BMI  $\geq 85$ th <95th percentiles and BMI  $\geq 95$ th percentiles, respectively),<sup>11</sup> and recommended cutoff values of the International Obesity Task Force ([IOTF]).<sup>12</sup>

Self-reported heights of biologic parents and player age, height, and weight were used to predict mature (adult) height. Current height was expressed as a percentage of

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BMI	Body mass index	IOTF	International Obesity Task Force
CDC	Centers for Disease Control		

**Table I. Descriptive statistics for age, BMI and BMI percentile of youth football players by age group**

Age, yrs			BMI, kg/m <sup>2</sup>					BMI Percentile				
M	SD	N	M	SD	Md	SE <sub>md</sub>	Range	M	SD	Md	SE <sub>md</sub>	Range
9.2	0.2	58	18.8	3.3	17.8	0.5	14.0-27.9	72.2	22.1	76.6	3.2	5.1-99.1
10.0	0.3	106	20.2	3.8	19.2	0.5	14.8-33.8	76.2	22.6	83.7	2.8	24.4-99.5
11.0	0.3	153	21.0	4.4	19.5	0.5	14.7-37.5	74.3	23.7	80.0	2.4	8.1-99.6
12.0	0.3	156	22.0	4.6	20.7	0.5	16.3-40.1	76.9	20.9	83.8	2.1	18.9-99.7
12.9	0.3	138	22.5	4.2	21.5	0.5	15.6-34.8	76.5	22.4	83.3	2.4	8.2-99.4
13.8	0.2	42	23.5	5.1	21.8	0.9	16.9-36.1	76.9	20.9	79.6	4.0	15.3-99.3
Total		653	21.4	4.4	20.3	0.2	14.0-40.1	75.7	22.3	82.7	1.1	5.1-99.7

predicted mature height to provide an estimate of biological maturity status. Percentages were expressed as z-scores to classify players into maturity groups by chronological age as follows: z-score between -1.0 and +1.0 = average or "on time"; z-score below -1.0 = late or delayed; z-score greater than +1.0 = early or advanced.<sup>13</sup>

The BMI did not differ between seasons and communities<sup>5</sup>; data were thus pooled. The BMI of each player was converted to a percentile score using the NutStat program of Epi Info™ (version 3.3.2, February 2005; [www.cdc.gov/epiinfo](http://www.cdc.gov/epiinfo)). Descriptive statistics for the BMI and BMI percentiles, and the prevalence of overweight and obesity and 95% confidence interval (CI) were calculated. Age differences were examined with analysis of variance. Concordance of classification as normal weight, overweight, and obese with CDC and IOTF criteria was evaluated with the Kappa statistic. Estimates of overweight and obesity were also calculated for players classified by maturity status in 2-year age groups, 9-10, 11-12, and 13-14 years.

It was not logistically practical to categorize players by position; most played several positions during a game and the season. Position or activity of 180 injured players at the time of injury was available: offensive line, defensive line, linebackers, defensive backs and ball carriers (running backs, quarterbacks, receivers). Players injured in drills before and during the season, on special teams (kick-offs, extra points) and in undetermined contexts were grouped separately. Descriptive statistics for the BMI and prevalence of overweight and obesity in each subgroup of injured players was calculated. Weight restrictions, in full football attire, were in effect for ball carriers: ≤120 lbs (54.4 kg), ≤130 lbs (59.0 kg), and ≤140 lbs (63.5 kg), in the 4th-5th, 6th and 7th grades, respectively. Players exceeding the weight limit were required to play from tackle to tackle on the offensive line. Weight limits did not apply for any defensive positions. Eighth grade teams had no weight restrictions.

Analysis of covariance, with age as the covariate, was used to compare BMI percentile scores among maturity groups and BMIs of injured and noninjured players. A  $\chi^2$  test was used to evaluate distributions of overweight and obesity by maturity group and between injured and non-injured players. Data were analyzed with SPSS version 14.0 (SPSS, Inc., Chicago, IL).

## RESULTS

Descriptive statistics for age, BMI, and BMI percentiles by age group and for the total sample are shown in Table I. The maximum BMI is more than twice as large as the minimum BMI in all age groups except 9 years. Mean BMI increases with age ( $P < .001$ ), but mean BMI percentiles do not differ among age groups (ns).

The prevalence of overweight and obesity and 95% CI are shown in Table II. The 95% CI overlap across all age groups with each criterion, indicating no significant age effect in prevalence. Overall, 19.9% (17.0%-23.2%) are overweight and 25.1% (21.9%-28.7%) are obese with CDC and 24.7% (21.4%-28.2%) are overweight and 17.9% (15.1%-21.1%) are obese with IOTF criteria. The combined prevalence of overweight and obesity is similar with the 2 criteria, CDC 45.0% (41.2%-48.9%) and IOTF 42.6% (38.8%-46.5%). Concordance of classification of normal weight, overweight, and obese with CDC and IOTF criteria is 90.4% with a Kappa coefficient of  $0.84 \pm 0.02$  ( $P < .001$ ).

The overall prevalence of overweight and obesity in the 180 injured players is 42.2% (35.0%-49.8%) and 40.6% (33.4%-48.1%) with CDC and IOTF criteria, respectively, which do not differ significantly from estimates for the total sample (above). On the basis of position-activity at time of injury, offensive linemen ( $n = 32$ ) have the highest BMI (age-adjusted mean  $\pm$  SE,  $26.1 \pm 0.7$  kg/m<sup>2</sup>) and prevalence of overweight and obesity (78%, CDC criteria). Estimates for other injured players by position are: defensive linemen ( $n = 28$ ,  $22.7 \pm 0.8$  kg/m<sup>2</sup>, 50%), linebackers ( $n = 8$ ,  $20.6 \pm 1.5$  kg/m<sup>2</sup>, 50%), defensive backs ( $n = 14$ ,  $19.2 \pm 1.1$  kg/m<sup>2</sup>, 14%), primary ball carriers ( $n = 50$ ,  $19.5 \pm 0.6$  kg/m<sup>2</sup>, 20%); for other: special teams/undetermined ( $n = 20$ ,  $22.0 \pm 0.9$  kg/m<sup>2</sup>, 50%) and drills ( $n = 28$ ,  $20.9$  kg/m<sup>2</sup>  $\pm$   $0.8$  kg/m<sup>2</sup>, 39%).

Partial correlations between the BMI and BMI percentiles and percentage of predicted mature height, controlling for age, in the total sample are 0.62 ( $P < .001$ ) and 0.50 ( $P < .001$ ), respectively. BMI percentile scores (age-adjusted mean  $\pm$  SE) are significantly higher in boys advanced in maturity status ( $n = 157$ ,  $90.3 \pm 1.6$ ) than boys average or on time ( $n = 402$ ,  $71.4 \pm 1.0$ ) and late ( $n = 22$ ,  $58.2 \pm 4.3$ ) in maturity status.

**Table II. Prevalence of overweight and obesity and 95% CI in youth football players by age group**

Age group	No.	Criterion	Overweight			Obese		
			n	%	95% CI	n	%	95% CI
9.0	58	CDC	6	10.3	4.3-21.8	11	19.0	10.3-31.8
		IOTF	7	12.1	5.4-23.9	9	15.5	7.8-27.9
10.0	106	CDC	20	18.9	12.2-27.9	30	28.3	20.2-38.0
		IOTF	26	24.5	16.9-34.0	20	18.9	12.2-27.9
11.0	153	CDC	29	19.0	13.3-26.3	42	27.5	20.7-35.3
		IOTF	39	25.5	18.9-33.3	28	18.3	12.7-25.5
12.0	156	CDC	37	23.7	17.4-31.3	38	24.4	18.0-32.0
		IOTF	41	26.3	19.7-34.0	29	18.6	13.0-25.8
13.0	138	CDC	30	21.7	15.4-29.7	33	23.9	17.2-32.1
		IOTF	39	28.3	21.1-36.7	24	17.4	11.7-25.0
14.0	42	CDC	8	19.0	9.1-34.6	10	23.8	12.6-39.8
		IOTF	9	21.4	10.8-37.2	7	16.7	7.5-32.0
Total	653	CDC	130	19.9	17.0-23.2	164	25.1	21.9-28.7
		IOTF	161	24.7	21.4-28.2	117	17.9	15.1-21.1

**Table III. Prevalence of overweight and obesity in players of contrasting maturity status**

Age	N	Criteria	Maturity categories												
			Late				Average				Early				
			OW		OB	OW		OB	OW		OB	OW		OB	
N	n	%	n	N	n	%	n	%	N	n	%	n	%		
9-10	144	CDC	7	—	—	108	21	19	10	9	29	1	3	28	97
		IOTF					24	22	3	3		6	21	23	79
11-12	268	CDC	13	1	8	180	37	21	27	15	75	20	27	45	60
		IOTF		1	8		44	24	13	7		27	36	37	49
13-14	169	CDC	2	—	—	114	29	25	14	12	53	7	13	24	45
		IOTF					33	29	9	8		10	19	20	38
Total	581	CDC	22	1	4	402	87	22	51	13	157	28	18	97	62
		IOTF		1	4		101	25	25	6		43	27	80	51

Trends are significant and similar in specific age groups, but are tempered by the small number of later maturing boys.

The prevalence of overweight and obesity among boys of contrasting maturity status is shown in Table III. The  $\chi^2$  tests for the total sample and specific age groups are significant ( $P < .001$ , except 11-12 years,  $P = .005$ ). Among 402 boys classified average or "on time" in maturity status, a greater percentage are overweight (CDC 21.7%, IOTF 25%) than obese (CDC 13%, IOTF 5%), although among 157 players classified as advanced in maturity status, a greater percentage are classified as obese (CDC 62%, IOTF 51%) than overweight (CDC 18%, IOTF 27%). Among the small number of players classified as late maturing ( $n = 22$ ), only 1 is overweight and none is obese.

## DISCUSSION

Obesity was almost twice as prevalent in football players 9 to 14 years (CDC 25.1%) than in American white boys from 1999 to 2002: 6 to 11 years, 14.0%, and 12 to 19 years, 14.6%.<sup>14</sup> Overweight plus obesity were also more prevalent (CDC 45.0%) than in American white boys: 6 to 11 years,

29.3%, and 12 to 19 years 29.2%.<sup>14</sup> Because <1% of players were non-white, generalization to youth football participants of other ethnic groups requires caution.

CDC and IOTF criteria gave similar estimates for overweight plus obesity, 45.0% and 42.6%, respectively. IOTF criteria identified proportionally more players as overweight, and CDC criteria identified proportionally more players as obese. CDC criteria are based on age- and sex-specific percentiles derived from representative samples of American youth in several national surveys.<sup>11</sup> IOTF criteria are based on nationally representative samples from six countries: Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the United States (excluding the 1988-1994 U.S. national survey). Adult criteria for overweight (25.0 kg/m<sup>2</sup>) and obesity (30.0 kg/m<sup>2</sup>) were mathematically retrofitted into childhood to establish cutoff values for overweight and obesity at half-year intervals from 2 to 18 years.<sup>12</sup>

The BMI has limitations as an indicator of overweight and obesity, especially with adolescent males in general and athletes in particular given the growth spurt in fat-free mass and the generally larger fat-free mass of adolescent ath-

**Table IV. Prevalence of overweight and obesity in male participants in several youth sports**

Sport	Location	n	Age, years	Criterion	Overweight	Obese
American football, this study	Mid-Michigan	653	8.7-14.6	CDC	19.9%	25.1%
				IOTF	24.7	14.9
Soccer*	Mid-Michigan	187	9.0-14.7	CDC	15.5	4.8
				IOTF	16.0	2.7
Soccer†	Portugal	127	11.1-15.2	CDC	8.3	—
				IOTF	9.1	—
Basketball‡	Portugal	101	11.9-14.5	CDC	13.9	10.9
				IOTF	13.9	9.9
General athletics§	Hungary	107	8.8-14.5	CDC	3.7	0.9
				IOTF	4.7	—
Sport schools, multiple sports	Poland	143	10.5-15.0	CDC	5.3	0.7
				IOTF	5.3	—

\*Calculated from data reported in Kontos<sup>31</sup> and Cumming.<sup>32</sup>

†Calculated from data reported in Malina et al.<sup>33,34</sup>

‡Calculated from data provided by Professor Manuel Coelho e Silva, University of Coimbra, Coimbra, Portugal (2003).

§Calculated from data provided by Professor Julia Pápai, Eötvös Lorand University, Budapest, Hungary (2004).

||Calculated from unpublished data provided by Zofia Ignasiak, University School of Physical Education, Wrocław, Poland (2003).

letes.<sup>15,16</sup> Because the BMI does not distinguish between lean and fat tissue, it is not possible to determine whether the participants were simply heavy or “over fat.” Variation in maturity status is an additional factor. Advanced maturity status is associated with obesity, specifically in youth with larger fat-free and muscle masses.<sup>17,18</sup> Youth football players tend to be taller and heavier than reference values and also tend to be advanced in maturation.<sup>5,13</sup> Of 154 players classified as advanced in maturity status, more than one half were obese (Table III). It is possible that elevated BMIs are related, in part, to larger fat-free and muscle masses. Boys 6 to 12 years classified obese by both the BMI and triceps skinfold were advanced in skeletal age and larger in estimated arm muscle circumference than boys classified obese by the triceps skinfold alone.<sup>19</sup>

Football drills and games involve intermittent rather than continuous activities so that physical activities associated with the sport, especially at the community level, are probably not sufficient in frequency, intensity and duration to significantly modify body mass and specifically adiposity. It is possible that some participants were involved in resistance training, which has the potential to increase fat-free mass in adolescent boys. However, experimental resistance exercise programs are associated with negligible effects on body composition in youth,<sup>20</sup> whereas moderately intensive aerobic programs of 30 to 60 minutes duration, 3 to 7 days/week, are associated with reductions in total body adiposity in obese youth.<sup>21</sup> Individual differences in body weight and composition associated with growth and maturation, and in responsiveness to training also need consideration.<sup>16</sup>

Comparative data on overweight/obesity in youth American football players are not extensive. In a sample of 58 players 10 to 14 years from 2 semi-rural communities in the 1970s, 9 were overweight (16%) with CDC and IOTF criteria and 5 (10%) and 2 were obese (3%) with CDC and IOTF criteria, respectively.<sup>3</sup> Although obesity appeared to be less

frequent than in this study (Table I), small numbers limit inference about secular change. The median BMI for the total sample of football players 9 to 14 years, 20.3 kg/m<sup>2</sup>, was lower than that for interscholastic middle school football players 10 to 15 years, 22 kg/m<sup>2</sup>,<sup>22</sup> but the range of BMIs overlapped, 14.0 to 40.1 kg/m<sup>2</sup> and 15 to 48 kg/m<sup>2</sup>, respectively.

Overweight and obesity in youth football players are compared with youth participants in other sports in the United States and Europe in Table IV. Although comparative data are limited, obesity is more prevalent in football players compared with participants in other sports. One of the samples of soccer players was from the same area as the football players. The prevalence of overweight in Portuguese youth basketball participants is similar to mid-Michigan soccer participants, but the prevalence of obesity was greater in the former. Overweight and obesity are especially less prevalent in European youth participants in soccer, general athletics and multiple sports. Comparisons of youth athletes in Table IV should be tempered with caution, given body habitus or physique variation associated with the sports for which data were available. Ethnicity is a potential source of variation, but all samples are of European ancestry.

The physique<sup>15</sup> and body composition<sup>23</sup> of American football participants at high school, collegiate and professional levels vary by position. Positions are not firmly established at the youth level and frequently change during a game and season. Position-activity of 180 injured players at time of injury indicated a higher prevalence of overweight and obesity among offensive linemen and defensive linemen and linebackers compared to primary ball carriers and defensive backs. This would suggest that the risk of overweight and obesity among youth players is potentially associated with position. These estimates are based on position-activity at time of injury and extrapolation to all players requires caution. These differences may be due in part to weight restriction for ball carrier positions. Nevertheless, body size and maturity status

were not related to injury in the total sample,<sup>24</sup> whereas large size is often indicated as a risk factor for injury in American football.<sup>25,26</sup>

Obesity is also a risk factor for injury associated with physical activity in the general population of youth,<sup>27,28</sup> and overweight and obesity are risk factors for heat-related complications in physical activity and sport: hyperthermia, heat exhaustion, heat stroke.<sup>29</sup> Overweight and obesity also track moderately well from 9 years into adulthood.<sup>6-10</sup> Among boys 9 to 14 years in the Fels Longitudinal Study, probability of overweight at 35 years for those with a BMI at the 85th and 95th percentiles (CDC), respectively, varied between 61% and 73% and between 81% and 91%.<sup>8</sup> Corresponding probability for obesity at 35 years for those with a BMI at the 85th and 95th percentiles, respectively, varied between 16% and 22% and between 28% and 46%.<sup>8</sup> Many participants in the present study are thus at risk for later overweight or obesity.

Given the apparent value placed on body mass in American football, the sport may place some boys at risk for overweight and/or obesity. The size of elite football players, specifically massiveness, is often highlighted in the sport media from high school to professional levels. Elevated BMIs in youth participating in American football, especially those in offensive and defensive line positions, thus merit further study and raise the following question: Does the psychosocial environment of American football for youth, including parents, coaches, and the sport system, reward massiveness (overweight, perhaps obesity, specifically for linemen) in a manner similar to that attributed to the psychosocial environment of gymnastics and figure skating that fosters limited weight gain in girls?<sup>30</sup>

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