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Prevalence and Correlates of Muscle-Enhancing Behaviors among Adolescents and Young Adults in the United States

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Abstract

Purpose: To determine the prevalence of muscle-enhancing behaviors in adolescents and young adults using a nationally representative sample in the USA and to examine differences by sex, race/ethnicity, age, socioeconomic status, body mass index, and participation in team sports.

Methods: Prospective cohort data from the National Longitudinal Study of Adolescent to Adult Health, Waves I through III (1994–2002) were analyzed. Engagement in muscle-enhancing behaviors including dietary changes, exercise and weightlifting, supplement use, performance-enhancing substances, and anabolic androgenic steroids were recorded. Multiple logistic regression models using generalized estimating equations, incorporating robust standard errors with clustering by school and within persons, and using national sample weighting, were used to determine associations with muscle-enhancing behaviors across three data collection waves.

Results: Of the 18,924 adolescents at baseline, 29.2% of males and 7.0% of females reported weight gain attempts, while 25.2% of males and 3.8% of females reported any muscle-enhancing behavior. All muscle-enhancing behaviors were more common in males compared to females

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(p<0.001). Among young men 18–26 years old, 15.6% reported using legal performance enhancing substances and 2.7% reported using androgenic anabolic steroids. Factors that were associated with muscle-enhancing behaviors in males across three data collection waves included Black or Hispanic/Latino race/ethnicity, age over 14 years, higher parental education, lower body mass index, and participation in team sports.

Conclusions: Muscle-enhancing behaviors ranging from dietary changes to supplement and androgenic anabolic steroid use are common among adolescent and young adult males. Clinicians should consider screening for muscle-enhancing behaviors in these populations.

Keywords

Males; muscle-enhancement; adolescent; young adults; body image; weight control

Introduction

Over the past several decades, the idealized male body image has grown increasingly muscular and large. Recent studies indicate that both adolescent and young adult males (1) and females (2,3) have demonstrated muscularity concerns, which is associated with potentially harmful and damaging disordered muscle-enhancing behaviors (4). Engagement in muscle-enhancing behaviors may be associated with the development of eating disorders, particularly in males (5). Previous research from Minnesota has suggested that 12% of adolescent males and 6% of adolescent females engage in three or more muscle-enhancing behaviors, including dietary changes, increasing exercise, using protein powders, and/or using steroids (6). Similarly, Calzo et al. (7) found that between 1% and 7% of males aged 13–26 years old reported muscularity concerns, with the highest rates among males aged 19–22 years old. While these data span young adulthood, the findings were not nationally representative.

Most notably, there is a paucity of research on the use of anabolic androgenic steroids (AAS) (8), which, globally, is most prevalent among adolescents under 19 years old (9). Overall, supplement and AAS use is high among adolescents seeking to gain weight or bulk up. Eisenberg, Wall, and Neumark-Sztainer (6) found that 35% of adolescents used protein powders and nearly 6% used AAS in order to increase their muscle size or tone. Among adolescent females, nearly two in three changed their eating habits, nearly 80% exercised more, 21% used protein powders, and 4.6% used steroids in order to increase their muscle size or tone (6). Given these relatively high prevalence rates of AAS use, and of particular concern for adolescent development, AAS use may have serious consequences, including substance use, risk taking behavior, aggression, suicidal behavior, teen dating violence, and medical complications of the cardiovascular, hepatic, renal, and endocrine systems (10–12). This provides more need for identifying nationally representative prevalence rates of muscle-enhancing behaviors among adolescents and young adults. While this data provides important context for muscle-enhancing behaviors among adolescents, the generalizability of the study is limited due to the sample being constrained to Minnesota.

Nationally representative data on weight-gain behaviors are limited to high school students, where 30% of adolescent boys and nearly 7% of adolescent girls reported trying to gain

weight (13). These results further support the findings that boys across the United States are at greater risk of muscle-enhancing techniques. However, this study did not provide longitudinal data outlining the changes of weight gain behaviors from adolescences into young adulthood. Understanding the changes of use over time will inform health care providers, as well as intervention and prevention efforts.

Several studies have shown that muscle-enhancing behaviors differ based on sociodemographic characteristics, body mass index, and participation in team sports. For example, Eisenberg, Wall, and Neumark-Sztainer (6) found that Asian boys and girls had increased odds of AAS use compared to White-identified young people. Nagata et al. (5) found that both Black/African American boys and girls have significantly greater odds of engaging in muscularity-enhancing behaviors. Another study conducted by Nagata et al. (13) found that Black or African American and multiracial boys had greater odds of weight gain attempts compared to White-identified boys (13). The differences in muscle-enhancing behaviors may be explained by sociocultural and minority stress theories (43).

Weight status has also been shown to be associated with muscle-enhancing behaviors. For boys, being overweight increases the odds of using protein supplements, AAS, and three or more muscle-enhancing behaviors (6). Similarly, being obese increases the odds of AAS use and three or more muscle-enhancing behaviors (6). Among girls, being overweight increases the odds of using protein supplements, while being obese increases the odds of exercising often, using protein supplements, and using three or more muscle-enhancing behaviors (6). Nagata et al. (13) found that underweight and normal weight boys and girls had greater prevalence of weight gain attempts compared to overweight or obese boys and girls. Conversely, boys and girls who perceived themselves to be overweight had less likelihood of engaging in weight gain attempts and muscle-enhancing behaviors, while boys and girls who perceived themselves to be underweight had greater odds of weight gain attempts and muscle-enhancing behaviors (5).

Sports team participation (6) and sports and exercise activities (5) continue are associated with higher odds of muscle-enhancing behaviors for both boys and girls. In general, socioeconomic status has little influence on muscle-enhancing behaviors (5,6). It also remains uncertain how age impacts engagement in muscle-enhancing behaviors. Previous research has shown that high school boys engage in more muscle-enhancing behaviors compared to middle school boys (6).

Given that weight gain behaviors and muscularity concerns can lead to a clinical eating disorder (14), as well as substance use and psychiatric comorbidities (1,7), which may negatively impact adolescent development, further study is needed to identify the prevalence, sociodemographic differences, and correlates of muscle-enhancing behaviors among a nationally representative sample of adolescent and young adults across time. In this study, the first aim is to longitudinally identify the prevalence of weight gain attempts and muscle-enhancing behaviors among US adolescent and young adults. The second aim is to examine weight gain attempts and muscle-enhancing behaviors differences by sex, race/ethnicity, age, socioeconomic status, body mass index, and participation in team sports. The hypothesis for aim two is that male sex, black/African American and Asian/Pacific Islander race/ethnicity,

team sports participation, and age in later adolescence are associated with weight gain attempts and muscle-enhancing behaviors.

Methods

Study design and sample

Data from the National Longitudinal Study of Adolescent to Adult Health (Add Health), a nationally representative cohort of youth in the US that has been followed from adolescence through adulthood, were used for this analysis (15). The baseline adolescent sample used systematic sampling methods and implicit stratification to ensure that the high schools (n=80) and middle schools (n=52) selected were representative of US schools with respect to region of country, urbanicity, size, type, and ethnicity. This particular study used the restricted-use samples with available sample weightings from Wave I (11–18 years, 1994–1995, N=18,924), Wave II (12–20 years, 1996, N=13,570), and Wave III (18–26 years, 2001–2002, N=14,322) (16). Further details about the Add Health study design, coordinated by the Carolina Population Center, can be found elsewhere (15,16). The University of North Carolina Institutional Review Board approved all Add Health study procedures. Written informed consent was obtained from the parent if the participant was under age 18 (with child assent), or from the participant if 18 or older. Data cannot be shared publicly because of legal restrictions from Add Health. Data are available from Add Health for researchers who meet the criteria for access to confidential data. Information on how to obtain the Add Health data files is available on the Add Health website (http://www.cpc.unc.edu/addhealth).

Measures

Baseline characteristics such as race/ethnicity, percent of federal poverty line, highest parental education, and team sports participation were collected during the in-home interview. Household income was based on parents' self-report of household income in the previous calendar year. Gaussian normal regression imputation models were used to impute income for the 1,638 parents who either refused to answer the income question or stated they did not know based on race/ethnicity, region, hours of self-reported work per week by mother and father, and parental marital status, similar to the method used in previous studies (17,18). The household income variable was then transformed into a continuous measure that was a ratio of household income relative to the federal poverty level. Parental education was based on parent self-report of the highest educational attainment of either parent, dichotomized to 1) high school (including completion of an equivalency test) or less and 2) some college or more as has been categorized previously (19,20). Participation in team sports was based on the answer to the question at baseline: "Are you participating/do you plan to participate in the following teams (check all that apply): baseball/softball, basketball, cheerleading/dance team, field hockey, football, ice hockey, soccer, swimming, tennis, track, volleyball, wrestling, other sport." Adolescents were designated as participating in team sports if they selected 1 or more sport as has been coded in previous studies.(21) Time-varying covariates included age and body mass index (BMI). Measured (Waves II and III) or self-reported (Wave I) weight (pounds) and height (inches) were converted to kilograms and meters to calculate BMI using the standard formula weight (kilograms) divided by height (meters) squared (BMI = weight/height^2).

Weight gain attempts:

Participants were asked at all three Waves, “What are you currently doing about your weight?” Response choices included: “trying to lose weight,” “trying to gain weight or bulk up,” “trying to stay the same weight,” or “not trying to do anything about your weight.” “Trying to gain weight or bulk up” was coded as a weight gain or muscle-enhancing attempt.

Muscle-enhancing behaviors:

Participants who reported weight gain attempts were then asked at all three Waves, “During the past seven days, which of the following things did you do in order to gain weight or build muscle?” Response choices included: dieting (only Waves I and II), ate different foods than usual (only Wave III), ate more (only Wave III), took food supplements, exercised, and lifted weights. These questions were adapted from validated eating behavior measures used in the Adolescent Health Survey and similar to those used in Project Eating Among Teens (22,23). In addition, at Wave III only, participants were asked if they had used in the past year “anabolic steroids or other illegal performance enhancing substances for athletes” or “legal performance enhancing substances for athletes (such as creatine monohydrate or andro).” Response choices included yes or no. Those who had affirmative responses to any of the above behaviors were coded as engaging in muscle-enhancing behaviors.

Statistical analysis

Descriptive comparisons between males and females were calculated using Pearson’s chi-square tests for categorical variables and independent samples *t*-tests for continuous variables. Generalized estimating equations (GEE) (24) logistic models were used in combination with regression standardization (25) to estimate adjusted prevalence estimates by sex and age group. GEE logistic models were also used to assess associations with weight gain attempts and muscle-enhancing behaviors. All models used Add Health’s pre-constructed sample weights to provide nationally representative estimates (16,26); incorporated robust standard errors with clustering by school, which also captures clustering within persons across waves (27); and adjusted for age, race/ethnicity, BMI, percentage of the federal poverty line at baseline, highest parental education at baseline, participation in team sports at baseline (28–30) and wave. Age effects were nonlinear, as shown by the addition of a quadratic term ($p<0.001$ in males); to address this, age was categorized (11–13, 14–16, 17–19, 20–22, and >23 years). Analyses were stratified by sex given the different rates of weight gain attempts (13) and muscularity-oriented disordered eating behaviors (6) in males and females. Data analysis was performed using STATA 16.0.

Results

Baseline adolescent demographic, behavioral, mental health, and weight characteristics of the sample (N=18,924) are reported in Table 1. Mean baseline age was 16 and the sample was racially and ethnically diverse. Overall, 43% of adolescent boys and 38% of adolescent girls participated in team sports.

Table 2 summarizes the prevalence of weight gain attempts and muscle-enhancing behaviors at each wave by sex. Significantly more boys than girls reported weight gain attempts and

every muscle-enhancing behavior at each of the three waves ($p<0.001$). In adolescence, the prevalence of weight gain attempts was 29% among boys versus 7% among girls. Similarly, the prevalence of any muscle-enhancing behavior was 25% among boys versus 4% among girls. Changes in the adjusted prevalence of weight gain attempts and muscle-enhancing behaviors by age group from adolescence to young adulthood are illustrated in Figures 1-5. The prevalence of weight gain attempts, any muscle-enhancing behavior, weightlifting, exercise for muscle-enhancement, and supplement use peaked at ages 20–22 years for males (Figures 1-4). The prevalence of legal performance enhancing substances for athletes declined slightly after age 17–19 years for males whereas AAS use remained relatively stable from 17–23 years (Figure 5).

Table 3 shows socio-demographic associations with muscle-enhancing behaviors across the three data collection waves using generalized estimating equations. Among males, Black/African American and Hispanic/Latino race/ethnicity, higher parental education, lower BMI, ages older than 14 years (versus 11–13 years), and participation in team sports were associated with engaging in any muscle-enhancing behavior. Among females, Black/African American, Hispanic/Latino, and Asian/Pacific Islander race/ethnicity, lower baseline percent of federal poverty line, and lower BMI were associated with engaging in any muscle-enhancing behavior. The team sports specifically associated with engaging in muscle-enhancing behaviors in males included basketball (OR 1.52, 95% CI 1.35–1.71), track (OR 1.45, 95% CI 1.26–1.68), ice hockey (OR 1.35, 95% CI 1.02–1.78), football (OR 1.83, 95% CI 1.59–2.09), and baseball (OR 1.50, 95% CI 1.33–1.70).

Discussion

This study identified important longitudinal prevalence rates of weight gain and muscle-enhancing behaviors among adolescents and young adults. Overall, and not surprisingly, the prevalence of all weight gain attempts and muscle-enhancing behaviors was higher in males than in females across all age groups. These results indicate that weight gain attempts and muscle-enhancing behaviors are prevalent throughout adolescence and young adulthood and highlight the need for more research in this area.

Weight gain attempts among adolescents and young adults have largely been understudied. In this study, nearly a third of males were trying to gain weight or bulk up, which aligns with previous research among adolescents (13). This study adds to the prior literature by including young adults and using longitudinal data to show that weight gain attempts peak at ages 20–22 years. This age range overlaps with the 19–22 year age range when young men have been shown to have the highest rates of muscularity concerns (7), though other studies have indicated that muscle-enhancing techniques (31,32), including AAS use (33), was more common among younger boys. This discrepancy may be explained by survey methods (i.e. in-person interview versus confidential survey). Both methods have strengths and limitations to gathering accurate, unbiased results.

Over 30% of males engaged in any muscle-enhancing behavior from adolescence to young adulthood, and these behaviors peaked around ages 20–22. Weightlifting and exercising to gain weight or bulk up were among the most common muscle-enhancing behaviors across

adolescences and young adulthood. These results align with and expand on Eisenberg, Wall, and Neumark-Sztainer's (6) study by providing a nationally representative and longitudinal perspective. AAS use remains a significant concern due to the many adverse effects (8,10–12). In this study, 2.7% of 18–26-year-old males used AAS. This result was smaller than that of other studies investigating middle and high school age adolescent males (6,34). This lower rate may be due to more effective decision making processes in young adulthood compared to adolescence (35). Along with AAS use, over 15% of young men aged 18–26 years used legal performance enhancing substances and 6% used food supplements to bulk up, which is less than the 35% of adolescent males who used supplements in Eisenberg, Wall, and Neumark-Sztainer's (6) study. This variance may be due to differences in timeframe presented in items in the respective measures used across studies (i.e. point prevalence versus lifetime prevalence). Legal performance enhancing substances are mostly unregulated (36,37) and have significant adverse health effects that can impact a young person's health and well-being, including significant medical events such as death, disability, hospitalization, and emergency room visits (38). Further, legal performance enhancing drugs may influence the use of illicit appearance and performance enhancing drugs, including AAS use, among young adults (39).

Across all measures, adolescent males had higher rates of muscle-enhancing behaviors compared to females. However, among females, overall attempts to gain weight or bulk up decreased over time, as did exercising and taking food supplements to gain weight or bulk up. Dieting and lifting weights to gain weight remained relatively stable across time. These results may be indicative of adolescent and young adult females striving for a thin body ideal (40) and males striving for a big and muscular body ideal (4).

Our results indicate that individuals who do not identify as White may be at greater risk of attempting to gain weight and using any form of weight gain behaviors. For example, compared to Whites, Black/African-American and Hispanic/Latino males and females had greater odds of both attempting to gain weight and using any form of muscle-enhancing behaviors. Similarly, compared to Whites, females in this sample who identify as Asian/Pacific Islander had greater odds of attempting to gain weight. Our research confirms previous findings that Black males may be more likely to use weight gain behaviors compared to White males (41). Other studies have indicated that Hispanic ethnicity and Asian race may be risk factors for muscle-enhancing behaviors, but these samples were not nationally representative (6,41). Among females, research has shown the adolescent and adult females across racial/ethnic groups experience disordered eating behaviors (42), while weight gain research is limited. However, Eisenberg, Wall, and Neumark-Sztainer (6) found that, compared to Whites, Asian adolescent females had greater odds of engaging in three or more behaviors in an attempt to increase muscle size or tone. Similarly, compared to Whites, Hispanic adolescent females had greater odds of using protein supplements to increase muscle size or tone (6). The differences between racial/ethnic groups may be explained by the combination of two theories: sociocultural theory and minority stress theory. Sociocultural theory posits that individuals may engage in extreme behaviors in order to adhere to the unrealistic muscular ideals emphasized by societal norms (43). Similarly, minority stress theory posits that individuals from minority racial/ethnic groups experience stress due to their minority status in relation to the majority group (43). It may be that

individuals who identify their race/ethnicity as non-White are striving for unrealistic body ideals, which increases body dissatisfaction. This body dissatisfaction may be exacerbated by any stress experienced from their minority status, leading to extreme muscle-enhancing behaviors. Striving for and achieving the body ideals may also allow the individual to feel accepted into the majority group due to acquiring this ideal.

Participation in team sports in adolescence was associated with weight gain attempts and muscle-enhancing behaviors in males across all three waves. This may partially explain why weight gain attempts and several muscle-enhancing behaviors may peak around age 18 in males, as this coincides with the pinnacle of participation in high school team sports. Research by Eisenberg, Wall, and Neumark-Sztainer also found that males who participated in a team sport had greater odds of using a variety of muscle-enhancing behaviors (i.e. changing eating, exercising, using protein supplements, and other muscle-enhancing substances) (6). Participation in football in particular was associated with weight gain attempts. It may be that adolescent males who participate in sports such as football, where average body size has significantly increased over time (44), value muscularity and strength, thus leading to muscle-enhancing behaviors. Further research has indicated that adolescent females who participated in weight-related sports (i.e. ballet, gymnastics) had greater odds of disordered eating behaviors (i.e. purging, diet pill or laxative use for weight loss) (45). It is possible that certain team sports among females may value leanness and thinness over muscularity.

Limitations of this study include the use of self-reported data, a method that may be subject to reporting bias. The AAS question was combined with other illegal performance enhancing substances. Furthermore, the stigma associated with AAS use and the fact that AAS use for muscle-enhancing purposes is illegal in the US may contribute to underreporting (8). The supplement use to gain weight or build muscle question did not distinguish specific types of supplements. Lastly, several of the questions were not asked at all three Waves. This limits the ability to track prevalence over time, particularly for AAS. Strengths include the use of nationally representative longitudinal data with three waves of data collection encompassing adolescence through young adulthood, as well as using interview survey methods, which may improve validity of responses. Although the data were collected in 1994–2002, more recent nationally representative studies of adolescents have reported a similar prevalence of weight gain attempts (30% from the 2015 Youth Risk Behavior Survey compared to 29% from 1994–1996 Add Health baseline) (13). Given similar nationally representative prevalence rates, data may still be generalizable to current adolescents and young adults in the USA.

Conclusions

The results from this nationally representative study provide important information on the prevalence of weight gain attempts and behaviors among adolescent and young adult males and females over time. While much of the eating disorders literature focuses on weight loss attempts and behaviors, the results from this study indicate that throughout adolescence and young adulthood, weight gain attempts and behaviors are prevalent. This was particularly true for males in this study, as the prevalence of weight gain attempts and the use of specific

behaviors remained relatively high and peaked around ages 20–22 in males. Of particular concern is the 16% rate of young adult males using legal performance enhancing substances and the 3% prevalence of AAS use in young men. Clinicians caring for adolescents and young adults should screen for muscle-enhancing behaviors.

Given the lack of regulations related to dietary supplements and the potential harms for adolescents (8), the results from this study provides further evidence for public policies that aim to ban the sale of diet and muscle-enhancing supplements to individuals under the age of 18 years old, such as H.1942 An Act Protecting Children From Harmful Diet Pills and Muscle-Building Supplements currently in the Massachusetts State Legislature. Future research should examine long-term health outcomes of adolescent and young adult muscle-enhancing behaviors. Future research should also aim to replicate these findings using more recent data, as well as examine additional populations (i.e. sexual and gender minorities) at risk for muscle-enhancing behaviors.

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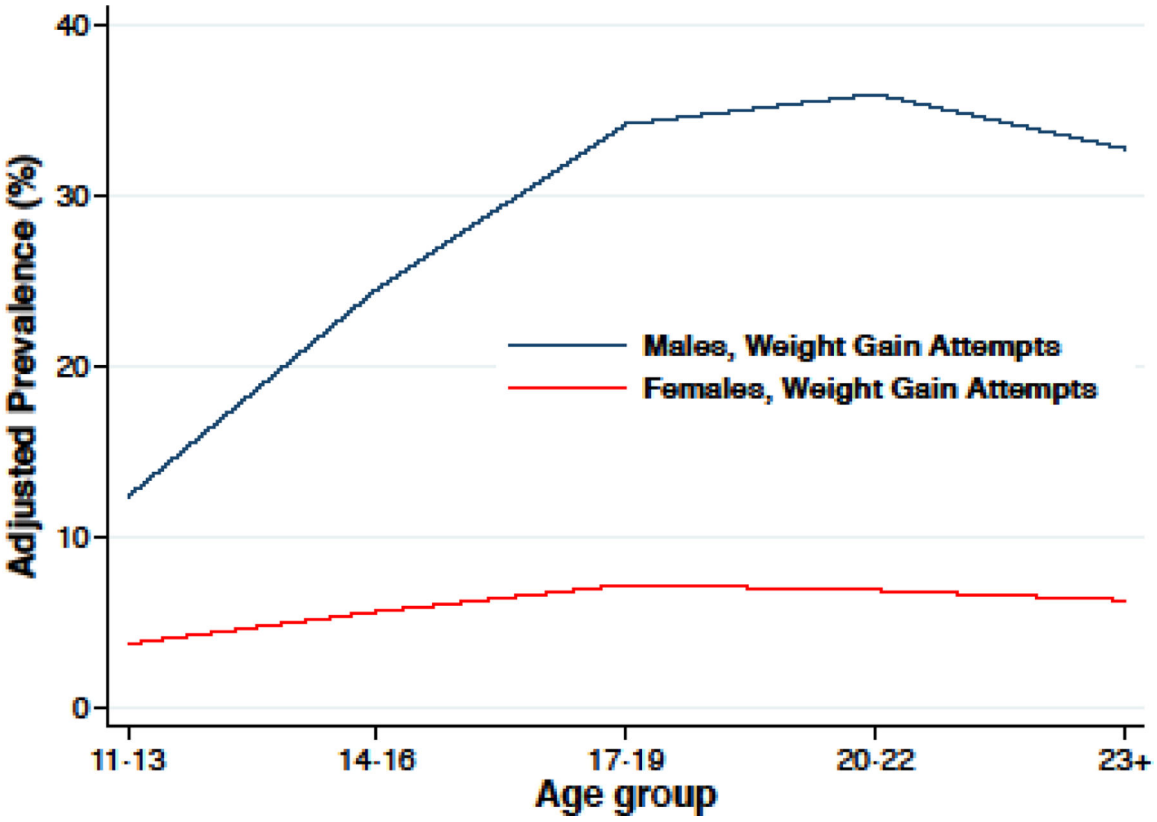

Figure 1.

Adjusted prevalence of weight gain attempts by sex and age group

Generalized estimating equations (GEE) logistic models were used in combination with regression standardization to estimate adjusted prevalence estimates by sex and age group. All models used Add Health's pre-constructed sample weights to provide nationally representative estimates and incorporated robust standard errors with clustering by school, which also captures clustering within students across waves

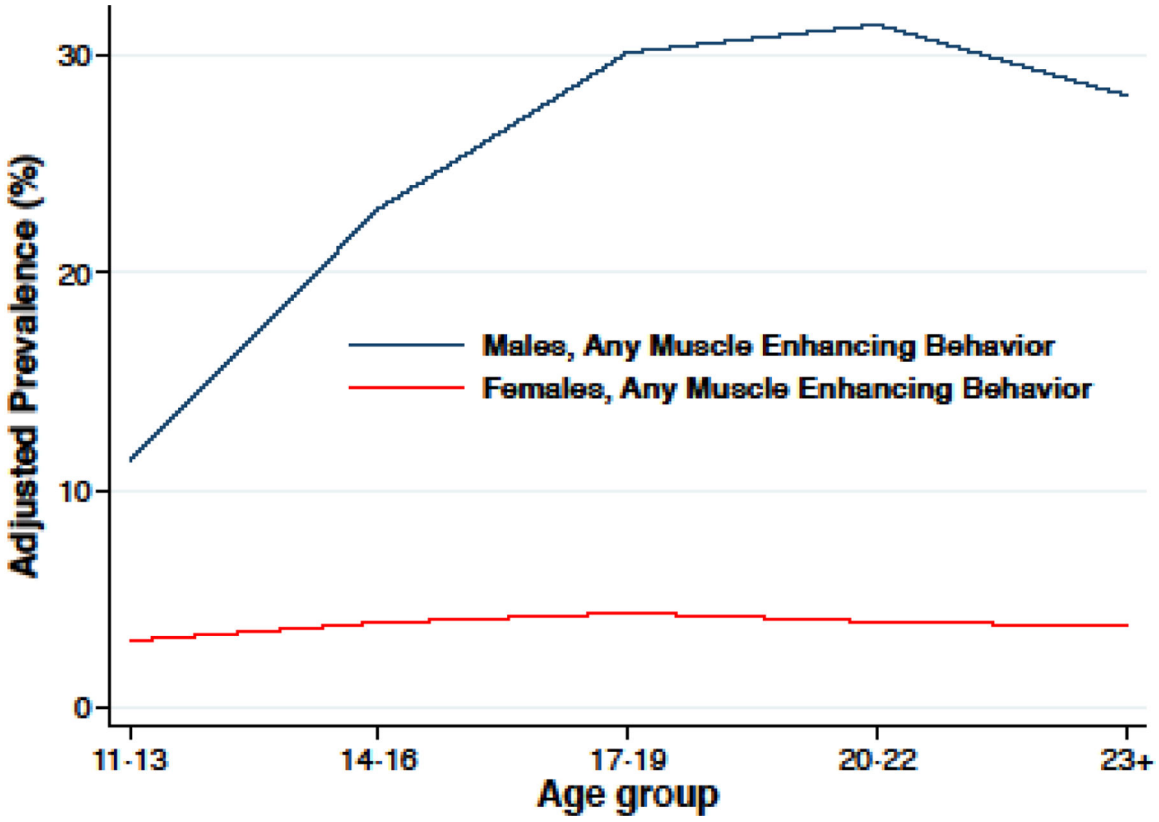

Figure 2.

Adjusted prevalence of any muscle-enhancing behaviors by sex and age group

Generalized estimating equations (GEE) logistic models were used in combination with regression standardization to estimate adjusted prevalence estimates by sex and age group. All models used Add Health's pre-constructed sample weights to provide nationally representative estimates and incorporated robust standard errors with clustering by school, which also captures clustering within students across waves

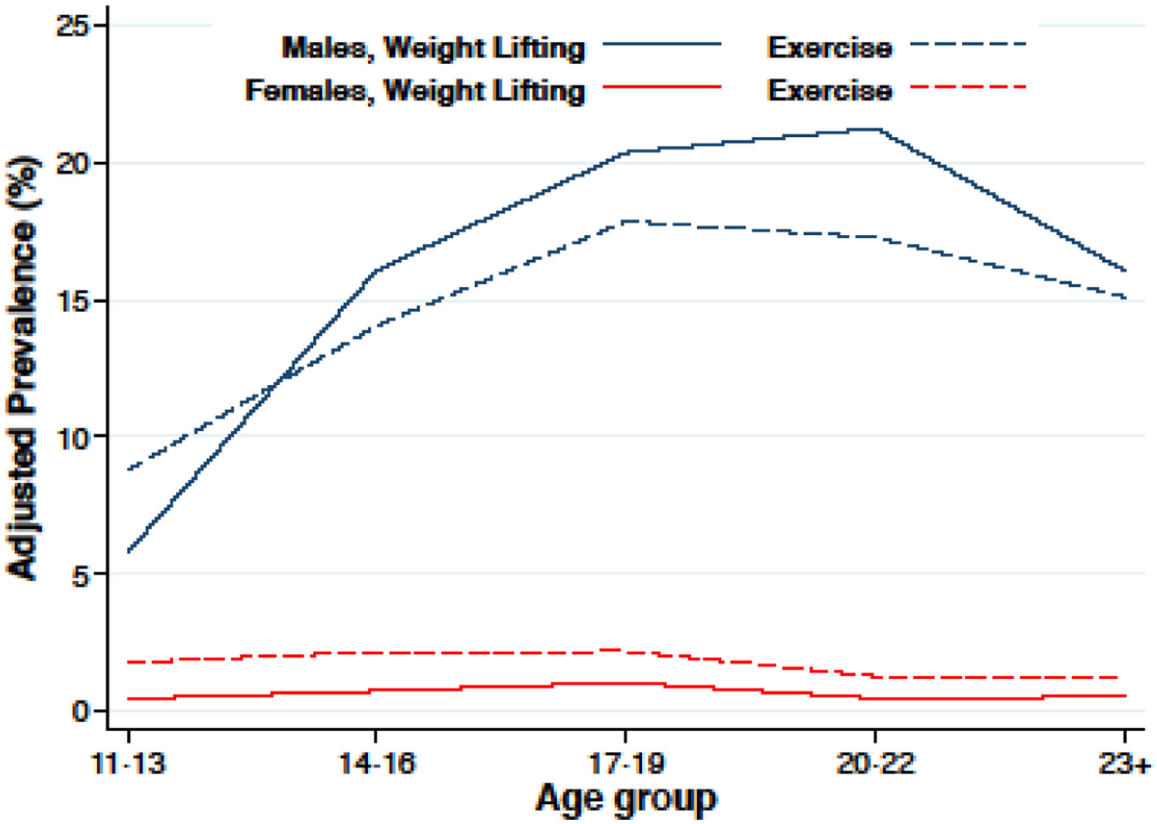

Figure 3.

Adjusted prevalence of weight lifting and exercise by sex and age group

Generalized estimating equations (GEE) logistic models were used in combination with regression standardization to estimate adjusted prevalence estimates by sex and age group. All models used Add Health's pre-constructed sample weights to provide nationally representative estimates and incorporated robust standard errors with clustering by school, which also captures clustering within students across waves

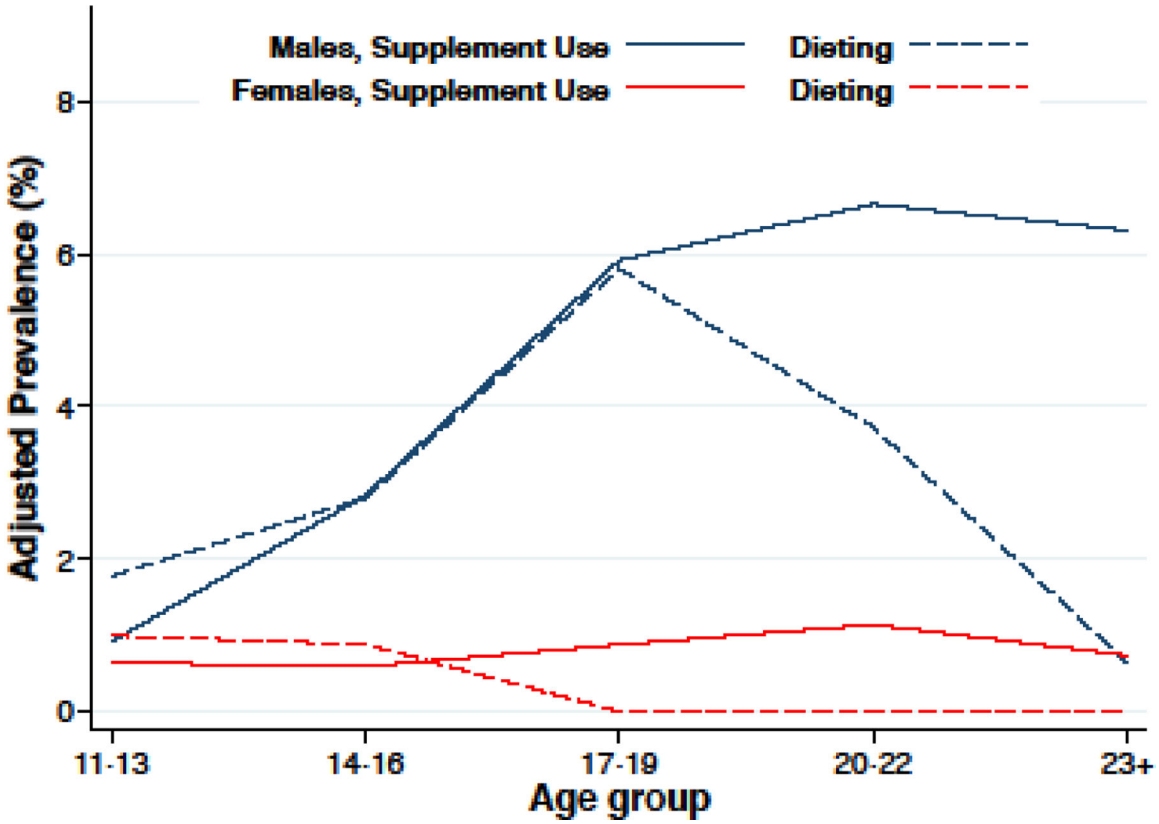

Figure 4.

Adjusted prevalence of supplement use and dieting to gain weight by sex and age group Generalized estimating equations (GEE) logistic models were used in combination with regression standardization to estimate adjusted prevalence estimates by sex and age group. All models used Add Health's pre-constructed sample weights to provide nationally representative estimates and incorporated robust standard errors with clustering by school, which also captures clustering within students across waves

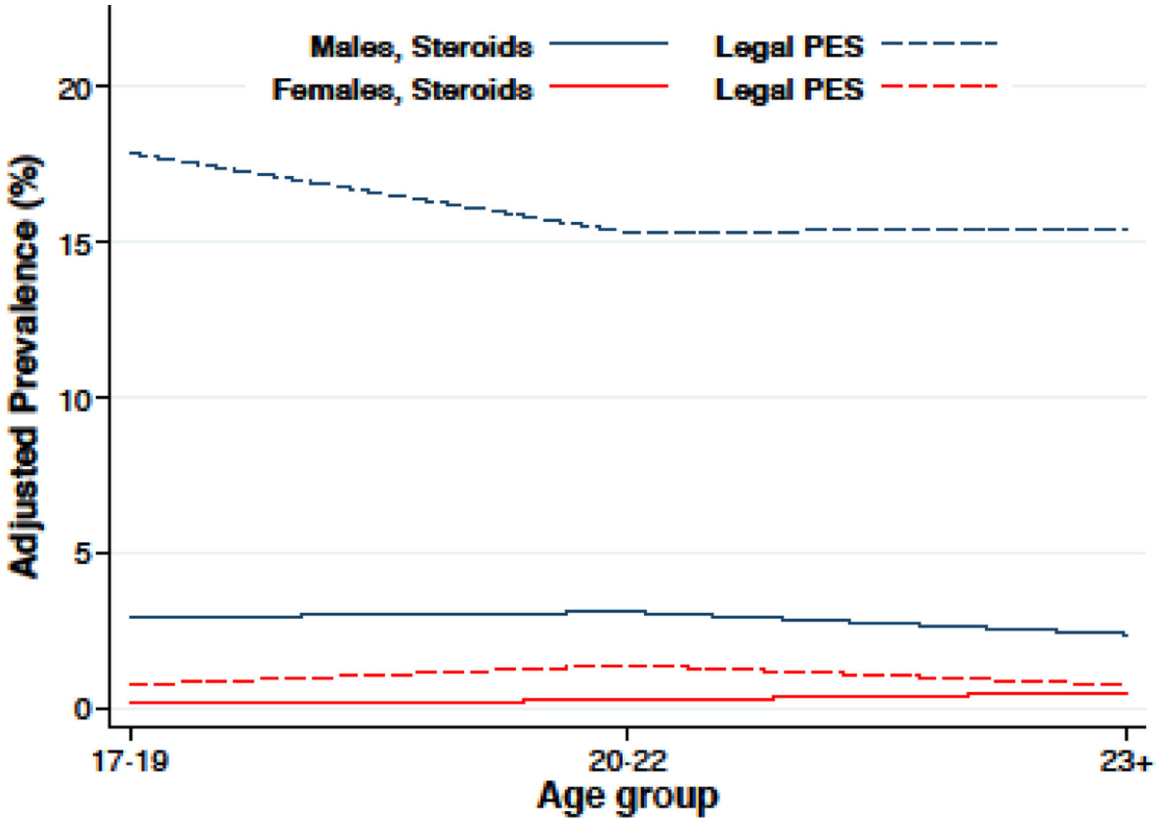

Figure 5.

Adjusted prevalence of anabolic-androgenic steroids and legal performance-enhancing substances for athletes by sex and age group

Generalized estimating equations (GEE) logistic models were used in combination with regression standardization to estimate adjusted prevalence estimates by sex and age group. All models used Add Health's pre-constructed sample weights to provide nationally representative estimates and incorporated robust standard errors with clustering by school, which also captures clustering within students across waves

Table 1.

Descriptive characteristics of baseline sample from the National Longitudinal Study of Adolescent to Adult Health

	Males (n=9,288)	Females (n=9,634)
Baseline (Wave I, ages 11–18)	**Mean ± SE / % ± SE (n)[a]**	**Mean ± SE / % ± SE (n)[a]**
Age	15.98 ± 0.12	15.79 ± 0.12
Race/ethnicity		
White	66.4 ± 2.9% (4,735)	67.0 ± 2.9% (4,909)
Black/African American	14.4 ± 2.0% (1,933)	15.9 ± 2.1% (2,174)
Hispanic/Latino	11.7 ± 1.7% (1,612)	10.8 ± 1.6% (1,618)
Asian/Pacific Islander	4.3 ± 1.0% (729)	3.7 ± 0.9% (657)
American Indian/Native American	2.2 ± 0.4% (177)	1.8 ± 0.2% (163)
Other race/ethnicity	1.0 ± 0.2% (97)	0.7 ± 0.1% (102)
Percentage of federal poverty line	146.6 ± 3.7%	147.8 ± 3.7%
Highest parental education		
High school or less	33.9 ± 1.6% (3,049)	34.5 ± 1.5% (3,258)
Some college or more	66.1 ± 1.6% (6,239)	65.5 ± 1.5% (6,376)
Body mass index	22.66 ± 0.12	22.23 ± 0.12
Participation in team sports	42.9 ± 2.0% (4,268)	38.4 ± 2.0% (3,926)

[a]All means and percentages are calculated with weighted data to reflect the representative proportion in the target U.S. population

Table 2.

Prevalence of weight gain goals and muscle-enhancing behaviors among male and female participants

	Wave 1 (11–18 years)	Wave 2 (12–20 years)	Wave 3 (18–26 years)		
	% ± SE (n)[a]	% ± SE (n)[a]	% ± SE (n)[a]	OR[b]	p[b]
Males					
Trying to gain weight or bulk up	29.2 ± 1.0% (2,920)	27.7 ± 1.1% (2,048)	26.5 ± 0.9% (1,843)	0.83	<0.001
Any muscle-enhancing behavior	25.2 ± 0.9% (2,546)	23.9 ± 1.0% (1,784)	26.3 ± 0.9% (1,832)	0.91	0.021
Dieted to gain weight or bulk up	3.8 ± 0.3% (370)	3.1 ± 0.4% (217)	--		
Exercised to gain weight or bulk up	15.4 ± 0.7% (1,523)	13.9 ± 0.7% (1,043)	15.5 ± 0.7% (1,076)	0.95	0.274
Lifted weights to gain weight or bulk up	17.5 ± 0.8% (1,768)	17.7 ± 0.8% (1,318)	15.7 ± 0.7% (1,099)	0.90	0.070
Took food supplements to gain weight or bulk up	3.3 ± 0.4% (350)	4.1 ± 0.4% (296)	6.3 ± 0.4% (427)	1.05	0.538
Ate different foods than usual to gain weight or bulk up	--	--	7.1 ± 0.4% (500)		
Ate more to gain weight or bulk up	--	--	13.4 ± 0.7% (916)		
Used legal performance enhancing substance for athletes[c]	--	--	15.6 ± 0.7% (1,019)		
Used androgenic anabolic steroids	--	--	2.7 ± 0.3% (153)		
Females					
Trying to gain weight or bulk up	7.0 ± 0.4% (756)	6.7 ± 0.6 (519)%	4.6 ± 0.3% (378)	0.83	0.419
Any muscle-enhancing behavior	3.8 ± 0.3% (434)	4.0 ± 0.3 (298)%	4.6 ± 0.3% (373)	1.17	0.030
Dieted to gain weight or bulk up	0.9 ± 0.1% (92)	1.0 ± 0.1 (69)%	--		
Exercised to gain weight or bulk up	2.4 ± 0.2% (252)	2.7 ± 0.3 (186)%	1.1 ± 0.2% (88)	1.03	<0.001
Lifted weights to gain weight or bulk up	6.0 ± 0.1% (75)	0.9 ± 0.1 (70)%	0.8 ± 0.1% (64)	1.26	0.169
Took food supplements to gain weight or bulk up	0.9 ± 0.1% (121)	0.8 ± 0.1 (64)%	0.6 ± 0.1% (52)	0.86	0.359
Ate different foods than usual to gain weight or bulk up	--	--	1.6 ± 0.2% (132)		
Ate more to gain weight or bulk up	--	--	2.9 ± 0.3% (243)		
Used legal performance enhancing substance for athletes[c]	--	--	1.1 ± 0.2% (99)		
Used androgenic anabolic steroids	--	--	0.4 ± 0.1% (30)		

P<0.001 for comparisons of males versus females or all behaviors

[a] All percentages are calculated with weighted data to reflect the representative proportion in the target U.S. population

[b] Estimate and p-value for change over time (wave) accounting for within- and between-person changes. Results from generalized estimating equations logistic models

[c] Including creatine monohydrate or andro

Table 3.

Associations of sociodemographic characteristics with weight gain attempts and muscle-enhancing behaviors, by sex

	Males		Females	
	Weight gain attempts	Any muscle-enhancing behavior[a]	Weight gain attempts	Any muscle-enhancing behavior[a]
	OR (95% CI)[b]	OR (95% CI)[b]	OR (95% CI)[b]	OR (95% CI)[b]
Race/ethnicity				
White (referent)	-	-	-	-
Black/African American	**2.21 (1.92 – 2.54)**	**2.18 (1.91 – 2.50)**	**5.65 (4.51 −7.09)**	**4.64 (3.66 – 5.88)**
Hispanic/Latino	**1.20 (1.02 – 1.40)**	**1.19 (1.02 – 1.40)**	**2.69 (2.08 – 3.46)**	**3.14 (2.36 – 4.18)**
Asian/Pacific Islander	1.19 (0.89 – 1.59)	1.11 (0.82 – 1.50)	**1.90 (1.33 – 2.71)**	**2.00 (1.27 – 3.14)**
American Indian/Native American	1.22 (0.84 – 1.77)	1.33 (0.91 – 1.03)	1.23 (0.63 – 2.38)	1.51 (0.68 – 3.38)
Other race/ethnicity	1.48 (0.83 – 2.65)	1.44 (0.84 – 2.48)	1.18 (0.54 – 2.59)	1.35 (0.60 – 3.03)
Percent federal poverty line	0.97 (0.92 – 1.02)	0.97 (0.91 – 1.03)	**0.78 (0.68–0.89)**	**0.82 (0.71 – 0.95)**
Parental college education	1.10 (0.96 – 1.26)	**1.14 (1.00 – 1.29)**	**0.82 (0.69 – 0.98)**	0.96 (0.78 – 1.18)
Body mass index	**0.81 (0.80 – 0.82)**	**0.83 (0.82 – 0.84)**	**0.60 (0.56 – 0.63)**	**0.62 (0.59 – 0.65)**
Participation in team sports	**1.27 (1.12 – 1.43)**	**1.31 (1.16 – 1.48)**	0.87 (0.71 – 1.08)	1.02 (0.83 – 1.25)
Age				
11–13 years (referent)	-	-	-	-
14–16 years	**2.53 (2.13 – 3.00)**	**2.51 (2.11 – 2.99)**	**1.66 (1.26 – 2.19)**	1.32 (0.94 – 1.86)
17 – 19 years	**4.36 (3.51 – 5.40)**	**3.80 (2.11 – 2.99)**	**2.30 (1.72 – 3.08)**	**1.50 (1.06 – 2.14)**
20 – 22 years	**4.77 (3.42 – 6.67)**	**4.07 (2.82 – 5.88)**	**2.16 (1.24 – 3.78)**	1.34 (0.74 – 2.42)
>23 years	**4.04 (2.76 – 5.91)**	**3.41 (2.28 – 5.09)**	**1.93 (1.05 – 3.55)**	1.26 (0.68 – 2.32)
Wave				
Wave I (referent)	-	-	-	-
Wave II	**0.88 (0.79 – 0.99)**	**0.88 (0.79 – 0.98)**	0.90 (0.79 – 1.03)	0.99 (0.83 – 1.19)
Wave III	1.01 (0.73 – 1.40)	**1.31 (0.95 – 1.79)**	1.26 (0.83 – 1.93)	**3.15 (2.06 – 4.81)**

Bold indicates p<0.05

[a]Any muscularity-oriented disordered eating behaviors included an affirmative response to dieted, exercised, weight lifted, or took supplements to gain weight or bulk up

[b] OR = odds ratio; all models include time invariant covariates race/ethnicity, percent federal poverty line, parental education, and participation in team sports and time-varying covariates body mass index and age and are calculated with weighted data to reflect the representative proportion in the target U.S. population. All models incorporate robust standard errors with clustering by school, which also captures clustering within students across waves