

Yoga Practice Among Ethnically/Racially Diverse Emerging Adults: Associations with Body Image, Mindful and Disordered Eating, and Muscle-Enhancing Behaviors

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Abstract

Background: Yoga may be beneficial for young people at risk for body dissatisfaction and unhealthy behaviors aimed at changing one's body shape and size. This study explores associations between yoga practice and body image, mindful eating, disordered eating, and muscle-enhancing behaviors among a population-based sample of emerging adults from diverse socio-economic and ethnic/racial backgrounds.

Methods: Survey data were collected from 1,568 ethnically/racially diverse emerging adults (18-26 years) as part of the EAT 2010-2018 study (Eating and Activity over Time).

Results: Practicing yoga at least 30 minutes/week was reported by 12.7% (n=210) of the sample. In models adjusted for sociodemographic characteristics, yoga practitioners had higher levels of mindful eating and body satisfaction than non-practitioners. Of concern, yoga practitioners were more likely to use steroids to enhance the size or tone of their muscles than those not practicing yoga (4.2% vs. 0.8%, $p < .001$). Furthermore, 35.4% of yoga practitioners used protein powder or shakes in the past year as compared to 25.0% of those not practicing yoga ($p = .005$). Yoga practitioners had similar levels of unhealthy weight control behaviors and binge eating to those not practicing yoga. Associations between yoga practice and body satisfaction, mindful eating, disordered eating, and muscle-enhancing behaviors were similar across ethnic/racial groups.

Conclusions: In order to promote yoga among diverse populations, and enhance its safety and benefits for weight-related health, it is crucial for settings in which yoga is offered, and yoga teachers, to have awareness of the high prevalence of concerning disordered eating and muscle-enhancing behaviors among students and to address accordingly.

Background

Body image concerns, disordered eating behaviors, and behaviors aimed at changing one's body shape and size are highly prevalent among adolescents and young adults (1–4). While behaviors such as engaging in physical activity, eating varied nutrient-dense foods, and mindful eating are to be encouraged, other actions such as unhealthy weight control behaviors (e.g., skipping meals, taking diet pills, and self-induced vomiting) and use of muscle enhancers, such as steroids, are problematic (5, 6). Research suggests that the prevalence of disordered eating and muscle-enhancing behaviors may be equally high, or even higher, among adolescents from lower socio-economic and ethnic/racial minority backgrounds than among adolescents from white and middle or upper socio-economic backgrounds (2, 7–11). There is a need for more research on the prevalence, correlates, and use of potentially helpful strategies aimed at promoting a healthy body image and preventing the use of unhealthy behaviors aimed at changing body shape or size among populations that are likely to have been understudied and underserved in terms of prevention and treatment interventions.

Yoga is a mind-body practice that involves physical postures, breathwork, mindfulness, meditation, self-inquiry, and lifestyle practices (12–14). The practice of yoga has several underlying tenets that may assist in promoting a positive body image and a reduction in harmful disordered eating and muscle-enhancing behaviors (13, 15–19). For example, yoga encourages making space to come inward to notice what one needs (e.g., more movement, more rest) and then responding in accordance; caring for one's physical, energetic, mental, emotional, and spiritual needs; learning to connect to one's body with kindness and respect; and the promotion of a greater sense of awareness of the body from the inside-out rather than outside-in. Therefore, if young people at risk for body dissatisfaction and unhealthy behaviors aimed at modifying one's body's shape and size can participate in yoga, and the yoga is taught in a sensitive manner, the practice may be helpful.

The popularity of yoga within westernized societies appears to be growing (20–23). For example, in the United States, practicing yoga over the past year was reported by 9.5% of adults in 2012 and the prevalence increased to 14.3% in 2017 (24). The practice of yoga has been shown to be associated with a number of positive physical and emotional health outcomes (25–29). Reviews of research examining the relationships between practicing yoga and body image, disordered eating behaviors, and eating disorders, suggest that yoga may be beneficial, although associations tend to be modest and are not always consistent across studies (16, 30–33). For example, in a mixed-methods pilot study examining a yoga-based intervention conducted within an eating disorders treatment center, participants described many positive changes to their body image as a result of their yoga practice (34). College students participating in a yoga program showed decreases in body dissatisfaction and in eating disorder pathology and increases in body appreciation (35). A pilot randomized controlled trial examining the impact of yoga on risk and protective factors for disordered eating among college students found improvements in some outcomes (e.g., positive affect), whereas others (e.g., body dissatisfaction) were not found to be statistically significant (36). Halliwell and colleagues conducted a randomized control trial with undergraduate college female students to assess the impact of a body image centered yoga practice and found the program to be effective in modifying most of the body image outcomes (37). A population-based study of young adults found that yoga practice predicted improvements in body satisfaction over time among those who had lower levels of body satisfaction at a prior assessment (38).

While the body of research on yoga is rapidly growing, there is a dearth of research on the practice of yoga and associations with body image and disordered eating that has been conducted with young people from lower income and diverse ethnic/racial backgrounds (39), particularly outside of the college/university context. Learning more about yoga practice among ethnically/racially diverse populations during the period of transition from adolescence to young adulthood, e.g., emerging adulthood (18–30 years), and associations between yoga and body image, mindful eating, disordered eating, and the use of supplements to change one's muscular shape or size, can provide insight into who is practicing yoga and how best to address their needs. For example, if there is a high prevalence of disordered eating behaviors among those practicing yoga, teachers may need to adapt their language and teaching styles. Likewise, settings where yoga is taught may need to modify the types of products sold and images used in marketing.

The current study aims to address the following research question: How is the practice of yoga associated with various measures of psychological and behavioral health of relevance to the promotion of a healthy body image and the prevention of disordered eating/eating disorders and unhealthy muscle-enhancing behaviors in an ethnically/racially diverse population-based sample of emerging young adults? This study expands on the extant literature in that it explores associations between yoga practice and a broad array of variables, including body satisfaction, body mass index (BMI), mindful eating, extreme and less extreme unhealthy weight control behaviors, binge eating, steroid use, and protein powders/shakes, in an ethnically/racially diverse, population-based sample of emerging young adults. There has been little work examining the practice of yoga in diverse samples of young people, although there have been calls for learning more about diverse populations (39). Furthermore, to the best of our knowledge, some of the variables assessed here, including the use of protein powders/shakes and steroids to enhance muscle size or tone have not been assessed in relation to yoga practice in population-based samples. Given the mixed findings of existing studies (31) and dearth of research examining associations between yoga and such a broad array of outcomes in diverse populations (39), we did not make specific hypotheses with regard to expected associations. Findings will be helpful in informing best practices for yoga practitioners, yoga teachers, and settings in which yoga is taught.

Methods

Study Design and Population

Data were collected from 1,568 ethnically/racially diverse emerging adults (mean age = 22.0 ± 2.0 , range: 18–26 years) as part of the EAT 2010–2018 (Eating and Activity over Time) study. EAT 2010–2018 is a population-based, longitudinal study of eating, activity, and weight-related health, and associated factors, in young people. Middle school and senior high school students at 20 urban public schools in Minneapolis-St. Paul, Minnesota completed classroom surveys and anthropometric measures during the 2009–2010 academic year (EAT 2010) (2, 40, 41). Participants completed follow-up surveys in 2017–2018 (EAT 2018).

Of the original 2,793 participants, 410 (14.7%) were lost to follow-up, primarily due to missing contact information at EAT 2010 or no current address found at follow-up ($n = 397$). Invitations to participate in EAT 2018 were mailed to the remaining 2,383 young people along with a secure online survey link. Non-responders were mailed up to eight reminders; two of these reminders included paper copies of the survey. Additional contact attempts were made using email, phone calls, text messages, social media messages, and home visits. The University of Minnesota's Institutional Review Board Human Subjects Committee approved all protocols.

The 1,568 young people who completed the consent process and EAT 2018 survey represents 65.8% of the original, school-based sample for whom current contact information was available at follow-up. Inverse probability weighting (IPW) was used for all analyses to account for missing data (42, 43). IPW minimizes potential response bias due to missing data and allows for extrapolation back to the original EAT 2010 school-based sample. Weights for IPW were derived as the inverse of the estimated probability that an individual responded at the two time points based on characteristics reported in 2010, including demographics, past year frequency of dieting, and weight status. Among the analytic sample ($n = 1555$ with non-missing yoga practice responses) the weighted demographics (Table 1) were: 28.7% African American or Black, 19.9% Asian American, 18.9% white, 16.9% Hispanic, 3.7% Native American, and 11.9% mixed or other. Most of the Asian American participants reported Southeast Asian heritage; approximately 79.1% of this group was Hmong. The weighted distribution across categories of parental socio-economic status (SES) based primarily on formal educational attainment was: 39.3% low, 22.3% low-middle, 17.7% middle, 13.2% upper-middle, and 7.5% high.

Table 1
Yoga practice (at least 30 minutes/week) by sociodemographic characteristics

	Unadjusted results				Model 1 ³	Model 2 ⁴		
	Total N (%) ¹	Number practicing yoga	% practicing yoga	p-value	Adjusted % practicing yoga	p-value	Adjusted % practicing yoga	p-value
Age categories								
18–21	708 (42.9)	85	11.4		9.9	0.187	9.1	
22–25	794 (53.0)	116	13.5	0.380	12.3		11.8	0.095
26+	53 (4.1)	9	15.5		16.3		17.2	
Gender								
Female	901 (53.2)	158	17.2	< .001	17.0	< .001	16.2	< .001
Male	643 (46.2)	48	7.2		6.8		6.3	
Different identity	11 (0.6)	4	36.4		32.3		27.1	
Ethnicity/Race ²								
White	365 (18.9)	56	14.6	0.043	12.2	0.142	11.1	0.268
Black	340 (28.7)	42	11.1		10.2		9.8	
Hispanic	271 (16.9)	36	12.4		11.8		11.8	
Asian American	353 (19.9)	37	10.6		10.0		9.3	
Native American	62 (3.7)	4	7.0		7.4		7.5	
Other/Mixed	164 (11.9)	35	19.4		17.5		15.8	
Socio-economic status								

¹ All proportions are weighted for non-response to be representative of the original EAT-2010 sample.

² Structurally racialized categories labelled by ethnicity/race.

³ Model 1 is adjusted for age, gender, ethnicity/race, and socio-economic status (SES) (n = 1518; 3.9% dropped due to missing SES).

⁴ Model 2 is additionally adjusted for Body Mass Index (BMI) category (n = 1483; 6.4% dropped due to missing SES or BMI).

			Unadjusted results		Model 1 ³	Model 2 ⁴		
Low	558 (39.3)	64	10.7	0.038	9.2	0.027	8.5	0.045
Low-middle	332 (22.3)	49	14.8		13.9		13.6	
Middle	254 (17.7)	29	10.9		9.7		9.4	
High-middle	241(13.2)	39	15.6		14.8		13.5	
High	133 (7.5)	26	19.2		17.5		15.8	

¹ All proportions are weighted for non-response to be representative of the original EAT-2010 sample.

² Structurally racialized categories labelled by ethnicity/race.

³ Model 1 is adjusted for age, gender, ethnicity/race, and socio-economic status (SES) (n = 1518; 3.9% dropped due to missing SES).

⁴ Model 2 is additionally adjusted for Body Mass Index (BMI) category (n = 1483; 6.4% dropped due to missing SES or BMI).

Survey Development and Variables

Key items from the EAT 2010 survey were retained on the follow-up EAT 2018 survey, while additions were made to assess areas of emerging interest and to reflect participants' transition from adolescence to young adulthood (40, 44–46). Focus groups with 29 emerging adults were conducted to pretest the EAT 2018 survey. Test-retest reliability of measures was examined using data from a subgroup of 112 participants who completed the EAT 2018 survey twice within a period of three weeks. All variables utilized in the current analysis, which are described below, were assessed on the EAT 2018 survey unless indicated otherwise.

To assess *yoga practice*, participants indicated if they had ever done yoga over the past year (yes/no) (test-retest agreement = 89%). Those who had ever done yoga were additionally asked, "On average, how frequently did you do yoga over the past year?" Seven response options ranged from "less than ½ hour/week" to "10 + hours/week." Respondents who engaged in yoga at least 30 minutes/week were identified as practicing yoga (test-retest agreement = 86%).

Body Satisfaction was assessed with a modified version of the Body Satisfaction Scale (47). Satisfaction with 13 parts of the body (height, weight, body shape, waist, hips, thighs, stomach, face, body build, shoulders, muscles, chest, overall body fat) was rated using five response categories ranging from "very dissatisfied" to "very satisfied" (Cronbach's alpha = 0.94; range: 13–65; test-retest r = 0.80).

Mindful eating was assessed with four items from the Mindful Eating Questionnaire: "I eat so quickly that I don't taste what I'm eating; I snack without noticing that I am eating; Before I eat I take a moment to appreciate the colors and smells of my food; I taste every bit of food that I eat." (48). Each item had four response options. The first two items were reverse scored and items were summed to form a score (range: 4–16; test-retest r = 0.67).

Unhealthy weight control behaviors were assessed by asking: "Have you done any of the following things in order to lose weight or keep from gaining weight during the past year?" (yes/no for each method). Practices categorized as *extremely unhealthy weight control behaviors* included 1) took diet pills, 2) made myself vomit, 3) used laxatives, and

4) used diuretics. Practices categorized as *less extreme unhealthy weight control behaviors* included 1) fasted, 2) ate very little food, 3) used a food substitute (powder or a special drink), 4) skipped meals, and 5) smoked more cigarettes. Those who responded “yes” for one or more methods were coded as users of extreme (test-retest agreement = 93%) and less extreme unhealthy weight control behaviors (test-retest agreement = 76%).

Binge eating was assessed with the questions: “In the past year, have you ever eaten so much food in a short period of time that you would be embarrassed if others saw you (binge eating)?” (yes/no). “During the times when you ate this way, did you feel you couldn’t stop eating or control what or how much you were eating?” (yes/no). Those who responded “yes” to both questions were categorized as engaging in binge eating (test-retest agreement = 89%) (49).

To assess muscle-enhancing behaviors, participants were asked: “Have you done any of the following things in order to increase your muscle size or tone during the past year?” and specifically were asked to report (yes/no) on use of *protein powder or shakes* (test-retest agreement = 88%) and *steroid use* (test-retest agreement = not available) (50–52).

Two items individually assessed *moderate-to-vigorous physical activity (MVPA)*: “In a usual week, how many hours do you spend doing the following activities?” (Six response options ranged from none to six or more hours). Strenuous activity was described as activity during which the heart beats rapidly and moderate activity was described as not exhausting. Examples of activities were given after each question (test-retest $r = 0.72$) (53).

Structurally racialized groups (ethnicity/race) were assessed by self-report at baseline with the question: “Do you think of yourself as...? (1) White, (2) Black or African American, (3) Hispanic or Latino, (4) Asian American, (5) Native Hawaiian or Pacific Islander, (6) American Indian or Native American, or (7) Other” (test-retest agreement = 98–100%). Since very few participants reported “Hawaiian or Pacific Islander”, or did not report their ethnicity/race, they were coded as “mixed/other.” *SES* was determined at baseline and was primarily based on the highest education level of either parent with adjustments made for student eligibility for free/reduced-price school meals, family public assistance receipt, and parent employment status (54, 55). On the EAT 2018 survey, participants were given three options for *gender*. Male, Female, or Different identity (please specify). *Age* was calculated based on reported birth date and the date of survey completion. *BMI* was calculated based on self-reported height and weight.

Statistical Analysis

Descriptive proportions of young adults practicing yoga by sociodemographic characteristics were summarized. Differences across sociodemographic characteristics were tested by logistic regression of yoga practice (yes/no) as the outcome on each characteristic. Models were run unadjusted (e.g., for each sociodemographic characteristic separately); then mutually controlled for all sociodemographic characteristics (Model 1); and finally, additionally controlling for body mass index (BMI) category (< 18.5 , $18.5–25$, $25–30$, ≥ 30) (Model 2). Measures of body satisfaction, mindful eating, disordered eating, and unhealthy muscle-enhancing behaviors were all examined in relation to yoga practice using separate regressions of each measure (as the outcome) on yoga practice as the predictor controlling for sociodemographic variables (Model 1) and additionally controlling for BMI category. Continuous measures used linear regression, dichotomous measures used logistic regression. Regression-adjusted means and proportions of each measure are presented by yoga practice as well as effect size differences (standardized mean difference Cohen’s d for mean differences, Cohen’s h for proportion differences). Effect sizes are used to provide a means for comparing magnitudes across various outcomes on different scales. Commonly used labels to describe Cohen’s d and h effect sizes are 0.20 (small), 0.50 (medium), 0.80 (large) effects (56). Additional regression models were fit for each outcome controlling for physical activity and also testing ethnicity/race by yoga interactions. As previously described, to adjust for attrition, all regression analyses and percentages were weighted

with the non-response weights (IPW) while raw sample size values are presented. All analyses were conducted in SAS software (version 9.4, 2013; SAS, Inc., Cary, NC).

Results

Yoga practice by sociodemographic characteristics

Practicing yoga (at least 30 minutes/week) was reported by 12.7% (n = 210) of the study participants. Among these participants, the average frequency of practice was as follows: 30 minutes to less than one hour/week (n = 68); one hour to less than two hours/week (n = 84); two to three hours/week (n = 38); and four or more hours/week (n = 17).

Yoga practice did not differ across age categories. Female young adults were much more likely to practice than male young adults. There was some variation across ethnicity/race, although differences were not statistically significant after adjustment for sociodemographic characteristics and further adjustment for BMI. Young adults from higher socio-economic levels were more likely to practice yoga (Table 1).

Body satisfaction, mindful and disordered eating, and muscle-enhancing behaviors by yoga

As shown in Table 2, in analyses adjusted for socio-demographic characteristics, young adults practicing yoga had higher levels of body satisfaction (Effect size (ES) = 0.19, p = .020) and mindful eating (ES = 0.22, p = .002). Young adults practicing yoga had lower BMI values than young adults not practicing yoga (25.6 and 27.4 kg/m², respectively; ES=-0.26, p < .001). After further adjustment for BMI category, the association between practicing yoga and body satisfaction became negligible (ES = 0.06, p = 0.469).

Table 2

Body satisfaction, mindful eating, BMI, disordered eating, and muscle-enhancing behaviors by yoga practice (n = 1555)

	Model 1 ¹		ES ^a	p-value	Model 2 ²	
	No (n = 1334)	Yes (n = 209)			ES ^a	p-value
	Adjusted ¹ Mean (SE) or % (n)	Adjusted ¹ Mean (SE) or % (n)				
Body satisfaction (range: 13–65)	42.0 (0.34)	44.3 (0.94)	0.19	0.020	0.06	0.469
Mindful eating (range: 4–16)	11.7 (0.06)	12.1 (0.14)	0.22	0.002	0.20	0.006
BMI (kg/m ²)	27.4 (0.2)	25.6 (0.45)	-0.26	< 0.001	-	-
Extreme unhealthy weight control behaviors	11.7% (177)	10.0% (25)	0.06	0.473	-0.01	0.962
Less extreme unhealthy weight control behaviors	51.0% (671)	55.9% (118)	0.10	0.225	0.24	0.010
Binge eating	10.9% (159)	10.3% (28)	-0.02	0.786	0.04	0.602
Steroid use	0.8% (14)	4.2% (10)	0.23	< .001	0.22	< .001
Protein powder/shakes	25.0% (338)	35.4% (66)	0.23	0.005	0.22	0.007
¹ Model 1 is adjusted for age, gender, ethnicity/race, and socio-economic status. Adjusted Mean (SE) and % by yoga status for each outcome are the expected mean outcomes from the regression Model 1 with socio-demographics fixed at their respective sample means.						
² Model 2 is additionally adjusted for Body Mass Index category.						
^a ES is effect size provides a comparable measure of magnitude across outcomes. It is calculated as the standardized mean difference Cohen's d (for continuous outcomes) and a scaled difference in proportions Cohen's h (for dichotomous outcomes).						

Regardless of yoga practice, high percentages of study participants engaged in disordered eating behaviors (Table 2). In analyses adjusted for socio-demographic characteristics, yoga was not associated with these disordered eating variables. Extreme weight control behaviors, such as diet pill use or self-induced vomiting, were used by 11.7% and 10.0% of young adults practicing and not practicing yoga, respectively. Less extreme unhealthy weight control behaviors, such as meal skipping or fasting, were used by 51.0% and 55.9% of those practicing and not practicing yoga, respectively. Binge eating was reported by 10.9% of yoga practitioners and 10.3% of those not practicing yoga. After further adjustment for BMI, young adults practicing yoga were more likely to engage in less extreme unhealthy weight control behaviors than those not practicing yoga (Model 2 adjusted proportions: 62.4% vs. 50.8%, ES = 0.24, p = .01).

Use of steroids or protein powder/shakes to increase muscle size or tone were reported by 1.8% and 27.0% of all study participants, respectively. The use of these muscle-enhancing behaviors was higher among young adults practicing yoga than those not practicing (Table 2). Among those practicing yoga, 4.2% used steroids as compared to 0.8% of

those not practicing yoga (ES = 0.23, $p < .001$). Furthermore, 35.4% of young adults practicing yoga used protein powder or shakes in the past year as compared to 25.0% of those not practicing yoga (ES = 0.23, $p = .005$).

Given the direction and magnitude of the association between yoga and muscle-enhancing behaviors, and the thought that this association may reflect a higher overall level of physical activity among yoga practitioners, we further explored whether the associations between yoga practice and muscle-enhancing behaviors were maintained after adjustment for overall levels of moderate-to-vigorous physical activity levels, in addition to socio-demographic characteristics. Associations remained statistically significant (steroids: $p < .001$; protein powders/shakes: $p = .029$). In analyses, additionally adjusted for BMI category, associations also remained significant (steroids: $p < .001$; protein powders/shakes: $p = .034$). This finding suggests the association between yoga practice and muscle-enhancing behaviors is independent of overall levels of physical activity and BMI category.

Associations were further examined to assess if there was a dose-response relationship between frequency of practicing yoga and the various outcomes. No statistically significant dose-response relationships were found in analyses adjusted for sociodemographic characteristics and additionally adjusted for weight status. Thus, the above-mentioned associations did not differ in accordance with the frequency of practice.

Interactions with structurally racialized categories - ethnicity/race

In order to determine if associations between yoga practice and the different outcomes were similar across ethnicity/race, interactions with yoga and ethnicity/race were examined. As shown in Table 3, in analyses, patterns were similar across ethnicity/race and there were no statistically significant interactions. Small numbers (e.g., cell sizes < 5) precluded testing interactions with ethnicity/race for less prevalent outcomes: binge eating, extreme unhealthy weight control, and steroid use.

Table 3

Body image related variables by yoga practice by structurally racialized categories (interaction by ethnicity/race)

	Model 1 ¹		Model 2 ²			
	Yoga Practice					
	No (n = 1334)	Yes (n = 209)	ES	p-value	ES	p-value
	Mean (SE) or % (N)	Mean (SE) or % (N)				
Body satisfaction						
White	42.2 (0.74)	45.5 (1.75)	0.27	0.069	0.14	0.320
Black	45.8 (0.74)	47.0 (2.28)	0.10	0.618	-0.10	0.627
Hispanic	39.9 (0.80)	41.7 (2.00)	0.14	0.415	0.06	0.699
Asian	36.8 (0.66)	41.5 (2.00)	0.38	0.026	0.25	0.116
Native American	42.2 (1.87)	37.9 (8.66)	-0.35	0.623	-0.58	0.410
Other	43.7 (1.15)	44.6 (1.86)	0.07	0.651	0.02	0.910
Interaction p-value				0.73		0.67
Mindful eating						
White	11.2 (0.13)	11.9 (0.29)	0.35	0.018	0.32	0.034
Black	11.5 (0.13)	12.1 (0.30)	0.27	0.082	0.25	0.115
Hispanic	12.0 (0.14)	11.8 (0.27)	-0.09	0.560	-0.10	0.506
Asian	11.6 (0.12)	11.8 (0.34)	0.09	0.584	0.02	0.931
Native American	11.9 (0.25)	12.5 (0.25)	0.28	0.103	0.21	0.247
Other	11.9 (0.22)	12.9 (0.32)	0.44	0.016	0.51	0.007
Interaction p-value				0.19		0.13
BMI						
White	26.4 (0.37)	25.9 (1.17)	-0.08	0.654	-	-
Black	27.1 (0.44)	24.2 (0.70)	-0.42	0.000	-	-
Hispanic	28.2 (0.48)	26.4 (0.86)	-0.25	0.079	-	-
Asian	27.4 (0.39)	24.7 (1.00)	-0.40	0.010	-	-
Native American	27.8 (0.91)	24.4 (1.57)	-0.49	0.060	-	-
Other	27.8 (0.72)	27.0 (1.21)	-0.12	0.539	-	-
Interaction p-value				0.47		-

¹ Model 1 is adjusted for age, gender, ethnicity/race, and socio-economic status.

² Model 2 is additionally adjusted for Body Mass Index category.

	Model 1 ¹		Model 2 ²			
Less extreme unhealthy weight control behaviors						
White	42.3% (3.09)	52.6% (7.09)	0.21	0.164	0.38	0.030
Black	50.9% (3.10)	40.8% (8.00)	-0.20	0.249	-0.06	0.765
Hispanic	47.9% (3.43)	61.1% (8.44)	0.27	0.157	0.20	0.053
Asian	63.3% (2.85)	68.0% (8.24)	0.10	0.597	0.31	0.118
Native American	60.6% (6.77)	72.4% (24.7)	0.25	0.662	0.30	0.638
Other	46.2% (4.56)	56.8% (8.71)	0.21	0.279	0.22	0.314
Interaction p-value				0.46		0.59
Protein powder						
White	22.8% (2.76)	33.6% (6.61)	0.24	0.098	0.27	0.097
Black	24.5% (2.71)	32.9% (7.92)	0.19	0.291	0.18	0.303
Hispanic	32.3% (3.23)	32.8% (8.49)	0.01	0.956	0.04	0.887
Asian	22.3% (2.57)	30.6% (8.39)	0.19	0.308	0.16	0.445
Native American	20.9% (5.57)	21.4% (19.8)	0.01	0.981	0.00	0.992
Other	25.3% (4.06)	51.7% (9.30)	0.55	0.008	0.56	0.010
Interaction p-value				0.57		0.60
¹ Model 1 is adjusted for age, gender, ethnicity/race, and socio-economic status.						
² Model 2 is additionally adjusted for Body Mass Index category.						

Discussion

The aim of this study was to explore the prevalence of practicing yoga and associations with body image, mindful eating, disordered eating, and muscle-enhancing behaviors in a diverse population-based sample of emerging adults. Findings among this primarily low-income and ethnically/racially diverse population-based sample indicate that yoga practitioners had higher levels of mindful eating and body satisfaction than those not practicing yoga. However, and of concern, young adults practicing yoga had similar levels of unhealthy weight control behaviors and binge eating, and were more likely to use steroids or protein powders/shakes to enhance the size or tone of their muscles than those not practicing yoga. After further adjustment for BMI, which was lower among yoga practitioners than non-practitioners, yoga practice was not associated with body satisfaction and was associated with higher levels of less extreme unhealthy weight control behaviors. These patterns did not differ significantly across ethnic/racial subgroups of the population. While yoga may offer many health benefits broadly (25–29) and in terms of body image, disordered eating, and weight-related health (37, 57, 58), it is important that yoga teachers are aware that many of their students may be engaging in unhealthy behaviors aimed at changing their body shape or size. Yoga teachers and yoga practitioners, themselves, can take steps toward the promotion of greater body acceptance and appreciation.

To the best of our knowledge, this is the first population-based study that has examined associations between yoga practice and the use of muscle enhancers such as steroids or protein powders/shakes. Just over a third of emerging young adults practicing yoga used protein powders or shakes to enhance the size or tone of their muscles. While there is a lack of clarity about what they were consuming and potential adverse health consequences, findings suggest a preoccupation with muscle enhancement. The higher use of steroids to enhance muscles among yoga practitioners is of great concern, particularly given the known adverse consequences of using steroids (59). While further research in different populations is needed to confirm these findings, results from the current study suggest that yoga teachers would do well to avoid any language likely to increase concerns about physique.

Similarly, it is of concern that equal or higher percentages of young adults practicing yoga engage in disordered eating behaviors as compared to those not practicing yoga. It is promising to see that young adults engaging in disordered eating behaviors are choosing to practice yoga, given the underlying tenets of yoga, in addition to research findings suggesting that yoga may be helpful in terms of promoting a stronger sense of self and positive embodiment (17, 39, 60). Furthermore, some longitudinal and intervention studies have suggested that yoga may be effective in improving body image and disordered eating behaviors (37, 38, 57, 58, 61, 62). Although findings do not consistently show the benefits of yoga (30, 31), we are not aware of research findings showing that yoga can be harmful in terms of worsening these health outcomes. Our findings suggest the need for yoga teachers to be aware of the high percentage of their students who may be engaging in disordered eating behaviors and engage in teaching practices likely to help, and not harm, their students. For example, given that internal critique and comparative critique during yoga class have been identified by yoga practitioners as factors with the potential to harm one's body image, teachers are encouraged to use language to help students focus inward and minimize students' tendencies to make comparisons with either the teacher or other students (14). Furthermore, work by Halliwell and colleagues (37), suggests the value of intentionally inserting language to support an improved body image to enhance the positive impact of yoga (e.g., practicing gratitude for all the things one's body can do or envisioning the body as a guesthouse for the soul).

In the current study, yoga was associated with higher levels of mindful eating. In prior qualitative research, young adults practicing yoga discussed how yoga helped with increased awareness of their bodies' needs, the selection of more nourishing foods, attentiveness to internal signs of hunger or fullness, and greater presence while eating (63). A randomized, controlled trial examining the impact of yoga among adults engaging in binge eating (61), found that yoga was associated with decreased binge eating. Likewise, qualitative interviews with study participants indicated perceived improvements in eating behaviors, including greater presence and mindfulness while eating (64). Further work is needed to determine if yoga can lead to more mindful eating and, in turn can help reduce binge eating behaviors in the general population.

Body satisfaction was found to be higher among emerging adults practicing yoga in analyses adjusted for sociodemographic characteristics but not after further adjustment for weight status. The difference between these two analyses can be attributed to the lower mean BMI among yoga practitioners and the inverse associations that tend to exist in our society between BMI and body satisfaction (65). The first analysis indicates that young adults practicing yoga have higher levels of body satisfaction after adjusting for any differences in socio-demographic characteristics. The second analysis, with additional adjustment for weight status, informs us that if young adults practicing and not practicing yoga were similar with regard to their weight status, there would not be differences in body satisfaction across the groups. What remains unclear from the current analysis is whether young adults with lower BMI values choose to engage in yoga more often than their counterparts, or whether yoga has helped them reduce their BMI. There is some evidence that yoga can help in reducing BMI (66), with two population-based studies suggesting that yoga can help with weight gain prevention (67, 68). However, it is also highly likely that the mean difference in BMI between the yoga practitioners and the non-practitioners is due to young adults with lower BMI

values being more likely to choose to engage in yoga. Persons living in larger bodies may not feel comfortable at some settings in which yoga is taught. For example, in one of these population-based studies, among young adults practicing yoga, those with higher BMI values were less likely to practice at yoga studios than yoga practitioners with lower BMI values (68). Yoga settings need to be proactive in helping persons from diverse backgrounds, and of diverse body shapes, sizes, and abilities, to feel more welcome and comfortable (39, 69–72).

Study strengths and limitations should be taken into account in interpreting the findings. An important strength of the current study is the large size and diverse nature of the study population. There has been a dearth of research on yoga among low-income and ethnically/racially diverse populations. The assessment of a broad array of attitudes and behaviors related to body image is also a study strength. We are unaware of any studies that have examined yoga in relation to muscle enhancing behaviors in any population-based studies. Young people from diverse ethnic/racial and low socio-economic backgrounds have been found to be at high risk for problematic eating and weight-related outcomes (2, 7–11), but may be underserved with regard to prevention and treatment interventions (73, 74). It is crucial to learn more about how to help in promoting a healthy body image and prevent and reduce unhealthy muscle-enhancing and disordered eating behaviors among diverse and potentially underserved populations.

While the diverse nature of the study population is a study strength, it is important to note that in order to properly examine patterns of relatively rare behaviors (e.g., steroid use) by yoga practice, within separate ethnic/racial groups, larger numbers will be needed. Likewise, while utilizing a community-based sample allows for a determination of who is practicing yoga, the mean frequency of practicing yoga among such a broad sample tends to be low, with relatively few respondents reporting practicing an average of more than two hours a week. While we conducted a dose-response analysis, and did not see trends suggesting that those practicing more often were better off, the numbers of young adults practicing frequently was low, leading us to interpret the findings cautiously. Additionally, the cross-sectional nature of the study needs to be considered in interpreting findings; inferences about directionality of associations or causation cannot be inferred. Further longitudinal work is needed to detect changes over time following a consistent period of yoga practice. Finally, it is important to replicate these findings in other study populations and to examine differences in associations by characteristics of the yoga practice (e.g., intensity, focus), teaching styles, and locations of practice (e.g., home vs. studio). As previously noted, we are unaware of any other studies that have examined muscle enhancing behaviors in population-based samples and it will be important to replicate our findings and explore in more depth.

Conclusion

In summary, among a large population-based sample of emerging adults from diverse ethnic/racial and socio-economic backgrounds, disordered eating and muscle-enhancing behaviors were equally or more common among young adults practicing yoga as compared to those not practicing yoga. In order to promote yoga among diverse populations, and enhance its safety and benefits, it is crucial for settings in which yoga is offered, and yoga teachers, to have awareness of the high prevalence of these concerning behaviors among students and to address accordingly. Certainly, these settings should not be promoting products aimed at muscle enhancement such as protein powders and shakes. For those practicing yoga on their own, it may also be helpful to learn to how to focus more on the process of coming inward during one's yoga practice to enhance the potential for yoga's positive impact on overall well-being. Increased awareness to self-critique and replacing potentially harmful self-dialogues with increased positive self-talk and greater self-compassion may also enhance the positive impact of one's yoga practice. Further research exploring yoga practice among diverse populations is needed, including studies that include more details on muscle-enhancing products being used and reasons for using these products; longitudinal studies to examine changes in body image attitudes and behaviors following a consistent yoga practice; qualitative research to better

understand yoga practitioners' perceptions how the practice of yoga could be enhanced to improve body image and related behaviors; and intervention studies to examine the impact on outcomes of interest of yoga taught in different manners.

DECLARATIONS

Declarations

Ethics approval and consent to participate

The University of Minnesota's Institutional Review Board Human Subjects Committee approved all protocols used. Committee reference number: 1101S94792.

Consent for publication

Not applicable.

Availability of data and materials

Investigators interested in utilizing the dataset used in the current study should contact the corresponding author.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

DNS is Principal Investigator of the study, conceptualized the manuscript, and wrote all drafts of the manuscript. MMW is a Co-Investigator on the study and contributed to data analysis and interpretation of the data. JC conducted data analysis for this study. DJB, NL, and ME are Co-Investigators on the study and contributed to study design, study implementation, interpretation of the findings, and manuscript writing. All authors critically reviewed and approved the manuscript and agree to be accountable for all aspects of the work regarding the accuracy or integrity of any part of the work.

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