



A Biopsychosocial Model of Social Media Use and Body Image Concerns, Disordered Eating, and Muscle-Building Behaviors among Adolescent Girls and Boys

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Abstract

Social media use is associated with body image concerns, disordered eating and body change behaviors in adolescents. This study aimed to examine these relationships within a biopsychosocial framework and test an integrated model. A sample of 681 adolescents (49% female), mean age = 12.76 years (SD = 0.74), completed a questionnaire assessing social media use, depression, self-esteem, body mass index, social media and muscular ideal internalization, appearance comparison, body dissatisfaction, disordered eating, and muscle-building behaviors. Path analysis was used to test the hypothetical model, which after modification revealed good fit to the data, although gender differences emerged. The findings suggest that biopsychosocial frameworks are useful for conceptualizing relationships between social media use and body image, eating, and muscle building outcomes.

Keywords Biopsychosocial model · Adolescents · Social media · Body image · Disordered eating · Gender

Introduction

Social media use has been increasing among adolescent boys and girls in recent years (Chassiakos et al. 2016), and is associated with and predictive of body image concerns

(McLean et al. 2015; Tiggemann and Slater 2017) and disordered body change behaviors (de Vries et al. 2016; Rodgers and Melioli 2016). Thus, understanding the pathways from social media use to these negative outcomes is essential. The effects of traditional media on body image concerns and related behaviors have been described within integrated models that bring together influences across different levels including sociocultural, psychological, and biological influences (Ricciardelli et al. 2003; Rodgers et al. 2014). Such models may also be useful for conceptualizing relationships between social media use and body image concerns and disordered body change behaviors, such as dietary restraint and muscle-building behaviors. However, to date no attempts have been made to test such models. The present study aimed to fill this gap by testing a biopsychosocial model of the relationships between social media and body image concerns and disordered eating and muscle building behaviors among adolescent girls and boys.

The biopsychosocial model brings together elements from sociocultural and psychological theories, along with acknowledging the role of biological influences on body image and eating concerns. Sociocultural theories have highlighted how exposure to appearance-focused media content may be associated with higher levels of internalization of appearance ideals, that is, the endorsement of

Preregistration The study is registered with the Australian New Zealand Clinical Trials Registry (ACTRN12617000137392; www.anzctr.org.au).

Research involving Human Participants and/or Animals The research involved Human Participants and was approved by the appropriate Institutional Review Board for ethical compliance.

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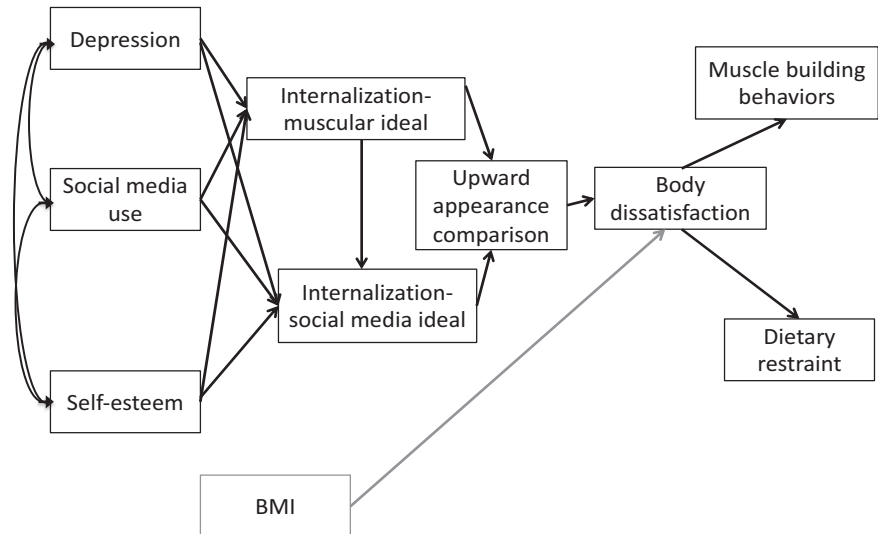
appearance ideals as a personal standard to strive for (Schaefer et al. 2015). In addition, these theories posit that appearance comparisons contribute to the impact of exposure to such idealized images on adolescents' own body image, which may in turn lead them to engage in disordered eating behaviors and muscle building behaviors, in the pursuit of these appearance ideals (Thompson et al. 1999). Other theoretical frameworks have highlighted that a number of psychological attributes have been proposed to increase risk, with a principal focus on low self-esteem and depressive symptoms among adolescents (Ricciardelli and McCabe 2004a, b; Rodgers et al. 2014). Low self-esteem may increase risk by impacting evaluations of one's personal attributes, including physical appearance. In addition, negative affect has been proposed to heighten the risk for body dissatisfaction due to the association between depressive symptoms and low self-esteem with a negative processing bias leading to the perception of one's own appearance being very discrepant from the social ideal, contributing to general feelings of low self-worth (Rodgers et al. 2014). Furthermore, it has been suggested that their association with body image and eating concerns may be indirect, through the mediating variables of the internalization of appearance ideals and appearance comparison (Rodgers et al. 2014). This mediating pathway represents the confluence of the sociocultural and psychological aspects of the model. As a final component, the biological element of the biopsychosocial model reflects the inclusion of body size as a reflection of biological influences on body image concerns and associated disordered behaviors, due to the weight bias that is endemic in Western society, and strong pressures towards extreme thinness (Ricciardelli et al. 2003).

With respect to the role of social media use within a biopsychosocial model of body dissatisfaction and disordered eating, many types of social media are highly visual and appearance focused (e.g., Instagram; Rodgers 2016). In addition, they bring together both commercial and user-generated content that is heavily edited and unrealistic (Rodgers and Melioli 2016). These characteristics increase the opportunities for unfavorable appearance comparisons, that is, upward comparisons with individuals judged to be more attractive than oneself (O'Brien et al. 2009) and have been suggested to be most detrimental compared to downward and horizontal appearance comparisons (Schaefer and Thompson 2018), as well as exposing adolescents to content that promotes unattainable appearance ideals (Boepple and Thompson 2016; Ho et al. 2016). In contemporary Western social media, these appearance ideals include both a focus on thinness and leanness, but also increasingly on muscularity, as two important components of appearance ideals for both boys (Rodgers et al. 2012) and girls (Rodgers, Franko et al. 2018). Consequently, a relationship

between social media use and body dissatisfaction and disordered eating behaviors would be anticipated. Furthermore, given this increasing focus on muscularity and muscle tone across gender, exploring the relationships between social media use and muscularity behaviors among girls as well as boys is important and represents one of the novel contributions of the current study.

Consistent with these expectations, recent research has overall found a small but robust relationship between social media use and body image concerns and disordered eating among adolescent girls (McLean et al. 2015; Tiggemann and Slater 2017) and to some extent among boys although data are more scarce (de Vries et al. 2016; Holland and Tiggemann 2016). In addition, a smaller body of research has supported the relationship between social media use and the internalization of appearance ideals (Mingoia et al. 2019), as well as engagement in appearance comparisons among adolescent girls (Tiggemann and Slater 2013). Among adolescent boys, data are lacking, and even among young men they are scarce. One study among male adolescents in Singapore suggested that comparisons with peers and celebrities on social media were associated with higher body dissatisfaction and drive for muscularity (Ho et al. 2016). In addition, the few existing studies to have examined these relationships among young men show preliminary support for relationships between indicators of social media use and internalization of appearance ideals (Rodgers et al. 2019) and appearance comparisons as well (Kim and Chock 2015). Thus, increasing support exists for the mediating role of the internalization of appearance ideals and appearance comparisons in the relationship between social media use and body image and eating concerns. Therefore, this pathway is predicted in the proposed model (Fig. 1).

In relation to pathways from psychological factors, in particular low-self-esteem and depressive symptoms, to internalization, appearance comparison, body dissatisfaction and disordered eating, some empirical support exists. Among adolescent girls, a previous test of a biopsychosocial model of sociocultural influences on body image and eating concerns supported the presence of an indirect effect of negative affect on body image and eating concerns via internalization and comparison processes (Rodgers et al. 2014). Among adolescent boys, again data are more scarce; however, evidence has emerged for a relationship between negative mood and muscle dysmorphic symptoms (Cafri et al. 2006), body dissatisfaction (Paxton et al. 2006), and disordered eating (Ricciardelli and McCabe 2004a, b), as well as self-esteem and body dissatisfaction and disordered eating (Cafri et al. 2006). In addition, relationships have emerged between negative affect and appearance comparison and media-ideal internalization among adolescent boys (Smolak et al. 2005).

Fig. 1 Hypothetical model for girls and boys

Thus, overall the extant research supports an indirect relationship between negative affect and body image concerns and disordered eating behaviors through media-ideal internalization and appearance comparison among both adolescent girls and boys (see Fig. 1).

Regarding the relationship between larger body size and body dissatisfaction, longitudinal studies among adolescent girls and boys have supported actual body size, frequently operationalized as body mass index (BMI), as a factor contributing to these concerns (Paxton et al. 2006). Therefore, body size is likely an important variable to include in an explanatory model of the relationships between social media and body image concerns and disordered body change behaviors (see Fig. 1).

Current Study

In the context of the literature reviewed above, the aim of the present study was to test a model among adolescent girls and boys, in which social media use, as well as negative affect (depression and self-esteem), were predicted to be associated with body image concerns and body change behaviors through the internalization of appearance ideals related to thinness and muscularity, as well as upwards appearance comparisons (see Fig. 1). As described above, such models have proved useful in describing the relationships among traditional media influences and body image and eating concerns (Rodgers et al. 2014), and there is evidence to suggest that social media may show similar relationships (e.g. McLean et al. 2015). Some of the principal criticisms levied at the body image literature include the disproportion in research interest directed towards understanding and preventing body image concerns in girls, compared to the relative paucity in boys (McCabe

and Ricciardelli 2004a, b). Furthermore, it has been suggested that examining gender-specific models and interventions as opposed to aiming to develop those that might be applicable across all genders might be more useful (McCabe et al. 2017). With this in mind, the model was tested among girls and boys separately. It was hypothesized that the model would be a good fit among both boys and girls.

Methods

Participants

A sample of 770 adolescents was recruited as part of a larger intervention study. A total of 681 (49% female) participants, mean age = 12.76 years (SD = 0.74), provided complete data at baseline and were included in this study. The majority (79.5%) were born in Australia and more than half had an Australian born mother (59.1%) and father (57.7%). The majority of participants identified English as the main language spoken at home (81.7%) and 1.8% identified as either or both Aboriginal and Torres Strait Islander. The majority of participants (71.6%) were in areas of high relative socio-economic advantage (deciles 7–10), whereas only a small percentage (10.5%) were in an area of low relative disadvantage (deciles 1–4).

Procedure

Participants were recruited as part of a larger intervention study. Details regarding the study can be found in the published protocol (Gordon et al. 2019). Briefly, participants were recruited from 8 schools in the area of Melbourne, Australia. Active parental consent was required for six of the

eight schools from which adolescents were recruited, thus 43% of parents provided active parental consent. In the remaining two schools, parent-informed opt-out consent was used to recruit participants. Only 7% of parents from these two schools chose to opt their child out of the study. Adolescents were then offered the opportunity to provide active assent, none of the adolescents declined to participate.

Measures

Social Media Use

Frequency of social media use was assessed by adolescents rating how often they used different social networking services including Snapchat, Instagram, Facebook, YouTube, Twitter, Tumblr, and Pinterest. For each of these platforms, participants responded to the stem “I use this service...” by selecting their response on a 5-point scale, from 1 (*Never*) to 5 (*Always*). A total social media use score was generated by summing these responses across the 7 platforms to represent cumulative use over these platforms. In the present data this measure of frequency was positively correlated with self-reported time in hours/minutes spent on social media across these 7 platforms ($r = 0.53$)

Self-esteem

Self-esteem was assessed with a well-established single item measure (Robins et al. 2001). Participants were asked to indicate on a scale ranging from 1 (*Not very true of me*) to 5 (*Very true of me*), their response to the item “I have high self-esteem.” This single item measure revealed strong psychometric properties in college students as well as community members of both genders, including strong convergent validity with other frequently used longer measures of self-esteem, providing further evidence for its validity (Robins et al. 2001), and has previously been successfully used with children (Bird et al. 2013).

Depressive Symptoms

Depressive symptoms were assessed using the Center for Epidemiologic Studies Depression Scale-revised version for adolescents (CESDR-10 (Haroz et al. 2014)) that was adapted to exclude the item related to suicidality. The resulting 9-item measure includes items assessing affective and somatic symptoms of depression that are optimized for adolescents and are scored on a 5-point response scale ranging from 0 (*Not at all or less than 1 day in the last week*) to 4 (*Nearly every day for 2 weeks*). Higher summed scores indicate greater levels of depressive symptoms. An example item is “I felt like a bad person.” The scale has revealed good psychometric properties in adolescent

samples. In this sample $\alpha = .88$ among male and $\alpha = 0.90$ among female adolescents.

Muscular Ideal Internalization

Internalization of the muscular-ideal was assessed using the 5-item Muscular/Athletic Internalization subscale of the Sociocultural Attitudes Towards Appearance Questionnaire-4 (Schaefer et al. 2015). Items are scored on a 5-point likert-scale ranging from 1 (*Definitely Disagree*) to 5 (*Definitely Agree*), with higher averaged scores indicating higher levels of muscular-ideal internalization. An example item is, “I think a lot about looking muscular.” The scale has previously been found to possess good psychometric properties among young adults (Schaefer et al. 2015). In this sample $\alpha = 0.93$ among male and $\alpha = 0.92$ among female adolescents.

Social Media Ideal Internalization

The reduced 5-item version of the Internalization General subscale of the Sociocultural Attitudes Towards Appearance Questionnaire-3 was modified to be specific to social media. The reduced version of the scale omits the 4 original items that assess for comparisons with media images as appearance comparisons were assessed separately (McLean et al. 2019; Thompson et al. 2004). The five items are scored on a 5-point likert-scale ranging from 1 (*Definitely Disagree*) to 5 (*Definitely Agree*), with two of the items reverse-scored. Higher average scores represent higher levels of internalization. An example item is, “I would like my body to look like the models who appear on social media.” In this sample, the scale revealed good internal reliability $\alpha = 0.75$ among male and $\alpha = 0.84$ among female adolescents.

Upward Appearance Comparison

Upward appearance comparison was assessed using a modified version of the Upward Physical Appearance Comparison Scale (McLean et al. 2016; O’Brien et al. 2009), that reflects extent of engagement in appearance comparisons with others who are perceived as more attractive than the self. The revised version of the scale is modified to include five of the original items scored on a 5-point Likert-scale ranging from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*), with higher average scores reflecting greater tendencies to upward appearance comparison. An example item is, “I tend to compare myself to people who look better than me.” The original scale has shown good psychometric properties in young adults (O’Brien et al. 2009), and the revised version used here has shown good reliability among adolescent girls (McLean et al. 2016). In this sample, $\alpha = 0.96$ among male and $\alpha = 0.96$ among female adolescents.

Body Dissatisfaction

Body dissatisfaction was assessed using the weight and shape concern subscales from the Eating Disorders Examination Questionnaire (EDE-Q; Fairburn and Beglin 1994). The scale is a very well-established measure of body image concerns over the course of the last 28 days and has been previously used among adolescent girls and boys (Allen et al. 2013). The scale includes 12 items scored on a 7-point Likert-scale ranging from 0 (*Not at All*) to 6 (*Markedly*), with higher average scores reflecting greater body dissatisfaction. An example item is, “How dissatisfied have you felt about your shape?” In adolescents, the psychometric properties have been reported to be good (Allen et al. 2013). In this sample, $\alpha = 0.95$ among male and $\alpha = 0.97$ among female adolescents.

Dietary Restraint

Dietary restraint was assessed using the restrained eating subscale of the Dutch Eating Behavior Questionnaire (DEBQ; Van Strien et al. 1986). The scale includes 10 items assessing efforts to restrict eating for weight control that are scored on a 5-point Likert-scale ranging from 1 (*Never*) to 5 (*Very often*), with higher summed scores reflecting greater restraint. An example item is, “Do you try to eat less at mealtimes than you would like to eat.” The scale has previously been found to display good psychometric properties among both adolescent girls and boys (Snoek et al. 2008). In this sample, $\alpha = 0.92$ among male and $\alpha = 0.95$ among female adolescents.

Muscle-building Behaviors

Muscle-building behaviors were assessed using the Body Change Inventory that was developed for use among adolescent girls and boys (Ricciardelli and McCabe 2002). The muscle-building subscale includes six items that are scored on a 5-point Likert-scale ranging from 1 (*Never*) to 5 (*Always*), with higher summed scores reflecting greater engagement in muscle-building behaviors. An example item is, “How often do you change your levels of exercise to increase the size of your muscles?” The scale has previously been found to display good psychometric properties among both adolescent girls and boys (Ricciardelli and McCabe 2002). In this sample, $\alpha = 0.91$ among male and $\alpha = 0.93$ among female adolescents.

Body Mass Index

Adolescents were invited to provide self-reported weight and height, or to have the supervisor on site measure their height and allow the adolescent to discretely measure their

own weight, if they preferred. They were also able to select that they would prefer not to respond. In the final sample, $n = 286$ (36.9%) indicated that they estimated their height and weight, $n = 236$ (30.5%) indicated that the supervisor measured their height and weight, and $n = 253$ (32.6%) selected neither. Significantly more girls opted out of providing BMI data compared to boys, $p = 0.004$.

Data Analyses

Descriptive statistics were computed, and correlations among the study variables were examined among boys and girls separately. The model presented in Fig. 1 was tested using path analysis. Model fit was assessed using the comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). Guidelines suggest that CFI values of .90 or higher indicate acceptable model fit and CFI values of 0.95 indicate good fit, while RMSEA values of 0.08 or less and SRMR values of 0.05 or less indicate good model fit (Bentler 1990; Browne and Cudeck 1993; Hu and Bentler 1999). Analyses were conducted using AMOS v.25. As AMOS handles only complete data, no data were missing in the data utilized.

Results

Descriptive Statistics and Correlations

Means and standard deviations for study variables are presented in Table 1. Overall, the variables revealed the expected patterns of associations. Specifically, social media use was correlated weakly-to-moderately with lower self-esteem, higher depressive symptoms, higher internalization of appearance ideals, higher tendency to engage in appearance comparison, dietary restraint, body dissatisfaction and muscle change behaviors among both girls and boys. In addition, low self-esteem and depressive symptoms were both correlated with the internalization of muscularity and social media-related appearance ideals, as well as appearance comparison. Finally, internalization of the social media ideal and the muscular ideal, as well as appearance comparisons, were all three positively correlated with body dissatisfaction, restraint, and muscle behaviors.

BMI data were available in a sub-sample of adolescents ($n = 450$). Adolescents who chose to not provide BMI data reported higher levels of internalization of the muscular ideal ($p = 0.01$), and higher levels of restraint ($p = 0.05$) than those who did. BMI was weakly associated with lower self-esteem, and higher depressive symptoms, appearance comparison, body dissatisfaction and restraint among both adolescent boys and girls.

Table 1 Descriptive statistics and correlation coefficients among boys (*n* = 349) and girls (*n* = 332)

	Social Media Use	Self-esteem	Depression	Internalization muscularity	Internalization social media	Appearance comparison	Body dissatisfaction	Dietary restraint	Muscle behaviors	BMI
Social Media Use										
Self-esteem	-0.29**									
Depression	0.23**	-0.57**								
Internalization muscularity	0.12*	-0.31**	0.39**							
Internalization social media	0.31**	-0.51**	0.48**	0.51**						
Appearance comparison	0.30**	-0.60**	0.58**	0.55**	0.72**					
Body dissatisfaction	0.30**	-0.55**	0.61**	0.47**	0.61**	0.62**				
Dietary restraint	0.29**	-0.55**	0.63**	0.48**	0.62**	0.63**	0.78**			
Muscle behaviors	0.22**	-0.39**	0.46**	0.68**	0.48**	0.50**	0.62**	0.64**		
BMI (<i>n</i> = 450)	0.04	-0.19**	0.16*	0.08	0.14	0.24**	0.33**	0.83**	0.11	
Means (SD) Boys	12.80 (4.24)	3.78 (0.93)	14.79 (6.78)	2.44 (1.11)	2.17 (.94)	1.33 (.75)	1.81 (.88)	15.93 (7.52)	11.24 (5.30)	18.92 (4.02)
Means (SD) Girls	13.80 (3.74)	3.56 (1.02)	17.29 (8.29)	2.15 (1.04)	2.59 (1.11)	1.61 (.96)	2.11 (1.09)	18.75 (9.42)	10.73 (5.34)	19.46 (4.24)

Values in grayed cells are correlation coefficient among boys while those in white cells are values among girls

p* < .01; *p* < 0.001

Model Testing

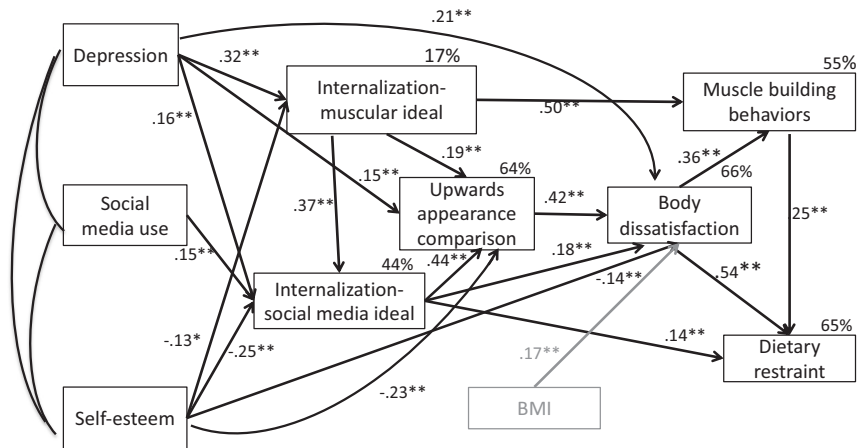
As BMI was available only in a subsample, within each gender, the hypothetical model was tested first in the full sample without BMI.

Findings Among Girls

Among girls, the hypothetical model (Fig. 1) was a poor fit to the data, $\chi^2(21) = 337.11, p < 0.001, GFI = 0.85, CFI = 0.81, RMSEA = 0.22$. Examination of the modification indices, in conjunction with the consideration of the underlying theoretical framework, led to the inclusion of eight additional pathways between: (1) internalization of the muscular ideal and muscle building behaviors; (2) depressive symptoms and body dissatisfaction; (3) muscle building behaviors and restraint; (4) depressive symptoms and upward appearance comparison; (5) self-esteem and body dissatisfaction; (6) self-esteem and upward appearance comparisons; (7) internalization of the social media ideal and restraint; and (8) internalization of the social media ideal and body dissatisfaction. In addition, non-significant pathways were trimmed. The final modified model revealed a good fit to the data, $\chi^2(21) = 37.91, p = 0.001, GFI = 0.97, CFI = 0.99, RMSEA = 0.073$. The model is displayed in Fig. 2 and explained 17% of the variability in internalization of the muscular ideal, 44% of variability in social media ideal, 64% of variability in upward appearance comparison, 66% of variability in body dissatisfaction, 65% of variability in dietary restraint, and 55% of variability in muscle building behaviors. Social media use revealed a direct effect on both internalization of the social media ideal and internalization of the muscular ideal. In addition, significant indirect effects were found between social media use and upward appearance comparison, standardized estimate = 0.067, 90% CI [0.04–0.11], *p* = 0.002, social media use and body dissatisfaction, standardized estimate = 0.056, 90% CI [0.03–0.09], *p* = 0.002, social media use and dietary restraint, standardized estimate = 0.056, 90% CI [0.03–0.09], *p* = 0.002, and social media use and muscle building behaviors, standardized estimate = 0.02, 90% CI [0.01–0.04], *p* < 0.001.

The final model was then tested with the addition of BMI in the subsample of girls providing these data (*n* = 192). The final model including BMI and a pathway to body dissatisfaction was an acceptable fit to the data, $\chi^2(19) = 47.19, p = 0.001, GFI = 0.96, CFI = .98, RMSEA = 0.089$. The explained variability in body dissatisfaction increased to 71%, that of dietary restraint to 76%, and that of muscle building behaviors to 61%. The similarity of the model with and without including BMI among girls speaks to the robustness of the model.

Fig. 2 Final model in girls with standardized regression weights and proportion of explained variance. BMI in grey was included in a subsample. * $p < 0.01$, ** $p < 0.001$



Findings Among Boys

Among boys, the hypothetical model was also a poor fit to the data, $\chi^2(21) = 315.12$, $p < 0.001$, GFI = 0.85, CFI = 0.74, RMSEA = 0.20. Examination of the modification indices led to the inclusion of five additional pathways, which were identical to those included in the final model among girls. They were between: (1) internalization of the muscular ideal and muscle building behaviors; (2) depressive symptoms and body dissatisfaction; (3) muscle building behaviors and restraint; (4) depressive symptoms and upward appearance comparison; and (5) self-esteem and body dissatisfaction. In addition, non-significant pathways were trimmed. The final modified model (Fig. 3) revealed a good fit to the data, $\chi^2(18) = 52.94$, $p < 0.001$, GFI = 0.97, CFI = 0.97, RMSEA = 0.077. The model is displayed in Fig. 3 and explained 11% of the variability in internalization of the muscular ideal, 24% of variability in social media ideal, 47% of variability in upward appearance comparison, 42% of variability in body dissatisfaction, 55% of variability in dietary restraint, and 42% of variability in muscle building behaviors. Social media use revealed a direct effect of both internalization of the muscular ideal and internalization of the social media ideal. In addition, significant indirect effects were found between social media use and upward appearance comparison, standardized estimate = 0.165, 90% CI [0.13–0.23], $p < 0.001$, social media use and body dissatisfaction, standardized estimate = 0.058, 90% CI [0.04–0.09], $p = 0.002$, social media use and dietary restraint, standardized estimate = 0.067, 90% CI [0.05–0.10], $p < 0.001$, and social media use and muscle building behaviors, standardized estimate = 0.147, 90% CI [0.09–0.21], $p = 0.004$.

The final model was then tested with the addition of BMI in the subsample of boys providing these data ($n = 258$). The final model including BMI and a pathway to body

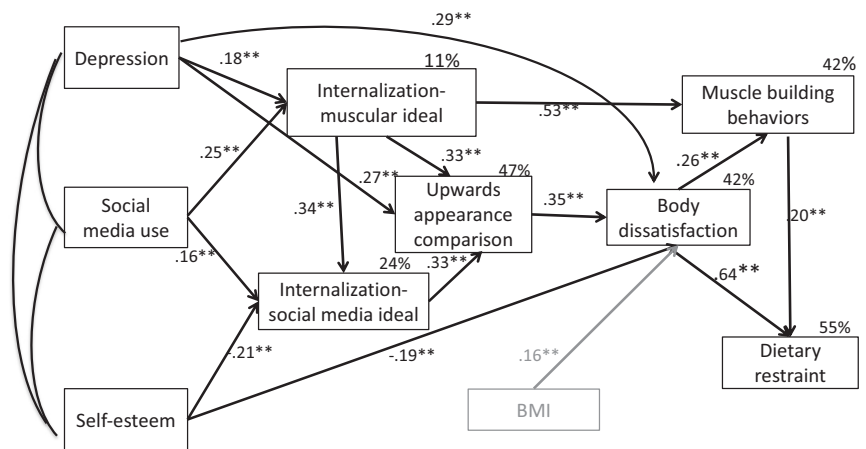
dissatisfaction was a good fit to the data, $\chi^2(23) = 43.64$, $p = 0.006$, GFI = 0.97, CFI = 0.97, RMSEA = 0.06. The explained variability in body dissatisfaction increased to 44%, that of dietary restraint decreased to 54%, and that of muscle building behaviors decreased to 39%. Thus, among boys also, the similarity of the model with and without including BMI speaks to the robustness of the model.

Discussion

The present study aimed to extend previous research by testing a biopsychosocial model of relationships between social media use and body image, dietary restraint, and muscle building behavior outcomes among adolescent boys and girls. Support for the usefulness of biopsychosocial models for describing the relationships among traditional media and body image and eating concerns has previously emerged (Rodgers et al. 2014), as well as for bivariate relationships between social media use and these concerns, although largely among female samples (Holland and Tiggemann 2016). The present study, therefore, builds upon the extant literature by examining an integrated model of these relationships among adolescent girls and boys separately. The findings provide additional support that the biopsychosocial framework is useful among adolescents of both genders and add to the growing body of research that has positioned social media use as an important aspect of adolescents' sociocultural environment, including in the context of appearance pressures. Although the final model included several modifications compared to the initial hypothesized model, the resulting models explained substantial proportions of the variance in dietary restraint and muscle building behaviors among both girls and boys.

Among girls, the final model included a number of additional pathways compared to the parsimonious

Fig. 3 Final model in boys with standardized regression weights and proportion of explained variance. BMI in grey was included in a subsample. * $p < 0.01$, ** $p < 0.001$



hypothetical model and explained large proportions of the variability in body image, restraint, and muscle building behavior outcomes. Consistent with bivariate findings social media use was associated with social media-ideal internalization that mediated the effects of social media on appearance upward comparison and body dissatisfaction (McLean et al. 2015), dietary restraint, and muscle building behavior outcomes (Ho et al. 2016). This is an important finding that provides support for theories (Rodgers 2016) describing how the influence of social media on body image and eating outcomes among youth can be conceptualized within sociocultural frameworks that emphasize appearance comparisons and the endorsement of unrealistic ideals as important mechanisms in these relationships. In addition, self-esteem and depressive symptoms, two indicators of negative affect, were both directly associated with social media-ideal internalization, as well as muscular-ideal internalization. Furthermore, depressive symptoms were associated with higher appearance upward comparison while low self-esteem was associated with higher body dissatisfaction. These additional pathways confirm previous findings regarding the usefulness of integrating negative affect components into integrated models of body image and eating concerns among adolescent girls (Rodgers et al. 2014).

In addition to the findings extending previous literature by supporting the role of social media within the biopsychosocial model among adolescent girls, the present study is novel in that it included muscle building behaviors as an outcome for girls. A small number of previous studies have examined muscle building behaviors among adolescent girls (Hoffmann and Warschburger 2017; McCabe and Ricciardelli 2004a, b; McCabe and Ricciardelli 2003); however, this is the first to consider them as an outcome in an integrated model, thus positioning them within the spectrum of disordered appearance driven behaviors for girls. The final model explained 55% of the variance in these behaviors among girls, which while lower than that for dietary

restraint, is a significant proportion and suggests that the model successfully captures dimensions that are associated with muscle-building behaviors among girls. Given the rising profile of muscularity related concerns and behaviors among adolescent girls and young women (Rodgers et al. 2018), further work to clarify the extent to which these concerns are associated with unhealthy or excessive exercise and muscle building behaviors, including disordered eating patterns, and the consumption of supplements, is warranted.

Among boys, the fit of the final model, and the inclusion of direct pathways between social media use and internalization of both social media and muscularity related ideals, the latter somewhat more strongly, also provided further evidence of the usefulness of sociocultural frameworks when investigating these relationships. Data on the relationship between social media use and body image and eating outcomes are much more scarce among boys compared to girls, thus these findings constitute an interesting and novel contribution to the literature. In addition, both depressive symptoms and self-esteem revealed direct relationships with the internalization and comparison mediator variables and direct relationships with body dissatisfaction, and when included, BMI was also associated with body dissatisfaction, supporting the usefulness of including negative affect and biological components in integrated models for boys also (Paxton et al. 2006).

As among girls, the model was successful in predicting a notable proportion of the body image, eating, and muscular building behavior outcomes among boys, thus extending previous research (Rodgers et al. 2012). Nevertheless, the overall explained variability among boys was slightly lower than among girls. It may be that other contributing factors might be important to consider in explanatory models of body image, eating, and muscle building outcomes among adolescent boys. Future research should consider including peer variables as well as celebrity engagement on social media dimensions as additional components among boys (Ho et al. 2016).

Although some differences for girls and boys in the final supported models were revealed, as has been described by other work among adolescents (Rousseau et al. 2017), overall, the models were characterized by greater similarities than differences. Interestingly, one of the differences that did emerge was the way in which social media use was directly related to dimensions of internalization of appearance ideals. Among boys the strongest relationship was with internalization of the muscular ideal, while among girls this pathway was not significant. This finding suggests that adolescent girls and boys may either be exposed to gender-specific content through their use of social media, or may react to content in different ways. Future research should aim to expand our understanding of the ways in which adolescent boys in particular use social media to shed light on these differences. For example, it may be that gender differences in the types of platforms preferentially used by adolescent girls and boys partially explain the findings. Nevertheless, the similarity in factors that may contribute to negative body image and unhealthy body change behaviors among adolescents, and the pathways by which they operate, suggests that it would be appropriate to focus on the same factors in prevention interventions for adolescents. Furthermore, the inclusion of a focus on muscularity behaviors in such programs, typically seen as being a relevant domain only for boys or men (e.g., Yager et al. 2018), would be indicated by these findings as also relevant for girls. However, confirmation of the pathways in longitudinal research, to provide evidence for causality, would strengthen this implication.

This study has several limitations including varying rates of participation across sites that may have led to unequal representation in the final sample. Nevertheless, the large and comparably sized samples of adolescent girls and boys is an important strength as many of these relationships have not been investigated among boys so far. In addition, the data were self-reported and cross-sectional, which prevented us from investigating the directionality of the relationships. Developing increasingly sensitive measures related to social media usage will also support additional research in this area. Future prospective studies in this area will be critical to help identify the directionality of relationships. Finally, only a subset of the sample provided BMI data and data were not collected on other biological dimensions that could be important contributors to outcomes such as pubertal timing (McCabe and Ricciardelli 2004a, b).

Conclusion

The present study tested a biopsychosocial model of the relationships between social media use and body change behaviors among adolescent girls and boys, in which social

media use, as well as negative affect (depression and self-esteem), were predicted to be associated with outcomes through the internalization of appearance ideals related to thinness and muscularity, as well as upwards appearance comparisons. This study presents several novel aspects including the inclusion of adolescent boys, the testing of an integrated biopsychosocial model of the relationships between social media use and body image, dietary restraint, and muscle building outcomes among adolescents, with the inclusion of muscularity behaviors as an outcome of interest for adolescent girls. The findings regarding the usefulness of the model build upon and extend previous work in this area and suggest that sociocultural influences, psychological dimensions, and biological variables may all be important contributors to these outcomes in adolescents, pending replication in longitudinal work. Should the findings be confirmed, they also suggest useful targets for interventions aiming to decrease body image and eating concerns among adolescents, as well as the usefulness of addressing social media use among adolescents as an important part of prevention efforts in this group. Future work clarifying the relationships between social media use and mental health outcomes, particularly body image and related behaviors, is needed. In addition, efforts to identify mechanisms that may exacerbate or diminish these effects, such as literacy related to social media, types of social media use (Vannucci and Ohannessian 2019), or parental influences (De Vries and Vossen 2019), as well as individual factors that might modulate vulnerability among adolescents, such as types will be important.

Author Contributions RFR conceived of the study, participated in its design, conducted the analysis, and drafted the manuscript; SJP participated in the design and interpretation of the data, and helped to draft the manuscript; CG participated in the design and coordination of the study and performed the measurement; HKJ participated in the design of the study coordination; AS and SAM participated in the study design and interpretation of the data. All authors read and approved the final manuscript.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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