

# Mediating effects of body composition between physical activity and body esteem in Hong Kong adolescents: a structural equation modeling approach

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**Abstract** This study investigated the mediating role of body mass index (BMI) in the relationship between physical activity and body esteem in adolescents. Nine hundred and five

Hong Kong Chinese students aged 12–18 years participated in a cross-sectional study in 2007. Students' BMI was computed as an indicator of their body composition. Their physical activity level and body esteem were examined using the Physical Activity Rating for Children and Youth (PARCY) and Body Esteem Scale (BES), respectively. Structural equation modelling was used to investigate the mediating effects of BMI and physical activity in predicting body esteem, with stratification by sex. The overall fit of the hypothesized models was satisfactory in boys (NFI=0.94; NNFI=0.88; CFI=0.95; RMSEA=0.07) and girls (NFI=0.89; NNFI=0.77; CFI=0.91; RMSEA=0.11). When BMI was considered as a mediator, higher physical activity had a significant negative total effect on body esteem in boys, but not in girls. The indirect effect of higher physical activity on body esteem via BMI was positive in boys, but negative in girls.

**Conclusions:** Regular physical activity may help overweight adolescents, especially boys, improve their body esteem. Kinesiologists and health professionals could explore the use of physical activity prescriptions for weight management, aiming at body esteem improvement in community health programs for adolescents.

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## What is Known:

- Among Western adolescents, negative body esteem is more pervasive in girls than in boys.
- There are consistent findings of the association between higher body mass index and lower body esteem in adolescents, but the association between physical activity and body esteem are equivocal.

## What is New:

- A negative association between body mass index and body esteem was found in both Hong Kong adolescent boys and girls.
  - The indirect effect of physical activity on body esteem via body mass index was positive in Hong Kong adolescent boys, but negative in girls.
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**Keywords** Body mass index · Physical activity · Body esteem · Adolescents

Being overweight affects not only physical but also psychological components of health. While the majority of studies have reported that obese adolescents tend to have lower self-esteem than the lean [9, 10, 23, 35], non-significant associations have also been reported [6, 16]. On the other hand, regular physical activity has been found to be related to better self-esteem [34], with corresponding results available in adolescents from different countries [17, 37]. A recent systematic review has suggested that adolescent obesity may have different effects on various components of global self-esteem, including physical appearance and physical activity competencies [12]. These mixed findings suggest that investigating the effect of body weight on specific domains of global self-esteem may help disentangle the associations between body composition, physical activity, and self-esteem.

Body esteem is an important component of the self-esteem construct, measuring one's own physical self-esteem. While several adolescent studies have examined the relationship between physical activity and self-esteem [8, 32], a specific focus on body esteem has been limited. Few studies have attempted to explore the interrelationships among the three variables, i.e., body composition, physical activity, and body esteem, and separate models for boys and girls were rarely used [19, 22]. A recent study among primary school students found that body esteem was not associated with physical activity, yet an interaction between weight status and sex was found on body esteem and specifically the Appearance subscale of Body Esteem Scale (BES) [33]. In addition to sex, age is another key demographic factor affecting body esteem. Improvement of body esteem with age may be owing to age-related body mass index (BMI) differences [21].

Using data from a cross-sectional study, we tested the hypotheses that (1) physical activity mediates the relationship between BMI and body esteem and (2) BMI mediates the relationship between physical activity and body esteem. As the cross-sectional nature of the data did not allow establishment of the direction of influences (BMI influencing physical activity vs physical activity influencing BMI) and both hypotheses were theoretically plausible, our study simultaneously tested both hypotheses. We also hypothesized that such mediating effects may differ between sexes. By investigating these two hypotheses, this study aimed to provide a more comprehensive understanding of the relationships between physical activity, body esteem, and body composition using a structural equation modeling approach.

## Methods

### Participants and procedures

A total of 905 Form 1–7 Chinese students (55.2 % boys) aged 12–18 years from a Hong Kong secondary school participated in a cross-sectional study in 2007. Body height was measured with a measuring tape fixed to a vertical wall, to the nearest 0.1 cm. Body weight was measured using digital scales with subjects barefoot, to the nearest 0.1 kg. BMI was computed from weight (kg)/height squared ( $m^2$ ). Ethics approval was obtained from the Ethics Committee of the University.

The students completed a questionnaire in Chinese language to report their physical activity level and body esteem. The Physical Activity Rating for Children and Youth (PARCY) was developed based on the Godin-Shephard Activity Questionnaire [11], and the scale has been shown to be predictive of cardiovascular risks in Chinese adolescents [18]. The PARCY scale includes a list of activities under three metabolic equivalent (MET) categories, light (3 METs), moderate (5 METs), and vigorous (9 METs). Students chose the best statement describing their physical activity habits from 11 items, which differ by activity frequency, duration, and intensity. A higher PARCY score indicates a higher physical activity level in the past 12 months. In addition, body esteem was evaluated by the 23-item body esteem scale (BES) which focuses on general individual feelings related to own appearance (subscale “appearance” with ten items), evaluations attributed to others about one's body (subscale “attributions” with five items), and weight satisfaction (subscale “weight” with eight items). The scoring options were presented in a five-point scale ranging from zero (never) to four (always). A higher score indicates a higher level of body esteem. The BES has been validated in adolescents [24, 26] and in adults with different weight statuses [25]. Among children, BES-determined body esteem has been found to be closely related to self-esteem [27, 28]. In Asia, BES has been used among Japanese college students [31].

### Data analysis

The main analysis was conducted with stratification by sex. Students' weight status was defined by the International Obesity Task Force standards [5]. Structural equation modeling (SEM) was used to investigate our two possible hypotheses: (1) physical activity mediates the relationship between BMI and body esteem and (2) BMI mediates the relationship between physical activity and body esteem. The root mean square error of approximation (RMSEA), Bentler-Bonett normed (NFI), and non-normed fit index (NNFI) were used to evaluate the level of fit of the proposed pathway models [3]. The components of BES as well as the total latent score were included in the structural part (i.e., measurement part) of the

models. We tested hypothesis 1 in model 1 and hypothesis 2 in model 2 by reversing the direction of the association path (arrow) between physical activity and BMI, while the other components of the SEM diagrams remained unchanged. Although conceptually different, models 1 and 2 are mathematically equivalent. Each model was repeated in boys and girls. All analyses were conducted using SPSS and EQS programs.

**Results**

Table 1 provides the physical characteristics, body esteem, and physical activity data for boys and girls. The mean BMI value was 20.74 (SD=3.86) in boys and 20.52 (SD=3.56) in girls; 21.1 % of the boys and 14.3 % of the girls were overweight/obese. Boys scored significantly higher in BES-Total (42.33 vs 40.05) and the subscale BES-Weight Concern (15.44 vs 13.22) than girls. No significant sex difference was found for BES-Appearance (21.53 in boys and 21.12 in girls) and BES-Attribution (5.37 in boys and 5.62 in girls). The mean PARCY score (4.76 vs 3.64) was also significantly higher in boys. In Table 2, the independent model testing the hypothesis that all estimated parameters were uncorrelated was rejected in both boys with  $\chi^2$  (10,  $N=500$ )=202.32 ( $p<0.005$ ) and girls with  $\chi^2$  (10,  $N=405$ )=213.69 ( $p<0.005$ ). The overall models 1 and 2 fit the data satisfactorily for boys,  $\chi^2$  (4,  $N=500$ )=13.19; NFI=0.94; NNFI=0.88; CFI=0.95; RMSEA =0.07, and girls,  $\chi^2$  (4,  $N=405$ )=22.60; NFI=0.89; NNFI=0.77; CFI=0.91; RMSEA=0.11.

**Model 1**

In boys (Fig. 1a), BMI was negatively related to physical activity (standardized coefficient=-0.17;  $z=-0.11$ ,  $p<0.001$ ), and physical activity was not significantly

associated with body esteem (standardized coefficient=0.05;  $z=0.037$ ,  $p=0.23$ ). A higher BMI value also directly and negatively associated with the level of body esteem (standardized coefficient=-0.20;  $z=-0.09$ ,  $p<0.001$ ). BMI had a non-significant indirect effect, mediated by physical activity, on body esteem (standardized coefficient=-0.009;  $z=-0.004$ ,  $p=0.25$ ). The total (indirect and direct) effect of BMI on body esteem was statistically significant and negative (standardized coefficient=-0.21;  $z=-0.097$ ,  $p<0.001$ ).

In girls (Fig. 1b), the overall model shows that BMI had a significant positive effect on physical activity (standardized coefficient=0.13;  $z=0.08$ ,  $p=0.007$ ). Physical activity had a non-significant effect on body esteem (standardized coefficient=0.08;  $z=0.09$ ,  $p=0.10$ ). In addition, BMI had a significant negative direct effect on body esteem (standardized coefficient=-0.32;  $z=-0.21$ ,  $p<0.001$ ). When the mediating role of physical activity was taken into account, BMI had a non-significant indirect effect on body esteem (standardized coefficient=0.011;  $z=0.007$ ,  $p=0.16$ ). BMI also had significant negative total (indirect plus direct) effect on body esteem (standardized coefficient=-0.31;  $z=-0.20$ ,  $p<0.001$ ).

**Model 2**

In boys (Fig. 2a), physical activity had a significant negative effect (standardized coefficient=-0.17;  $z=-0.24$ ,  $p<0.001$ ) on BMI and a non-significant direct effect on body esteem (standardized coefficient=0.05;  $z=0.037$ ,  $p=0.23$ ). BMI was negatively related to body esteem (standardized coefficient=-0.20;  $z=-0.09$ ,  $p<0.001$ ). When BMI was considered as a mediator, physical activity had a significant positive indirect effect on body esteem (standardized coefficient=0.033;  $z=0.023$ ,  $p=0.006$ ). The total (indirect plus direct) effect of physical activity on body esteem was marginally significant and positive (standardized coefficient=0.087;  $z=0.059$ ,  $p=0.056$ ).

**Table 1** Basic characteristics, body esteem, and physical activity in boys and girls

Mean (SD)	Boys ( $N=500$ )	Girls ( $N=405$ )	<i>t</i>	<i>p</i> values
Age, years	14.63 (1.92)	14.76 (1.89)	-0.981	0.327
BMI, kg/m <sup>2</sup>	20.74 (3.86)	20.52 (3.56)	0.884	0.377
BES-Total	42.33 (10.22)	40.05 (11.15)	3.204	0.001
BES-Appearance	21.53 (4.75)	21.12 (5.16)	1.243	0.214
BES-Attribution	5.37 (4.30)	5.62 (4.04)	-0.884	0.377
BES-Weight Concern	15.44 (5.04)	13.22 (5.66)	5.870	<0.001
PARCY	4.76 (2.61)	3.64 (2.16)	7.051	<0.001

BMI Body Mass Index, BES Body Esteem Scale, PARCY Physical Activity Rating for Children and Youth

**Table 2** Fit statistics for structural equation models of body esteem in boys and girls

	$\chi^2$	<i>df</i>	$\chi^2/df$	NFI	NNFI	CFI	RMSEA	90 % CI
Independence model for boys	202.32	10	20.23					
SEM model for boys	13.19	4	3.30	0.94	0.88	0.95	0.07	0.03–0.11
Independence model for girls	213.69	10	21.40					
SEM model for girls	22.60	4	5.65	0.89	0.77	0.91	0.11	0.07–0.15

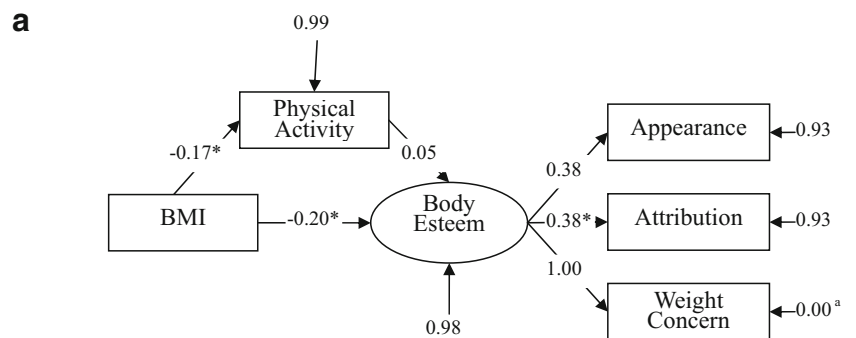
*NFI* normed fit index, *NFI* non-normed fit index, *CFI* comparative fit index, *RMSEA* root mean square error of approximation, *CI* confidence interval, *SEM* Structural Equation Model

In girls (Fig. 2b), the overall model shows that physical activity had a non-significant direct effect on body esteem (standardized coefficient=0.08;  $z=0.09$ ,  $p=0.098$ ). Physical activity has a significant positive effect on BMI (standardized coefficient=0.13;  $z=0.22$ ,  $p=0.007$ ). When the mediating role of BMI was taken into account, physical activity had a significant negative indirect effect on body esteem (standardized coefficient=-0.042;  $z=-0.045$ ,  $p=0.016$ ). Nevertheless, the total effect of physical activity on body esteem was not statistically significant (standardized coefficient=0.038;  $z=0.04$ ,  $p=0.45$ ).

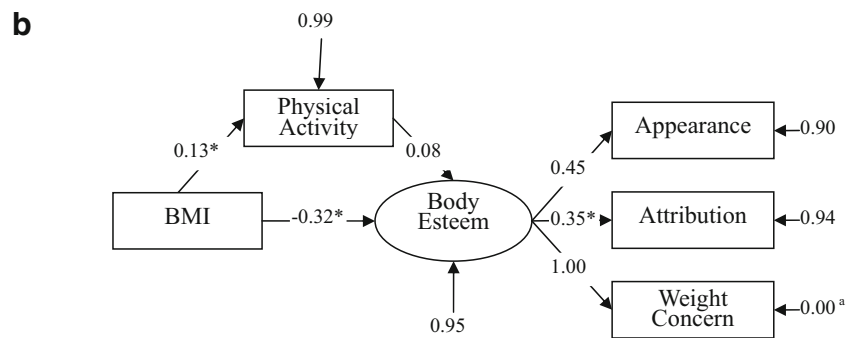
**Discussion**

This study reported the intricate relationships between body composition, physical activity level, and body esteem in Chinese adolescents. The acceptable goodness of fit revealed that the proposed models could explain the interrelationships between the measured variables and constructs. In both boys and girls, BMI had a negative total and direct effect on body esteem. A higher BMI was related to lower body esteem in adolescents, regardless of sex. This is consistent with the past findings that heavier adolescents perceived their body image

**Fig. 1** a Structural equation model showing the mediating effect of physical activity between body mass index and body esteem in boys. b Structural equation model showing the mediating effect of physical activity between body mass index and body esteem in girls

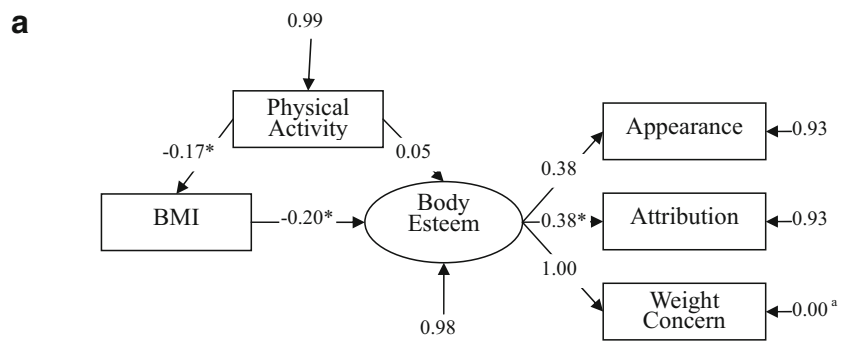


<sup>a</sup> Constrained at lower bound as 0  
\*  $p < 0.05$

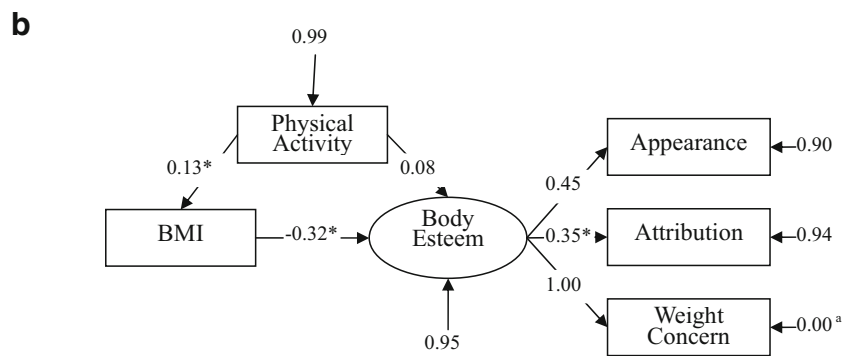


<sup>a</sup> Constrained at lower bound as 0  
\*  $p < 0.05$

**Fig. 2 a** Structural equation model showing the mediating effect of body mass index between physical activity and body esteem in boys. **b** Structural equation model showing the mediating effect of body mass index between physical activity and body esteem in girls



<sup>a</sup> Constrained at lower bound as 0  
 \*  $p < 0.05$



<sup>a</sup> Constrained at lower bound as 0  
 \*  $p < 0.05$

negatively than those who are lighter [35]. However, the relationship between BMI and physical activity level was different by sex. Higher BMI was associated with higher physical level in girls but lower physical level in boys. It is reasonable to believe that heavier girls may be more self-conscious about losing weight using physical activity than boys in Hong Kong.

Our further mediation analyses seem to support hypothesis 2 (rather than hypothesis 1): BMI mediates the effect of physical activity on body esteem. From the SEM models with BMI as a mediator, a higher level of physical activity was found to be associated with a lower BMI and in turn higher body esteem in boys but a higher BMI and in turn lower body esteem in girls. These indicated that a higher physical activity level may not have direct benefits to body esteem in both boys and girls. It is a general belief that body esteem is an outcome of habitual physical activity patterns, and active adolescents may develop their confidence to perform physical activity regardless of their body size. Our study further found that merely being engaged in physical activities, without actual body composition changes, would not effectively promote the body esteem of adolescents. This may help explain the previous findings that no significant relationship was found between physical activity and body dissatisfaction in British children aged 11 to 14 [7]. At the same time, it partially explains the findings

that physical activity did not help increase the physical self-esteem in adolescent boys, but not in girls from a 3-year longitudinal study in Sweden [30].

There are several noteworthy points to the result interpretations of the present study. The activity descriptions of the 11 items in PARCY may not provide sufficient and equivalent meaning to all adolescents, owing to different physical and social environments in their daily life. Reading the chart with different MET values may require some basic scientific knowledge and be time-consuming. The single PARCY score may therefore not reflect the actual physical activity patterns of adolescent boys and girls who may differ in their understanding of intensity of activities. Improving the scale with supplementary diagrams may help self-assess of physical activities among the adolescent population. If possible, activity diary could be used to examine the validity of the self-reported activity time. At the same time, sedentary activities such as video gaming and studying should be included to generate a more holistic profile of the health behaviors of the adolescents, to understand their clustered effects on body esteem. Ideally, biological maturation which is closely related to physical activity among adolescents [2] should be investigated. Another study from Mainland China also showed declines in body esteem in boys during adolescence [4]. Other factors

such as relationships with parents which would mediate the association between body image and self-esteem [29] were also not investigated in this study.

Causality between physical activity level and body esteem was not ascertained in this cross-sectional study. It is also unclear if BMI or physical activity was the mediator in the models, as temporal precedence could not be ascertained. Nonetheless, PARCY assessed the usual physical activity levels within the previous year while the BES and BMI assessed their current body esteem and weight status, respectively. Our robust SEM results also indicated a significant indirect effect of physical activity on body esteem through BMI in both boys and girls, but not from BMI to body esteem through physical activity. Indeed, the relationships between BMI and internalization may not be linear in adolescents [36].

In spite of these limitations, this study built upon a previous study, which found a simultaneous positive effect of body esteem and negative effect of high BMI on the overall self-esteem among Icelandic adolescents [19]. It has also provided new information of the relationship between body composition, physical activity, and the specific domain of self-esteem–body esteem in adolescents. Although physical activity may not improve body esteem directly in adolescent boys, it could potentially help them to lose weight and ultimately enhance their body esteem. Such results are not replicable in girls from our findings. It is not sure if the function of physical activity was compromised by other health behavioral problems, such as eating disturbance in girls, resulting in a net increase in BMI and poorer body esteem [13]. Different results are reported in Western countries. Results from the USA vary with gender and race, being overweight and physically inactive were both associated with low self-esteem in Hispanic adolescent girls [23]. In Turkey, both BMI and physical activity were positively associated with perceived body attractiveness in adolescent boys, while in girls, only BMI was positively associated with perceived body attractiveness [1]. Therefore, it is not clear if our observations are specific to Hong Kong adolescents, owing to the special culture in Hong Kong, where the West meets the East. As reported in another Hong Kong study, BMI does not contribute to the development of self-esteem among early adolescents [38]. This study may further suggest that BMI could contribute to body esteem in a later developmental stage, i.e., mid- and late adolescence.

In practice, physical education programs could aim at improving the body esteem of adolescents according to their sex and weight status. This may help relieve the possible stigmatization of adolescents with an unhealthy weight status. The results are also important for physical education teachers and wellness instructors for prescribing physical activity as an intervention for improving the body esteem of students and clients [14]. Future studies could explore extrapolation of the results for specific adolescent groups, including those at risk of eating disorders [20] and diabetics [15].

## Conclusions

Regular physical activity may help overweight adolescents, especially boys to improve their body esteem. Kinesiologists and health professionals could explore the use of exercise prescriptions to help adolescents maintain a healthy body composition and improve their body esteem in future community health program planning.

**Conflict of interest** The authors declare that they have no competing interests.

**Authors' contributions** KKM performed the data analysis, interpreted the results, and drafted and approved the manuscript. CE, AMM, and CML assisted in the data analysis and interpretation, and reviewed the manuscript. JRD and SYH revised the manuscript.

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