

Original article

The mirror's curse: Weight perceptions mediate the link between physical activity and life satisfaction among 727,865 teens in 44 countries

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Abstract

Purpose: The present study aimed to examine the link between physical activity (PA) and life satisfaction in a large international study of adolescents. We also aimed to test whether overweight and underweight perceptions act as mediators and whether age and sex acted as moderators.

Methods: For this purpose, we analyzed data from the Health Behavior in School-aged Children study, which comprises 727,865 observations from 44 nations at 4 measurement occasions.

Results: Multilevel analyses revealed a positive link between PA and life satisfaction. In addition, underweight and overweight perceptions mediated the effect of PA on life satisfaction. We further found that age and sex acted as moderators. In older adolescents, stronger effects were found in the links between PA and life satisfaction, PA and overweight perception, and both weight perceptions and life satisfaction. In addition, in female adolescents, the link between overweight perception and life satisfaction was stronger. Conversely, the links between PA and both weight perceptions were stronger for boys.

Conclusion: The results suggest that weight perception explains part of the relationship between PA and life satisfaction in adolescents and that these effects vary as a function of age and sex.

Keywords: Adolescent health; Life satisfaction; Multinational evidence; Physical activity; Weight perceptions

1. Introduction

Exercise not only has implications for better physical health but can also have a positive effect on psychological factors, such as self-esteem, emotions, or mood.¹ Mental health matters particularly in adolescence: rapid structural brain maturation makes adolescence a critical period of psychosocial development and adaptation.² During this time, especially for girls, internalizing problems—such as lower self-regard—seem to increase.³ As part of an adolescent's personal health, well-being can be seen as a basic requirement to reach developmental milestones in adolescence and well-being in adulthood.⁴

Physical activity (PA), sometimes operationalized as participation in sports, has consistently been associated with higher psychosocial health in adolescents.⁵ Therefore, PA is

considered a protective factor for the well-being of adolescents.⁶ Previous research has shown that increased PA relates to higher general well-being, better health, lower anxiety and depressive symptoms, and a lower risk of mental health problems.^{7,8}

During adolescence, youth are especially vulnerable to dissatisfaction with their body,⁹ which is related to negative outcomes in adulthood, such as eating disorders and depression.¹⁰ Because of its connection to PA as well as to life satisfaction, body satisfaction and weight perception could potentially explain part of the link between PA and life satisfaction.^{11,12} Regarding practical implications, some intervention studies that increase PA do not take into account psychological constructs.⁸ Therefore, it is important to investigate whether weight perception could be one of the psychological factors that play a significant role when considering the implications of PA. The goals of the current study were, therefore, to examine the effect of PA on life satisfaction and to determine whether weight perception partly mediates this link.

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1.1. Physical exercise and life satisfaction in adolescents

There is a large body of cross-sectional and longitudinal research that shows which different kinds of PA, such as a more active lifestyle or exercising, are related to higher life satisfaction or happiness in adolescents.^{5,8} Life satisfaction describes the cognitive–evaluative component of subjective well-being¹³ and encompasses individuals' appraisal of their life in general. High life satisfaction confers many benefits to adolescents in terms of their intrapersonal, social, and cognitive functioning.¹⁴ This makes the study of predictors of life satisfaction in adolescence a valuable endeavor.

1.2. Weight perception as an explanatory mechanism

Weight perception reflects one part of body image, which is a multidimensional construct that comprises 4 ways in which people see and evaluate their body (i.e., global subjective satisfaction, affective distress regarding appearance, cognitive aspects, and behavioral aspects). Weight perception can therefore be understood as a cognitive component of body image.¹⁵

Adolescent girls are especially vulnerable to a negative body image,⁹ mostly due to physical changes experienced during puberty, such as the increase in body fat.¹⁶ Correlation between actual body mass index (BMI) and body satisfaction is only moderate in girls and low to moderate in boys, indicating that body image may encompass a psychological component.¹⁷ Recent evidence from a cross-sectional study from Spain suggests significant differences between perceived and desired body perceptions in female adolescents, independent of BMI.¹⁸

Previous research corroborates the link between PA (especially exercise) and body image.¹⁹ A meta-analysis of the effects of exercise participation and body image reported a positive but small effect of exercise on body image.²⁰ Similarly, a recent review of more than 210 studies²¹ has found that PA and sport were associated with a more favorable body image. However, due to the cross-sectional nature of the studies reviewed, causality cannot be inferred. Furthermore, regular exercise has also been linked to concepts similar to body image, like a more favorable self-image.⁷ An integrative review of reviews showed a positive association between PA and the way adolescents think about themselves in general, finding higher self-esteem among more active adolescents.⁸

Body image could also be linked to life satisfaction. Theoretical models define self-acceptance as one of the 6 domains of psychological well-being.²² In line with these theories and evidence, concepts similar to body image, such as body shame, body satisfaction, and self-acceptance, have been linked to life satisfaction.^{23,24} In addition, multinational evidence suggests that satisfaction with the self and self-esteem were correlated with life satisfaction in general across most nations,²⁵ and a study of 652 adolescents from Spain showed that body image acted as a mediator between PA and self-esteem.²⁶

Evidence is mixed, however, regarding the link between body image or weight perception and life satisfaction in adolescence. A longitudinal study of more than 1000 Norwegian adolescents and young adults found no link between body satisfaction and life satisfaction,²⁷ but a study of 1281 Australian

adolescents found that weight satisfaction and appearance ratings were positively linked to life satisfaction.²⁸ In addition, a study of 5570 young Iranian adolescents reported an association between misperceptions of oneself as overweight or underweight and lower life satisfaction scores.¹²

To sum up, PA can improve self-image,⁷ which in turn, measured as weight satisfaction, can be linked to life satisfaction.²⁸ Therefore, weight perception is likely to explain a part of the relationship between PA and life satisfaction. To our knowledge, however, this effect has not yet been investigated, although studies have examined this mediation with concepts close to weight perception or body image (e.g., self-esteem) and life satisfaction (e.g., psychological well-being). A comparatively small study of female American students found no significant relationship between sports participation and body satisfaction, of which weight satisfaction was one part. A mediating effect of body satisfaction in total, however, emerged for the link between sports participation and psychological well-being in combination with physical competence as an additional mediator.²⁹ Data from 18,922 adolescents in the United States revealed that participation in sports decreased the odds of depressive symptoms in adolescents, and this association was mediated by self-esteem.³⁰

1.3. Moderating effects of age and sex

Age might act as a potential moderator for the associations between PA, weight perception, and life satisfaction because older children engage more in social comparison than younger children.¹⁰ In addition, the motives for participation in sports might change from childhood to adolescence: during adolescence, weight management becomes more important.³¹ This could also mean that the effect of PA on weight perception could increase with age. Evidence on the moderating role of age is, however, still lacking.

Regarding the moderating role of sex, it has been found that, although girls are more concerned that they are overweight, boys tend to be more concerned that they are underweight or insufficiently muscular,¹⁰ suggesting a linear relationship between body mass and body satisfaction for female children and youth compared to a curvilinear link in male children and youth.³² Based on additional longitudinal evidence that supports the gender specificity of the link between BMI and body satisfaction,^{33,34} it is likely that sex differences contribute to the relationship between PA, weight perception, and life satisfaction.

1.4. Universality across Western countries

To investigate the universality of these associations, in the current study we examined the link between PA and life satisfaction and the mediating role of weight perception in 44 nations across Europe and North America. This allowed us to account for international variation in PA³⁵ and life satisfaction²⁵ in Western countries. Further, North American samples are currently overrepresented in studies of, for example, the relationship between exercise or physical health and life satisfaction.³⁶ Likewise, regarding research on weight perception as a part of body image, there is an overrepresentation of American, Australian, and British studies.¹⁰ Using

multinational data enabled us to investigate whether the evidence found in previous research can also be generalized across a multitude of Western countries.

1.5. The present study

As Biddle and Asare⁸ concluded in their review, most interventions to improve mental health do not integrate other factors aside from PA. Therefore, target individuals might not benefit enough from these interventions in terms of their mental health⁸ because it has been shown that weight-based teasing can especially exacerbate mental health issues, even after controlling for actual body weight.³⁷

When it comes to preventing obesity, a study by Neumark-Sztainer et al.³⁸ underscored the importance of intervention programs that simultaneously increase PA and body satisfaction in adolescents. Because overweight and obesity are negatively correlated with life satisfaction,³⁹ it is likely that PA interventions, which include body weight concerns, can lead to a more considerable improvement of adolescents' life satisfaction.

Therefore, in the present study we investigated the mediating role of weight perception in the relationship between PA and life satisfaction in adolescents. Using representative multinational data from the Health Behavior of School-aged Children (HBSC) study, we examined (1) whether more PA relates to higher life satisfaction, (2) whether weight perception acts as a mediator of the link between PA and life satisfaction, and (3) whether age and sex moderate these associations.

2. Methods

We used cross-sectional data from 44 countries (Supplementary Table 1) from 2002, 2006, 2010, and 2014 of the ongoing international HBSC study, which has a nationally representative sample of adolescents aged 10–17 years.⁴⁰

2.1. Participants

Participants were randomly recruited through their schools and anonymously completed a standardized questionnaire, translated into their local language, in a classroom setting without their teachers being present. The students were allowed to leave any question unanswered. Institutional ethical permission was obtained in each participating country, with both schools and adolescents giving informed written consent.

All participating countries for which there were data on PA, life satisfaction, and weight perception in all study waves were included in the present analysis. The pool of participants was 795,918, of which 68,053 (8.55%) were excluded due to missing responses, resulting in a final sample of $n = 727,865$. Of these participants, the mean age was 13.59 years (range: 9.83–17.25 years) and 51.3% were female. The data of the 4 survey years were collapsed in our analyses.^a

^a We conducted the analyses for each survey year separately and found largely overlapping confidence intervals (CIs) and therefore no significant differences (see Supplementary Tables). Consequently, we did not control for the survey year.

2.2. Measures

2.2.1. PA

Participants were first given a definition of PA and then examples for particular sports, which were adjusted to their country. For instance, in Switzerland, the following example sports were presented: fast walking, jogging, dancing, skateboarding, swimming, surfing, and football or similar team sport, as well as martial arts and horse riding. Then the participants were asked, "Over the past 7 days, on how many days were you physically active for a total of at least 60 min per day?" Participants answered this question using a scale from 0 (0 day) to 7 (7 days). Asking participants about their PA over the past week for a given minimum of minutes that refer to current health recommendations has been shown to be a reliable and valid approach to measuring PA.⁴¹

2.2.2. Life satisfaction

Regarding life satisfaction, the participants were shown a picture of a ladder with the following instructions: "Here is a picture of a ladder. The top of the ladder "10" is the best possible life for you and the bottom "0" is the worst possible life for you. In general, where on the ladder do you feel you stand at the moment?"⁴² Participants were then asked to check the box next to the number that described best where they currently stood. Single items measuring life satisfaction as well as the Cantril Ladder itself have been shown to provide good retest reliability and convergent validity.^{43–45}

2.2.3. Weight perception

To assess weight perception, the participants were asked, "Do you think your body is ...?" and answered on a scale: 1 (*much too thin*), 2 (*a bit too thin*), 3 (*about right*), 4 (*a bit too fat*), and 5 (*much too fat*). As in similar studies with HBSC data,⁴⁶ Values 1 and 2 were then recoded as underweight perception and Values 4 and 5 were recoded as overweight perception, with Value 3 serving as the reference category, which was recoded to Value 0. This procedure resulted in 2 variables representing weight perception. In the HBSC study wave of 2006, this single-item question of weight perception was tested for reliability and stability and showed a good retest reliability (intraclass correlation coefficient = 0.99).⁴⁷

2.3. Statistical analyses

We used multilevel modeling techniques to account for the interdependent structure of the data. Level 1 represents the variation among individuals within nations, and Level 2 represents the variation among the 44 nations.^b All variables were country-mean centered and z standardized, which makes the interpretation of the unstandardized regression coefficient b

^b Nine countries did not participate in all of the 4 survey waves. We ran the analyses separately with and without these countries and did not find significant differences, showing that the countries did not systematically drop out (differences in the direct effects and CIs are ≤ 0.001 , with CIs largely overlapping). Therefore, we did not exclude these countries, thereby maintaining a larger sample of nations.

Table 1
Bivariate correlations between key variables.

	1	2	3	4	5	6	7	8
1. PA	–							
2. LS	0.147**	–						
3. UP	–0.036**	–0.095**	–					
4. OP	–0.114**	–0.216**	– ^a	–				
5. Age	–0.122**	–0.174**	0.014**	0.070**	–			
6. Sex	–0.151**	–0.055**	–0.037**	0.139**	0.001	–		
7. BMI	–0.080**	–0.115**	–0.238**	0.432**	0.333**	–0.061**	–	
8. GDP	0.021**	–0.022**	–0.013**	0.019**	–0.003*	–0.003*	–0.070**	–

^a Correlation could not be computed because of missing values (when someone has underweight perception, there are missing values in the variable overweight perception).

* $p < 0.05$, ** $p < 0.001$.

Abbreviations: BMI = body mass index; GDP = gross domestic product; LS = life satisfaction; OP = overweight perception; PA = physical activity; UP = underweight perception.

comparable to the standardized regression coefficient β . We controlled for age, sex, and BMI^c to investigate the effects independent of age, sex, or actual body size of the participants. Controlling for BMI is important because, although weight perception and BMI are correlated constructs, there are substantial discrepancies between the constructs.⁴⁸

In addition, there is evidence that PA of individuals, especially when undertaken during leisure time, is related to a country's gross domestic product, at least in Europe.⁴⁹ Therefore, we controlled for gross domestic product^d to account for possible variance across the countries.^e

To test for possible mediation of weight perception on the relationship between PA and life satisfaction, we used multilevel mediation with PA as an independent variable, life satisfaction as a dependent variable, and underweight or overweight perception as mediation variables. Missing values were excluded listwise. To calculate the significance of the indirect effects, 95% Monte Carlo confidence intervals (95%MCCIs) were computed with 10,000 bootstrapping samples with within-cluster standard errors. Finally, we ran all analyses with age and sex as moderators. The analyses were conducted with MLmed⁵⁰ in SPSS Statistics (Version 23.0; IBM, Armonk, NY, USA). To examine significant interaction effects, we conducted simple slopes analyses with the medmod package⁵¹ in R (Version 3.6.0; the R Foundation for Statistical Computing, Vienna, Austria).

3. Results

3.1. Descriptive statistics

Supplementary Table 1 shows the sample characteristics, including mean age, percentage of female participants, and the

^c BMI was weight (kg) divided by height (m²) and was based on the World Health Organization's child growth curve (for more information see WHO data set notes: https://gateway.euro.who.int/en/indicators/hbhc_18-bmi/); BMI was not measured in the survey year 2006; therefore, BMI for this study wave was excluded listwise.

^d GDP 2002-2014. Retrieved from: <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD>

^e For England, Scotland, and Wales, we used the GDP of the United Kingdom.

means and standard errors (SEs) of the key variables of all participating countries. Table 1 shows the bivariate correlations between the investigated variables. PA was significantly associated with life satisfaction, as well as with both weight perception variables. Underweight as well as overweight perceptions were in turn correlated with life satisfaction. BMI was only moderately correlated with the weight perception variables, suggesting that weight perception is not only an objective evaluation of the adolescent's body. We therefore controlled for BMI to measure the psychological part of weight perception.

3.2. Direct effects and mediation results

We first tested the direct effect of PA on life satisfaction with multilevel analyses. We found that PA acted as a significant predictor of life satisfaction ($b = 0.118$, $SE = 0.001$, $p < 0.001$), explaining 1.4% of the variance in life satisfaction.

We then used multilevel mediation analyses to test the hypothesis that underweight and overweight perceptions mediate the effect of PA on life satisfaction. Regarding underweight perception, results indicate that PA was negatively associated with underweight perception ($b = -0.043$, $SE = 0.002$, $p < 0.001$). Furthermore, underweight perception was negatively associated with life satisfaction ($b = -0.093$, $SE = 0.005$, $p < 0.001$). The indirect effect was significant ($b = 0.004$, 95%MCCI: 0.0035–0.0045), suggesting that the effect of PA on life satisfaction was partly mediated by underweight perception. The indirect effect explained 0.002% of the variance in life satisfaction.

Regarding overweight perception, a significant association between PA ($b = -0.054$, $SE = 0.002$, $p < 0.001$) and life satisfaction ($b = -0.189$, $SE = 0.009$, $p < 0.001$) emerged. The indirect effect was significant ($b = 0.010$, 95%MCCI: 0.009–0.011), indicating that overweight perception partly mediated the effect of PA on life satisfaction. The indirect effect explained 0.01% of the variance in life satisfaction.

3.3. Age and sex interaction effects

Finally, we also tested possible moderating effects of age and sex (Supplementary Tables 2 and 3). Age moderated the

direct link between PA and life satisfaction ($b = 0.006$, $SE = 0.001$, $p < 0.001$). Simple slopes analyses revealed that this effect was slightly stronger for older adolescents (1 SD above the mean age, $b = 0.132$, 95%CI: 0.129–0.136, $p < 0.001$) than for younger adolescents (1 SD below the mean age, $b = 0.123$, 95%CI: 0.119–0.126, $p < 0.001$). We also found that age significantly moderated the link between PA and overweight perception ($b = -0.016$, $SE = 0.001$, $p < 0.001$), which was also slightly stronger for older adolescents (1 SD above the mean age, $b = -0.121$, 95%CI: -0.124 to -0.117 , $p < 0.001$) than for younger adolescents (1 SD below the mean age, $b = -0.094$, 95%CI: -0.098 to -0.091 , $p < 0.001$). Furthermore, age moderated the link between underweight perception and life satisfaction ($b = -0.011$, $SE = 0.002$, $p < 0.001$), with the effect being slightly stronger for older adolescents (1 SD above the mean age, $b = -0.098$, 95%CI: -0.102 to -0.094 , $p < 0.001$) than for younger adolescents (1 SD below the mean age, $b = -0.078$, 95%CI: -0.083 to -0.075 , $p < 0.001$). Finally, age also moderated the link between overweight perception and life satisfaction ($b = -0.007$, $SE = 0.001$, $p < 0.001$), with the effect being slightly stronger for older adolescents (1 SD above the mean age, $b = -0.210$, 95%CI: -0.214 to -0.207 , $p < 0.001$) than for younger adolescents (1 SD below the mean age, $b = -0.196$, 95%CI: -0.200 to -0.191 , $p < 0.001$).

Sex emerged as a significant moderator in the effect of overweight perception on life satisfaction ($b = -0.030$, $SE = 0.002$, $p < 0.001$). An additional test of simple slopes signified that the moderation was slightly stronger for girls ($b = -0.240$, 95%CI: -0.244 to -0.237 , $p < 0.001$) than for boys ($b = -0.168$, 95%CI: -0.173 to -0.164 , $p < 0.001$). Sex further moderated the link between PA and underweight perception, with the effect being slightly stronger for boys ($b = -0.048$, $SE = 0.002$, 95%CI: -0.052 to -0.044 , $p < 0.001$) than for girls ($b = -0.036$, $SE = 0.002$, 95%CI: -0.040 to -0.033 , $p < 0.001$). The same was found for the link between PA and overweight perception, it being slightly stronger for boys ($b = -0.110$, $SE = 0.002$, 95%CI: -0.112 to -0.106 , $p < 0.001$) than for girls ($b = -0.082$, $SE = 0.002$, 95%CI: -0.086 to -0.078 , $p < 0.001$).

4. Discussion

The aim of this study was to test the link between PA and life satisfaction in adolescents and to examine whether weight perception acted as a mediator and age and sex as moderators. In line with previous research,⁵ we found that PA and life satisfaction in adolescence were positively associated in Western nations. Despite the importance of PA, adolescents worldwide do not attain the recommended minimum of 60 min of moderate-to-vigorous PA per day.⁶ Instead, across adolescence, PA starts to decrease around the age of 12 years.⁵² The present study suggests that an active life is linked to a happier life in adolescents. Even though our study was cross-sectional, past prospective and intervention studies corroborate a positive effect of increased PA on later well-being, such as a decrease in depressive symptoms^{53,54} and an increase in self-esteem.⁵⁵ The effect between PA and life satisfaction was small: one additional day on which PA was reported (e.g., from an

average of 4–5 days) was accompanied by an added 0.2 points on the life satisfaction ladder. It has to be noted that a number of life circumstances are linked to life satisfaction, and many of these factors combined to contribute only little to life satisfaction compared to inherent factors, such as personality traits.⁵⁶ Moreover, small effect sizes are also found in intervention studies. However, from a prospective viewpoint, small effects on life satisfaction can accumulate across time and thereby grow in meaning and importance for adolescents.⁵⁷

Weight perception—measured as subjective underweight and subjective overweight perception—mediated the effect of PA and life satisfaction in adolescents. This finding is contrary to the results from Greenleaf et al.,²⁹ who did not find a mediating effect of weight perception in the relationship between sports participation and psychological well-being. The contrasting results could be due to different methods: whereas Greenleaf et al.²⁹ investigated female adolescents and their sports participation in a relatively smaller sample ($n = 260$), in the current study, we examined female and male adolescents and PA in a large sample ($n = 727,865$). In addition, differences in the measures used could also account for the diverging results: the HBSC used more time-economic measures for weight perception and life satisfaction, whereas Greenleaf et al.²⁹ made use of more extensive scales.

This study also showed that effects are stronger for older adolescents. This is in line with evidence from a study of 9- to 18-year-olds that reported that body dissatisfaction increased with age.³³ Additionally, previous research suggests that the time between adolescence and adulthood carries the largest risk for weight gain and therefore weight perceptions could become more important with age.⁵⁸

Furthermore, sex emerged as a moderator, suggesting that the effect of overweight perception on life satisfaction may be stronger for girls than for boys. This finding is consistent with the finding that girls are more likely to report lower life satisfaction when they perceive themselves as overweight.⁵⁹ However, the link between PA and both weight perceptions may be stronger for boys. This finding is in line with previous research that has shown that the link between weight perception and weight loss attempts (PA and exercise may be undertaken as an attempt at weight loss) is slightly stronger for men than for women.⁶⁰ Furthermore, a study of adolescents found that the correlation between physical self-perception and PA is stronger for boys than for girls. On a subdomain level, body attractiveness was more strongly correlated with PA for boys than for girls.⁶¹ It seems that PA is slightly more important to boys than to girls for gaining a positive weight perception. This difference could also be because girls use other methods to manage their weight, like choosing a healthy diet.⁶² A study of adolescents in Hong Kong, China showed that boys and girls use exercise as a weight management strategy, but the girls also used other strategies, such as self-medication with diet pills, purging, or the use of laxatives.⁶³ A study of American adolescents showed that, although females seem to be more interested in weight loss and healthy eating, males reported more interest in weight lifting.⁶⁴ It could therefore be argued that males do not only use PA to lose weight but also to gain weight in the form of muscles.

Although our findings are to some extent in line with previous longitudinal research, we refrain from drawing causal conclusions given the cross-sectional nature of the HBSC data. Furthermore, all variables were self-reported, which could have led to an overestimation or underestimation of the results. Regarding the measurement of PA, we could not control for the hours spent in mandatory school sports, which could have an effect on how much time adolescents are physically active in their spare time.

Despite these limitations, the study presents the first cross-national evidence of the mediating role of weight perception in the link between PA and life satisfaction across adolescence. Therefore, our results can be considered valid for most Western countries. Despite the small effect sizes, the results underline the mediating role of weight perception for the association between adolescents' PA and their life satisfaction. More important, this study shows the importance of considering age and gender in studies of body image and PA.

Supplemental analyses (Supplementary Tables 4 and 5) suggest that this effect could become more important in subsequent generations: With each survey wave the effect was slightly stronger, as shown by the confidence intervals. This is therefore important for future research.

5. Conclusion

Our representative multinational study supports previous findings that suggest that physical interventions, adopted with the intention of alleviating mental health issues, should also consider improving weight perception and body concerns in general, especially in adolescents.³⁸ Our findings additionally show that such an intervention should be adopted, especially for older adolescents and separately for boys and girls because they need support at different stages when it comes to weight concerns.

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Authors' contributions

SM conceived and performed the statistical analyses, interpreted the data, and drafted the manuscript; RW contributed analysis tools and provided comments on the manuscript; AG provided comments on the manuscript. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:[10.1016/j.jshs.2020.01.002](https://doi.org/10.1016/j.jshs.2020.01.002).

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