

# Body image, body composition and environment: do they affect adolescents' physical activity?

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**Background:** Most adolescents are less physically active than recommended, despite the strong effort of various stakeholders to promote physical activity (PA). Body image and body composition may play an important role not only in directly facilitating adolescents' PA but also in enabling environment-related factors. As evidence is lacking, we aimed to assess the associations of adolescents' PA with body-related and environment-related factors, whether this differs by age and gender, and whether these factors interact. **Methods:** We used data on 888 11- to 15-year-old adolescents (mean age = 13.5, 56% boys) from the Health Behaviour in School-aged Children study conducted in 2018 in Slovakia. We used multinomial logistic regression analysis to assess the association of adolescents' PA with body-related factors (body image, body composition) and environment-related factors (PA-promoting environment, less leisure constraints), taking into account age and gender. **Results:** Adolescents who perceived their body as not too fat were more likely to be physically very active rather than inactive [odds ratios (ORs)/95% confidence interval (CI) 2.15/1.44–3.22], and similarly those who were not overweight/obese (3.24/2.09–5.01) and perceived less leisure constraints (1.74/1.44–2.11). In older adolescents and in girls, the association of adolescents' PA with body composition and environment-related factors was stronger. The association of adolescents' PA with perceiving less leisure constraints was stronger among adolescents who did not perceive their body as too fat (OR/95% CI 1.98/1.26–3.14), and for those who were not overweight/obese (OR/95% CI 1.62/1.01–2.57). **Conclusion:** Adolescents' PA is associated with both body-related and environment-related factors. These associations are stronger in girls and older adolescents, if co-occurring.

## Introduction

Worldwide, physical activity (PA) is decreasing and obesity is increasing among adolescents.<sup>1,2</sup> Low levels of PA have been shown to substantially contribute to obesity among adolescents.<sup>3</sup> Next, obesity leads to health problems, such as diabetes, cardiovascular diseases and oncological diseases.<sup>4</sup>

Body-related factors, such as body image and body composition, are associated with PA and may provide cues to counteract the trend of the low PA levels among adolescents. According to Jensen and Steele,<sup>5</sup> body image is one of the determinants of PA. Moreover, associations have been reported of negative body image and objectively measured weight with level of PA among adolescents.<sup>6,7</sup> This indicates that body-related factors can have an impact on the level and involvement of adolescents in PA.

Besides body-related factors, environment-related factors may also play a role in PA. Previous studies have shown that e.g. a lack of suitable travel routes and a lack of provision of local activities are major barriers for young people to be physically active.<sup>8,9</sup> In addition, perceptions of certain neighbourhood features (e.g. safety, socialization of children) are associated with PA.<sup>10,11</sup> However, Bringolf-Isler et al.<sup>12</sup> found in Swiss children that environmental factors (e.g. the building density, population density) were not associated with PA. Moreover, Haerens et al.<sup>13</sup> noted that perceived

availability of neighbourhood facilities was not related to engagement in leisure time sports. An explanation for these contradictory findings may be that other factors moderate the effect of environment-related factors.

Body-related factors may be examples of such moderators of the influence of environment-related factors. For example, the availability of green space and playgrounds and the availability of sports equipment or of peers willing to join in may promote PA only in adolescents who do not perceive their body as fat or who are not overweight/obese.<sup>14,15</sup> However, evidence on this issue lacks.

The impact of both body-related and environment-related factors on adolescents' PA may further depend on age and gender issues, which may play a role in the sensitivity to various barriers and facilitators of PA. Regarding age, adolescence is a sensitive period in terms of the formation of an active lifestyle.<sup>16</sup> While in childhood, it is rather parents who organize their leisure time, when children grow up it is more up to them if they spend their leisure time in an active or passive way.<sup>17</sup> Trost and Loprinzi<sup>18</sup> note a tendency towards a decrease in the level of PA with age. Moreover, Inchley et al.<sup>2</sup> noted that age-related declines in moderate-to-vigorous PA were more common among girls, but not among boys. Generally, boys have been shown to participate much more in moderate-to-vigorous PA than girls,<sup>19,20</sup> but this may be different for various barriers and facilitators of PA.

Regarding gender, Mendonça et al.<sup>21</sup> found that in adolescence, girls' PA was associated with parental encouragement, and boys' PA was associated with transportation provided by parents. According to Peterson et al.,<sup>22</sup> parent instrumental social support was associated with a greater confidence to overcome PA barriers only for boys. Previous research by Kopcakova et al.<sup>23</sup> also showed that these mechanisms may vary by gender, with boys but not girls being prone to be physically inactive when they are dissatisfied with their body image. In addition, as noted by Yan et al.,<sup>24</sup> girls appear to perceive more PA-related built environmental barriers than boys.

In sum, body-related and environment-related factors may both affect adolescents' PA and interact in this to a degree that varies by age and gender. However, to date, little research has examined these interactions. The aim of this study was therefore to explore the associations of adolescents' PA with body-related and environment-related factors, and whether this varies by age and gender. Furthermore, we explored if body-related factors modify the association of adolescents' PA with environment-related factors.

## Methods

### Sample and procedure

We used data on 888 adolescents (mean age = 13.5, 56% boys; SD = 1.30) from the Health Behaviour in School-aged Children (HBSC) study conducted in 2018 in Slovakia. These constituted a random sample of about 10% of all children participating in the HBSC study (more detailed information can be found at Karchynskaya et al.<sup>25</sup>). The study was approved by the Ethics Committee of the Medical Faculty at P. J. Safarik University in Kosice (16N/2017).

### Measures

We measured PA as a composite variable 'adolescents' PA' based on the combination of moderate-to-vigorous PA and engagement in organized sports. Moderate-to-vigorous PA was measured by an item asking adolescents about the number of days over the past week that they were physically active for a total of at least 60 min/day.<sup>26</sup> The engagement in organized sports regarded items dealing with team sports and individual sports, respectively, and was measured by asking adolescents: 'In your leisure time, do you do any of these organized activities?' with response categories 'yes' and 'no'.<sup>26</sup> The three categories of adolescents' PA based on this combination were as follows: (i) inactive: adolescents who were active less than 5 days per week and were not engaged in organized sports; (ii) active: active 5–7 days per week or engaged in organized sports; and (iii) very active: active 5–7 days/week and also engaged in organized sports.

We used body image and body composition to measure body-related factors. 'Body image' was assessed by the single-item HBSC question asking: 'Do you think your body is?' with five possible answers ranging from 'much too fat' to 'much too thin'.<sup>26</sup> We dichotomized the answers into two categories—being 'too fat' and 'right size or too thin'.

We measured 'body composition' using body fat percentage (%) as determined by Bioimpedance Body Composition Analysis with an InBody 230 (Biospace Co., Ltd.). The analysis was carried out according to the manufacturer's instructions.<sup>27</sup> Adolescents were instructed to dress in a t-shirt and trousers or skirt. The starting weight was set to -0.5 kg, considering that we weighed the adolescents in their underwear. Boys and girls with a proportion of body fat of over 25 and 30% were considered to be overweight and obese, respectively.<sup>28</sup>

We used PA-promoting environment and less leisure constraints to measure environment-related factors. 'PA-promoting environment' was assessed using a five-item scale derived from the European Youth Heart Study and covers perceptions of the social-physical environment comprising two subscales, opportunity ('It is safe to walk or play alone in my neighbourhood during the day', 'There are other children nearby home to go out and play with', 'There is somewhere

at home I can go out and play') and facilities ('There are playgrounds or parks close to my home where I can play', 'At school there are playgrounds or fields where I can run around').<sup>26</sup> Each item is scaled with a three-response option of agreement/disagreement ('Definitely yes', 'Undecided', 'Definitely no'). Items were summed, and the sum score varied from 5 to 15, with higher scores indicating a better PA-promoting environment for adolescents.

'Less leisure constraints' were assessed using from a list of barriers based on the 'Hierarchical Leisure Constraints' model<sup>29</sup> and cover three levels of possible obstacles: 'intrapersonal' ('I do not have enough time', 'My health does not allow it', 'I do not have enough skills and abilities to participate', 'I am not interested in participating in anything'); 'interpersonal' ('My parents do not want me to take part in activities that I would like to do', 'I do not have any friends who would like to participate with me'); and 'structural' ('We do not have enough money', 'I have no way to get to the activities, there is no one to take me there', 'There are no quality and suitable activities or facilities in my area', 'I do not have my own equipment to participate').<sup>26</sup> Each barrier was measured with five responses ('Definitely yes', 'Rather yes', 'Undecided', 'Rather no', 'Definitely no'). Responses were summed, leading to sum scores varying from 10 to 50 with higher scores meaning less leisure constraints, i.e. more promotive for PA.

### Statistical analyses

First, we described the sample using descriptive statistics. Secondly, we assessed the association of adolescents' PA (with 'inactive' as reference category) with body-related and environment-related factors using multinomial logistic regression (adjusted for age, gender), leading to odds ratios (ORs) and 95% confidence intervals (CIs). In these analyses, continuous variables (PA-promoting environment and less leisure constraints) were standardized, so that the OR indicates the increase in odds for the outcome per SD of that predictor. Moreover, age was dichotomized into 'younger' (11.00–12.99 years) and 'older' (13.00–15.96 years). Thirdly, we assessed whether age and gender modified the associations of adolescents' PA with body-related and environment-related factors by including two-way interactions of age and gender with body-related and environment-related factors into the multinomial logistic model. Finally, we assessed if body-related factors modified the association of adolescents' PA with leisure constraints by including two-way interactions of body-related factors and leisure constraints in separate models. All analyses were performed using IBM SPSS Statistics 21 for Windows.

## Results

Of our respondents, 56.0% were boys, 37.0% were very active, 36.2% were active and 26.8% were physically inactive. In addition, a quarter of the respondents (26.4%) perceived themselves as 'too fat', and 22.8% of respondents were overweight or obese (table 1).

Results of multinomial regression (table 2) showed that adolescents who reported their body as the 'right size or too thin' were more likely to be very active rather than inactive in comparison to adolescents who reported their body as 'too fat'. Similarly, those having normal weight based on body composition in comparison to those who were overweight/obese were more likely to be very active or active rather than inactive. A PA-promoting environment was not associated with PA of adolescents. Furthermore, adolescents were more likely to be very active or active rather than inactive, if they reported less leisure constraints.

Next, we assessed whether age and gender modified the associations of adolescents' PA with body-related and environment-related factors (data shown in Supplemental tables SA1–SA4). Age modified the association of body composition with adolescents' PA, meaning that the association of overweight/obesity with less PA was stronger in older adolescents (OR/95% CI 0.37/0.15–0.94). Gender modified

**Table 1** Description of the sample

Characteristic	N (%)
Adolescents' PA	
Very active	318 (37.0)
Active	311 (36.2)
Inactive	230 (26.8)
Body image	
Right size or too thin	651 (73.6)
Too fat	233 (26.4)
Body composition	
Normal weight	686 (77.3)
Overweight/obese	202 (22.7)
Age	
Younger (11–12 years old)	345 (38.9)
Older (13–15 years old)	543 (61.1)
Gender	
Boys	497 (56.0)
Girls	391 (44.0)
	Mean (SD)
PA-promoting environment (sum score varied from 5 to 15)	13.46 (1.82)
Less leisure constraints (sum score varied from 10 to 50)	39.54 (7.79)

Note: PA—physical activity; numbers of missing cases per variables: Adolescents' PA—29; body image—4; body composition—0; age—0; gender—0; PA-promoting environment—25; less leisure constraints—60.

**Table 2** Association of adolescents' PA with body image, body composition, PA-promoting environment and leisure constraints: OR and 95% CI, resulting from multinomial logistic regression model adjusted for age and gender

Characteristic	Very active vs. inactive OR (95% CI)	Active vs. inactive OR (95% CI)
Body image		
Right size or too thin	2.15 (1.44–3.22)	1.23 (0.84–1.79)
Too fat	Ref.	Ref.
Body composition		
Normal	3.24 (2.09–5.01)	1.50 (1.02–2.21)
Overweight/obese	Ref.	Ref.
PA-promoting environment (per SD)	1.13 (0.95–1.36)	1.01 (0.85–1.20)
Less leisure constraints (per SD)	1.74 (1.44–2.11)	1.26 (1.05–1.50)

Note: Ref.—reference category. Each variable was included separately in a model adjusted for age and gender.

the association of perceiving the PA-promoting environment with adolescents' PA, meaning that the association of PA-promoting environment with more PA was stronger among boys (OR/95% CI 0.67/0.45–0.99). Similarly, gender modified the association of less leisure constraints with adolescents' PA, meaning that the association of less leisure constraints with more PA was stronger among boys (OR/95% CI 0.63/0.41–0.95).

Finally, we assessed the associations of adolescents' PA with body image and less leisure constraints (table 3, top), and with body composition and less leisure constraints (table 3, bottom). Adolescents had a relatively higher PA in association with less leisure constraints if they perceived their body as the 'right size or too thin' than if perceiving their body as 'too fat' (OR/95% CI 1.98/1.26–3.14). In addition, adolescents had a relatively higher PA in association with less leisure constraints if they had a normal weight than if they had overweight/obesity (OR/95% CI 1.62/1.01–2.57). In other words, perceiving less leisure constraints was associated with a higher chance of being very active rather than inactive in adolescents who did not perceive their body as too fat and for those who were not overweight/obese, but not in adolescents who perceived themselves as too fat or suffering from overweight/obesity.

## Discussion

This study explored the associations of adolescents' PA with body-related and environment-related factors in 888 Slovak adolescents from 11 to 15 years old. We found that adolescents who perceived their body as not too fat were more likely to be physically very active rather than inactive, and the same holds if they were not overweight/obese and perceived less leisure constraints. In older adolescents and in girls, the associations of adolescents' PA with body composition and environment-related factors were stronger. Looking in more detail to less perceived leisure constraints, high PA was more likely only for adolescents who did not perceive their body as too fat, and for those who were not overweight/obese.

We found that a positive body image and normal body composition were associated with more PA in adolescents. Adolescents with overweight or obesity thus avoid PA, potentially due to a fear of weight stigmatization,<sup>30</sup> body shaming and negative body evaluation.<sup>31</sup> This aligns with the findings of Kopcakova et al.,<sup>23</sup> that boys who had a negative body image were more likely to have a lower PA level. However, it is in contrast with the findings of Zaker and Radzi<sup>32</sup> that girls who were dissatisfied with their current body image were more physically active. In addition, Humbert et al.<sup>33</sup> reported that for some adolescents weight loss and weight control were primary facilitators of PA. This demonstrates that body-related factors affect the levels of adolescents' PA and could be a facilitator or a real barrier for PA. This evidently requires further study.

In terms of body composition, we used body fat percentage as a measure, whereas body mass index (BMI) is the dominant one in the literature and is relatively easier to use in routine care. However, using BMI as an estimate of body composition can lead to misclassifications, e.g. overfat adolescents with little muscle development may be mistakenly classified as normal weight, and some adolescents with higher muscle mass may be mistakenly classified as overweight/obese.<sup>25</sup> Our analyses thus show PA to add to optimally measured body composition. Whether this also holds for body composition measured by BMI requires further study.

We also found that age modifies, i.e. that the association of overweight/obesity with less PA is stronger in older adolescents. An explanation can be that stigmatization<sup>30</sup> and bullying because of body composition increase with age in obese or overweight adolescents or have a cumulative effect when getting older, making it increasingly an additional barrier to their PA. Evidently, this strengthening with age of the association requires further study regarding its underlying mechanisms.

Regarding environmental factors, we found the associations to differ per measure, and next also to differ by age, gender and personal factors. First, a PA-promoting environment did not affect the level of PA among adolescents. This aligns with the findings of Bringolf-Isler et al.<sup>12</sup> that also found no associations between environmental factors and PA. However, it contrasts with previous study examining environmental predictors have found home equipment availability, safety and crime,<sup>10</sup> the number of places within one's neighbourhood to be active<sup>34</sup> and walkability<sup>35</sup> to be associated with PA among adolescents. In other words, it is unclear whether environmental factors are important facilitators or do not affect the level of adolescents' PA.

Secondly, we found that adolescents reporting less leisure constraints were more likely to be very active or active rather than inactive. An explanation might regard the temporal self-regulation theory,<sup>36</sup> according to which intention strength, behavioural propensity and self-regulatory capacity can help adolescents to be more physically active and less overweight at older age. Another explanation regards that the perception of PA-related environment may differ within generations of adolescents. Evidence on these changes in PA when ageing is still inconsistent indicating that the prospective contribution of these important environment-related factors to PA among adolescents deserves further study.

**Table 3** The moderating effect of body image (top) and body composition (bottom) on the association of adolescents' PA with leisure constraints

Characteristic	Model 1		Model 2	
	Very active vs. Inactive OR (95% CI)	Active vs. Inactive OR (95% CI)	Very active vs. Inactive OR (95% CI)	Active vs. Inactive OR (95% CI)
Body image				
Right size or too thin	1.95 (1.27–2.98)	1.15 (0.78–1.69)	2.09 (1.36–3.20)	1.23 (0.83–1.83)
Too fat	Ref.	Ref.	Ref.	Ref.
Less leisure constraints (per SD)	1.69 (1.40–2.05)	1.24 (1.04–1.48)	1.00 (0.67–1.48)	1.00 (0.69–1.43)
Age				
Younger	1.88 (1.27–2.79)	1.85 (1.26–2.71)	1.94 (1.30–2.89)	1.88 (1.28–2.77)
Older	Ref.	Ref.	Ref.	Ref.
Gender				
Boys	2.42 (1.67–3.52)	1.97 (1.37–2.84)	2.40 (1.64–3.48)	1.95 (1.36–2.82)
Girls	Ref.	Ref.	Ref.	Ref.
Body image right/thin × less leisure constraints	–	–	1.98 (1.26–3.16)	1.35 (0.89–2.04)
Body composition				
Normal	2.78 (1.76–4.37)	1.44 (0.96–2.15)	2.92 (1.84–4.63)	1.49 (0.99–2.24)
Overweight/obese	Ref.	Ref.	Ref.	Ref.
Less leisure constraints (per SD)	1.68 (1.38–2.04)	1.24 (1.04–1.48)	1.14 (0.76–1.72)	1.20 (0.84–1.72)
Age				
Younger	2.02 (1.36–3.02)	1.90 (1.29–2.79)	2.05 (1.37–3.06)	1.90 (1.29–2.80)
Older	Ref.	Ref.	Ref.	Ref.
Gender				
Boys	2.57 (1.76–3.74)	1.97 (1.37–2.84)	2.56 (1.75–3.73)	1.98 (1.37–2.84)
Girls	Ref.	Ref.	Ref.	Ref.
Body composition × less leisure constraints	–	–	1.62 (1.01–2.57)	1.06 (0.70–1.60)

Multinomial logistic regression models adjusted for gender and age: OR and 95% CI.

Note: Ref.—reference category.

Model 1 (top): The associations of adolescents' PA with less leisure constraints and body image, model adjusted for age and gender.

Model 2 (top): The moderating effect of body image on the association of adolescents' PA with less leisure constraints, model adjusted for age and gender.

Model 1 (bottom): The associations of adolescents' PA with less leisure constraints and body composition, models adjusted for age and gender.

Model 2 (bottom): The moderating effect of body composition on the association of adolescents' PA with less leisure constraints, model adjusted for age and gender.

Thirdly, we found that gender modifies the association of a PA-promoting environment with adolescents' PA, i.e. that it is stronger among boys. This aligns with the findings of Patnode et al.<sup>37</sup> that among boys, factors at the environmental level emerged as important predictors of moderate-to-vigorous PA. Contradictory, Chaparro et al.<sup>38</sup> found that girls exposed to high-crime neighbourhoods had lower odds of engaging in moderate-to-vigorous PA and higher odds of being overweight/obese, but no significant associations were found among boys. An explanation can be that girls' PA levels are heavily influenced by concerns for safety, more than in boys, as reported by Ries et al.<sup>39</sup> In addition, our findings show that age strengthens the association of less leisure constraints with more PA in older adolescents.

Fourth, we also found that body-related factors modify the association of adolescents' PA with environment-related factors, i.e. that the association of perceiving less leisure constraints with adolescents' PA is stronger among adolescents who did not perceive their body as too fat and among those who were not overweight/obese. This aligns with the findings of Flotnes et al.<sup>40</sup> that the risks of feeling downhearted and dissatisfied with life were higher for both underweight and overweight girls compared with girls with normal weight. Overall, these cases support the view that body image is strongly associated with symptoms of anxiety/depression and measures of well-being.<sup>40</sup> This may explain why adolescents with body-related factors are 'insensitive' to a PA-promoting context, i.e. environment-related factors do not help adolescents who

perceive themselves as too fat or suffering from overweight/obesity to be active.

### Strengths and limitations

The major strengths of this study regard its large, nationally representative sample of adolescents and the comparability of our data with the international data within the HBSC study. Another strength is that we used a composite variable enabling a multifactorial consideration of the phenomenon of PA in adolescents, and our use of two separate items for measuring body-related factors—body image, which represented subjective perceptions of body size, and body composition, which represented objective measurements (using body fat percentage).

Some limitations should also be mentioned. First, our data mostly regarded self-reports, making them prone to reporting bias. This is unlikely to explain the associations found but may have added some measurement error. A second limitation regards the cut-offs of body fat percentage that were included in the body composition variable and were used to identify overweight and obesity among adolescents. The generally accepted cut-offs of adolescents' body fat percentage at different stages of maturation have not yet been established, and in this study, gender was used for separation in the cut-offs of body fat percentage (25% for boys and 30% for girls)<sup>28</sup> in adolescents. A third limitation was the cross-sectional design of this study, which hinders conclusive inferences about

causality. Therefore, our findings need to be confirmed in longitudinal studies.

### Implications

The results of this study can help inform intervention and prevention efforts to counteract the documented decline in PA among youth. For adolescents with normal weight and a positive perception of their own body, adapting to the environment may help in promoting PA. For adolescents who are overweight, obese or who have a negative body image, a stronger focus on the underlying psychological problems of body perception may add to the contents of preventive interventions. Physical training that matches the physical limits of these adolescents, minimizing injury and pain, could help to involve adolescents with body-related factors in PA. Based on our findings, it seems that PA promotion programmes may further need to consider gender-specific strategies.

Our findings that perceiving leisure constraints are associated with PA implies that environmental interventions to promote PA can be expected to be in particular of use for certain groups of adolescents and less for the others, e.g. adolescents who are overweight/obese or perceived themselves as too fat. Taking that into account, intervening on the environment can offer a route to make considerable health gains in these particular groups.

### Conclusions

Body-related factors, e.g. perceiving one's own body as too fat or being overweight/obese, and environment-related factors, e.g. perceiving leisure constraints, are associated with being less physically active among adolescents. Age and gender partially modify this association. On top, body-related and environment-related factors seem to interact, i.e. perceiving less leisure constraints is associated with a higher chance of being physically active only in adolescents who did not perceive their body as too fat and for those who were not overweight/obese.

### Supplementary data

Supplementary data are available at *EURPUB* online.

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### Key points

- Positive body image and normal body composition are associated with physical activity (PA) of adolescents and strongest for the very active, i.e. those who are both active 5–7 days per week and engaged in organized sports.
- In older adolescents and in girls, the association of adolescents' PA with body composition and environment-related factors is stronger.
- Perceiving less leisure constraints is associated with a higher chance of being physically active only in adolescents who did not perceive their body as too fat and for those who were not overweight/obese.

### References

- 1 Inchley J, Currie D, Budisavljevic S, et al. Spotlight on adolescent health and well-being. Findings from the 2017/2018 Health Behaviour in School-aged Children (HBSC) survey in Europe and Canada. International Report. Volume 1. Key findings. WHO Regional Office for Europe: Copenhagen, Denmark, 2020.
- 2 WHO. *Adolescent Obesity and Related Behaviours: Trends and Inequalities in the WHO European Region, 2002–2014: Observations from the Health Behaviour in School-aged Children (HBSC). WHO Collaborative Cross-National Study.* Copenhagen, Denmark: WHO Regional Office for Europe, 2017.
- 3 Karuc J, Mišigoj-Duraković M. Relation between weight status, physical activity, maturation, and functional movement in adolescence: an overview. *J Funct Morphol Kinesiol* 2019;4:31.
- 4 Lobstein T, Jackson-Leach R. Planning for the worst: estimates of obesity and comorbidities in school-age children in 2025. *Pediatr Obes* 2016;11:321–5.
- 5 Jensen C, Steele RG. Body dissatisfaction, weight criticism, and self-reported physical activity in preadolescent children. *J Pediatr Psychol* 2009;34:822–6.
- 6 Kleszczewska D, Dzielska A, Nałęcz H, Mazur J. Physical activity, BMI and body weight perception among 15-year-old boys and girls in Poland in the light of international comparisons. *Dev Period Med* 2017;21:235–47.
- 7 Kantanista A, Osiński W. Underweight in 14 to 16 year-old girls and boys: prevalence and associations with physical activity and sedentary activities. *Ann Agric Environ Med* 2014;21:114–9.
- 8 McCrorie PRW, Fenton C, Ellaway A. Combining, GPS, GIS, and accelerometry to explore the physical activity and environment relationship in children and young people - a review. *Int J Behav Nutr Phys Act* 2014;11:
- 9 Christian D, Todd C, Hill R, et al. Active children through incentive vouchers - evaluation (ACTIVE): a mixed-method feasibility study. *BMC Public Health* 2016; 16:890–903.
- 10 Evenson KR, Scott MM, Cohen DA, Voorhees CC. Girls' perception of neighborhood factors on physical activity, sedentary behavior, and BMI. *Obesity* 2007;15:430–45.
- 11 Franzini L, Elliott MN, Cuccaro P, et al. Influences of physical and social neighborhood environments on children's physical activity and obesity. *Am J Public Health* 2009;99:271–8.
- 12 Bringolf-Isler B, Mäder U, Dössegger A, et al. Regional differences of physical activity and sedentary behaviour in Swiss children are not explained by socio-demographics or the built environment. *Int J Public Health* 2015;60:291–300.
- 13 Haerens L, Craeynest M, Deforche B, et al. De Bourdeaudhuij I. The contribution of home, neighbourhood and school environmental factors in explaining physical activity among adolescents. *J Environ Public Health* 2009;2009:320372.
- 14 Hobbs M, Griffiths C, Green M, et al. Associations between the combined physical activity environment, socioeconomic status, and obesity: a cross-sectional study. *Perspect Public Health* 2018;138:169–72.
- 15 Jiménez Candel MI, Carpena Lucas PJ, Ceballos-Santamaría G, et al. Relationship between modifiable risk factors and overweight in adolescents aged 12–14 years. *An Pediatr (Engl Ed)* 2021;95:159–66.
- 16 Lloyd RS, Cronin JB, Faigenbaum AD, et al. National Strength and Conditioning Association position statement on long-term athletic development. *J Strength Cond Res* 2016;30:1491–509.
- 17 Partridge JA, Brustad RJ, Babkes Stellino M. Social influence in sport. In: T. S. Horn, editor, *Advances in Sport Psychology*. Champaign, IL: Human Kinetics, 2008: 269–91.
- 18 Trost SG, Loprinzi PD. Parental influences on physical activity behavior in children and adolescents: a brief review. *Am J Lifestyle Med* 2011;5:171–81.
- 19 Condessa LA, Chaves OC, Silva FM, et al. Sociocultural factors related to the physical activity in boys and girls: peNSE 2012. *Rev Saude Publica* 2019;53:25.
- 20 Hong JT, Chen ST, Tang Y, et al. Associations between various kinds of parental support and physical activity among children and adolescents in Shanghai, China: gender and age differences. *BMC Public Health* 2020;20:–1161.
- 21 Mendonça G, Farias Júnior JCD. Physical activity and social support in adolescents: analysis of different types and sources of social support. *J Sports Sci* 2015;33:1942–51. 2015;
- 22 Peterson MS, Lawman HG, Wilson DK, et al. The association of self-efficacy and parent social support on physical activity in male and female adolescents. *Health Psychol* 2013;32:666–74.
- 23 Kopcakova J, Dankulincova Veselska Z, Madarasova Geckova A, et al. Is being a boy and feeling fat a barrier for physical activity? The association between body image, gender and physical activity among adolescents. *Int J Environ Res Public Health* 2014;11:11167–76.

- 24 Yan AF, Voorhees CC, Clifton K, Burnier C. "Do you see what I see?" – Correlates of multidimensional measures of neighborhood types and perceived physical activity – related neighborhood barriers and facilitators for urban youth. *Prev Med* 2010;50:18–23.
- 25 Karchynskaya V, Kopcakova J, Klein D, et al. Is BMI a valid indicator of overweight and obesity for adolescents? *Ijerp* 2020;17:4815.
- 26 Inchley J, Currie D, Cosma A, Samdal O. Health Behaviour in School-aged Children (HBSC) Study Protocol: background, methodology and mandatory items for the 2017/18 survey. CAHRU, St Andrews.
- 27 InBody 230 User's Manual. Available at: <https://inbodyusa.zendesk.com/hc/en-us> (4 June 2021, date last accessed).
- 28 Costa-Urrutia P, Vizuet-Gómez A, Ramirez-Alcántara M, et al. Obesity measured as percent body fat, relationship with body mass index, and percentile curves for Mexican pediatric population. *PLoS One* 2019;14:e0212792.
- 29 Crawford D, Jackson E, Godbey G. A hierarchical model of leisure constraints. *Leis Sci* 1991;13:309–20.
- 30 Puhl RM, King KM. Weight discrimination and bullying. *Best Pract Res Clin Endocrinol Metab* 2013;27:117–27.
- 31 Sabiston CM, Pila E, Pinsonnault-Bilodeau G, Cox AE. Social physique anxiety experiences in physical activity: a comprehensive synthesis of research studies focused on measurement, theory, and predictors and outcomes. *Int J Sport Exerc Psychol* 2014;7:158–83.
- 32 Zaker A, Radzi AA. Body image perception and physical activity among female adolescents. In: Ismail S, Sulaiman N, Adnan R., editors. *Proceedings of the 2nd International Colloquium on Sports Science, Exercise, Engineering and Technology*. Singapore: Springer, 2015: 291–300.
- 33 Humbert ML, Chad KE, Bruner MW, et al. Using a naturalistic ecological approach to examine the factors influencing youth physical activity across grades 7 to 12. *Health Educ Behav* 2008;35:158–73.
- 34 Norman GJ, Nutter SK, Ryan S, et al. Community design and access to recreational facilities as correlates of adolescent physical activity and body-mass index. *J Phys Act Health* 2006;3:118–28.
- 35 Kligerman M, Sallis JF, Ryan S, et al. Association of neighborhood design and recreation environment variables with physical activity and body mass index in adolescents. *Am J Health Promot* 2007;21:274–7.
- 36 Hall PA, Fong GT. Temporal self-regulation theory: a model for individual health behaviour. *Health Psychol Rev* 2007;1:6–52.
- 37 Patnode CD, Lytle LA, Erickson DJ, et al. The relative influence of demographic, individual, social, and environmental factors on physical activity among boys and girls. *Int J Behav Nutr Phys Act* 2010;7:79.
- 38 Chaparro MP, Bilfield A, Theall KP. Exposure to neighborhood crime is associated with lower levels of physical activity and higher obesity risk among adolescent girls, but not boys. *Child Obes* 2019;15:87–92.
- 39 Ries AV, Gittelsohn J, Voorhees CC, et al. The environment and urban adolescents' use of recreational facilities for physical activity: a qualitative study. *Am J Health Promot* 2008;23:43–50.
- 40 Fløtnes IS, Nilsen TIL, Augestad LB. Norwegian adolescents, physical activity and mental health: the Young-HUNT study. *Nor Epidemiol* 2011;20:153–61.