2019

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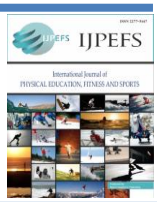
RESEARCH ARTICLE

DOI: 10.26524/ijpefs1917

International Journal of
PHYSICAL EDUCATION, FITNESS AND SPORTS



The Relationship between Body Mass Index (BMI) and Sedentary Behavior is Mediated by Negative Peer Interaction in Boys.

Received 01st January 2019
Accepted 12th March 2019

www.ijpefs.com

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Abstract: To determine if self-reported negative social interaction mediates the relationship between sedentary behavior and body mass index (BMI) percentile in boys. Twelve overweight/obese (≥85th BMI percentile) and 14 non-overweight (<85th BMI percentile) boys (10.5 ± 1.5 years old) completed surveys assessing overt peer victimization and relational victimization. Children were individually given access to a gymnasium with physical activity equipment and sedentary alternatives for 30 minutes. Children could play with the equipment in any pattern they wished and the amount of time allocated to sedentary activities (sitting time) was recorded. Overt and relational victimization were moderately and positively associated with BMI percentile ($r \geq 0.40$, $p \leq 0.04$) and sitting time ($r \geq 0.40$, $p \leq 0.05$) and sitting time was positively associated with BMI percentile ($r = 0.4$, $p = 0.05$). After controlling for overt and relational victimization the correlation between sitting time and BMI percentile was non-significant ($r \leq 0.28$, $p \geq 0.18$). The positive relationship between BMI percentile and sedentary behavior was mediated by measures of negative social interaction.

Key Words: Child, peer influence, peer victimization.

1. Introduction

Overweight/obese children allocate more time to sedentary behaviour (i.e., sitting) and are less physically active than their non-overweight peers [1-6]. This phenomenon has been demonstrated in free-living environments using self-report surveys as well as objective physical activity monitors (e.g., accelerometers) [7-9]. There is also evidence of disparate sedentary behaviour and physical activity between overweight/obese and non-overweight children in controlled laboratory environments using objective measures.10,11 Several factors have been identified that may explain this disparity including differences between overweight/obese and non-overweight children in: the relative reinforcing (i.e., motivating) value of physical activity versus sedentary alternative, self-efficacy for physical activity, self-confidence and discomfort during exercise [12-18].

In addition to the variables outlined above, negative social interaction has been identified as a potentially important factor in explaining why overweight/obese children are less active and more sedentary than their non-overweight peers [4, 7, 11, 19-23]. Overweight/obese children are more frequently the target of negative social interaction than their non-overweight peers [4, 10, 11, 24, 25]. This negative social interaction can include less social support and greater overt and relational victimization [26-29]. Overt victimization are threats or acts of physical violence. Relational victimization is attempts by peers to harm a child's relationships with other children. These forms of negative social interaction are associated with greater sedentary behaviour and reduced physical activity in children [4, 7, 11]. Additionally, ostracism (i.e., social

exclusion) is also more common among overweight/obese children and there is experimental evidence suggesting that a bout of simulated ostracism causes a subsequent reduction in physical activity and increase in sedentary behaviour in children regardless of their bodyweight.30 Taken together these findings suggest that overweight/obese children are more prone to negative social interaction and this negative social interaction is predictive of reduced physical activity and greater sedentary behaviour. This suggests that negative social interaction is a potential mediator of the relationship between adiposity and physical activity/sedentary behaviour. However, the ability of negative social interaction to mediate the relationship between adiposity and physical activity/sedentary behaviour in youth has not been previously tested.

Therefore, the purpose of this study was to assess the relationships between self-reported measures of peer victimization (overt and relational victimization), body mass index (BMI) percentile for age and objectively-observed sedentary behavior during free play in a controlled laboratory setting in boys. We then assessed the ability of overt and relational victimization to mediate the relationship between BMI percentile and sedentary behavior. We hypothesized that both measures of peer victimization, BMI percentile and sedentary behavior would all be significantly and positively related to one another. In other words, children with a greater BMI percentile would report greater peer victimization and participate in greater sedentary behavior than non-overweight children and greater peer victimization would be associated with greater sedentary behavior. We also hypothesized that the significant, positive relationship between BMI percentile and sedentary behavior would be rendered non-significant when controlling for peer victimization, thus identifying peer victimization as a potential mediator of this relationship.

2. Methods

Participants included 14 non-overweight (BMI <85th percentile) boys (10.1 ± 1.4 years old, 138.7 ± 9.5 cm, 33.5 ± 6.2 kg, 56.2 ± 15.8 BMI percentile) and 12 overweight/obese (BMI >85th percentile) boys (10.8 ± 1.6 years old, 147.6 ± 9.6 cm, 56.8 ± 17.1 kg, 93.4 ± 6.0 BMI percentile). Participants were recruited from a database of families who had previously participated in unrelated studies in our laboratory and from flyers posted in the local community. All participants were free from any orthopedic, cardiovascular, metabolic or cognitive disorders that would prevent them from safely participating in physical activity. Participants and a parent/legal guardian read and signed assent and consent forms, respectively. All procedures were approved by the University institutional review board.

2.1 Procedure

Children completed a single laboratory/activity session. While in the laboratory, they were measured for height and weight using a digital stadiometer (Charder, Taichung City, Taiwan) and balance beam scale (Health O Meter, Alsip, IL), respectively. Children also completed the validated Children Self-Experience Questionnaire to assess self-reported incidence of peer victimization [26-27]. Children then participated in physical activity and sedentary behavior in any pattern they chose during a 30-minute, free-play session in a 4,300 square foot gymnasium that was located within the same facility as the laboratory. The gymnasium was equipped with a variety of physical activities (obstacle courses, balls, hoops, etc.) and a table equipped with a chair and sedentary activities (age-appropriate books, toys, coloring sheets, crayons, pencils, etc.). The specific configuration of the gymnasium and activity options has been reported previously [31-32]. Each child participated in this free-play activity session with no other children present as the presence of a peer can affect physical activity and sedentary behavior [4, 10, 32] During this session, research personnel recorded the time children allocated to the sedentary activities. If children wished to play with the sedentary activities, they were instructed they had to do so while seated in the chair located at the table with said activities.

2.2 Measurements

Peer victimization: Children completed the

validated Children Self-Experience Questionnaire to assess peer victimization. This questionnaire reports peer victimization in two different subscales: overt and relational victimization. The overt victimization subscale assessed the frequency of threats or acts of physical violence a child is subjected to by their peers. The relational victimization subscale assessed the frequency of attempts to harm relationships children were subjected to by their peers. These scales have previously been shown to possess strong internal consistency (Cronbach's α = 0.82 - 0.97) [26, 27, 29, 33].

Sedentary behavior: The amount of time children allocated to sedentary behavior during the 30-minute activity session was recorded via a stopwatch (Traceable® Stopwatch, Fisher Scientific, Waltham, Massachusetts) by research personnel discretely observing the participant. The stopwatch was started at the moment a child sat in the chair at the sedentary activity table and stopped when/if they vacated the chair and returned to the physical activities. The process was repeated should a child participate in multiple bouts of sedentary activity during the 30-minute activity session. The time allocated to these multiple bouts of sedentary behavior was then summed as the measure of sedentary behavior.

2.3 Analytic plan

Independent samples t-tests were utilized to assess potential differences in BMI percentile, self-reported peer victimization (overt, relational) and sedentary behavior in non-overweight and overweight boys. The remaining analytic approach was designed to assess the ability of the two scales of self-reported peer victimization to mediate the relationship between BMI percentile and sedentary behavior. According to Baron and Kenny, a mediator is a variable that accounts for the relationship between two other variables [34]. This mediator will be correlated to both of the other two variables and the correlation between these two other variables will be rendered non-significant after controlling for the potential mediator. Therefore Pearson's correlation analyses were first performed to assess the relationship between the following variables: peer victimization subscales (overt, relational), BMI percentile and sedentary time. Subsequent partial correlations were then performed assessing the relationship between BMI percentile and sedentary time after individually controlling for the two peer victimization subscales

3. Results

Mean comparisons between non-overweight and overweight boys are listed in Table 1.

Peer victimization subscales (overt, relational) were significantly and positively correlated (r = 0.85, p < 0.001) to one another and each subscale was significantly and positively correlated to both BMI percentile (r = 0.46, p = 0.02 for overt, r = 0.40, p = 0.04 for relational) and sedentary behavior (r = 0.40, p = 0.05 for overt, r = 0.42, p = 0.04 for relational). In other words, children reporting greater peer victimization had a greater BMI percentile and participated in more sedentary behavior. BMI percentile was also significantly and positively correlated to sedentary behavior (r = 0.4, p = 0.05). In other words, children with a greater BMI percentile participated in more sedentary behavior.

Partial correlations revealed that when separately controlling for each of the two peer victimization subscales the relationship between BMI percentile and sedentary behavior was rendered non-significant (r = 0.28, p = 0.18 for overt, r = 0.26, p = 0.21 for relational, Figure 1).

Table 1. Data are means ± SD. There were significant differences ($t \geq 2.3$, $p \leq 0.03$) between groups for all variables.

	BMI percentile	Overt victimization	Relational victimization	Sedentary time (min)
Non-overweight boys	56.2 ± 15.8	7.7 ± 2.6	8.2 ± 3.2	1.4 ± 3.6
Overweight/obese boys	93.4 ± 6.0	11.5 ± 3.9	11.8 ± 4.7	7.7 ± 6.6

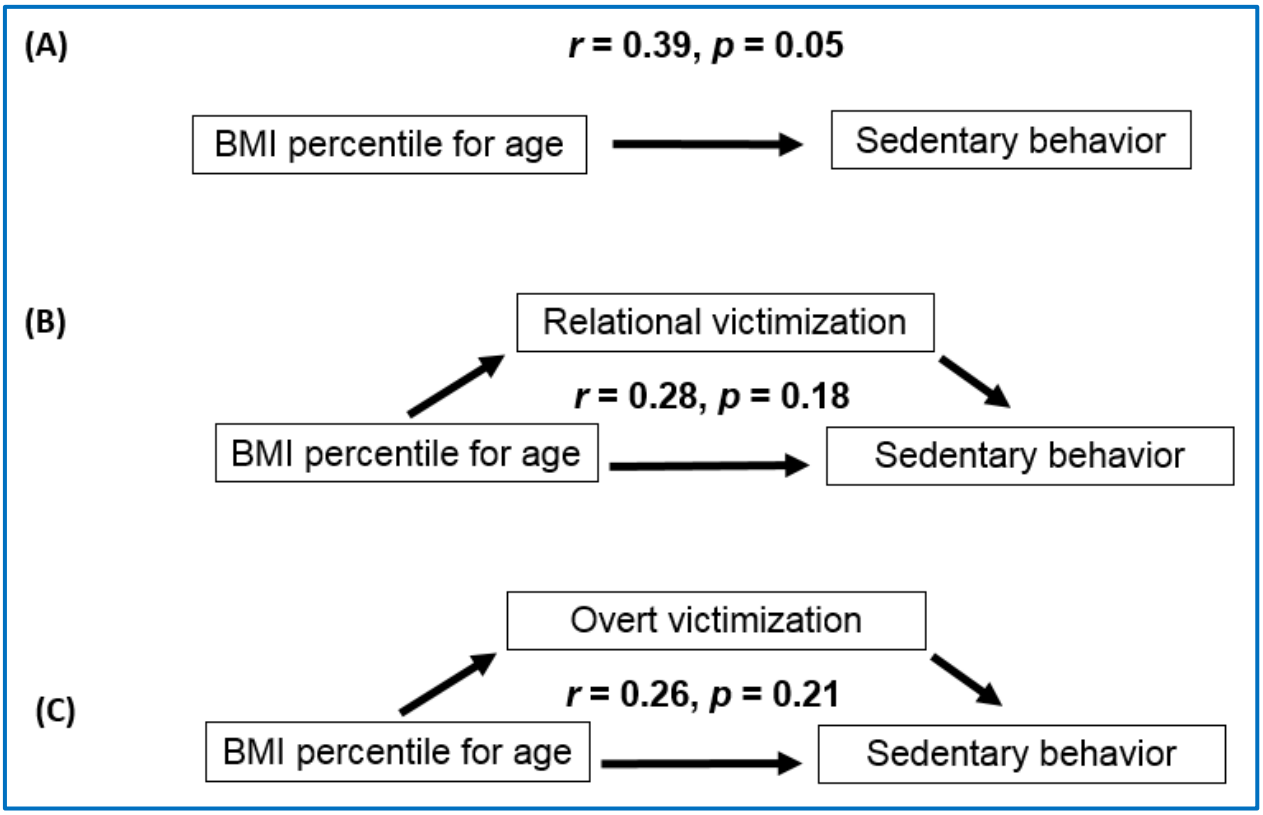

Figure 1. Illustrates the correlations before (A) and after separately controlling for the relational victimization (B) and overt victimization (C) subscales of the peer victimization questionnaire.

4. Discussion

The purpose of this study was to assess whether or not self-reported measures of peer victimization mediated the relationship between BMI percentile and sedentary behavior in boys during free play in a controlled environment. Presently, overweight boys reported greater peer victimization and were more sedentary during the 30-minute activity session than non-overweight boys. There were also positive relationships between BMI percentile, sedentary behavior and both scales of self-reported peer victimization. However, when separately controlling for each of the two peer victimization scales, the correlations between BMI percentile and sedentary behavior were no longer significant. According to the methodology proposed by Baron and Kenny, self-reported peer victimization did mediate the relationship between BMI percentile and sedentary behavior [34]. In other words, peer victimization may play an important role in predicting the greater sedentary behavior seen in overweight/obese youth.

Previous research from our group and others have reported that children who experience more negative social interaction (e.g., peer victimization) are less physically active and more sedentary in both controlled and free-living environments than peers who experience less negative interaction [4,7,11,19-23]. We have also demonstrated that a bout of negative peer interaction (i.e., simulated ostracism) causes a subsequent reduction in physical activity and an increase in sedentary behavior.30 Furthermore, we and others have reported that overweight/obese children are more likely to be the targets of negative peer interaction and are less physically active than their non-overweight peers [4,10,11,24-25]. Therefore, it is possible that the more frequent negative peer interaction reported by overweight/obese youth may be, at least in part, an explanatory factor behind why these overweight/obese children are more sedentary and less physically active than their non-overweight peers. The present finding that peer victimization mediated the relationship between BMI percentile and sedentary behavior in boys supports this notion.

The ability of peer victimization to mediate the relationship between BMI percentile and sedentary behavior in boys is a novel finding. However, research from Storch et al offers insight into the possible mechanism behind the effect negative peer interaction may have on physical activity/sedentary behavior in children.19 Similar to the present study, Storch et al used Baron and Kenny's approach and reported that symptoms of depression mediated the negative relationship between peer victimization and physical activity. It is therefore possible that depression, possibly as a result of peer victimization, suppresses physical activity. Taking this and the present findings together, there are relationships between being overweight/obese, increased peer victimization, greater depressive symptoms and reduced physical activity/increased sedentary behavior. If this is true, suppressed physical activity/greater sedentary behavior may then contribute to greater depression and weight gain which would likely lead to further negative peer interaction [24-25, 35-38] In other words, the relationship between elevated BMI percentile, negative peer interaction, greater depression and physical inactivity/greater sedentary behavior may be cyclical.

While this study provides additional evidence of the role that negative peer interaction may play in children's sedentary behavior, it is not without limitations. First, the study examines a small sample and only included boys. Future research should include a larger sample and also examine girls. However, while there is evidence that certain types of negative peer interaction (e.g., weight criticism) may be more prevalent in girls than boys, prior research examining the impact of peer victimization on physical activity and sedentary behavior in both boys and girls has found no differences between the sexes.7,19,30 Second, while the purpose of the study was to examine sedentary behavior in a controlled, free-play environment, future research should include separate measures of physical activity (e.g., accelerometery), apart from time allocated to activities. Because physical activity and sedentary behavior, while typically correlated to one another, are independent risk factors of a myriad of cardio-metabolic disorders, it is worthwhile to assess both variables [6, 39-41]. Finally, measures of peer victimization were self-reported thus removing the ability to make causal inferences regarding the effect of peer victimization upon sedentary behavior and BMI percentile. However, prior experimental research has reported that simulated negative peer interaction caused a subsequent increase in children's sedentary behavior regardless of the child's sex or BMI percentile [30].

5. Conclusion

In conclusion, presently self-reported peer victimization mediated the positive relationship between BMI percentile and sedentary behavior in boys during free play in a controlled environment. This finding is in support of previous experimental and non-experimental research indicating negative peer interaction may cause and/or is associated with increased sedentary behavior and reduced physical activity. Taken together, there is mounting evidence of the importance of positive peer interaction to promote physical activity and discourage sedentary behavior in children. Additional research examining this mediating effect of peer victimization in girls is warranted.

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Acknowledgements

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

Competing Interests: The author declares to have no competing interests

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