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Associations among psychological satisfaction in physical education, sports practice, and health indicators with physical activity: Direct and indirect ways in a structural equation model proposal

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ABSTRACT

Background and objectives: Physical education (PE) classes are among the main intervention strategies for increasing levels of physical activity (PA) to adolescent's health improvements. However, low levels of psychological satisfaction in physical education classes (PE satisfaction) and multiple associations with some factors as sex, age, sedentarism, sports practice, sleep, quality of life can act as moderators of levels of physical activity. Considering these aspects, this study aims to propose a theoretical model of multivariate relationships to verify the association between PE satisfaction with PA levels, considering the contribution of sports practice, health indicators, age, and sex on these relations.
Methods: A cross-sectional study with 470 adolescents (230 boys) aged 11–17 years from the south of Brazil. Several questionnaires were applied to measure the study variables. The theoretical/statistical support of the structural equation model was evaluated according to fit parameters and strength of relations.
Results: Sports practice, health indicators, age, and sex were mediators of the relationship between PE satisfaction and PA levels.
Conclusion: There is a positive, however indirect, relationship between PE satisfaction with the levels of physical activity in adolescents, with greater strength of association in boys and at younger ages. It was identified that the practice of sport contributes to the main mediator factor for all relationships beneficial to the health of adolescents in the multivariate model. This means that adolescents who practiced sports showed greater PE satisfaction, more appropriate health indicators, associated with higher levels of physical activity as compared to nonpractitioners of sport.

1. Introduction

Physical education (PE) classes are among the main intervention strategies for improving levels of muscular, cardiorespiratory fitness, and the increasing health of adolescents. For these benefits, classes should be planned and structured, considering the moderate to vigorous physical activity (MVPA) as an objective [1–4].

However, if psychological satisfaction in PE classes is low, it seems a factor that reduces the probability of adolescents reaching adequate MVPA levels [5–7]. Duda and Nichols explain that PE satisfaction can be positive feelings and well-being during PE or

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sports practice [5]. This variable suggests that when there is high PE satisfaction, there is also higher engagement in physical education [8]. Regarding this, some studies show positive relationships between higher levels of PE satisfaction and high MVPA [7,9,10].

Nevertheless, other variables such as sex, age, self-perception, quality of life, and perception about motivational climate can play a role as mediators between associations of levels of PE satisfaction with MVPA [7,11,12]. Consequently, studies presented that boys in early adolescence have higher levels of PE satisfaction as compared to girls, but as they grow, PE satisfaction and MVPA seem to reduce [6,7,11,12]. Also, the quality of life, general satisfaction, and playing sports outside the school environment are possible intervening factors in this relationship, increasing PE satisfaction and MVPA levels [6,7,11,12].

Additionally, it is also necessary to consider health indicators in these relations. For example, the less sedentary time, high quality of life, and sleep time are factors which seem positively intermediating the relationship between high levels of PE satisfaction with higher levels of physical activity [13–17]. However, the first aspect to the relevance of the present study comes from the idea that little is known about the paths for understanding this set of variables in the same sample, also considering adolescents in the educational context of the Brazilian physical education.

Physical education teaching in the Brazilian context depends on the functioning of these several variables together [8]. These complex hypotheses are sustained and demonstrated in previous theoretical models of factors associated with physical activity. Sallis et al. showed an ecological model that proposes the behaviors, environment, and personal factors organized in the multilevel model, and this impact in itself and the possibility of this affects the physical activity levels [18]. Bauman et al. proposed a similar idea, which considered psychological, lifestyle, social, biological, and individual factors in a longitudinal view across the ages [19]. Furthermore, recently Miller et al. suggest a theoretical model to the effective mathematical test of this multiple relationships [7]. However, Miller et al. have not succeeded in the conclusion of the study because of the low quality of the structural equation model (SEM) and its insufficient parameters for sustainability [7]. It suggests that the author's idea for a model with multiple factors associated with physical activity was not infact simple to be represented with the empirical data. The present study is relevant because it intends to propose an alternative model, based on this complex theory that shows movement behaviors, individual and psychological factors present associations in itself that increase or decrease physical activity levels [7,18,19].

The proposal of a theoretical model with empirical data and sustainable parameters in the SEM to demonstrate multiple associations, including PE satisfaction, sleep time, sedentarism, quality of life, sports practice, age, sexes, and possible multiple associations with physical activity is relevant, and the main contribution of the present study. Besides, it has a pedagogical and social relevance, that is because PE in the Brazilian context needs to be aimed at physical activity practice, the movement, motor performance, skills and abilities, sports development, and health as one of its central goals for the health promotion of children and adolescents [8,20]. A fact that is not currently in government proposes and has many divergent questions to affect negatively the school PE teaching in this country. [8,21,22] However, few studies are effectively testing this relationship originally and empirically, with a specific model, to facilitate the teaching in PE [6,7]. Also, it is important to consider the role of sport and health indicators as mediators to show direct and indirect ways of PE satisfaction association with physical activity levels [7,8]. Thus, the following research objective was established: to propose a theoretical model of multivariate relationships to verify the association between PE satisfaction with physical activity levels, considering the contribution of sports practice, health indicators, age, and sex on these relations.

2. Methods

2.1. Study design and ethical procedures

This cross-sectional study was approved by the ethics and research committee of the Federal University of Rio Grande do Sul (approval number: 3.634.294). The research followed the guidelines for ethical procedures with human beings in line with the Declaration of Helsinki [23]. Data collections took place in the first and second weeks of October, at the end of an academic year in December of the year 2017. Adolescents were included in the study according to the assent form and free and informed consent of parents or legal guardians.

2.2. Population and sample

The population was about 1570 adolescents enrolled in seven state elementary schools in a city in southern Brazil (Charqueadas, RS). Among these, four schools were selected according to the following convenience criteria: the largest number of students in the state elementary school network in the city, approximately 1166 schoolchildren (totaling 74% of the total population of the 7 schools); having different educational development indexes (IDEB); and distinct geographic distribution, covering four regions of the city (center-north, center-south, east, and west) [24].

The sample size (N) estimated to represent the student population consisted of at least 470 subjects (including 20% dropouts). This N was obtained according to the power of the statistical test in the G-power software, for the multivariate test of associations with 15–20 predictor variables, the test power of 0.80, alpha of 0.05, and strength relation of 0.10. Also, it was considered the mathematical assumption of at least 20 subjects for each endogenous or exogenous variable [25,26].

The students' selection was carried out in classes from the sixth to the ninth year of an elementary school in the year 2017, in adolescents aged from 11 to 17 years, who were proportionally and randomly chosen. The values of distribution by the school were obtained considering the variability in the number of enrollments in these classes, which varied from 15 to 30 students. [24] Considering these approximated assumptions, the sample in each school was: School 1 (IDEB = 4.5), N = 135, and classes = 5. School 2 (IDEB = 3.3), N = 139, and classes = 7. School 3 (IDEB = 2.1) N = 51 and classes = 4. School 4 (IDEB = 5.1), N = 145, and classes = 9.

3. Instruments and methods for measuring variables

3.1. PE satisfaction

First, it is important to clarify that all subjective measuring instruments are translated by previous studies or reviewed regarding English to Portuguese translation by a professor of English language, culturally adapted to the present research context. These verifications occurred before application in the present study. According to this, the PE satisfaction was measured by the "Assessment of satisfaction in PE classes" according to a scale [5]. In the present study, 6 domains of the questionnaire were used: to think that time passes quickly in physical education; being bored in physical education; to think that the PE class is interesting; thinking that PE is fun; get involved in physical education; and enjoy physical education.

3.2. Sports practice

It was assessed considering that the sample consisted of adolescents aged 11–17 years in the Portuguese language learning phase. During the evaluation, researchers explained the concept of sport [27,28]. According to this, the adolescents answered the following question: "In the last 7 days, did you participate in any sport with body movement? (answer options: yes or no)."

3.3. Health indicators

Health-related quality of life was assessed according to the validated Kidscreen questionnaire [29]. The Kidscreen was translated and culturally adapted into Brazilian Portuguese in children and adolescents aged 10–18 years in previous research [29]. The Kidscreen questionnaire was completed individually in the classroom. The researchers helped the students when they presented questions or doubts. The questionnaire was applied in one PE class period. The 27 questions composed a self-reported health-related quality of life score according to the following domains [29]: fitness capacity and health self-perception; to be happy with yourself; good feelings; family support; free time; development in school and learning; bad-mood and sadness; and friends support.

Sedentarism, sleep time, and physical activity were measured using a self-reported movement questionnaire (Appendices A), adapted from the International Physical Activity Questionnaire (IPAQ-C) in Portuguese language [30]. The researchers created a new version from the original questionnaire, specific for the context of sample and present school's city (Appendices A).

It was done due to the limitation presented by adolescents in comprehension and estimative of time and intensity of physical activity following the instruction of IPAQ-C original Portuguese version [30]. Thus, the questionnaires divided 24 h considering the memory recordation of adolescents during the three periods of a day. In the general form, morning was defined as the period from 08:00 to 13:00; afternoon was from 13:00 to 20:00; and night was from 20:00 to 8:00 of the other day. This adaptation was provided in a previous pilot test before the main data collection. In the application of questionnaires during PE, the teachers at each school helped to explain: physical activities intensity differences, what is the sedentary time and movement time, physical exercise, and sports concepts. This explanation was provided before all days of data collection in each class participant of the present study.

Sedentary time was reported according to the time adolescents sat without sleep. This response was driven by self-perception in the morning, afternoon, and night. The school shift of students was also considered to calculate the sedentary time out of school [31]. For example, if the student studied in the morning shift, the following calculation was performed: [afternoon] + [night] - [morning] = sedentary time out of school).

Sleep was estimated by the total hours that adolescents reported sleeping on average during the night [32,33]. It was decided to adapt the instrument to facilitate the students' understanding due to the low consistency of the original version [34]. The questions are presented in appendices A.

3.4. Physical activity levels

It was also evaluated according to the IPAQ-C adaptation [30] (Appendices A). The individuals reported that the amount of physical activity in minutes by intensities: A) weak or light (e.g., walking slowly in short moments and standing up moving) and B) moderate or strong (vigorous) physical activity that they sweated or felt tired (e.g., exercising, running, jumping, playing a sport, dancing intensely, and doing gymnastics). The sum of the MVPA level was obtained by the time reported in MVPA in questions 2, 3, and 4 (answers B).

4. Statistical analysis

4.1. Proposed structural equation models (SEM)

A prerequisite for proposing a multivariate model of the structural equation is the validity of the questionnaire measurement models (Table 1), for each specific sample in factorial SEMs [26]. We performed an exploratory analysis of the data distribution previously, visual inspection for linearity in distribution graphs, histograms, and box plot. The consistency and internal reliability of the adaptation from the IPAQ-C were measured, which indicated Cronbach's alpha = 0.65. The analysis of multivariate normality was performed according to the identification of possible outliers of the centroid distance in the "d" Mahalanobis test. Subsequently, the estimation method adopted was the maximum likelihood (robust). These analyses provided conditions to use the total sample (470).

The SEM was evaluated according to the theoretical perspective and according to the fit quality criteria. The quality adjustment parameters observed were the chi-square/degrees of freedom (CFMIN/DF) statistics below 5, lower AIC/BIC values, RMSEA below 0.09, and SRMR less than 0.10, and CFI values and TLI should be close to or above 0.90 [26,35]. The proposal and the result of the SEM (Fig. 1) were elaborated according to the objectives and literature presented in the introduction section. The alpha value adopted for all analyses was less than or equal to 5%. The analyses were performed using the IBM SPSS 22.0, AMOS 22.0, and Microsoft Office Excel software.

5. Results

5.1. Quality of measurement validation models in structural equation

The quality of fit parameters for the validation of the measurement models is described in Table 1. The models were sufficiently acceptable according to present sample characteristics, mainly in the RMSEA and SRMR parameters.

5.2. Confirmation of the theoretical structural equation model (SEM)

The SEM (Fig. 1) presented acceptable and consistent adjustment values: CFMIN/DF = 1891; TLI = 0.916; CFI = 0.927; RMSEA = 0.044 (95% CI: 0.037–0.055); and SRMR = 0.0473. The model can explain psychological satisfaction in PE classes in 30%, quality of life in 22%, and MVPA in one day is 12.4%. For the other variables, these values were as follows: sports practice (11.4%), weekly physical activity days (17%), and non-school sedentary lifestyle (45%).

5.3. Main results of multivariate relationships in the proposed structural equation model

According to the multivariate relationships presented considering Fig. 1, it is seen that there is no direct association between PE satisfaction with the levels of physical activity (b: 0.05 and $P = .547$). However, this relationship was manifested indirectly (Table 2), mediated mainly by the relationship between the practice of sports and the physical activity levels, weekly days, and daily MVPA (Fig. 1). Also, the path diagram showed that weekly physical activity was associated with an increase in the quality of life (b: 0.25; Fig. 1), with quality of life contributing strongly to the high

Table 1
Quality of measurement models (variables composed of three or more questions).

Measure model latent variable	Domains/dimensions (factorial score)	Parameter adjustment in SEM model				
		CFMIN	RMSEA	CFI	TLI	SRMR
PE satisfaction	To think time goes fast at PE (0.633)[a] To be bored at PE (−0.321)[a] PE is interesting (0.766)[a] To like PE (0.837)[a] PE is fun (0.846)[a] Involvement in PE (0.657)[a]	4.537	0.087	0.991	0.899	0.078
HQOL	Self-perception about Health and fitness (0.650)[a] Good feeling (0.774)[a] Bad mood/sadness (−0.487)[a] To be happy with yourself (0.527)[a] Free time (0.524)[a] Support from friends (0.484)[a] Family support (0.528)[a] To develop well in school/learning (0.579)[a]	3.198	0.068	0.933	0.901	0.066
PA levels	MVPA 1 morning (0.473)[a] MVPA 2 afternoon (0.585)[a] MVPA 3 night (0.212)[a] PA days/week (0.357)[a]	2.818	0.062	0.931	0.910	0.059
Sedentary time	SED 1 morning (0.427)[a] SED 2 afternoon (0.600)[a] SED 3 night (0.239)[a]	4.234	0.083	0.853	0.880	0.077

CFMIN/DF = chi-square statistics/degrees of freedom; RMSEA = root mean square error approximation; AIC/BCC = Bayesian parameters AIC and BIC; SRMR, CFI and TLI = standards and comparative indexes of model adequacy. PE = physical education; SED =Sedentary time; HQOL = health-related quality of life; MVPA = moderate and vigorous physical activity; PA = physical activity: Factor weights with significant values $P < .05$[a]. SEM = structural equation model.

level of PE satisfaction (b: 0.53; Fig. 1). In another way of evaluating the model, it is possible to notice that age is associated with less quality of life and low sleep time, according to the lowest design of the path diagram (Fig. 1). However, sleep time is positively associated with the practice of sport and with shorter sedentary time outside of school. Sport is positively associated with physical activity levels, which leads to the analysis made at the beginning of the diagram, to PE satisfaction. Regarding sex impact in SEM, the dichotomic variable (boys versus girls) is directly associated with higher levels of quality of life, days in weekly physical activity, and higher physical activity levels in one day.

In Table 2, it is possible to state that there was an indirect relationship, not shown by the arrows in the diagram, between a positive PE satisfaction with high physical activity levels (days per week and MVPA level). This relationship was light, as it was mediated by the practice of sport, quality of life, sleep time, sedentary time, sex, and age. All results suggest sports practice as the main mediator for positive relationships between PE satisfaction, more appropriate health indicators, with higher physical activity levels.

6. Discussion

The main objective of this study was to propose a theoretical model of multivariate relationships to verify the association between PE satisfaction with levels of physical activity, considering the contribution of sport, health indicators, age, and sex in these relationships in adolescents. The theoretical model tested showed that sports practice, positive health indicators, less age, and sex (boys) were mediators for a higher relationship between PE satisfaction with higher physical activity levels. The most significant result is the connection between the high level of PE satisfaction with the sports practice. In practice, these associations become a starting point for future interventions using a theoretical model that seeks to improve the level of quality of life, sleep time, physical activity levels, and a reduction in sedentary time. It should also be noted that these associations were consistent, observed in a non-recursive SEM (with no end variable), which was supported mathematically [26]. Nonetheless, a fact that is very difficult to analyze in a sustainable SEM [7].

It reinforces the relevance of the proposed theoretical model to interpret these relationships together, as they are manifested in the daily reality of PE classes. Evidence published to date supports the theoretical validity of these findings, which show an interconnection between psychological satisfaction, sports, well-being, health-related quality of life, less sedentarism, high sleep time, and all of these with higher physical activity levels [9–12,15,36,37].

In the present model, quality of life is a health indicator strongly related to sports and physical activity. Both act as comprehensive mediators linked to improvements in several areas of adolescents' lives, such as self-perceived fitness and general health, well-being, mood, sensations, relationships with family, friends, and school [15,37–40].

Regarding the other variables that are present in this study, there is an indirect relationship between PE satisfaction, sleep, and physical activity levels. This association occurred through the negative relationship between sleep and sedentary time and the positive relationship between sleep and the sports practice, evidence partially suggested in some previous research [17,31,41–44]. These aspects are theoretically acceptable according to studies showing interdependent associations between physical activity levels, sleep, sedentary time as 24-h movement behavior, and association with several health indicators [45,46].

The present study also indicates that age and sex are important factors to be considered when planning PE classes, focusing on older adolescents and girls to obtaining a more active profile due to the set of associations presented. According to these relationships, they are the youngest adolescents and boys who play more sports. The boys also present the highest level of satisfaction in PE classes, health indicators, and physical activity. Probably, this set of findings indicates some reasons why boys engage in physical activity in higher proportions than girls [9–11,15,36,37,47,48].

The strengths of this study are that the results come from research carried out in a well-distributed sample, adequately sized to the population of elementary school students from Southern Brazil. Also, it was one of the first SEM theoretical multivariate

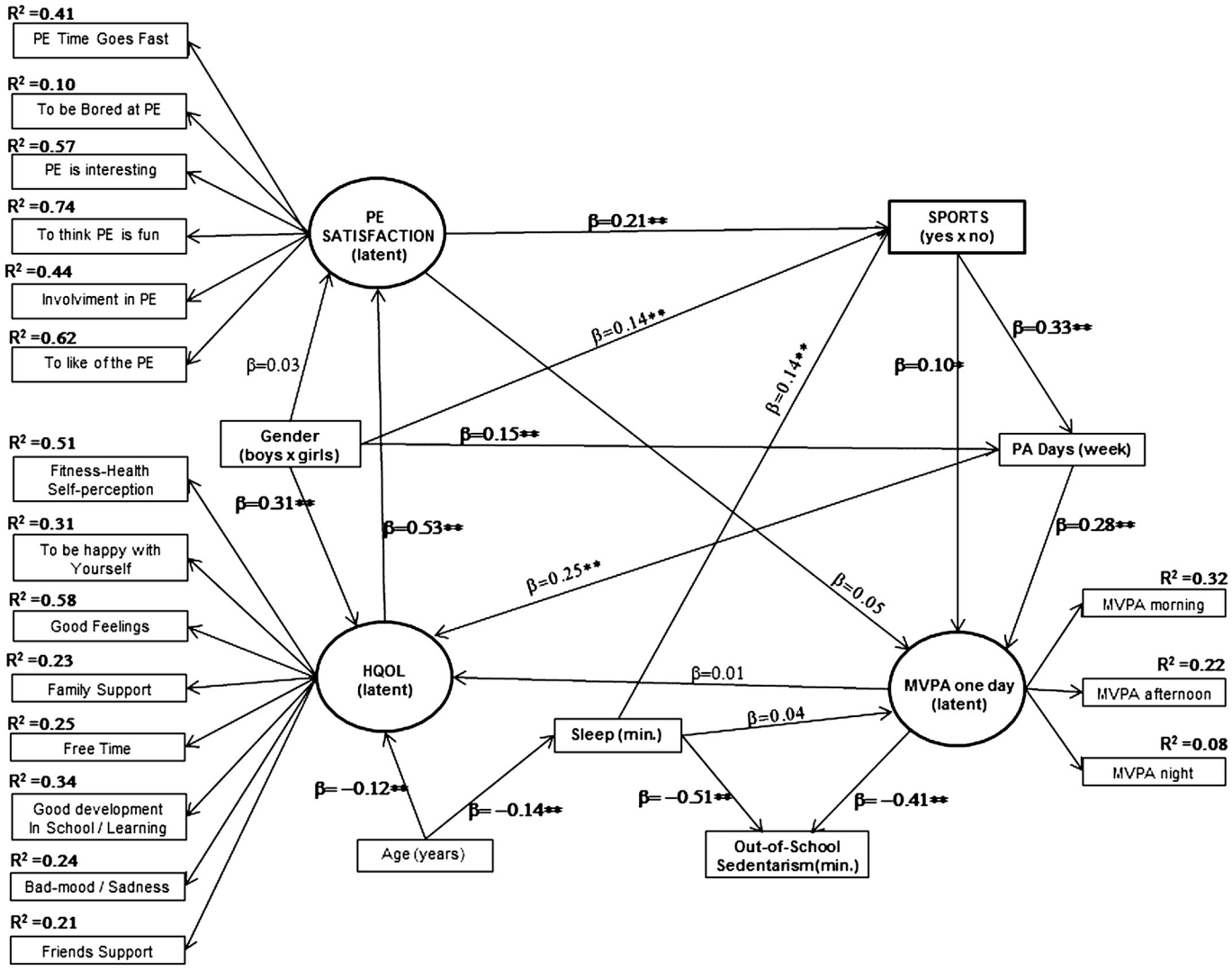

Fig. 1. Results of SEM multivariate relationships between psychological satisfaction in physical education classes, health indicators (quality of life, sleep time, and sedentarism out of school) with the practice of sports, and levels of physical activity. PE = physical education classes; MVPA time in minutes in moderate to vigorous physical activity in the morning, afternoon, and night; PA = physical activity; min. = minutes; and HQOL = health-related quality of life (Kidscreen-27). R2 = the multiple squared exponential correlation value (SEM model explanation of each variable).β= Standardized Z score regression weight; **significance value = 0.001; and *significance value $P < .05$.

study proposals in Latin America which mathematical adequate sustainability. The limitations are established in transversal data because the questionnaire to measure physical activity, sedentarism, and sleep time has not been previously standardized, and the natural bias of subjective physical activity is measured by questionnaires. However, it should be noted that the subjects of the present study understood the questionnaire, a fact revealed by the high Cronbach's alpha (0.65) and the adequate adjustment of the measurement models. Furthermore, it is emphasized that the relationships are established in the factorial models (Table 1). This study should be interpreted with caution, as it is not possible to establish definite cause and effect patterns. It is important to highlight that the present sample represents only the students' population described in the present study and generalization of results should be interpreted with caution.

7. Conclusion

There is a positive, however indirect, relationship between PE satisfaction with the physical activity levels in adolescents, with greater strength of association in boys and at younger ages. It was identified that the sport practice contributes to the main mediator factor for all relationships beneficial to the health of adolescents in the multivariate model. This means that adolescents who practiced sports showed greater PE satisfaction, more appropriate health indicators, associated with higher physical activity levels as compared to nonpractitioners of sport. Adolescents must have greater opportunities to practice sports in the social, family, competitive, and leisure context, in the context of school PE and school hours or outside school.

CRediT authorship contribution statement

Vanilson Batista Lemes: Conceptualization, Methodology, Formal analysis, Application of statistical, Investigation, Resources, Data curation, Writing, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Adroaldo Cezar Araujo Gaya:** Conceptualization, Methodology, Investigation, Writing, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Caroline Brand:**

Table 2
Indirect relationships between PE satisfaction, health indicators, sports practice, and levels of physical activity in the structural equation model.

Independent/dependent variables	PA days per week			MVPA			Sports practice		
	b	Se	*P*	b	Se	*P*	b	Se	*P*
PE satisfaction (latent variable)	**0.070**	**0.019**	**.001**	**0.041**	**0.017**	**.001**	**0.002**	**0.002**	**.048**
Sports practice (dichotomic variable)	**0.003**	**0.001**	**.001**	**0.096**	**0.027**	**.001**			
Sleep time (hours/night)	**0.047**	**0.015**	**.001**	**0.027**	**0.014**	**.002**	0.001	0.001	.063
HQOL (latent variable)	**0.037**	**0.011**	**.001**	0.048	0.046	.304	**0.112**	**0.032**	**.001**
PA days per week				0.012	0.012	.257	**0.028**	**0.009**	**.001**
MVPA (latent variable)	0.000	0.004	.929				0.001	0.012	.927
Age (years)	**−0.011**	**0.004**	**.001**	−0.015	0.011	.066	**−0.034**	**0.010**	**.001**
Sex (boys x girls)	**0.063**	**0.017**	**.001**	**0.089**	**0.027**	**.001**	**0.046**	**0.016**	**.001**
	HQOL			**PE satisfaction**			**Out of school sedentarism**		
	b	**Se**	***P***	**b**	**Se**	***P***	**b**	**Se**	***P***
PE satisfaction (latent variable)	0.018	0.013	.065				−0.037	0.036	.295
Sports practice (dichotomic variable)	**0.085**	**0.025**	**.002**	**0.045**	**0.014**	**.002**	**−0.080**	**0.031**	**.001**
Sleep time (hours/night)	0.012	0.011	.088	0.007	0.006	.094	−0.026	0.028	.270
HQOL (latent variable)				0.005	0.004	.051	−0.020	0.020	.271
PA days per week	0.005	0.032	.851	**0.135**	**0.031**	**.001**	**−0.120**	**0.031**	**.001**
MVPA (latent variable)	0.000	0.001	.981	0.004	0.056	.935	0.000	0.003	.685
Age (years)	**−0.003**	**0.002**	**.041**	**−0.068**	**0.024**	**.006**	**0.077**	**0.022**	**.001**
Sex (boys x girls)	**0.054**	**0.017**	**.001**	**0.191**	**0.033**	**.002**	**−0.037**	**0.012**	**.001**

PE = physical education classes; HQOL = health-related quality of life (kidscreen-27); PA = physical activity; MVPA = moderate and vigorous physical activity; b = standardized beta regression weight; and Se = standard error; Values in **bold** indicate significant differences.

Conceptualization, Methodology, Investigation, Writing, Writing – review & editing, Visualization. **Arieli Fernandes Dias:** Conceptualization, Methodology, Investigation, Writing, Writing – review & editing, Visualization. **Carlos Cristi-Montero:** Methodology, Writing, Writing – review & editing, Visualization. **Jorge Mota:** Methodology, Writing, Writing – review & editing, Visualization. **Anelise Reis Gaya:** Conceptualization, Methodology, Formal analysis, Application of statistical, Investigation, Resources, Data curation, Writing, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijpam.2020.11.004.

Visual abstract

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijpam.2020.11.004.

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