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Original Article

Reliability and consistency of movement behavior questionnaire (MBQ) in children at COVID-19 social distancing

Fiabilidad y consistencia del cuestionario de comportamiento de movimiento (MBQ) en niños en distancia social COVID-19

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Abstract

Objectives: To describe the reliability and consistency of a questionnaire about physical activity and sedentary time in children aged 6 to 12 years old during COVID-19 social distance: to describe the physical activity and sedentary times according to ages, verifying if there are differences between genders.

Methods: Cross-sectional study carried out with a convenient sample (n=261; 125 girls and 136 boys) with an age average of 8.63 ± 1.81 years old. Participants answered a "Movement Behavior Questionnaire" (MBQ). Sedentary time, light (LPA), moderate to vigorous physical activity (MVPA) were estimated in minutes. We applied the Statistical interclass coefficient correlations, Cronbach's Alpha and Cohen's d.

Results: MBQ consistency and reliability values were superior to 0.70 for the general sample. In general, while girls spend more time in LPA and less time in sedentary living, boys spend more time in MVPA.

Conclusions: MBQ presented adequate consistency and reliability values. Furthermore, there are differences in the practice of LPA, MVPA, and sedentary time between ages and genders. It is an easy method to diagnose and estimate MVPA, LPA, and sedentary time in physical education in remote, non-presence or presence classes for parents and children.

Keywords: motor activity; sedentary behavior; child; surveys and questionnaires

Resumen

Objetivos: Describir la fiabilidad y consistencia de un cuestionario sobre la actividad física y el tiempo de sedentarismo en niños de 6 a 12 años durante la distancia social de COVID-19; describir los tiempos de actividad física y sedentarismo según edades, verificando si hay diferencias entre géneros. **Métodos:** Estudio transversal realizado con una muestra conveniente de 125 niñas y 136 niños con 6 a 12 años. Los participantes contestaron un "Cuestionario de comportamiento en el movimiento" (MBQ). El tiempo de sedentarismo, la actividad física ligera (AFL) y moderada a vigorosa (AFMV) se estimaron en minutos. Se aplicaron correlaciones estadísticas de coeficientes intercalase, Alpha de Cronbach y d de Cohen.

Resultados: La consistencia MBQ y valores de fiabilidad fueron superiores a 0,70 para la muestra general. En general, mientras que las niñas pasan más tiempo en AFL y menos en sedentarismo, los niños pasan más tiempo en AFMV. **Conclusiones:** El MBQ presentó valores adecuados de consistencia y fiabilidad. Además, hay diferencias en los tiempos de AFL, AFMV y sedentarismo entre edades y géneros. MBQ es un método fácil para diagnosticar y estimar AFMV, AFL y sedentarismo en educación física en clases remotas, no presenciales, o presenciales para padres e hijos.



Palabras clave: actividad motora; conducta sedentaria; niño; encuestas y cuestionarios

Highlights

- Participants answered a “Movement Behaviour Questionnaire” (MBQ).
- The questionnaire presented adequate reliability and consistency of over 70% for boys and girls.
- Girls spent a longer time in light physical activity and less sedentary time compared to boys.
- In contrast, moderate to vigorous physical activity time was higher in boys than girls.

Introduction

Physical activity and sedentary time in children and adolescents are negatively correlated behaviors into 24 hours a day^{1,2}. While the extended time in moderate to vigorous physical activity (MVPA) brings health benefits, such as better cardiorespiratory profiles, reduced changes for metabolic syndrome, obesity, and cancer^{3,6}. The sedentary time and elevated screen time was correlated to diseases and health problems as low levels of physical fitness, poor quality of life, and poor mental health^{2,7,8}.

Thus, the studies that propose different methods of evaluating MVPA and sedentary time in children during the early years are important as health diagnoses^{9,12}. About this, it suggested that 40 to 80% of children and adolescents around the world do not reach the recommended guidelines for MVPA (60 minutes in seven days a week), and sedentary times (less than 2 hours per day)^{9,10}.

Accelerometers are considered one of the adequate methods to evaluations of MVPA and sedentary time in the epidemiologic context¹¹. However, an accelerometer is a device that has elevated cost and had limitations in the conversion of counts for comprehensive measures^{11,13}. Therefore, questionnaires of measuring MVPA and sedentary time were applied on a large scale, mainly in low-income countries such as Brazil^{9,10}. Researches presented divergent values for reliability and consistency of questionnaires with the variability of 0.30 to 0.95^{13,15}, and a small to a moderate relationship with MVPA and sedentary time accelerometry with $r=0.20$ to 0.50 ^{16,18}.

On the other hand, it is possible to argue the recurrent and important suggestion that those questionnaires for physical activity and behaviors of movement should be adapted and applied in specific samples and populations^{19,20}. The proposal of new and specific questionnaires for different populations in the present historical moment is also relevant due to the social distancing related to coronavirus (COVID-19) pandemic disease²¹. It can be a form to diagnoses and following the health indicators of children in a remote and present way according to the necessities of each community context²¹. Therefore, the physical education classes and teachers in the middle to low-income countries such as Brazil have the necessity of new instruments and methodologies for monitoring children's movement behavior, as adapted questionnaires with simple language, fast application, and comprehensive approach for children answer^{1,2,16,20}. These are some of the practical factors justifying the approaching of the present study, which proposes an adapted Movement Behavior Questionnaire (MBQ) applied in school physical education context on remote or no remote form^{1,2,16,20}. Thus, considering the social and pedagogical relevance of the aforementioned aspects, we have the following aims: 1) to describe the reliability and consistency of a questionnaire about physical activity and sedentary time in children aged 6 to 12 years old during COVID-19 social distancing; and 2) to describe the physical activity and sedentary time according to ages, verifying if there are differences between genders.



Methods

Ethical procedures

The National Research Commission of Ethics (CONEP) and Estácio de Sá University Center (3.758.311) approved this research. The research followed the guidelines for ethical procedures with human beings in line with the Declaration of Helsinki²². The children were included in the study in accordance with free informed consent of the parents or legal guardians.

Study design

It was an observational, cross-sectional, and descriptive study with a quantitative approach. It was carried out in a primary school in the state of Santa Catarina in southern Brazil. The population of children and adolescents enrolled in this school is about 830 students. The school socioeconomic characteristics present students from low to middle-income families. Some children are in vulnerable situations and come from the peripheric city region.

Sample

It was a non-randomized sample, selected in a convenient form according to the school needs of evaluation for physical activity and sedentary time from children in early elementary school grades. Thus, the sample size was calculated posteriorly²³. The present study included 261 children aged 6 to 12 years old, considering the power of statistical to comparative, reliability, and correlation tests²³. It was adopted in G. power software, with a post hoc statistical power (1-b) of 0.80, for the coefficient of correlation family and comparison t-test (Cohen's d), an error of 0.05, the effect size of 0.30 (moderate), and at ten predictor factors for analysis²³.

Evaluators

The evaluators responsible for elaborating and applying the adapted questionnaires were two physical education professionals. They have ten years of experience with physical education in a scholar context, and they own expert postgraduate degrees.

Data collection

Data collections took place in the first and second weeks of May 2020, according to remote physical education classes and support of physical education teachers²⁴. They applied the adapted form of international physical activity questionnaire short version (IPAQ-S)²⁵ utilizing the Google Formulary Instruments. The IPAQ-S was adapted, and teachers created a new version due to the difficulty presented by parents and children's comprehension and the low reliability of the original version²⁵ in the present scholar context.

Therefore, parents or legal guardians of children aged 6 to 9 years old, and children aged 10 to 12 years old, were invited to answer a "Movement Behavior Questionnaire" (MBQ) in the Portuguese language. The questions were divided considering the three periods of a day. Morning=08:00 to 13:00; Afternoon=13:00 to 20:00; and night=20:00 to 8:00 of the other day. It was ranged a time to answer the questionnaire between 20 to 40 minutes. The adapted questions of MBQ can be observed as follow.

Children and parents were instructed with the following examples, according to the context of the present research. Teachers explained that Physical activities are walking, running, football, handball, gymnastics, dancing, games with body movement, exercises. Questions: 1) Physical activity in the morning: Between 08:00 in the morning until 13:00, how long, in minutes, do you move, doing physical activity? A) Weak or light: ___minutes: B) moderate or strong (vigorous): ___minutes. (They followed



this to answer other questions): 2) Physical activity in the afternoon: Between 13:00 to 20:00, how long, in minutes, do you move, doing physical activity? A) Weak or light; B) moderate or strong (vigorous); 3) Physical activity at night: From 20:00 to 8:00 the next day, how long, in minutes, do you move, doing physical activity? A) Weak or light; B) moderate or strong (vigorous); 4) Sedentary time in the morning: How long, in minutes, did you sit/lay down without sleep in the morning (between 8:00 am and 13:00); 5) Sedentary time in the afternoon: How long, in minutes, did you sit/lay down without sleep in the afternoon (between 13:00 and 20:00)?; 6) Sedentary time at night: How long, in minutes, did you sit/lay down without sleep at night (between 20:00 and 8:00)? The MBQ has two separate questions about weekly physical activity and sleeping time. That was not used in the present study because it is not possible to include in the same construct to evaluate the reliability and consistency due to the different measure unity, like so: How many days a week do you do physical activity? Sleep Time: On average, how many hours do you sleep every night?

Statistical analyses

Initially, we adopted an exploratory analysis according to box-plot visual inspection, scatter-dot graphs to verify the behavior of variables concerning linearity and agreement; normal distribution was verified as well, according to centroid distribution multivariate from *Mahalanobis D distancing*. Later we applied a reliability test according to Cronbach Alpha (CA) and Interclass Coefficients of Correlations (ICC)^{26,27}. First, it was done in 9 items related to moderate to vigorous physical activity (MVPA), light physical activity (LPA), and sedentary time evaluated in minutes in each day. The General Inter-items matrix correlations were presented. Finally, we evaluated the Reliability and consistency stratified by gender and ages with CA and ICC²⁶. The significant variability in each age and the possible differences between genders was calculated according to Cohen's d. It was classified as a considerable effect when it was higher than 0.30²⁸. All analyses were carried out in IBM SPSS 22.0.

Results

The sample characteristics (n=261; 125 girls and 136 boys) presented an age range of 8.63 (± 1.81) years. The children proportion in each school grade level was 14.9% from the first year, 19.5% from the second, 16.5% from third, 16.1% from fourth, 21.8% from fifth, and 11.1% from the sixth year of elementary school. Thus, table 1 showed general results of reliability, consistency, and significant variability of MBQ responses. This result indicates good reliability and consistency. These values were superior to 0.70 in all analyses. In practice, it suggests that 261 children had the same comprehension about the content in questions of MBQ. The squared multiple correlations also indicated that others explained all variables in large proportions (35% to 64.5%). The significant variability was high with a broad range in standard deviations, a fact that suggests an extensive range of responses to minutes of MVPA, LPA, and sedentary time to each research participant.

Table 2 presented the matrix of correlations between all questions evaluated in minutes from MBQ. These results confirmed the high consistency between the nine items with a correlation variation from 0.271 to 0.783, corroborating the presented results above mentioned.

Table 3 presented the general consistency in the interclass coefficient correlations with 95% confidence intervals. These results suggested higher consistency in all ages (superior to 0.517). However, it is possible to perceive the differences between genders that occur mainly around 8, 9, 10, 11, and 12 years old. Girls had more comprehension about MBQ in all ages, with an exception for 6, 7, and 11 years old.



Table 4 showed the physical activity and sedentary time in each age and differences between genders by day periods. The results suggested that the average time in self-reported MVPA in different periods of the day are ranged between 1.91 to 119 minutes for girls and 12 to 107 minutes for boys with large standard deviations. The main differences of gender in each age can appear at six years old; by this age, girls presented higher MVPA and LPA in the morning than boys, and boys presented more LPA than girls at night. Regarding seven years old children, the girls presented less MVPA in the morning compared to boys, and girls had more LPA than boys in the afternoon. Girls had less LPA in the afternoon and had higher LPA and sedentary time at night compared to boys, by the age of eight years old. Girls had high LPA in all day periods, presenting more MVPA in the morning and night, and high sedentary time in the afternoon compared to boys, by the age of nine years old. The girls showed more LPA in the morning and MVPA in the afternoon and less sedentary in the afternoon and night periods, compared to boys, by the age of ten years old. Girls presented less MVPA than boys in all day periods and had more LPA at night, by the age of eleven years old. Finally, at twelve years old, girls showed less sedentary in the morning and night and had less LPA in the morning and afternoon; however, girls at this age had higher MVPA than boys during the night period.

Table 1. General reliability, consistency, and variability mean characteristics (n=261)

Day period / Movement behavior		Mean	SD	SMC	Alpha-I	Alpha-T	Interclass CC
Morning	MVPA (minutes)	52.38	69.27	0.551	0.845		
	LPA	62.69	70.37	0.646	0.843		
	SED	114.05	98.40	0.514	0.845		
Afternoon	MVPA	87.21	109.55	0.566	0.837		0.857
	LPA	90.44	103.98	0.656	0.835	0.857	(IC 95%: 0.830-0.882)
	SED	158.14	142.21	0.495	0.850		
Night	MVPA	46.70	125.52	0.673	0.830		
	LPA	65.27	144.56	0.662	0.829		
	SED	167.57	207.36	0.353	0.865		

MVPA: moderate to vigorous physical activity time; LPA: light physical activity time; SED: sedentary time; SMC: squared multiple correlations; Alpha-I: Cronbach alpha if the item was deleted; Alpha-T: Cronbach Alpha total of 9 items; SD: standard deviation; CC: coefficient correlation; IC95%: Confidence interval for 95% of probability.

Table 2. General Inter-items matrix correlations (n=261)

Day period / Movement behavior		1	2	3	4	5	6	7	8	9
Morning	MVPA (1)		0.683	0.271	0.574	0.570	0.292	0.587	0.529	0.376
	LPA (2)	0.683		0.332	0.643	0.723	0.314	0.537	0.497	0.384
	SED (3)	0.271	0.332		0.309	0.398	0.679	0.372	0.389	0.402
Afternoon	MVPA (4)	0.574	0.643	0.309		0.685	0.280	0.541	0.464	0.416
	LPA (5)	0.570	0.723	0.398	0.685		0.322	0.573	0.564	0.321
	SED (6)	0.292	0.314	0.679	0.280	0.322		0.316	0.369	0.419
Night	MVPA (7)	0.587	0.537	0.372	0.541	0.573	0.316		0.783	0.414
	LPA (8)	0.529	0.497	0.389	0.464	0.564	0.369	0.783		0.468
	SED (9)	0.376	0.384	0.402	0.416	0.321	0.419	0.414	0.468	

MVPA: moderate to vigorous physical activity time; LPA: light physical activity; SED: sedentary time: the number represents each question.

**Table 3.** Interclass Correlation Coefficients by sexes and ages

Age	Girls			Boys		
	ICC (mean)	CI 95% (low-upper)		ICC (mean)	CI 95% (low-upper)	
6	0.890	0.764	0.963	0.909	0.846	0.952
7	0.818	0.693	0.905	0.870	0.753	0.946
8	0.960	0.926	0.983	0.784	0.617	0.897
9	0.795	0.658	0.892	0.514	0.196	0.740
10	0.941	0.891	0.974	0.765	0.533	0.908
11	0.643	0.211	0.887	0.732	0.479	0.891
12	0.901	0.774	0.971	0.652	0.200	0.898

ICC: interclass coefficient correlation; IC95% (Low upper): Lower and upper confidence interval for 95% of probability.

Table 4. Children's Physical activity and sedentary time description according to ages and differences by sexes.

Age	Sex		Morning			Afternoon			Night		
			MVPA 1	LPA 2	SED 3	MVPA 4	LPA 5	SED 6	MVPA 7	LPA 8	SED 9
6	Girls	Mean	56.92	84.83	77.58	54.83	85.67	111.17	20.00	28.33	167.50
		SD	66.89	91.13	84.87	80.99	99.28	99.40	31.62	57.34	236.65
	Boys	Mean	34.89	44.26	94.56	54.85	70.52	120.48	47.78	73.56	156.04
		SD	58.21	61.93	111.95	106.76	118.63	138.24	146.22	175.04	210.63
	Cohen's d	0.35	0.52	-0.17	0.00	0.14	-0.08	-0.26	-0.35	0.05	
7	Girls	Mean	32.00	57.30	85.26	62.52	106.30	114.41	25.93	55.00	114.74
		SD	40.98	70.12	99.81	94.76	126.88	142.33	36.32	80.69	164.21
	Boys	Mean	52.06	56.76	100.59	77.65	75.88	145.24	44.71	51.18	128.82
		SD	53.88	40.12	68.78	78.31	57.78	150.29	145.31	145.00	205.00
	Cohen's d	-0.42	0.01	-0.18	-0.17	0.31	-0.21	-0.18	0.03	-0.08	
8	Girls	Mean	74.72	77.50	93.89	98.33	105.00	165.83	119.78	130.56	183.89
		SD	102.33	105.12	96.54	139.44	137.16	154.73	249.08	251.50	210.86
	Boys	Mean	61.50	76.95	120.27	100.45	151.27	191.64	75.23	62.27	119.91
		SD	55.37	51.83	97.34	118.91	120.75	139.17	97.47	68.50	156.09
	Cohen's d	0.16	0.01	-0.27	-0.02	-0.36	-0.18	0.24	0.37	0.34	
9	Girls	Mean	63.57	80.00	143.75	112.86	89.64	198.00	48.04	106.43	208.75
		SD	89.14	97.56	110.36	129.55	86.99	159.13	144.44	223.96	204.47
	Boys	Mean	24.90	44.41	118.72	105.86	62.97	131.52	12.52	25.14	193.62
		SD	22.45	37.35	98.38	121.92	76.97	139.99	20.45	37.42	249.65
	Cohen's d	0.59	0.48	0.24	0.06	0.32	0.44	0.34	0.51	0.07	
10	Girls	Mean	57.16	71.11	122.11	107.63	104.68	155.95	67.63	87.16	153.26
		SD	81.60	83.60	93.72	107.68	114.98	121.60	163.93	169.48	160.91
	Boys	Mean	39.40	48.07	125.73	67.33	74.00	196.73	43.00	61.07	233.40
		SD	55.53	58.95	106.03	97.67	96.13	141.20	127.49	143.66	267.91
	Cohen's d	0.25	0.32	-0.04	0.39	0.29	-0.31	0.17	0.17	-0.36	
11	Girls	Mean	30.09	49.09	122.91	48.73	49.64	164.73	1.91	68.45	172.18
		SD	41.70	53.75	89.96	51.83	44.02	121.66	3.39	147.49	248.44
	Boys	Mean	42.81	43.75	118.75	77.50	55.31	150.31	13.75	16.88	112.50
		SD	37.10	38.75	92.37	92.48	61.63	133.92	18.57	28.22	168.03
	Cohen's d	-0.32	0.11	0.05	-0.38	-0.11	0.11	-0.89	0.49	0.28	
12	Girls	Mean	122.00	57.00	112.00	102.00	102.00	202.00	109.00	81.00	173.00
		SD	124.17	69.13	99.53	139.27	117.08	182.62	163.74	108.37	195.28
	Boys	Mean	118.50	114.00	189.00	155.50	141.00	242.00	42.00	52.00	298.00
		Sd	75.65	75.90	82.52	93.11	105.67	121.27	113.31	124.79	241.74
	Cohen's d	0.03	-0.79	-0.84	-0.45	-0.35	-0.26	0.48	0.25	-0.57	

MVPA: moderate to vigorous physical activity time; LPA: light physical activity; SED: sedentary time; SD: standard deviation.



Discussion

The present study aimed 1) To describe the reliability and consistency of a questionnaire about physical activity and sedentary time in children from 6 to 12 years old during COVID-19 social distancing 2) To describe the physical activity and sedentary times according to ages, verifying if there are differences between genders. The main results about reliability and consistency showed that children aged 10 to 12 years old and parents of children aged 6 to 9 years old comprehended the questions adequately in the presented MBQ. This fact and due to our questionnaire be an adaptation of IPAQ-S²⁵ sustain the descriptive comparisons regarding the gender differences in each age. In general, these results showed that boys and girls presented different MVPA, LPA, and sedentary time along of ages, and these movement behaviors have a large variability according to day periods.

The application of questionnaires is always linked to limitations, and one of them is related to the difficulty of understanding the questions that compose it. In this sense, when the direct assessment is not feasible, an adaptation of existing questionnaires contexts seems to be a good alternative^{19,20}. Our study showed that an adaptation of the IPAQ-S had acceptable values for reliability and consistency for parents of children between six and nine years old and for children between 10 and 12 years old. Likewise, similar questionnaires, which have undergone adjustments, were considered reliable instruments^{15,19,20}. Unlike what was found in our study, surveys of Chinese children²⁹ and adolescents from Central Europe³⁰, did not observe disparities between age and gender concerning the reliability of the questionnaires.

These specificities of the location of the questionnaire's applicability reinforce the importance of considering the context characteristics where the study is developed. These aspects sustain the good reliability and high consistency of MBQ, being about 70%. It is similar to previous studies that presented reliability and consistency adequate with coefficients ranged from 40% to 80%^{13,18,25}. These researches showed questionnaires tested in large samples, which were elaborated with rigor by professionals with experience in physical activity for children and adolescents. This similar fact happens in the present study.

Another important result is that the values of MVPA, LPA, and sedentary time are different according to gender and age. Overall, while girls spend more time in LPA and less time in sedentary behavior, boys, in contrast, spend more time in MVPA. This trend has continued over the increased ages. Studies from other countries were developed and found this same pattern of behavior^{31,32}. Mielgo-Ayuso et al.³³ demonstrated in a Spanish sample that gender and age are the main factors³³ associated with the practice of physical activity, with boys presenting greater time in total physical activity (MVPA + LPA).

It was possible to explain because they were also the ones who practiced more MVPA than adolescents and adults of both genders. Another point for this difference is that higher levels of physical activity in girls are associated with issues more complex such as self-efficacy, physical activity of parents during leisure time, and changes in expectations with increasing age³⁴. On the other hand, the girls in our study remain less sedentary time compared to boys, and evidence has pointed out that there is a relationship between sedentary time and LPA, since, generally, when there is an increase in LPA, there is also the replacement in sedentary time³⁵.

We emphasize the importance of questionnaires like this, considering the social distancing due to Covid-19, for the remote monitoring of students. In this sense, the main strength of this study is the adaptation of a questionnaire, capable of perceiving the activities carried out throughout the day, making it possible to have the number of minutes of physical activity that children and adolescents perform in each day shift. However, some limitations need to point out. The sample was not selected randomly, making it difficult to represent the population. The temporal stability also is a limitation, which is why; we do not have a re-test evaluation to confirm there is no time variability. In addition, the study does not



deal with external validation, although it has good reliability and internal consistency properties. Thus, validation studies that correlate this questionnaire with instruments of direct measurement are important.

Conclusions

Thus, in conclusion, the questionnaire MBQ presented adequate reliability and consistency, with indexes higher than 70% for boys and girls of the present sample. There are differences in the practice of LPA, MVPA, and sedentary time between ages and genders. Mainly regarding the fact that girls spend a longer time in LPA and less sedentary time compared to boys. In contrast, the boy's time in MVPA was longer than the MVPA time for girls. Besides, we reiterate the importance of considering the context and its specificities when dealing with questionnaires with behavioral variables. Also, the MBQ is an easy method to diagnose and estimate MVPA, LPA, and sedentary time in remote physical education, non-presence class, or presence classes for parents and children.

Future research can be performed from the present study in order to provide the reliability of the MBQ in other ages, as adolescents and adults. In addition, it is possible to apply this questionnaire in different languages like English and Spanish. Further research with representative and randomized samples are also welcome. These studies may be performed on the final validation of MBQ. It will also be necessary to consider the time effects between participants, samples with adolescents, and different evaluators. The MBQ questionnaire can be applied in future interventions in physical education to identify levels of physical activity and sedentary time as control variables or the main outcomes.

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V.B.L., C.F.F. and A.R.G. conceived of the presented idea, developed the theory, performed the computations and verified the analytical methods. V.B.L and C.F.F. collected the data. A.R.G. supervised

the findings of this work. All authors discussed the results, wrote the text and contributed to the final manuscript version.

Conflict of interest

None of the authors present a conflict of interest.



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