



# From awareness to action: Effects of a school-based intervention on TV viewing behavior stages and screen time guidelines knowledge in Brazilian adolescents

Da conscientização à ação: Efeitos de uma intervenção escolar nos estágios de mudança de comportamento para assistir TV e no conhecimento das diretrizes de tempo de tela em adolescentes brasileiros

## AUTHOR'S

Priscila Cristina dos Santos<sup>1</sup>   
Alexsandra da Silva Bandeira<sup>1</sup>   
Bruno Gonçalves Galdino da Costa<sup>2</sup>   
Ana Caroline Campos de Sousa<sup>1</sup>   
Kelly Samara Silva<sup>1</sup>

1 Federal University of Santa Catarina, Department of Physical Education, Research Centre in Physical Activity and Health, School of Sports, Florianópolis, Santa Catarina, Brazil.

2 Nipissing University, School of Physical and Health Education, North Bay, Ontario, Canada.

## CORRESPONDING

Priscila Cristina dos Santos  
[prisantos.personal@gmail.com](mailto:prisantos.personal@gmail.com)  
Campus Reitor João David Ferreira Lima, s/n  
- Trindade, Florianópolis - SC, 88040-900.

## DOI

10.12820/rbafs.28e0314

## ABSTRACT

The aims of the study were to verify the effect of an intervention on the stage of behavior change for TV viewing and to identify the possible mediating role of knowledge on screen time guidelines among Brazilian students. This study is a multicomponent school-based intervention conducted with 727 students (54.3% female, 13 years; 427 in the intervention group and 300 in the control group). The intervention was performed in 2017 with baseline and post-intervention assessments (over one academic year). Teacher training was carried out at the beginning of the intervention along with environmental improvements, while educational curriculum such as the delivery of folders and posters were performed throughout the year. The stages of behavior change for TV viewing and knowledge of screen time guidelines were measured by a self-reported questionnaire and the structural equation modeling approach was performed. The intervention had no significant effects on stages of behavior change for TV ( $p = 0.744$ ) nor did it result in significant changes on knowledge of screen time guidelines ( $p = 0.741$ ). While there was no mediation between knowledge of screen time guidelines and the effect of the intervention on stages of behavior change for TV (95%CI: -0.45;0.63), an association was found between knowledge of screen time guidelines and stages of behavior change for TV ( $p < 0.001$ ). In conclusion, intervention had no significant effect on the stages of behavior change for TV and no mediating effect was observed. However, enhancing awareness on screen time guidelines may positively impact the adolescent's intention to reduce TV time.

**Keywords:** Recreational screen time; Health behavior; School health; Clinical trial; Randomized controlled trial; Adolescent.

## RESUMO

Os objetivos do estudo foram verificar o efeito de uma intervenção nos estágios de mudança de comportamento para assistir TV e identificar o papel mediador do conhecimento sobre as recomendações de tempo de tela. A intervenção multicomponente, randomizada e controlada obteve a participação de 727 alunos em 2017 (54,3% meninas, 13 anos; 427 no grupo intervenção e 300 no grupo controle). A formação dos professores foi realizada no início da intervenção juntamente com as melhorias ambientais, enquanto as ações educativas foram realizadas ao longo do ano. Os estágios de mudança de comportamento para assistir TV e o conhecimento sobre as recomendações do tempo de tela foram mensurados por questionário auto reportado, pré e pós-intervenção (um ano letivo). Para análise dos dados foi realizada uma modelagem de equações estruturais. Não houve efeito da intervenção nos estágios de mudança de comportamento para TV ( $p = 0,744$ ) e também não houve mudanças significativas no conhecimento dos estudantes sobre as recomendações do tempo de tela ( $p = 0,741$ ). Embora não tenha havido mediação entre conhecimento das recomendações do tempo de tela e o efeito da intervenção nos estágios de mudança de comportamento para TV (IC95%: -0,45;0,63), foi encontrada associação entre o conhecimento das recomendações e os estágios de mudança de comportamento para TV ( $p < 0,001$ ). Conclui-se que a intervenção não teve efeito significativo nos estágios de mudança de comportamento para TV e efeito mediador. No entanto, aumentar a conscientização sobre as recomendações de tempo de tela pode impactar positivamente na intenção do adolescente de reduzir o tempo de TV.

**Palavras-chave:** Tempo de tela recreativo; Comportamento de saúde; Saúde escolar; Estudo clínico randomizado controlado; Adolescente.



This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

## Introduction

The screen time (ST) is defined as the time spent on screen-based behaviors as watching television (TV) and using computer, video game, tablets or smartphones<sup>1</sup>. The exposure of adolescents to excessive ST, and mainly TV viewing has been associated with unfavorable health indicators like unhealthy diet, obesity and depression<sup>2,3</sup>. As a result, there is an emerging need to reduce ST and, therefore, the development of interventions focused on ST reduction in adolescents has been encouraged<sup>2</sup>. However, systematic reviews showed that most interventions had low methodological quality<sup>5</sup>; small effect sizes<sup>6</sup>, and inconsistent results (studies with high methodological quality but which presented conflicting results, for example, some observed that the intervention had a significant effect, while others did not) regarding program effectiveness<sup>4</sup>. Two recent systematic reviews also found an overall small, positive effect of ST<sup>3,6</sup>. However, according to Jones et al.<sup>6</sup> some strategies are able to increase the effect of the intervention, such as strategies that use specific behavior change techniques<sup>6</sup>.

Identifying the individual's intention to adopt a reduction in TV time may be an important strategy for a better understanding of the sedentary behavior<sup>7</sup>. Changing behavior is complex, influenced by intrapersonal, interpersonal, environmental factors, moreover, it usually requires considerable time to happen<sup>8</sup>. Hence, interventions can impact the adolescent's intention to reduce ST, but this change does not necessarily translate into reduced ST at the time of measurement post intervention<sup>9</sup>. Behavior change is a process that can be described through the Transtheoretical Model (TTM)<sup>9</sup>, which has been widely used with different health outcomes, and that highlights the intention role in this process of change<sup>10</sup>. The TTM defines behavior change as a process composed of five stages: Precontemplation; Contemplation; Preparation; Action; and Maintenance<sup>9</sup>.

Although the TTM is a successful framework for behavior change programs, it has been neglected in interventions focused on ST<sup>11</sup>. Based on TTM, where the subject's intention to change is essential, increasing knowledge about ST guidelines may be an important strategy in intervention studies for helping individuals to advance in behavior change stages. A study performed with Chinese college students showed that knowledge related to physical activity guidelines improved stages of physical activity behavior<sup>13</sup> and the same has been found in elementary students in Brazil<sup>14</sup>.

Understand which strategies are most effective for reducing TV viewing among adolescents is important<sup>5,15</sup> to help design more effective interventions. Systematic reviews reported that there is little evidence about that<sup>4,6</sup>, showing the need to evaluate interventions. Another essential aspect to consider is the use of mediation analysis to identify possible variables that mediate the effect of the intervention (known as indirect effect)<sup>5</sup>, i.e., variables that can explain the effect of the intervention to the dependent variable<sup>16</sup>. However, few studies have analyzed this causal process with ST<sup>15,17</sup>. Therefore, the aims of the study were to verify the effect of a school-based intervention on stages of behavior change for TV viewing and to identify the possible mediating role of knowledge about ST guidelines in 7th to 9th grade Brazilian students.

## Methods

This study used data from the *Movimente* intervention, a cluster randomized controlled trial performed with 7th to 9th grade Brazilian students. After approval of the project by the Municipal Secretary of Education (Florianópolis), the schools were recruited (unit of randomization). A total of 36 schools were part of the Florianópolis Municipal Education Department. The criteria for schools to be in the study included: a) have elementary level grades; b) have a minimum of two classes from 7th to 9th grades; c) without any environment reforms during the intervention period. An invitation was sent to the 18 schools that were considered eligible and seven school principals agreed to participate. One school was selected for the pilot study, and six schools were matched (number of classes and geographic location) and randomly assigned to intervention or control groups. This matched process was performed in order to guarantee schools from different geographic areas in both groups. Also, we matched schools considering the sample size (number of classes) because it varied widely between schools. Thus, allocations were made to obtain a peers-grouped (1:1 ratio), with the aim of achieving a balance between trial levels (three schools in the control group and three in the intervention group).

Based on the sample size power calculations (statistical power of 80% and significance level of 5% for two-tailed tests) a minimum sample of 1,034 students was estimated. It was considered eligible all 7th to 9th grades students who were present in the first week of class (1,427 students), of which 999 agreed to participate in the study and 921 answered the research

questionnaire. All adolescents from the seventh to the ninth grade, of both sexes, regularly enrolled in the selected schools, attending the first two weeks of classes (data collection period) were eligible for the present study. The exclusion criterion was to present physical and/or mental limitations that could prevent their participation during the program evaluations.

The intervention was registered on Clinical Trials (NCT02944318) and approved by the National Research Ethics System (protocol number: 1.259.910). The students who agreed to participate signed an assent form, and their guardians signed a consent form authorizing participation. More detailed information has been described elsewhere<sup>18</sup>.

The *Movimente* study was a multicomponent intervention whose primary focus was to promote physical activity and reduce sedentary behavior among students, with other secondary outcomes such as healthy diet. This program was based on the Social Cognitive Theory; Socioecological frameworks, and Health Promoting School Models; and comprised three main components: teacher training, education curriculum, and environmental improvements. All materials, such as handbooks and educational materials, and structure for teacher training were created by researchers from the *Movimente* program. The materials used are available online at <https://movimente.ufsc.br>. Although some strategies of the *Movimente* intervention have addressed more than one outcome, such as the teachers training that was performed addressing several health issues, the specificity and determinants of each behavior were considered, with specific content for each outcome.

The face-to-face teacher training was conducted by the research team after baseline data collection and consisted of health topics such as sedentary behavior, physical activity, and healthy diet. In relation to outcome of present study, the contents included the concept, information on children and adolescent's ST guidelines, and on prevalence of excessive ST among adolescents in Brazil and other countries. There was also a presentation of the handbook and discussion on how the information in this manual could be used during classes. The manual was prepared by program researchers and contained information on different topics and activities to reduce sedentary behavior, including class-time activity breaks and motivational messages to reduce ST outside of school.

The educational component included banners and folders on sedentary behavior, physical activity, healthy

diet, and the importance of physical activity for improving academic achievement. Specifically, about sedentary behavior, we used messages on excessive ST and its health consequences, as well as advice to adolescents to regulate ST to less than 2 hours. This process was conducted after school staff and teachers received the training and guidance to implement the intervention. Four banners were handed over to the school coordination at the beginning of the year, and program researchers advised the school staff to make these posters available in strategic locations to reach as many students as possible. Four folders (2 with screen time subject) were also delivered every two months to the school staff, which were advised to deliver to students and read them during class time as a strategy. A suggestion was given to the teachers on performing activities along with their students involving the parents or guardians as a strategy for disseminating the ST information in the folder to the family.

The four banners were delivered to the school coordination and program researchers advised the school staff to display these in places where students would have plenty of access. Every two months, folders on a particular theme were delivered, and to disseminate information, teachers were encouraged to carry out activities that involved parents. Environmental improvements included revitalization of sports courts and creation of new spaces. In addition, to avoid sedentary behavior during recess times, some strategies like new demarcations of old courts, creation of new spaces/courts for playing, and availability of sporting equipment such as balls, rackets and ropes. More details about the intervention can be accessed in the protocol article<sup>18</sup> and also in the program implementation<sup>19</sup>.

The intervention was conducted in 2017 over one academic year. In the first weeks of the school years (last week of February), we contacted the school principals and organized the data collection which started in March. The data collection process was performed in March (pre-intervention) and December (post-intervention) of the same year (2017) by trained and calibrated researchers, to standardize the entire procedure. Allocation of schools was done prior to the baseline data collection. Participants completed a self-report survey at school. The questionnaire was applied by researchers during school hours, in the classroom, with an average duration of 90 minutes. The researcher read the questions, one by one, out loud and explained in detail.

The stages were assessed by a validated question<sup>7</sup>

with satisfactory intraclass correlation coefficient (ICC = 0.78). The following question was used: “If you watch TV for two hours or more on weekdays, do you intend to reduce your TV time to less than two hours a day?” Participants had to choose one of the five answer options, and each answer defined a stage as follows: (a) Precontemplation (no, I don’t intend to reduce to less than two hours per day in the next six months); (b) Contemplation (yes, I intend to reduce to less than two hours per day in the next six months); (c) Preparation (yes, I intend to reduce to less than two hours per day in the next thirty days); (d) Action (I don’t watch television for two hours or more per day. I have been doing this for less than six months); and (e) Maintenance (I have been doing this for six months or more).

ST was measured by questions validated for the Brazilian population<sup>20</sup> and extended for each screen device separately for weekdays and weekends (e.g., Generally, how many hours of television do you watch on a weekday/weekend day?). The same questions were asked for: use computer/video game for gaming purpose; and use the computer, except for gaming use. For each ST device question there were eight answer options (I do not watch/play/use; Less than 1 h a day; 1 h a day; 2 h a day; 3 h a day; 4 h a day; 5 h a day and 6 or more hours a day), which were transformed into a linear scale of values ranging from zero to six (I do not watch/play/use = 0; Less than 1 h a day = 0.5; 1 h = 1; 2 h = 2, and so on) and weighted according to weekdays and weekend days by applying the following equation: [(Screen device use minutes/week \* 5) + (Screen device use minutes/weekend \* 2) / 7]. The ST guidelines was analyzed considering the cut-off point of less than 2 h per day.

The knowledge of the TV time recommendation was measured by a question previously validated<sup>21</sup> with an ICC of 0.64 through the statement: “I think the recommended time for my age is:”. Participants had to choose one of seven answers: a) do not watch TV; b) watch TV only a few times a week, c) watch TV less than 1 hour a day, d) watch TV less than 2 hours a day, e) watch TV for 2 hours or more a day, f) watch TV as many times as I wish, g) I do not know what is recommended. Thus, the following categorization was performed: answers e, f, and g (Don’t know); d (Correct); and a, b and c (Overestimate). Participants also were asked to report their sex (male and female) and their age (years) using a self-reported questionnaire.

Possible differences in profiles between the control and intervention groups at baseline were tested

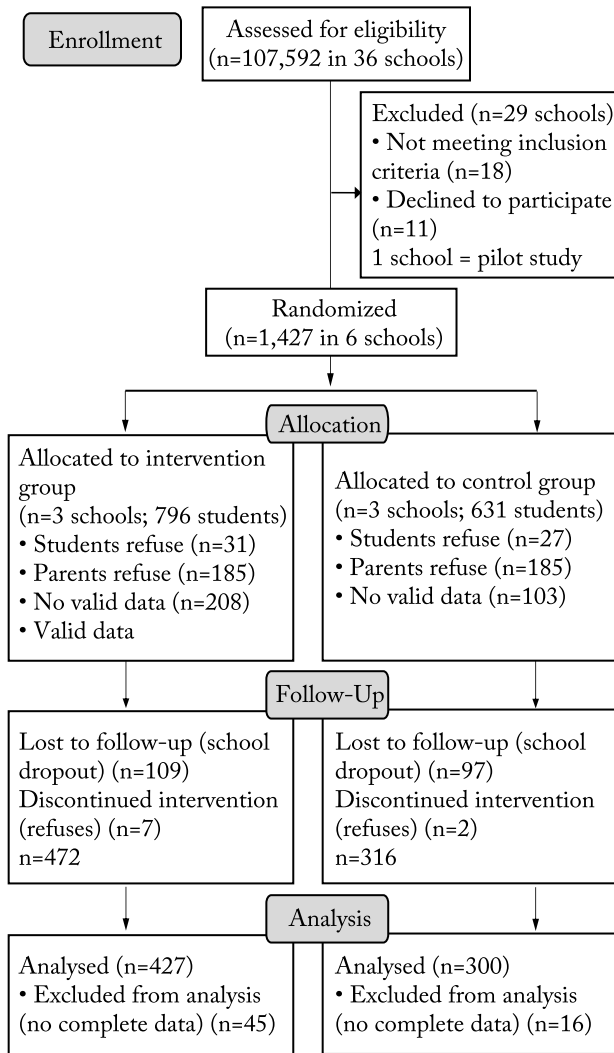
using chi squared tests. Structural equation modeling (SEM) was used to investigate the intervention’s effect on stages of behavior change for TV, as well as to analyze whether knowledge of ST guidelines mediate the intervention’s effect on stages of behavior change for TV. According to the categorical nature of the data, we opted for Weighted Least Squares estimator. The following paths were analyzed: (a) the total effect (c coefficient) that represents the intervention’s effect on stages of behavior change for TV, controlled by baseline outcome, sex, and age; (b) the intervention’s effect on knowledge of ST guidelines (a coefficient), adjusted by this variable in the baseline, sex, and age; (c) the association between the mediator and outcome (b coefficient), controlled for the condition (intervention vs. control), outcome and mediator at baseline, as well as sex and age; and (d) indirect effect (ab-coefficient) that represents the intervention effect explained by the mediator. The product-of-coefficients (ab-coefficient) was estimated to determine the presence of an indirect effect and for confirmation of existence of mediation (95% confidence interval [CI] does not include the null value)<sup>16</sup>. The statistical analysis was also performed with physical activity as a covariate, however, since there was no association, the model mentioned was maintained.

To estimate the overall fit model we used root mean square error of approximation (RMSEA), comparative fit index (CFI), Tucker–Lewis index (TLI), and standardized root mean squared residual (SRMR). Values <0.05 for RMSEA, >0.90 for CFI, >0.90 for TLI, and <0.05 for SRMR indicate adequate model fit<sup>22</sup>. The theoretical model for analysis of the present study is described in the supplementary file Figure A. A significance level of 5% was adopted to determine significant associations. Data were analyzed on STATA version 16.0.

## Results

Of the 1427 eligible students from the six schools, 788 participants provided complete baseline data (n = 472 intervention group, n = 316 control group)<sup>18</sup>. From those, 727 had baseline and post-intervention valid data (Figure 1).

Comparing the characteristics of the study participants at baseline, no difference was found between the control and intervention groups (Table 1). The sample size comprised predominantly girls (51.7%), adolescents from 10 to 13 years (63.3%), those who were unaware of the ST guidelines (52%), and those who were in the precontemplation stage (45%) (Table 1).



**Figure 1** – CONSORT diagram of stages of behavior change for TV in the Movimente intervention.

The model demonstrates adequate fit based on the criteria of RMSEA (0.058), CFI (0.945), TLI (0.849), and SRMR (0.024). According to mediation analysis adjusted for sex and age (Table 2), there was no significant intervention effect on stages of behavior change for TV (c coefficient: -0.40, p = 0.744). The interven-

**Table 1** – Baseline characteristics of the Movimente study sample. Florianopolis, Brazil, 2017.

Characteristics	Control (n = 300)		Intervention (n = 427)		p-value
	mean (SD) or n (%)		mean (SD) or n (%)		
Sex					0.582
Male	137	(45.7)	203	(47.6)	
Female	163	(54.3)	224	(52.4)	
Age					0.833
Years	13.33	± 1.07	13.05	± 1.02	
Time per day (min)					0.763
TV	148.07	± 111.24	145.75	± 102.33	
ST guidelines					0.135
≥ 2 hours	238	79.3	364	85.2	
< 2 hours	62	20.7	63	14.8	
Knowledge of screen time guidelines					0.530
Don't know	159	53	235	55.0	
Correct	41	13.6	75	17.6	
Overestimate	100	33.4	117	27.4	
Stages of behavior change for TV					0.265
Precontemplation	125	41.7	184	43.1	
Contemplation	48	16	62	14.5	
Preparation	22	7.3	49	11.5	
Action	43	14.3	47	11.0	
Maintenance	62	20.7	85	19.9	

TV = Television; min: minutes; CI = 95% confidence interval; SD = standard deviation. p-value = represent significant difference between treatments (control vs. intervention).

tion did not result in significant changes on knowledge of ST guidelines (a coefficient: 0.021, p = 0.741). According to b coefficient, there was an association between knowledge of ST guidelines and stages of behavior change for TV (b coefficient: 0.432, p < 0.001), i.e., higher knowledge about ST guidelines were related to advances toward positive stages of behavior change for TV. The knowledge of ST guidelines has not been identified as a mediator of the intervention effect on stages of behavior change for TV (ab coefficient: 0.010, CI 95%: -0.45; 0.63).

**Table 2** – Mediation analyses for the structural equation model adjusted for sex and age. Florianopolis, Brazil, 2017

Mediator	Intervention on mediator		Mediator on stages		Intervention on stages		Intervention on stages (total)		Mediated effect (indirect)	
	a (Coefficient)	p value	b (Coefficient)	p value	c' (Coefficient)	p value	c (Coefficient)	p value	ab	CI95%
Knowledge of screen time guidelines	0.021	0.741	0.432*	<0.001	-0.049	0.679	-0.40	0.744	0.010	-0.45;0.63

95%CI = 95% confidence interval; a = non-standardized regression coefficient of treatment (intervention vs. control) predicting the mediator in follow-up, with control to values of mediators in baseline, stages of behavior change for TV, sex and age; b = non-standardized regression coefficient of the mediator predicting the stages of behavior change for TV in the follow-up, with control to baseline values of the mediators, treatment and control variables (stages of behavior change for TV at baseline, sex and age); c' = non-standardized regression coefficient of treatment condition predicting the stages of behavior change for TV in the follow-up, adjusted to the mediator and control variables; CI = 95% confidence interval of the mediated effect. \* Indicates statistical significance (p<0.05).

## Discussion

The present study's aims were to test if the *Movimente* intervention had a positive effect on the stages of behavior change for TV viewing after one year of intervention (measurement performed after the end of the program), and if the knowledge about ST guidelines was the mediator of the intervention's effect. The results suggest that the intervention had no significant effect on the stages of behavior change for TV. Additionally, no intervention effect was observed for the knowledge about ST recommendations (the hypothesized mediator) and no mediating effect was observed. However, there was a significant association between knowledge about ST guidelines and the stages of behavior change for TV.

The TTM is one of the most used models in behavioral change modeling<sup>8</sup> and some interventions have found positive results on stages of behavior change for physical activity in adolescents<sup>23</sup>. However, it seems that only one study analyzed the stages of behavioral change for TV viewing<sup>11</sup>. This cross-transversal study with college students showed that the majority of the students spent a lot of time sitting throughout the day and had no intention of modifying this behavior<sup>11</sup>, which is similar to our results regarding time watching TV.

When considering interventions studies, according to recent reviews it appears that none of the ST interventions reported the effect on stages of behavior change for TV viewing<sup>4,6</sup>. The interventions included in the aforementioned reviews investigated effectiveness as a reduction of time spent on screen devices such as computer, games and TV<sup>4,5</sup>. The stages of behavior change for TV viewing can identify adolescents' intention to reduce TV viewing. Hence, identifying the intervention effect in this variable can be a novel strategy for understanding pathways for changing behavior related to ST. Mainly because despite the tendency to replace TV use with other devices TV still represents the most accessed device in this population segment<sup>24</sup>, strategies for reducing ST are not always clearly described in literature<sup>5,6</sup> and it is still unknown which are the most effective<sup>4,6</sup>.

Despite the *Movimente* program using strategies such as teachers training on the importance of reducing ST, as well as educational messages encouraging the reduction of this behavior with the intention of thereby increasing adolescents' self-efficacy to reduce ST, the intervention had no effect on the stages of behavior change for TV. Similar intervention whose strategies focused on training teachers, the education

curriculum, and improving opportunities for physical activity in the school environment, also observed no positive results on stages of behavior change for physical activity<sup>25</sup>. Some strategies used in the TTM interventions consider the stage of behavior change that the adolescent was at the beginning of the intervention, and through motivational meetings focus on advancing the stage. For example, an intervention performed with children and adolescents in Rhode Island (United States), included feedback on the stage of behavior change for physical activity, strategies for increasing self-efficacy based on stages of behavior change, and observed that adolescents in the intervention group had higher probabilities of transitioning toward the maintenance stage<sup>26</sup>. The *Movimente* intervention did not include these strategies, but it seems to be important to include strategies that target the stage at which the adolescent participants are, at the beginning of the intervention, and to include specific strategies to increase the change of progression in the stages throughout the program in order to verify progress in the stages of behavior change for TV<sup>23,26</sup>.

The lack of intervention effects in the present study may also be related to the implementation. Our intervention reached 30% of the teachers who could have participated in teacher training. After the intervention, teachers were asked which health topics addressed during teacher training were used in their classes and ST was the least addressed. And when students were asked about the topics addressed during classes, they remembered more topics on physical activity and nutrition compared to ST<sup>19</sup>. Therefore, the low adhesion of teachers to the program and low students' recall of the topics covered in class may have collaborated to the lack of effect.

In our study, less than half of the adolescents were aware or overestimated the ST recommendation and the intervention had no effect on their awareness of ST guidelines. The knowledge on ST guidelines is low even among professionals who work with this population<sup>27</sup>. A systematic review that analyzed the population's awareness about Canadian guidelines of sedentary behavior, detected poor knowledge on early childhood education among undergraduate students and pediatricians (91.6% and 95%, respectively, who did not know)<sup>27</sup>. Although there was dissemination of information on the ST guidelines for children and adolescents among teachers, as well as delivery of banners and posters with information about the appropriate

cut-off point for screen usage, it seems that these actions were either insufficient or were not implemented satisfactorily to make teenagers aware about the ST appropriate for their age. Failures in the implementation process is cited as one of the causes of ST interventions have been unsuccessful<sup>6</sup>.

The *Movimente* intervention reached only 30% of teachers and ST was considered for them, and it was the least topic addressed during the classes (38% of teachers) compared to physical activity (61%) and diet (81%). This seems to have interfered in the students' perception who also perceived more physical activity (43% of students), diet (29%) contents during the classes, and only 19% affirmed that ST was addressed (data not shown). Another reason that could explain the lack of effectiveness observed both in the adolescents' knowledge about ST guidelines and about the stage of behavior change for TV, is the fact that the *Movimente* intervention was not focused exclusively on ST<sup>5</sup>. The intervention was multicomponent, also focusing on promoting physical activity, healthy eating and other health behaviors. Thus, the low teacher participation and the fact that ST was barely addressed may have been determinant for the lack of changes in knowledge related to ST. And even if we had observed a change in knowledge, it was possible that this would not translate into behavior, as changes in intentions do not translate entirely to behavior change<sup>28</sup>.

One way to impart information on TV guidelines to youth may be through their parents. Often parents' ST behaviors serve as models for their children and consequently influence their behaviors<sup>29</sup>. Thus, parental attitudes, their knowledge of ST guidelines and family rules are important factors for reducing the use of ST devices<sup>29</sup>. The *Movimente* program had no specific strategies either for the parents or relatives of the adolescents, or for the family environment. It was only suggested to the teachers to carry out some activities with the banner materials and ask the children to give the folder to their parents. Perhaps, enforcing restriction rules that promote awareness of ST guidelines and providing explanations that would help adolescents understand why these rules exist could be important for improving ST guidelines knowledge among young people.

Despite the lack of intervention effect on stages of behavior change for TV and knowledge about ST guidelines, significant associations (b coefficient) were found between knowledge about ST and changes in stages of behavior change for TV. This study adds lon-

gitudinal evidence to these associations and consequently affirms that changes in the knowledge of ST guidelines are indeed important for impacting stages of behavior change for TV among adolescents. There is no specific information regarding disseminating information about ST guidelines and the effectiveness of these actions to reduce ST. However, due to the results found in the present study, it is suggested that future interventions also incorporate strategies focused on increasing knowledge about ST guidelines. Curricular and extracurricular initiatives that involve the dissemination of information about the intervention's outcomes, with active engagement from students, the school community, and family members, have shown effectiveness in reducing ST<sup>4</sup>. Furthermore, interventions that establish goals appear to be more effective. In other words, including goals related to ST guidelines and monitoring the reduction of this behavior throughout the intervention may be a relevant strategy to be considered in future studies<sup>6</sup>.

As regards the mediated effect, it was observed that the knowledge of ST guidelines did not mediate the intervention's effect on stages of behavior change for TV (CI 95%: -0.45; 0.63). Had the intervention strategies been effective in improving knowledge about the recommendations, we could have identified a mediating effect of knowledge of ST guidelines on change stages. Other study has reported non-significant mediation effects either because of a lack of intervention effect on the mediator or lack of indirect effect when mediation analysis was performed<sup>15</sup>. Identifying mediators is important to explore which strategy can be effective for behavior change<sup>5</sup>. Smith et al.<sup>15</sup> and Babic et al.<sup>17</sup> found that changes in motivational factors mediated the effect of school-based interventions on ST among adolescents, emphasizing that strategies with motivational focus can help to reduce this behavior.

This study's strengths include the randomized control trial design and the use of SEM analysis, which are robust methods to analyze the mediated effects of experiments. Moreover, the research problem investigated is still incipient in literature and more evidence is required. We recognize that the use of TTM has been questioned in the literature for presenting sequential stages of change, which can lead to an understanding that change happens in a linear way, when in fact the change in behavior can take place in circles. It is suggested to test other methodologies, such as "Behavior Change Wheel"<sup>30</sup> to analyze which is closer to the real way in which behavior

change occurs. Another limitation was the retention and response rates which were lower than expected. However, considering the sample power for mediation analyses, the needed sample was reached (539)<sup>18</sup>.

In conclusion, the *Movimente* program was not effective in improving the stages of behavior change for TV viewing. Although it did not have a mediated effect, a significant association was found between knowledge of ST guidelines and behavior change stages. These results suggest that future interventions focusing on reducing TV time may include strategies targeting on knowledge of ST guidelines for supporting participants advance in the stages of behavior change for TV viewing.

### Conflict of interest

The authors declare no conflict of interest.

### Funding

National Scientific and Technological Development Council (CNPq/Edital Universal 14/2014, process number 446227/2014-5). Scholarships offered by the Coordination for the Improvement of Higher Education Personnel (CAPES - 001),

### Author's contributions

Santos PC participated in the conceptualization, methodology, software, formal analysis, data curation, writing - original draft, writing - review & editing; Bandeira AS, Costa BGG & Sousa ACC participated in the formal analysis, writing - original draft, writing -review & editing; Silva KS participated in the writing - review & editing, supervision.

### Acknowledgments

The authors would like to thank the Municipal Department of Education of Florianopolis for authorization to carry out the study; to all members of the school community (managers, teachers, parents and students) of the schools involved for their support during the implementation of the program. We also thank the funding received from the National Scientific and Technological Development Council (CNPq/Edital Universal 14/2014, process number 446227/2014-5) and the scholarship received from the Coordination for the Improvement of Higher Education Personnel (CAPES), Brazil.

### References

1. Tremblay MS, Carson V, Chaput J, Gorber SC, Dinh T, Duggan M, et al. Canadian 24-Hour Movement Guidelines for Children and Youth : An Integration of Physical Activity, Sedentary Behaviour , and Sleep. *Appl Physiol Nutr Metab.* 2016;41:311-27.
2. Khouja JN, Munafò MR, Tilling K, Wiles NJ, Joinson C, Etchells PJ, et al. Is screen time associated with anxiety or depression in young people? Results from a UK birth cohort. *BMC Public Health.* 2019;19(1):1-11.
3. Nguyen P, Le LKD, Nguyen D, Gao L, Dunstan DW, Moodie M. The effectiveness of sedentary behaviour interventions on sitting time and screen time in children and adults: An umbrella review of systematic reviews. *Int J Behav Nutr Phys Act.* 2020;1(17):1-11.
4. Santos PC dos, Barbosa Filho VC, da Silva JA, Bandeira A da S, Minatto G, da Silva KS. What Works in Sedentary Behavior Interventions for Youth: A Review of Reviews. *Adolesc Res Rev.* 2019;4:1-26.
5. Altenburg TM, Kist-van Holthe J, Chinapaw MJM. Effectiveness of intervention strategies exclusively targeting reductions in children's sedentary time: A systematic review of the literature. *Int J Behav Nutr Phys Act.* 2016;13(65):1-18.
6. Jones, A; Armstrong, B; Weaver, RG; Parker, H; Von Klinggraeff, L; Beets, MW. Identifying effective intervention strategies to reduce children's screen time: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act.* 2021;1(18),1-20.
7. Hagler AS, Calfas KJ, Norman GJ, Sallis JF, Patrick K. Construct validity of physical activity and sedentary behaviors staging measures for adolescents. *Ann Behav Med.* 2006;31(2):186-93.
8. Prochaska JO, DiClemente CC. Stages and processes of self-change of smoking: Toward an integrative model of change. *J Consult Clin Psychol.* 1983;51(3):390-95.
9. Prochaska JO, DiClemente CC, Norcross JC. In search of how people change. Applications to addictive behaviors. *Am Psychol.* 1992;47(9):1102-14.
10. Tseng H-M, Liao S-F, Wen Y-P, Chuang Y-J. Stages of change concept of the transtheoretical model for healthy eating links health literacy and diabetes knowledge to glycemic control in people with type 2 diabetes. *Prim Care Diabetes.* 2017;11(1):29-36.
11. Han H, Gabriel KP, Kohl HW. Application of the transtheoretical model to sedentary behaviors and its association with physical activity status. *PLoS One.* 2017;12(4):1-13.
12. Cassar S, Salmon J, Timperio A, Naylor P, Van Nassau F, Ayala AMC, et al. Adoption, implementation and sustainability of school-based physical activity and sedentary behaviour interventions in real-world settings : a systematic review. 2019;120(16):1-13.
13. Abula K, Gröpel P, Chen K, Beckmann J. Does knowledge of physical activity recommendations increase physical activity among Chinese college students? Empirical investigations based on the transtheoretical model. *J Sport Heal Sci.* 2018;7(1):77-82.
14. Costa BG da G, dos Santos PC, Bandeira A da S, da Costa RM, de Sousa ACC, Da Silva KS. Is knowledge of screen time guidelines associated with stages of behavior change for television viewing among adolescents? *Transl Behav Med.* 2019;26:1-6.
15. Smith JJ, Morgan PJ, Lonsdale C, Dally K, Plotnikoff RC, Lubans DR. Mediators of change in screen-time in a school-based intervention for adolescent boys : findings from the ATLAS cluster randomized controlled trial. *J Behav Med.* 2017;40(3):423-33.
16. MacKinnon DP, Fairchild AJ, Fritz MS. Mediation Analysis. *JAMA - J Am Med Assoc.* 2007;321(7):697-98.



17. Babic MJ, Smith JJ, Morgan PJ, Lonsdale C, Plotnikoff RC, Eather N, et al. Intervention to reduce recreational screen-time in adolescents : Outcomes and mediators from the ‘ Switch-Off 4 Healthy Minds ’ ( S4HM ) cluster randomized controlled trial. *Prev Med.* 2016;91:50-57.
18. Silva KS, Silva JA da, Barbosa Filho VC, Santos PC dos, Silveira PM da, Lopes MVV, et al. Protocol paper for the Movimento school-based program. *Medicine.* 2020;99(31):e21233.
19. Bandeira, AS, Pizani, J, Sousa, ACFC, Silva, JA, Minatto, G, Barbosa Filho, VC, et al. Implementation of a school-based physical activity intervention for Brazilian adolescents: a mixed-methods evaluation. *Health Promot. Int.* 2022;2(37).
20. Guedes DP, Lopes CC. Validation of the Brazilian version of the 2007 Youth Risk. *Rev Saude Publica.* 2010;44(5):850.
21. Van Stralen MM, Te Velde SJ, Singh AS, De Bourdeaudhuij I, Martens MK, Van Der Sluis M, et al. European Energy balance Research to prevent excessive weight Gain among Youth (ENERGY) project: Design and methodology of the ENERGY cross-sectional survey. *BMC Public Health.* 2011;11(65):0-20.
22. Hoyle RH. *Handbook of Structural Equation Modeling.* (Hoyle RH, ed.). Guilford Press; 2012.
23. Brick LA, Redding CA, Paiva AL, Harlow LL, Velicer WF. Intervention Effects on Stage of Change Membership and Transitions among Adolescent Energy Balance Behaviors. *Multivariate Behav Res.* 2017;52(4):485-98.
24. Schaan CW, Cureau F V, Sbaraini M, Sparrenberger K, Kohl HW, Schaan BD. Prevalence of excessive screen time and TV viewing among Brazilian adolescents : a systematic review and meta-analysis. 2018; 95(2):155-65.
25. Filho VCB, Samara K, Mota J, Beck C, Lopes S. A Physical Activity Intervention for Brazilian Students From Low Human Development Index Areas : A Cluster-Randomized Controlled Trial. *J Phys Act Heal.* 2016;13:1174-82.
26. Velicer WF, Redding CA, Paiva AL, Mauriello LM, Blissmer B, Oatley K, et al. Multiple behavior interventions to prevent substance abuse and increase energy balance behaviors in middle school students. *Transl Behav Med.* 2013;3(1):82-93.
27. LeBlanc AG, Berry T, Deshpande S, Duggan M, Faulkner G, Latimer-Cheung AE, et al. Knowledge and awareness of Canadian Physical Activity and Sedentary Behaviour Guidelines: a synthesis of existing evidence. *Appl Physiol Nutr Metab.* 2015;40(7):716-24.
28. Sheeran P, Webb TL. The Intention – Behavior Gap. *Soc Personal Psychol Compass.* 2016;10(9):503-18.
29. Määttä S, Kaukonen R, Vepsäläinen H, Lehto E, Ylönen A, Ray C, et al. The mediating role of the home environment in relation to parental educational level and preschool children ’ s screen time : a cross-sectional study. *BMC Public Health.* 2017;17(688):1-11.
30. Michie S, Stralen MM van, West R. The behaviour change wheel: A new method for characterising and designing behaviour change interventions Michie. *Arch Dermatol.* 2011;6(42):2-11.

Received: 01/02/2023  
Approved: 10/10/2023

#### Quote this article as:

Santos PC, Bandeira AS, Costa BGG, Sousa ACC, Silva KS. From awareness to action: Effects of a school-based intervention on TV viewing behavior stages and screen time guidelines knowledge in Brazilian adolescents. *Rev Bras Ativ Fis Saúde.* 2023;28:e0314. DOI: 10.12820/rba-fs.28e0314