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SLEEP, SEDENTARY BEHAVIOR, PHYSICAL ACTIVITY AND ASSOCIATED FACTORS AMONG BRAZILIAN ADOLESCENTS

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Bruno Gonçalves Galdino da Costa

Sleep, sedentary behavior, physical activity and associated factors among Brazilian adolescents

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RESUMO

Atividade física, comportamento sedentário e duração do sono compõem os comportamentos de movimento de 24 horas. Os níveis desses comportamentos são preocupantes entre os adolescentes brasileiros e muitos fatores podem influenciá-los, incluindo comportamentos alimentares, uso de substâncias e fatores sociodemográficos como sexo, idade, e nível socioeconômico. As evidências a esse respeito são escassas, pois a maioria dos estudos inclui apenas um ou dois dos comportamentos do movimento das 24 horas. Assim, o objetivo da presente tese de doutorado foi analisar transversalmente os correlatos sociodemográficos e comportamentais de comportamentos de movimento de 24 horas medidos por acelerômetro e autorreferidos em uma amostra de adolescentes brasileiros matriculados no ensino médio integrado à educação técnica. Todos os alunos matriculados do primeiro ao sexto semestre do ensino médio integrados a cursos técnicos de três campi do *Instituto Federal de Santa Catarina n*a mesorregião Grande Florianópolis (Santa Catarina, Brasil) foram convidados a participar em 2019. Os participantes foram convidados após a equipe de pesquisa explicar a justificativa do estudo, e os participantes foram solicitados a fornecer um termo de consentimento assinado pelos responsáveis legais. Os participantes receberam um acelerômetro para usar no punho não dominante por sete dias consecutivos (avaliação de 24 horas). Uma semana depois, os acelerômetros foram recuperados e os alunos foram convidados a responder a um questionário estruturado online usando um smartphone. A duração do sono, comportamento sedentário, atividade física de intensidade leve (AFL), e atividade física moderada a vigorosa (AFMV) foram estimados a partir de acelerometria e sexo, idade, estrutura familiar, status socioeconômico, comportamentos alimentares, comportamentos de tempo de tela, e o uso de substâncias foram autorrelatados pelos alunos. Os volumes diários de cada comportamento de movimento de 24 horas foram estimados, o volume de esportes e não esportes, de cada indicador de tempo de tela, de tempo de tela de lazer, de tempo de tela involuntário e duração do sono, e a adesão às diretrizes de movimento das 24 horas foram usadas para dicotomizar os comportamentos diários (ou seja, ≥60 minutos por dia de AFMV, ≤2 horas por dia de tempo de tela recreativa e 9-11 horas por noite de sono). Modelos lineares multiníveis foram ajustados para identificar as associações dos indicadores de comportamento do movimento de 24 horas com ajustes para covariáveis relevantes. Quando os resultados da acelerometria foram analisados, as participantes do sexo feminino dormiram mais, se envolveram em mais AFL e se envolveram em menos comportamento sedentário e AFMV do que os participantes do sexo masculino. Idade foi associada positivamente ao

comportamento sedentário. Alimentos não processados foram positivamente relacionados ao AFL, enquanto alimentos processados foram positivamente relacionados ao comportamento sedentário e inversamente relacionados a AFMV. Tempo de tela para estudar foi inversamente relacionado a AFL e AFMV. O tempo de tela relacionado ao trabalho foi inversamente relacionado ao sono e positivamente relacionado ao LPA. Assistir a vídeos foi associado a menor AFL e AFMV. Para o sexo masculino, os videogames foram associados ao aumento do comportamento sedentário e menores AFL e AFMV. Para o sexo feminino, estudar e usar a mídia social foi associado a menor AFL e AFMV. Quando os comportamentos de movimento de 24 horas autorreferidos foram analisados, as participantes do sexo feminino se envolveram em menos atividades físicas autorreferidas, esportes, tempo total de tela e tempo de tela de lazer (vídeos, videogames, e mídia social), mas em um tempo de tela involuntário maior (trabalhar e estudar) do que os participantes do sexo masculino. A idade associou-se positivamente com comportamento de tela involuntário e atividades físicas não-esportivas e involuntária. O nível socioeconômico associou-se positivamente à atividade física total autorrelatada. Os adolescentes que moravam com a mãe praticavam mais esportes do que os que viviam com os dois pais. Alimentos não processados foram positivamente associados à atividade física total e esportes autorrelatados. Alimentos processados foram inversamente associados com atividade física autorreferida e atividade física não esportiva e positivamente associados com tempo total de tela e tempo de tela de lazer. O uso de álcool foi positivamente associado a atividade física autorreferida, e o tabagismo foi negativamente associado à atividade física autorreferida. Nenhuma associação foi observada para a duração do sono. Quanto à adesão às diretrizes de movimento de 24 horas, a proporção de adolescentes atendendo às diretrizes de AFMV, tempo de tela, e duração do sono foi de 25%, 28% e 41%, respectivamente, para dados autorreferidos. A partir de dados do acelerômetro, 7,1% cumpriram as recomendações de duração do sono e 31,7% AFMV. A adesão a todas as três recomendações foi de 3% com autorrelato e 0,2% com dados do acelerômetro. Os participantes do sexo masculino foram mais propensos a atender a recomendação de AFMV, mas não as recomendações de tempo de tela e duração do sono. Foi observada uma relação positiva entre a idade e o cumprimento da recomendação de tempo de tela. Em conclusão, os resultados sugerem que os comportamentos de movimento de 24 horas dos adolescentes são influenciados por diversos fatores sociodemográficos e comportamentais. A relação entre os comportamentos de movimento de 24 horas entre si e com outros fatores pode ser específica por tipo e essa informação pode ser particularmente relevante ao planejar e otimizar estudos, intervenções, políticas, e a prática profissional no futuro.

Palavras-chave: atividade física; acelerômetro; sono; comportamento sedentário; transversal; adolescentes

RESUMO EXPANDIDO

Introdução

Atividade física, comportamento sedentário e duração do sono compõem os comportamentos de movimento de 24 horas. Os níveis desses comportamentos são preocupantes entre os adolescentes brasileiros e muitos fatores podem influenciá-los, incluindo comportamentos alimentares, uso de substâncias e fatores sociodemográficos como sexo, idade, e nível socioeconômico. As evidências a esse respeito são escassas, pois a maioria dos estudos inclui apenas um ou dois dos comportamentos do movimento das 24 horas. Assim, o objetivo da presente tese de doutorado foi analisar transversalmente os correlatos sociodemográficos e comportamentais de comportamentos de movimento de 24 horas medidos por acelerômetro e autorreferidos em uma amostra de adolescentes brasileiros matriculados no ensino médio integrado à educação técnica.

Objetivos

O objetivo do presente estudo foi analisar fatores sociodemográficos e comportamentais associados aos comportamentos de movimento humano das 24h medidos por acelerômetro e autorrelato em uma amostra de adolescentes de ensino médio integrado com ensino técnico. Os objetivos específicos incluem examinar fatores sociodemográficos, alimentares, comportamentos de tela, e de uso de substancias associados ao sono, comportamento sedentário, e atividades físicas leve, moderada e vigorosa tanto medidos objetivamente quanto por autorrelato. Por último, também é objetivo analisar possíveis associações entre fatores sociodemográficos e a aderência às recomendações de comportamentos de movimento das 24h.

Metodologia

Todos os alunos matriculados do primeiro ao sexto semestre do ensino médio integrados a cursos técnicos de três campi do Instituto Federal de Santa Catarina na mesorregião Grande Florianópolis (Santa Catarina, Brasil) foram convidados a participar em 2019. Os participantes foram convidados após a equipe de pesquisa explicar a justificativa do estudo, e os participantes foram solicitados a fornecer um termo de consentimento assinado pelos responsáveis legais. Os participantes receberam um acelerômetro para usar no punho não dominante por sete dias consecutivos (avaliação de 24 horas). Uma semana depois, os acelerômetros foram recuperados e os alunos foram convidados a responder a um questionário estruturado online usando um smartphone. A duração do sono, comportamento sedentário, atividade física de intensidade leve (AFL), e atividade física moderada a vigorosa (AFMV) foram estimados a partir de acelerometria e sexo, idade, estrutura familiar, status socioeconômico, comportamentos alimentares, comportamentos de tempo de tela, e o uso de substâncias foram autorrelatados pelos alunos. Os volumes diários de cada comportamento de movimento de 24 horas foram estimados, o volume de esportes e não esportes, de cada indicador de tempo de tela, de tempo de tela de lazer, de tempo de tela involuntário e duração do sono, e a adesão às diretrizes de movimento das 24 horas foram usadas para dicotomizar os comportamentos diários (ou seja, ≥60 minutos por dia de AFMV, ≤2 horas por dia de tempo de tela recreativa e 8-10 horas por noite de sono). Modelos lineares multiníveis foram ajustados para identificar as associações dos indicadores de comportamento do movimento de 24 horas com ajustes para covariáveis relevantes.

Resultados e Discussão

Quando os resultados da acelerometria foram analisados, as participantes do sexo feminino dormiram mais, se envolveram em mais AFL e se envolveram em menos comportamento sedentário e AFMV do que os participantes do sexo masculino. Idade foi associada positivamente ao comportamento sedentário. Alimentos não processados foram positivamente relacionados ao AFL, enquanto alimentos processados foram positivamente relacionados ao comportamento sedentário e inversamente relacionados a AFMV. Tempo de tela para estudar foi inversamente relacionado a AFL e AFMV. O tempo de tela relacionado ao trabalho foi inversamente relacionado ao sono e positivamente relacionado ao LPA. Assistir a vídeos foi associado a menor AFL e AFMV. Para o sexo masculino, os videogames foram associados ao aumento do comportamento sedentário e menores AFL e AFMV. Para o sexo feminino, estudar e usar a mídia social foi associado a menor AFL e AFMV. Quando os comportamentos de movimento de 24 horas autorreferidos foram analisados, as participantes do sexo feminino se envolveram em menos atividades físicas autorreferidas, esportes, tempo total de tela e tempo de tela de lazer (vídeos, videogames, e mídia social), mas em um tempo de tela involuntário maior (trabalhar e estudar) do que os participantes do sexo masculino. A idade associou-se positivamente com comportamento de tela involuntário e atividades físicas não-esportivas e involuntária. O nível socioeconômico associou-se positivamente à atividade física total autorrelatada. Os adolescentes que moravam com a mãe praticavam mais esportes do que os que viviam com os dois pais. Alimentos não processados foram positivamente associados à atividade física total e esportes autorrelatados. Alimentos processados foram inversamente associados com atividade física autorreferida e atividade física não esportiva e positivamente associados com tempo total de tela e tempo de tela de lazer. O uso de álcool foi positivamente associado a atividade física autorreferida, e o tabagismo foi negativamente associado à atividade física autorreferida. Nenhuma associação foi observada para a duração do sono. Quanto à adesão às diretrizes de movimento de 24 horas, a proporção de adolescentes atendendo às diretrizes de AFMV, tempo de tela, e duração do sono foi de 25%, 28% e 41%, respectivamente, para dados autorreferidos. A partir de dados do acelerômetro, 7,1% cumpriram as recomendações de duração do sono e 31,7% AFMV. A adesão a todas as três recomendações foi de 3% com autorrelato e 0,2% com dados do acelerômetro. Os participantes do sexo masculino foram mais propensos a atender a recomendação de AFMV, mas não as recomendações de tempo de tela e duração do sono. Foi observada uma relação positiva entre a idade e o cumprimento da recomendação de tempo de tela.

Considerações Finais

A presente tese teve como objetivo analisar correlatos sociodemográficos e comportamentais de comportamentos de movimento de 24 horas medidos por acelerômetro e autorreferidos em uma amostra de adolescentes brasileiros. Os resultados sugerem que sexo, idade, status socioeconômico, estrutura familiar, tempo de tela, comportamento alimentar, uso de álcool e uso de tabaco estão associados aos comportamentos de movimento de 24 horas, e que as associações podem ser específicas do comportamento, específicas do tipo e / ou específico do instrumento. O presente estudo complementa a literatura existente ao mostrar que os fatores que estão associados ao movimento corporal, sendo o ato de se mover medido pelo acelerômetro, não são necessariamente determinantes de como esses movimentos estão sendo realizados, em que contexto, e como eles se relacionam com os indivíduos que estão se movendo. Essas relações podem ser observadas pela mistura

de informações qualitativas e quantitativas, e já foram postuladas antes, mas apenas alguns estudos combinaram o protocolo do acelerômetro de 24 horas e dados informativos autorreferidos com informações sobre os tipos de atividades como no presente estudo. Nossos dados suportam a hipótese de que os tipos de atividades são tão importantes quanto a quantidade de movimento. Este não é apenas o principal ponto forte do presente estudo, mas os resultados sugerem que novos estudos precisam abordar essa hipótese a fim de avançar no campo.

Palavras-chave: atividade física; acelerômetro; sono; comportamento sedentário; transversal; adolescentes

ABSTRACT

Physical activity, sedentary behavior and sleep duration comprise the 24-hour movement behaviors. Levels of these behaviors are concerning among Brazilian adolescents and many factors can influence them, including dietary behaviors, substance use and sociodemographic factors such as sex, age, and socioeconomic status. Evidence in this regard is scarce as most studies include only one or two of the movement behaviors. Thus, the objective of the present doctoral thesis was to cross-sectionally analyze sociodemographic and behavioral correlates of accelerometer-measured and self-reported 24-hour movement behaviors in a sample of Brazilian adolescents enrolled in high school integrated with professional education. All students enrolled in the first to sixth terms of high school integrated with technical courses from three campuses of the *Instituto Federal de Santa Catarina* of the mesoregion Grande Florianópolis (Santa Catarina, Brazil) were invited to participate in 2019. Participants were invited after the research team explained the rationale of the study, and participants were asked to provide a consent form signed by the legal guardians (for the under-aged). The participants were given an accelerometer to wear on the non-dominant wrist for seven consecutive days (24-hour assessment). One week later, the accelerometers were retrieved and students were asked to answer a structured online questionnaire using a smartphone. Sleep duration, sedentary behavior, light-intensity physical activity (LPA), and moderate-to-vigorous physical activity (MVPA) were estimated from accelerometry and sex, age, family structure, socioeconomic status, dietary behaviors, screen time behaviors, and substance use were self-reported by students. The daily volume of each 24-hour movement behavior, the volume of sports and non-sports, of each screen time indicator, of leisure-time screen time, of involuntary screen time, and sleep duration were calculated, and the adherence to the 24-hour movement guidelines was used to dichotomize daily behaviors (i.e., ≥60 minutes per day of MVPA, ≤2 hours per day of recreational screen time, and 9-11 hours per night of sleep). Multilevel linear models were fit to identify the associations of the 24-hour movement behavior indicators with adjustments for relevant covariates. When accelerometry outcomes were analyzed, females slept more, engaged in more LPA, and engaged in less sedentary behavior and MVPA than males. Age and sedentary behavior were positively associated. Unprocessed food was positively related to LPA,

while processed food was positively related to sedentary behavior and inversely related to MVPA. Studying was inversely related to LPA and MVPA. Working was inversely related to sleep and positively related to LPA. Watching videos was associated with lower LPA and MVPA. For males, videogames were associated with increased sedentary behavior and lower LPA and MVPA. For females, studying and/or using social media were associated with lower LPA and MVPA. When self-reported 24-hour movement behaviors were analyzed, females engaged in less total self-reported physical activity, sports, total screen time, and leisure-time screen time (videos, videogames and social media), but in more involuntary screen time (work and study) than males. Age was positively associated with non-sports and involuntary SB. Socioeconomic status was positively associated with total self-reported physical activity. Adolescents who lived with the mother only practiced more sports compared to those living with two parents. Unprocessed food was positively associated with self-reported physical activity and sports. Processed food was inversely associated with self-reported physical activity and non-sports and positively associated with total screen time and leisure-time screen time. Alcohol use was positively associated with self-reported physical activity, and tobacco smoking was negatively associated with self-reported physical activity. No associations were observed for sleep duration. As for the adherence to the 24-hour movement guidelines, the proportion of adolescents meeting the MVPA, screen time, and sleep duration guidelines was of 25%, 28%, and 41%, respectively, for self-reported data. From accelerometer data, 7.1% met MVPA and 31.7% met sleep duration recommendations. Adherence to all three recommendations was 3% with self-report and 0.2% with accelerometer data. Males were more likely to meet MVPA, but not screen time and sleep duration recommendations. A positive relationship was observed between age and meeting the screen time recommendation. In conclusion, the results suggest that the 24-hour movement behaviors of adolescents are influenced by several sociodemographic and behavioral factors. The relationship between the 24-hour movement behaviors between themselves and other factors may be type-specific, and that information may be particularly relevant when planning and optimizing future studies, interventions, policies, and practice.

Keywords: physical activity; accelerometer; sleep; sedentary behavior; cross-sectional; adolescents

DOCUMENT STRUCTURE

This Doctoral thesis is structured according to the norm 02/2008 of the Programa de Pós-Graduação em Educação Física of the Centro de Desportos of the Universidade Federal de Santa Catarina. The present thesis is organized using the alternative format described on item 6 of the norm 02/2008. Using this structure, the present document has four chapters: 1) Introduction, composed by the rationale and justification for the research problem, its objectives and hypothesis; 2) The Development, composed by the material and methods, including the operationalization of the concepts, description of the instruments and procedures, and the treatment and analysis of data; 3) Results and Discussion, presented in the form of four research articles; and 4) Final considerations, summarizing the results and conclusions of the thesis. These are followed by the sections of references and appendix.

LIST OF TABLES

LIST OF ABBREVIATIONS

ELEVA: Longitudinal Study of the Lifestyle of Adolescents (Estudo Longitudinal do Estilo de Vida de Adolescentes)
UFSC: Universidade Federal de Santa Catarina
IFSC: Instituto Federal de Santa Catarina
TCLE: Parents/Guardians consent form
TALE: Participants/Students consent form
TIEM: High school course integrated with technical courses
HDI: Human Development Index
STB: Stationary Behavior
LPA: Light-intensity physical activity
MVPA Moderate- to vigorous-intensity physical activity
MET: Metabolic equivalent of task
ST: Screen time
PeNSE: National Student Health Survey (Pesquisa Nacional de Saúde do Escolar)
ISAK: International Society for the Advancement of Kinanthropometry
PCA: Principal Component Analysis
SES: Socioeconomic Status
BMI: Body Mass Index
AIC: Akaike Information Criteria
BIC: Bayesian Information Criteria

SUMMARY

1. INTRODUCTION

Sleep, sedentary behavior, and light-, moderate-, and vigorous-intensity physical activity are indicators of a continuum of movement behaviors that compose the day of each individual[1,2]. How each person engages in different patterns of these behaviors is determinant to several health outcomes, and more active lifestyles have been associated with protection from cardiometabolic diseases[3–7] and depression[8–10], beyond providing other biological, social, and psychological benefits[5,11,12]. However, during the lifespan, the movement behaviors constantly change, and while childhood is perceived a high engagement in physical activities, studies have shown that adolescence is marked by a rapid decline in physical activity levels[13–16], increased time spent in sedentary behaviors[17–20], and sleep deprivation[21–23]. Such changes may reflect accelerated development and access to new technologies which contributes to decreased physical activity and increased time spent in sedentary behaviors, with increased use of electronic media[24,25].

Multiple studies have shown that physical activity levels decline during adolescence using different indicators of physical activity. For example, a longitudinal study with 158 adolescents has found a 15.3% decline in accelerometer-measured steps in a 1-year follow up of 7th and 9th graders[26]. A pooled analysis conducted with 26 studies found a decline of 7.0% of physical activity levels during adolescence; however, most studies included analyzed physical activity with self-report instruments, and studies included dated back to 1997, when digital media was not as widespread and possibly have not impacted the changes in physical activity levels[27]. However, a study that monitored physical activity levels with accelerometers between 2010 and 2013 in Norway has shown a decline of 712 daily steps, and approximately 8.2 minutes per day of moderate-to-vigorous intensity physical activity (approximately 18% of the habitual levels)[28]. Overall, studies concur that the period that composes adolescence is marked by a steep decline in physical activity levels.

The decreasing levels of physical activity may be related to the increasing volumes of sedentary behavior observed during adolescence. High volumes of accelerometer-measured sedentary behavior, or more recently called stationary

behavior[29], have been investigated among adolescents[30,31], with 9.1 hours per day spent in this behavior as shown in a recent study among Australian adolescents[31] (15 year-olds). In the same way, longitudinal studies have shown increasing volumes of sedentary behavior during adolescence[32–40]. A study published in 2013 with Vietnamese adolescents found an increase in the range of 69 to 78 minutes per day in accelerometer-measured sedentary behavior in five years (from 12 to 16 years)[39]. A study published in 2015 with adolescents (baseline age was 10.2 years) from the United Kingdom found an increase of 10.6 minutes/day per year of follow-up in accelerometer-measured sedentary behavior in four years[36]. The high engagement in these behaviors have been shown to occur across many periods of the day, with an increased sedentary behavior in the school (8.2%), after school (7%), and weekend (6.9%) periods in a longitudinal study of four years with adolescents from the United Kindgom[35]. Longer periods of sedentary behavior have been shown to occur during adolescence, as a study found a decrease of over 200 sedentary behavior breaks per day over 10 years during the transition from childhood to adolescence[40]. As observed for physical activity, most studies have found that sedentary behavior seems to increase during adolescence, as shown by diverse indicators (e.g. self-reported minutes, accelerometer minutes, number of breaks per day, screen time).

Considering the continuum approach in relation to movement behaviors, changes in physical activity and sedentary behavior may not be independent from sleep behavior[1,41], which is also impacted by multiple factors during adolescence[21,22]. A recent cohort study with 3,660 adolescents found that 41.7% of adolescents with sleep problems such as nightmares, feeling overtired, or having trouble sleeping at 14 years still had problems at 21[42]. A recent study monitored sleep duration of 20,745 North Americans, and found that during adolescence (12-18 years), participants had a lower sleep duration (7.8 and 7.6 hours/night for boys and girls, respectively) compared to early adulthood (8.2 and 8.6 hours/night), and later adulthood (9.1 and 9.3 hours/night)[43]. The low duration of sleep during adolescence may negatively impact health, as current guidelines suggest that adolescents should sleep more hours than adults[2,44,45].

Although the movement behaviors have this time-dependent relationship, other behaviors may also be associated with less active lifestyles. Dietary behaviors play a role in providing enough energy and nutrients for the functions of the organism,

and unbalances may negatively impact physical activity[46,47] and sleep[48–50]. In addition, specific screen time behaviors, such as watching television, are more strongly related to decreased physical activity[51,52], compared to playing videogames[52]. The impact of the increased use of social media in movement behaviors is not clear, but some studies suggest they are negatively related with sleep duration[53–56] and other sleep indicators[54,55,57]. Overall, dietary and screen time behaviors have been shown to be predictors of the movement behaviors among adolescents; however, it is not clear if they predict changes in these movement behaviors during high school, as longitudinal studies with objective measures of all movement behaviors are lacking.

Assessing movement behaviors using a 24-hour protocol with wrist-worn accelerometry has been suggested as a solution of memory bias for self-reported measures of these behaviors[58–60]. This is imperative as most self-reported measures include limitations such as memory and social desirability bias, and thus limits the accuracy of activities' frequency, duration and intensity[61]. However, only more recent studies[1,58,62] have employed this protocol in studies with adolescents, and in high-income countries, which depicts a social organization that may not translate into middle- and low-income countries. In fact, a recent review analyzing prevalence and correlates of the 24-hour movement behaviors and adherence to the recommendations for these behaviors found no studies in Brazil using either accelerometer or self-reported measures of these behaviors.[63]

Accelerometer-measured 24-hour movements are accurate to the minute unit and prevent memory and social desirability bias.[64] However, some qualitative information cannot be inferred when using accelerometers, such as type and domain of activities. This is important, as different types of sedentary behavior and physical activity relate to health in different ways. For example, work-related physical activity has been shown to impair health, where leisure physical activity generally enhances health.[65] These specific subtypes of physical activities and sedentary behavior may also differ in relation to their correlates, as some sociodemographic, dietary, and substance use factors may be related to specific types of physical activity and sedentary behaviors.[66,67] For example, alcohol use has been linked specifically with participation in sports among adolescents in a review of longitudinal studies.[68] This

relationship may not be observed for other physical activities, such as commuting or doing chores. Drawing a parallel with sedentary behavior, unhealthy snacking has been linked specifically to increased television viewing,[69] but may not be observed with mandatory or involuntary screen time such as the time spent studying or working with screen-based devices. Identifying factors associated with specific subtypes of physical activity and sedentary behavior may be helpful, as some subgroups such as females may need specific interventions to engage in more sports,[70] while males may need specific strategies to reduce leisure-time sedentary behaviors.[30]

Some specific populational subgroups may be at a greater risk for some 24-hour movement behaviors[16,17,20,71–73]. For example, studies consistently show that females are less active than males[13,71,72,74–76], and also have a higher risk for poor health during adolescence[77]. Sedentary behavior and use of smartphones have also been shown to be higher among Brazilian adolescent females, compared to males[75,78]. Older adolescents are also less active and engage in more sedentary behaviors compared to younger peers[75,76]. As for sleep-related behaviors, a review has shown that low socioeconomic status has been related to worse subjective perception of sleep quality, shorter duration, and greater daytime sleepiness[79].

The present cross-sectional study aimed to identify correlates of accelerometer-measured and self-reported 24-hour movement behaviors with an integrated approach of sleep, sedentary behavior and physical activity. In addition, the adherence to public health guidelines for the 24-hour movement behaviors was also investigated. The findings of the present study are needed to inform the design of interventions and policies by identifying subgroups at greater risk of unhealthy movement behavior profiles (e.g. high sedentary time, insufficient sleep and low physical activity levels), and behavioral predictors that are modifiable.

1.1. OBJECTIVES

In the following sections are described the general and specific objectives of the present study.

1.1.1. General Objective

To analyze sociodemographic and behavioral correlates of accelerometer-measured and self-reported 24-hour movement behaviors in a sample of Brazilian adolescents enrolled in high school integrated with professional education.

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1.1.2. Specific Objectives

To examine if sociodemographic, dietary, screen time, and substance use indicators are correlated with accelerometer-measured sleep duration, sedentary behavior, and light-, moderate- and vigorous-intensity physical activity in a sample of Brazilian adolescents.

To test if sociodemographic, dietary, and substance use indicators are correlated with self-reported sleep duration, sedentary behavior, and physical activity, and the subtypes of physical activity and sedentary behavior in a sample of Brazilian adolescents.

To analyze if sociodemographic indicators are correlated with adherence to the 24-hour movement behavior guidelines using accelerometer-measured and self-reported sleep duration, sedentary behavior, and physical activity in a sample of Brazilian adolescents.

2. DEVELOPMENT

2.2. MATERIAL AND METHODS

2.2.1. Study design

This Doctoral thesis study has a cross-sectional observational design[80], being part of the Longitudinal Study of the Lifestyle of Adolescents (ELEVA, eleva.ufsc.br).

2.2.2. Ethical concepts of the study

The participation of the students in this study was authorized by the coordinator of research of the Colégio de Aplicação of the Universidade Federal de Santa Catarina (UFSC) (pilot phase, Appendix A), and by the principal (Appendix B, C, and D), Pro-Rectory of Research, Graduate and Innovation (Attachment E) of the Institutos Federais de Educação Tecnológica de Santa Catarina (IFSC).

Adolescents had to provide written informed consent signed by the parents/guardians (TCLE, Appendix F), and the terms of free and informed assent signed by themselves (TALE, Appendix G). All the guidelines established in resolutions 196 and 466 of the National Health Council were observed in the design of this study. The present research project was approved by the Ethics Committee in Research with Human Beings of the UFSC (protocol number: 3.168.745, Appendix H). Each participating school will receive a final report with the results of the survey, which should be presented to the school community by the research team. Due to the COVID-19 pandemic, the in-person presentation of the results was postponed, but some of the results of the study are being presented in video form that can be assessed by students, managers, and teachers.

2.2.3. Population and sample

The study population was composed by students of the IFSC enrolled in high school courses integrated to technician courses in the campuses located in the mesoregion of Grande Florianópolis, in the Santa Catarina State, Brazil.

Santa Catarina has more than 20 campuses of IFSC, with 156 technical courses available, of which 41 are integrated to high school courses (TIEM) in the same institution (with other courses being subsequent or concomitant to high school).

The metropolitan region of Florianópolis groups the largest proportion of students of TIEM students in three campuses (Florianópolis Centro, Palhoça and São José), with 2,468 students of the 5,530 (approximately 45%) students regularly enrolled in TIEM courses in all the state of Santa Catarina in 2017[81].

Florianópolis is the capital of the Santa Catarina State, inside the mesoregion Grande Florianópolis. The municipality has 421,000 inhabitants, and a Human Development Index (HDI) of 0.847, the third highest of the country in 2010, and the highest amongst the Brazilian State capitals. The Gini Index (the closer to zero, there is the less social inequality) was of 0.54 in 2010[82]. São José is, with 209,000 inhabitants, HDI of 0.809, in the very high stratum (above 0,8), and Gini index of 0.44[82]. Palhoça is a city in the Santa Catarina State, inside the mesoregion Grande Florianópolis. The municipality has 137,000 inhabitants and HDI of 0.757, with Gini index of 0.40[82].

The IFSC are part of the national technical education network, which began in 1809 after the creation of the College of Factories by the then Prince Regent D. João VI. Since then, the network has been systematized and updated to meet the different demands of technical and professional education in the country. It is currently a federal network of Institutes of Technological Education that covers all the Brazilian states, offering technical courses, undergraduate and graduate courses, in addition to other short-duration courses[83].

The enrollment to the IFSC network works according to the type of course. Most of the TIEM courses have the entrance done through a classification examination, with few exceptions of campuses that adopt the electronic random draw as a form of selection. Students are eligible to take the Classification Examination if they have completed elementary school. TIEM courses offered at the Palhoça-Bilingual campus are Visual Communication and Translation and Interpretation of Libras/Portuguese; in Campus São José, the courses are Refrigeration and Air Conditioning and Telecommunications; and at the Campus Florianópolis-Centro are Edification, Electronics, Electrotechnology, Chemistry and Sanitation.

The courses have a duration of six to eight semesters/terms, integrating the hours of high school, with the characteristic of basic education, and technical education, with an increase of specific subjects by area of knowledge.

The only inclusion criterion for the ELEVA study was to be enrolled in the first to sixth terms of a TIEM course offered at an IFSC campus in the Grande Florianópolis mesoregion in the year of 2019. The only exclusion criterion for participation in the research was students who presented with a disability or injury that prevented them from participating in the collection of study variables (for example: students wearing a plaster on the arm that prevented the use of accelerometer). Every student enrolled in the first to sixth terms of a TIEM and present at the data collection dates were invited to participate.

2.2.4. Measurement of variables

The variables of interest were measured using an online questionnaire. Body mass and stature were objectively measured, and accelerometers were used to assess 24-hour movement behaviors. In relation to the questionnaire, the questions and response options can be found in Appendix 9 and in the link of the questionnaire (link: https://pt.surveymonkey.com/r/7753PQ6).

2.2.4.1. Physical Activity

Actigraph accelerometers, models Gt3x+, wGt3x+, and wGt3x+bt, with dynamic range of ± 6 g and sampling frequency range of 30–100 Hz (ActiGraph Corporation, Pensacola, Florida, USA) were used to measure sleep, sedentary behavior, and physical activity. Accelerometers were used in the non-dominant wrist[84–86] and data was analyzed in acceleration measures proportional to the acceleration of gravity, *g*. The intensity of activities was classified as sedentary behavior (equivalent to <1.5 METs), light (LPA, between 1.5 and 3 METs), and moderate and vigorous (MVPA, above 3 METs). All analyses were conducted according to recommended methods[60,87–89]. Accelerometers were charged, initialized, and data were downloaded by trained researchers, using 30 Hz as sampling frequency.

2.2.4.2. Sedentary behavior

Sedentary behavior was operationalized as two independent indicators in the present study. The first is accelerometer-measured sedentary behavior, which refers to waking behaviors done while lying, reclining, sitting or standing with no ambulation[29].

The second indicator of sedentary behaviors is screen time, which was measured using a standardized questionnaire named “Questionnaire of the Screen Time of Adolescents (QueST)”, developed for the present study.[90] In this instrument, five components of screen time are measured: time spent working or doing work-related tasks exclusively on a screen, time spent studying or watching video classes and doing homework exclusively on a screen, time spent watching media in the format of videos like series or movies, time spent playing in electronic devices, and time spent using social media and chat applications. Daily volume in minutes spent on each activity while using electronic devices was reported for weekdays and weekend days. The description of each question can be observed in the attached questionnaire (Appendix 9).

This instrument was created for the present study as other instruments to measure sedentary behavior evaluate the electronic device (e.g. television, computer, videogame), with questions related to the time watching television, in the computer and cellphone, without identifying the type of activity being done (e.g. playing, watching videos, using social media)[91]. This instrument innovates in this sense, identifying the type of activity, as adolescents can commonly watch movies on the television, on the computer and/or on the cellphone. Identifying the type of screen behavior can contribute to a new understanding of sedentary behavior, especially when sedentary activities can impact health in different ways, as evidenced by the WHO, which included addiction in video games as a disease in the eleventh revision of the International Classification of Diseases (ICD-11)[92]. This instrument underwent a validation process, involving expert consultation, evaluation of objectivity (questionnaire content validation index of 0.98), clarity (every item was considered clear or very clear by 95% or more by the participating students), and reproducibility (intraclass correlations ranging from 0.24 to 0.76), being tested in the pilot study of the ELEVA.

2.2.4.3 Sleep

Sleep duration was derived from the accelerometry data[93]. This procedure was validated for adolescents using polysomnography as reference measure[93,94]. Although no study with adolescents has yet been published using the Heuristic algorithm looking at Distribution of Change in Z-Angle presented by Van Hees (2018)[93], this procedure has been validated and yields good estimates of sleep period time, sleep duration and efficiency with adults (c-statistic of 0.86 for detecting sleep period time versus polysomnography).

Participants reported the time they habitually went to bed and woke up on weekdays and weekend days, and self-reported sleep duration was calculated as the difference between both.

2.2.4.4. Covariates

Socio-demographic indicators of sex, age, and family structure (living with father and/or mother) were measured using questions used on the National School Health Survey (PeNSE)[95]. Socioeconomic status was assessed by asking the ownership of household belongings according to the Brazilian Association of Research Companies[96] (e.g. number of owned cars, refrigerators, computers).

Dietary habits were assessed using questions that were used in the PeNSE, which were also used in national-wide studies with Brazilian adolescents[97], and have good validation indexes (accuracy indexes varying from 59.8 to 88.4, versus 24-h recall)[98]. In these questions students report the number of days in the week preceding the study in which they consumed: beans; raw or cooked vegetables; raw salad; vegetables cooked in the food or soup; fresh fruit or fruit salad; milk; treats; biscuits, crackers, packet snacks or fried cheap packet; sweet biscuits; salty crackers; fried or salted fried snacks; sausages; soft drinks; beverages with sugar; juices or refreshments, teas, flavored waters, isotonic, soy-based drinks.

2.2.5. Procedures

The evaluation of the variables of interest took place between the months of August and December of 2019.

The campuses were visited by the research team, when they presented the research to the adolescents in the classroom, clarifying the nature and procedures of

the project, inviting all eligible students to participate, and delivering two copies of the TALE (Appendix F) and TCLE (Appendix G) for the students. The students were oriented to deliver the signed consent forms to the physical education teacher or the researchers in the follow-up visit. The research projected a video explaining the rationale of the research and its measures. The video was developed by the research team, in the Brazilian Portuguese language, and can be checked in the following link: https://www.youtube.com/watch?v=VnlL9mmuVy0&feature=youtu.be.

In a follow-up visit, the research team returned to the classrooms to collect the TCLEs and make the first measurements of the study. Students were asked to go to the physical education room, where body mass and stature measurements were conducted by trained researchers. Students wore light clothes, and measures of stature were conducted two times to the nearest 0.1 centimeter using the Alturaexata® stadiometer (Belo Horizonte, Brazil) and the average value of both measures was used. For the body mass measurement, a trained researcher conducted the measurement to the nearest 0.1 kg using the Welmy W300 scale (Santa Bárbara d'Oeste, Brazil). The team was trained by experienced researchers with level 3 course of the International Society for the Advancement of Kineanthropometry (ISAK), and the inter- (between 0.24 and 0.40, where values below 1 are acceptable), and intra-rater (between 0.07 and 0.28, where values below 1 are acceptable) variability was measured in the pilot study with 24 students. After the measurements, the accelerometers were delivered to each student in the same room by trained researchers who instructed students to use the device on the non-dominant hand wrist for seven days, and gave the orientations to not open the monitor and contact the team if they had any questions. Accelerometers were fixed using disposable PVC band (model Superband Fina 460, TAG Comércio de Materiais de Identificação, São Paulo, Brazil), as can be observed in the Appendix J.

In a third visit, the team retrieved the accelerometers and oriented the students to answer to the *online* questionnaire, hosted in the SurveyMonkey platform. Researchers wrote the link to the questionnaire in the whiteboard and students were asked to follow up the instructions and ask any questions they had. For students who did not have smartphones, tablets and notebooks were offered for them to use for

answering the questionnaire. Students could use the schools' wireless internet connection, and researchers also hosted wireless connection if needed. The average duration for the completion of the questionnaire was 24 minutes. Accelerometers were taken to the laboratory for download and processing.

All meetings were scheduled with the management team of each campus, according to the availability of infrastructure. Students who missed the classes at some stage of data collection were invited to participate with another class on the subsequent data collection date of that campus.

2.2.6. Treatment and reduction of data

2.2.6.1. Accelerometer data

Accelerometer data were obtained from the accumulated acceleration in each 5-s epoch[60,99,100]. Data were downloaded in the .gt3x file extension using the Actilife software, version 6.8.11 for Windows, and raw data were then saved in a .csv file with timestamps for each participant. The .csv file was processed in the GGIR package for R[101]. Accelerometer wear-time was calculated, and those who used the accelerometers for more than 16 hours per day, for four days a week and including a weekend day, were included in the analyses, as recommended for this age group[60].

Acceleration was classified as MVPA (activities above 201.4 m*g*), LPA (activities between 35.6 m*g* and 201.4 m*g*), and sedentary behavior (activities below 35.6 m*g*) using the cutoffs that Hildebrand et al.[102,103] recommend for this age group. Sleep duration was derived from the accelerometry data using the Heuristic algorithm looking at Distribution of Change in *z*-Angle.[104] This algorithm differentiates sleep from other inactivity windows (operationalized in the present study as sedentary behavior) by calculating the longest sustained period of inactivity (calculated based on changes in the angle of the wrist) with the lowest number of interruptions in a 24-h time window.

2.2.6.2. Questionnaire data

Questionnaire data were downloaded from the SurveyMonkey platform and merged with adolescents' entry from the control list, accelerometer data, and body mass and stature data using their school identifier. The control list had indicators of their campus, course and term, as well as dummy variables for each stage they

participated (e.g., one if they received an accelerometer and zero if not). Participants' data were then checked for incompleteness.

A factor analysis was used to create latent variables to represent different dietary patterns in two steps. Firstly, exploratory factor analysis was conducted and revealed that a two-factor solution was sufficient to represent the dietary patterns with adequate Keiser-Meyer-Olkin measure of sampling adequacy (0.67), using the Kaiser criterion (Eigen >1) to identify the number of factors. This model was estimated using maximum likelihood, using orthogonal varimax rotation. The only variable indicator with unstandardized factor loading lower than 0.40 was the beans, and it was dropped from the final model. In the second step, confirmatory factor analyses were used to calculate standardized factor loadings of the two factors named 'Unprocessed food' and 'Processed food' (Article 1: Supplementary table 1). The first factor was composed of two indicators, vegetables, and fresh fruits, and the second was composed of salted fried food, sweets, soda, ultra-processed sausages, and fast food. For each factor, a score was calculated for each participant based on their response pattern, and the estimated latent variables were rescaled from 0-10 for ease of interpretation, where higher values refer to high consumption of unprocessed food/processed food, respectively.

Self-reported sedentary behavior was measured by proxy of screen time across four variables: time spent studying, working, watching videos (e.g., series, news, sports, streams, and movies), and playing video games using screen-based devices. Daily screen time was calculated by weighting the volume on weekends by 2 and on weekdays by 5. Three continuous variables were calculated: the total volume of sedentary behavior, by summing the daily volume of the four indicators; the involuntary sedentary behavior, by summing time spent studying and working; and the leisure-time sedentary behavior, by summing the time spent watching videos and playing video games. When used as independent variable, screen time indicators were classified in categories including: <2 h/day, ≥2 h and <4 h/day, and ≥4 h/day.

The self-reported habitual sleep duration was calculated by weighting the volume on weekends by 2 and on weekdays by 5, and was treated as a continuous variable.

For analyzing adherence to the 24-hour movement behavior guidelines,[105] both self-reported and accelerometer-measured physical activity were dichotomized if the daily average duration in MVPA was above/below 60 minutes, if the self-reported leisure-time screen time average was above/below 2 hours, and if the sleep duration was between 8 and 10 hours/night.

Socioeconomic status (SES) was analyzed according to the 2019 Criteria Brazil guidelines[106] where a score ranging from 0-100 is estimated based on their possession of household items list, highest level of instruction of the provider, and indicators of public services (having piped water in the household, and living in a paved street).

2.2.7. Statistical analyses

Characteristics of the sample were described using means and standard deviations for continuous and relative and absolute frequencies for categorical variables.

To address the objectives of the present study, different statistical approaches were adopted on each individual article. All analyses were conducted using R (software version 4.0, R Foundation for Statistical Computing, Vienna, Austria). The multilevel models were estimated using the package lme4.[107] Different multilevel models were fit to test the associations, but a similar hierarchical structure was adopted, with participants nested within schools. In addition, models were checked for normality of residuals, heteroscedasticity and collinearity. For all associations, significance was set at $p<0.05$ (two-tailed).

In the first article, the associations between the sociodemographic, dietary, and substance use factors with each of the 24-hour movement behaviors were tested using multilevel linear regression analyses. Models were mutually adjusted for each other independent variables. Sex, age, and SES interactions were tested for each indicator of dietary pattern and substance use for each outcome (sleep duration, sedentary behavior, LPA, and MVPA). However, no statistically significant interaction effects were observed, and only the main effects were included in the final models. A random intercept was estimated to account for the structure of participants nested within schools using the Restricted Maximum Likelihood (REML) method. Associations

were presented in minutes per day as coefficients and 95% confidence intervals (CI) for sleep duration, sedentary behavior, LPA, and MVPA for ease of interpretation.

To test the association between screen time indicators (studying, working, watching videos, playing videogames, using social media) and sleep duration, sedentary behavior, LPA, and MVPA, multilevel linear regression analyzes were fit. These results are documented in the second article. When interaction effects between sex and screen time indicators were observed, screen time slopes for each level of sex were computed by linear combination of coefficients. The variable of MVPA was log-transformed to correct skewness.

To answer the second specific objective, the associations between sociodemographic (sex, age, SES, family structure), dietary (unprocessed food score, processed food score), and substance use (alcohol use, tobacco use, illicit drugs experimentation) with sleep duration, total sedentary behavior, leisure-time sedentary behavior, and involuntary sedentary behavior, multilevel linear regression models were estimated using Restricted Maximum Likelihood approach, and 95% confidence intervals were also estimated. The results are presented in article 3. For total physical activity, sports, and non-sports physical activity, generalized linear multilevel models with the Gamma family were fit using the Adaptive Gauss-Hermite Quadrature, and 95% confidence intervals were calculated. This was used as all physical activity indicators were right-skewed, and the Gamma models are recommended for such distributions and provided better residuals.[108] All models were mutually adjusted for all independent variables.

In the fourth article, analyses to answer the third specific objective are presented. Comparison of characteristics between those who provided valid accelerometer data and those who did not was conducted using Student's t-tests and Pearson's Chi Squared tests. Mixed-effects logistic regression analyses were fit using adherence of all and each 24-hour movement behavior variables as dependent variables, and sociodemographic variables. Categorical variables were sex, family structure, and parental education, whereas age (in years), SES (in 0-100 score), and number of people in the household (count of people) were continuous.

2.2.8. Pilot Study

The ELEVA research procedures were tested in a pilot study conducted in the first semester of 2019, at the Colégio de Aplicação of the UFSC. In the pilot study, the instruments and the logistics of the data collection protocol were tested. The Colégio de Aplicação was chosen as to mimic the IFSC infrastructure, as they offer high school in a school environment linked to the federal public-school system, like the IFSC.

Of the 203 eligible students present at data collection, 161 provided signed consent forms and participated in the study. Of this total, 151 had complete questionnaire data, one was dropped due health complications, two refused to wear the accelerometers, four had lost or broken the accelerometer and 26 did not provide valid data for accelerometer analyzes. A final analytic sample was composed of 118 students (67% girls, mean age 16.3 years), and 104 completed test and re-test of the questionnaire.

Some adjustments were made to the questionnaire form to improve its application (e.g. some questions were moved to different pages and logic was applied to skip non-applicable questions). In addition, the PVC band was tested and approved by students to secure the accelerometer to the wrist.

3. RESULTS

3.1. ARTICLE 1: ASSOCIATION BETWEEN SOCIODEMOGRAPHIC, DIETARY, AND SUBSTANCE USE FACTORS AND ACCELEROMETER-MEASURED 24-HOUR MOVEMENT BEHAVIORS IN A SAMPLE OF BRAZILIAN ADOLESCENTS

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Association between sociodemographic, dietary, and substance use factors and accelerometer-measured 24-hour movement behaviors in a sample of Brazilian adolescents

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Abstract

Introduction

Several sociodemographic characteristics and lifestyle behaviors can be related to sleep, sedentary behavior, and physical activity. The aim was to examine the association between sociodemographic, dietary, and substance use factors and accelerometer-measured 24-hour movement behaviors in a sample of Brazilian adolescents.

Methods

Adolescents reported sex, age, socioeconomic status (SES), family structure, dietary behaviors, and substance use behaviors. Sleep duration, sedentary behavior, light- (LPA), and moderate-to-vigorous physical activity (MVPA) were estimated with wrist-worn accelerometry.

Results

Females slept more (β=21.09, 95%CI 13.18; 28.98), engaged in more LPA (β=17.60, 95%CI 8.50;27.13), and engaged in less sedentary behavior (β=-16.82, 95%CI -30.01;-4.30) and MVPA (β=-4.76, 95%CI -7.48;-1.96) than males. Age and sedentary behavior were positively associated (β=8.60, 95%CI 2.53;14.64). Unprocessed food was positively related to LPA (β=2.21, 95%CI 0.55;3.92), while processed food was positively related to sedentary behavior (β=3.73, 95%CI 0.03;7.38) and inversely related to MVPA (β=-0.89, 95%CI -1.68;-0.10). Family structure, SES, and substance use factors were not significantly associated with any 24-hour movement behavior.

Conclusion

Sex, age, and dietary behaviors, but not SES or substance use, were associated with 24-hour movement behaviors in this sample of Brazilian adolescents, and are important factors to consider in intervention, policy, and practice.

Key words: physical activity, sedentary behavior, sleep, public health, accelerometry

Introduction

The 24-hour movement behaviors are composed of physical activity of light (LPA) and moderate-to-vigorous (MVPA) intensity, sedentary behavior, and sleep

duration. A significant body of evidence indicates that these behaviors are related to several health outcomes during adolescence.[109–112] Considering the relationship of these behaviors with health, the low engagement in physical activity,[113] high involvement in sedentary behaviors,[30] and high prevalence of short sleep duration[114] amongst adolescents is concerning. Accordingly, there is a need to better understand what factors are related to each of the 24-hour movement behaviors during adolescence, as past research has shown that these behaviors formed during this important developmental transition track into adulthood.[13,17] Many factors may influence the 24-hour movement behaviors of adolescents, including dietary behaviors, substance use, and sociodemographic factors such as sex, age, and socioeconomic inequalities.[30,72,115]

Dietary patterns have been associated with the 24-hour movement behaviors in different studies,[69,116–121] as optimal availability of micronutrients and energy-yielding nutrients influence the regulation of hormones, modulating the feelings of tiredness and energy levels, and impacting sleep, physical activity, and sedentary behaviors. The literature indicates that high consumption of snacks, fast food, and sugar-sweetened beverages and lower consumption of fruits and vegetables was related to higher time in sedentary activities and lower levels of physical activity in studies with Australian[122] and United States[123] adolescents.

The experimentation and use of alcohol, tobacco, and even illicit drugs have been shown to occur during adolescence as well.[124] These behaviors have been associated with the 24-hour movement behaviors, with research showing a positive relationship between using alcohol and tobacco, and increased sedentary behavior among 32,696 Asian adolescents.[125] Substance use has also been negatively associated with sleep in a study analyzing trends from 1991 to 2014 in nationally representative samples of adolescents from the United States.[126] In contrast, the use of alcoholic beverages has been associated with higher engagement in physical activity among adolescents.[127] It may be that in sports practice and events, social interactions may increase the exposition of adolescents to alcohol intake. However, alcohol ingestion results in acute and chronic effects that disrupt sleep.[128] Overall, research suggests that substance use impairs sleep and promotes sedentary

behaviors, and except for alcohol, which may be positively related to physical activity, they are likely to be associated with unhealthy 24-hour movement behaviors.

Most of the previous and limited literature that examined the relationship between socioeconomic, dietary, and substance use factors with sleep, physical activity, and sedentary behavior have been conducted in high-income countries, and findings may not be applicable to low- and middle-income settings, where differences in culture, laws, and social organization can differ greatly. For example, Brazil has a large production of fruits, vegetables and meat compared to most high-income countries and has unique dietary patterns with most of the population routinely consuming unprocessed food like rice and beans daily;[129] however, health inequalities are also exacerbated,[130] while also having a successful history of decreasing tobacco smoking.[131] Additionally, the measurement of 24-hour movement behaviors may also play a role in findings from previous studies, since the majority of previous research included self-reported measures of these indicators, which may be prone to memory bias among adolescents. The use of standardized accelerometry-measured behaviors is desirable to expand the current knowledge about this topic area. Identifying factors associated with each of the 24-hour movement behaviors can better inform policies, interventions, and practice to improve physical activity, reduce sedentary behavior and achieve sufficient sleep, which is desirable for adolescents in middle-income settings. Therefore, the objective of the present study was to examine the association between sociodemographic, dietary, and substance use factors and accelerometer-measured 24-hour movement behaviors in a sample of Brazilian adolescents.

Material and Methods

Study design and participants

The present study analyzed data from the baseline cross-sectional sample of the study called *Estudo Longitudinal do Estilo de Vida de Adolescentes* (ELEVA). Briefly, the ELEVA study aims to monitor changes in lifestyle behaviors during high school. The baseline measures were conducted between August and December 2019, in three campuses of the Federal Institutes of Technology in the mesoregion Grande Florianópolis, Southern Brazil, where all students enrolled in first to third years of high school integrated with professional courses were invited to participate (age range: 14-18 years). A total of 1,618 students were listed as enrolled by the schools, and 1,249

were present at data collection and were invited to participate, of which 1,010 (62% of the eligible students) provided signed assent and consent forms. The present research project was approved by the Ethics Committee in Research with Human Beings of the *Universidade Federal de Santa Catarina* (protocol number: 3.168.745).

Measures

24-hour movement behaviors

Sleep duration, sedentary behavior, LPA, and MVPA were measured using Actigraph accelerometers (ActiGraph Corporation, Pensacola, Florida, USA), model GT3x+ and wGT3x+. Participants were oriented to wear the accelerometers for seven consecutive days, 24 hours per day, except for activities where the accelerometer would be submerged into water (e.g., surfing or swimming, but not showering or washing dishes). Accelerometers were secured by a disposable PVC band, and each participant received at least two bands, in case they had to take the accelerometer off for any activity (e.g., airport security, swimming lessons). Accelerometer wear time was checked and participants with at least three weekdays and one weekend day with 16 or more hours of valid data per day were included in the analyses. Accelerometers collected data using a 30 Hz sampling frequency, and data were analyzed in 5 s epochs, using the cut-offs of Hildebrand et al.,[102,103] for this age group to classify sedentary behavior (activities bellow 35.6 mg), LPA (activities between 35.6 mg and 201.4 mg), and MVPA (activities above 201.4 mg). Sleep was calculated using the Heuristic algorithm looking at the Distribution of Change in Z-Angle.[93] Accelerometers were initialized and data were downloaded using the software Actilife, version 6.8.11 for Windows (ActiGraph Corporation, Pensacola, Florida, USA), and analyzed using the GGIR package.

Dietary patterns

Participants reported the weekly frequency in days they consumed beans, vegetables, fresh fruits, salted fried food, sweets, soda, ultra-processed sausages, and fast food. The question was structured as follows: '*In the last seven days, how many days did you consume [type of food]*?' These questions have been previously validated for Brazilian adolescents.[98]

A factor analysis was used to create latent variables to represent different dietary patterns in two steps. Firstly, exploratory factor analysis was conducted and revealed that a two-factor solution was sufficient to represent the dietary patterns with adequate Keiser-Meyer-Olkin measure of sampling adequacy (0.67), using the Kaiser criterion (Eigen >1) to identify the number of factors. This model was estimated using maximum likelihood, using orthogonal varimax rotation. The only variable indicator with unstandardized factor loading lower than 0.40 was the beans, and it was dropped from the final model. In the second step, confirmatory factor analyses were used to calculate standardized factor loadings of the two factors named 'Unprocessed food' and 'Processed food' (Supplementary Table 1). The first factor was composed of two indicators, vegetables, and fresh fruits, and the second was composed of salted fried food, sweets, soda, ultra-processed sausages, and fast food. For each factor, a score was calculated for each participant based on their response pattern, and the estimated latent variables were rescaled from 0-10 for ease of interpretation, where higher values refer to high consumption of unprocessed food/processed food, respectively.

Substance use

The following questions were used to assess substance use related to smoking and alcohol consumption: "*During the past 30 days, on how many days did you have smoke cigarettes?"*; *"During the past 30 days, on how many days did you have at least one drink containing alcohol?".* Participants who smoked at least once, and drank alcohol at least once were classified as Smokers (*vs* non-smokers) and Drinkers (*vs* non-drinkers), respectively. Regarding drug experimentation, students answered the following question: *"Have you ever used a drug like: marijuana, cocaine, crack, ecstasy, etc.?"*. Those who reported 'Yes' were classified as having experimented. These questions have been previously used in *Pesquisa Nacional de Saúde do Escola* (PeNSE).[132]

Sociodemographic factors

Sex, age, socioeconomic status (SES), and family structure were assessed via questionnaire. Sex was retrieved as males or females, age was answered in completed years, and participants reported if they lived with either mother, father, both, or none. SES was calculated using a standardized score calculated using the number of household belongings (e.g., televisions, computers, washing machines) specifically

developed to assess a nationally comparable socioeconomic level in Brazil.[106] The score ranges between zero and 100, with higher values indicating a higher SES.

Procedures

Participants were recruited during class time, by trained researchers who explained the study and played a video detailing the protocol and measures. Students received assent forms to sign and consent forms for their legal guardians or parents to sign. In a second visit, approximately one week after the first, those who provided written informed consent and assent forms had their body mass and stature measured by trained researchers and received the accelerometer. In the last visit, one week after the second one, the accelerometers were retrieved and participants answered the study survey, which took an average of 24 minutes to complete. The survey was hosted on an online platform, and adolescents answered using smartphones, tablets, or computers.

Statistical analyses

The characteristics of the sample were described using means and standard deviations for continuous variables, and absolute and relative frequencies for categorical variables. Associations between the sociodemographic, dietary, and substance use factors with each of the 24-hour movement behaviors were tested using multilevel linear regression analyses. Models were mutually adjusted for each other independent variables. Sex, age, and SES interactions were tested for each indicator of dietary pattern and substance use for each outcome (sleep duration, sedentary behavior, LPA, and MVPA). However, no statistically significant interaction effects were observed, and only the main effects were included in the final models. In addition, the collinearity between the variables was checked and there was no collinearity in any model. A random intercept was estimated to account for the structure of participants nested within schools using the Restricted Maximum Likelihood (REML) method. Associations are presented in minutes per day as coefficients and 95% confidence intervals (CI) for sleep duration, sedentary behavior, LPA, and MVPA for ease of interpretation. The statistical analyses were performed in R (software version 4.0, R

Foundation for Statistical Computing, Vienna, Austria) using the packages *lavaan* and *psych* for the factorial analyses and *lme4* for the multilevel regression analyses. Statistical significance was set at a p value of less than 0.05.

Results

Out of the 1,618 eligible participants, 1,010 participants provided written informed consent (62%), 856 answered the questionnaire (i.e., no missing data in any questionnaire variable), 762 provided valid accelerometer data (i.e., valid data in 4 or more days including at least one weekend day), and a total of 615 had valid data on all study measurements and were thus included in the present analyses. No statistically significant differences were found for sex, age, or SES between those who provided valid and non-valid accelerometer data (data not shown). Table 1 shows the descriptive statistics of the 615 students included in the analysis.

Table 1. Characteristics of the sample [Mean ±SD or n (%)].

	Total sample (n=615)	**Female (n=316)**	**Male (n=299)**
Age (years)	16.33 ±1.04	16.34 ±1.04	16.32 ±1.04
SES score (0-100)	48.81 ±9.96	48.11 ±9.65	49.54 ±10.24
Family structure [n (%)]			
Live with both parents	390 (63.4)	195 (61.7)	195 (65.2)
Live with mother	165 (26.8)	89 (28.2)	76 (25.4)
Live with father	25 (4.1)	13 (4.1)	12 (4.0)
Other	35 (5.7)	19 (6.0)	16 (5.4)
Dietary behavior			
Unprocessed food (0-10)	6.06 ±2.94	6.31 ±3.02	5.81 ±2.84
Processed food (0-10)	3.84 ±1.82	3.75 ±1.88	3.94 ±1.77
Alcohol use in the last 30 days [n (%)]			
No	373 (60.7)	186 (58.9)	187 (62.5)
Yes	242 (39.3)	130 (41.1)	112 (37.5)
Tobacco use in the last 30 days [n (%)]			

No	570 (92.7)	289 (91.5)	281 (94.0)
Yes	45 (7.3)	27 (8.5)	18 (6.0)
Illicit drug experimentation [n (%)]			
No	510 (81.5)	289 (75.9)	261 (87.3)
Yes	114 (18.5)	76 (24.1)	38 (12.7)
24-hour movement behaviors			
Sleep duration (hours/night)	6.57 ±0.8	6.72 ±0.87	6.40 ±0.76
Sedentary behavior (hours/day)	10.26 ±1.34	10.06 ±1.28	10.47 ±1.38
LPA (hours/day)	4.20 ±0.98	4.38 ±0.90	4.02 ±1.03
MVPA (minutes/day)	31.21 ±17.30	29.38 ±14.99	33.14 ±19.28

SES: socioeconomic status; SD: standard deviation; LPA: light-intensity physical activity; MVPA: moderate-to-vigorous physical activity.

Table 2 shows the associations between sociodemographic factors and dietary behaviors with 24-hour movement behaviors. After mutual adjustment, it was observed that females slept an average of 21.1 minutes per night more than males, engaged in 17.6 more minutes of LPA per day, and engaged in less sedentary behavior and less MVPA compared to males. Age was positively associated with sedentary behavior, the score of unprocessed food pattern was positively related to LPA, while the score of processed food was positively related to sedentary behavior and inversely related to MVPA. Family structure, SES, the use of alcohol, tobacco, and experimentation of illicit drugs were not significantly associated with any 24-hour movement behavior.

Table 2. Association between sociodemographic, dietary and substance use factors and accelerometer-measured sleep duration, sedentary behavior, light-intensity physical activity, and moderate-to-vigorous physical activity in a sample of Brazilian adolescents (n=615).

	Sleep duration (minutes/day)	**Sedentary behavior (minutes/day)**	**LPA (minutes/day)**	**MVPA (minutes/day)**
	Coef (95%CI)	**Coef (95%CI)**	**Coef (95%CI)**	**Coef (95%CI)**
Sex				
Male	Reference	Reference	Reference	Reference
Female	**21.09 (13.18; 28.98)**	**-16.82 (-30.01; -4.30)**	**17.60 (8.50; 27.13)**	**-4.76 (-7.48; -1.96)**
Age (years)	-2.14 (-5.91; 1.60)	**8.60 (2.53; 14.64)**	-2.02 (-6.40; 2.40)	-0.87 (-2.18; 0.44)
SES score (0-100)	0.11 (-0.30; 0.51)	0.17 (-0.48; 0.82)	-0.23 (-0.71; 0.24)	0.02 (-0.12; 0.16)
Family structure				
Live with both parents	Reference	Reference	Reference	Reference
Live with mother	-1.71 (-10.85; 7.59)	6.61 (-8.40; 21.35)	-9.78 (-20.54; 1.05)	-0.21 (-3.42; 3.00)
Live with father	7.64 (-12.08; 27.48)	-3.97 (-35.96; 27.83)	-7.03 (-30.19; 16.17)	2.98 (-3.92; 9.86)
Other	7.72 (-9.35; 24.82)	-7.11 (-34.9; 20.24)	-0.06 (-19.96; 20.10)	-2.94 (-8.88; 3.03)
Dietary behavior				
Unprocessed food (0-10)	-1.14 (-2.61; 0.28)	-0.05 (-2.38; 2.25)	**2.21 (0.55; 3.92)**	0.06 (-0.43; 0.57)
Processed food (0-10)	-1.13 (-3.41; 1.14)	**3.73 (0.03; 7.38)**	1.09 (-1.56; 3.79)	**-0.89 (-1.68; -0.10)**

Alcohol use in the last 30 days				
No	Reference	Reference	Reference	Reference
Yes	-0.39 (-8.88; 8.11)	-6.06 (-19.81; 7.58)	1.96 (-7.96; 11.94)	2.52 (-0.43; 5.48)
Tobacco use in the last 30 days				
No	Reference	Reference	Reference	Reference
Yes	-2.43 (-19.47; 14.53)	6.74 (-21.10; 33.85)	2.33 (-17.38; 22.55)	0.75 (-5.13; 6.73)
Illicit drug experimentation				
No	Reference	Reference	Reference	Reference
Yes	-4.58 (-16.68; 7.5)	-12.05 (-31.6; 7.4)	-2.64 (-16.77; 11.57)	1.76 (-2.44; 5.98)

SES: Socioeconomic status, LPA: light-intensity physical activity, MVPA: moderate-to-vigorous physical activity, Coef: non-standardized regression coefficient, 95%CI: 95% confidence intervals; Bold values indicate statistical significance at $p < 0.05$.

Discussion

The purpose of this study was to examine the associations between sociodemographic, dietary and substance use factors, and accelerometer-measured 24-hour movement behaviors in a sample of Brazilian adolescents. Results showed that sex was associated with all 24-hour movement behaviors, while age was positively associated with sedentary behavior only. Consumption of unprocessed food was positively associated with LPA only, and the consumption of processed food was inversely associated with sedentary behavior and MVPA. The findings suggest that the age and SES associations observed for the 24-hour movement behaviors in other studies[72] do not seem to completely translate to our sample of Brazilian adolescents

when movement behaviors are objectively measured. Also, alcohol, tobacco, and illicit drugs were not related to any of the 24-hour movement behaviors.

The relationship between sex and the 24-hour movement behaviors in the present study concurs with previous findings [72]. Males are usually more physically active than females,[72] as observed in our results for MVPA. On the other hand, the results for LPA show that males engage in fewer activities of this intensity, and although this does not seem to be consistent, it may be explained by females engaging in up to 50% more chores compared to males,[133] which may be captured by the accelerometers as LPA. This may also explain why females were less sedentary than males in the present study. Females also slept more than males, on average, which is also consistent with existing literature with objective measures.[134] Overall, these results suggest an agreement between our study and previous literature, and specific interventions may be needed to increase the MVPA of females. Regarding age, a positive association was found with sedentary behavior, which has also been observed before,[135] and may be related to increased work and study activities, and higher engagement in screen-time sedentary activities during leisure time. The lack of association between SES and the 24-hour movement behaviors in the present sample is not similar to previous studies that used socioeconomic class, parental education, family income, and other measures of SES.[72,79,115,135] The relationship between SES and movement behaviors has been shown to differ between country settings,[136,137] and it may be that in this specific sample, the difference between the highest and lowest SES may not translate to different opportunities to engage in more or less accelerometer-measured behaviors.

Concerning the association between dietary patterns and the 24-hour movement behaviors, we observed associations for sedentary behavior, LPA, and MVPA, but not for sleep. More specifically, the positive association between LPA and unprocessed food is aligned with previous studies that observed that fruits and vegetables are associated with increased physical activity.[123,138,139] In contrast, the negative relationship between processed food and physical activity is not in line with the limited available literature, with studies showing that those who practice more physical activity may also consume more energy drinks,[121] unhealthy food,[120] or observed no association[140]. It is not clear why our results differ from other studies; however, there is some evidence that suggests that healthy behaviors tend to

cluster,[141] with people who are active also opt to eat healthier food, and engage in less sedentary behavior, and this may explain why more active individuals also opt to avoid processed foods. In relation to the association of unprocessed food with sedentary behavior, this relationship is consistently found in the literature, more specifically with self-reported measures of screen time and television viewing,[69] and it seems that this relation is also observed in the present study with Brazilian adolescents and an objective measure of sedentary behavior. Regarding sleep, the lack of association may be related to strict school hours, which influence sleep schedule on most weekdays, and thus, reducing the influence of other behaviors or preferences. Based on the findings of the present study, no causality can be determined, but taken together, the results suggest that the 24-hour movement behaviors are related to dietary habits, which may support interventions targeting both, as prioritizing less processed food,[129] being more active, and less sedentary is desirable among adolescents.

No relationship was found between the use of alcohol and tobacco in the last 30 days or illicit drugs experimentation with the 24-hour movement behaviors, contrasting with what previous studies have observed.[126–128] Although the use of substances may be associated with sleep, sedentary behavior, and physical activity, it may be that adolescents do not regularly consume the substances, or for enough time for significant associations to be observed. However, it is important to track how these behaviors change through adolescence and form into adulthood to confirm if continuous use of substances will affect the 24-hour movement behaviors.

In the present study, we observed a few associations between sociodemographic and dietary factors with objectively measured 24-hour movement behaviors, which is inconsistent with findings observed with self-reported measures. One possibility to explain the lack of associations observed is that when we measured the 24-hour behaviors using a standardized 24-hour protocol for accelerometry, all movements are captured by the accelerometer, regardless of the type of physical activity (such as work and leisure related) and sedentary behaviors (such as studying or watching television). These different activities may have associations with the factors included in this study but are not observed when accelerometer data are analyzed. For example, adolescents from higher socioeconomic backgrounds may

have an increased chance to engage in physical activities in clubs and gyms while those from lower socioeconomic backgrounds can engage in more active transportation and house chores, but their volume of physical activity may be similar when accelerometer data are analyzed. Similarly, dietary behaviors may be associated with different types of screen time, but this may not be observed when accelerometer-measured sedentary behavior is analyzed. While accelerometer precisely measures volume and intensity of all activities throughout the day, making it possible to measure the different 24-hour movement behaviors simultaneously, qualitative information measured with self-report, direct observation, or ecological momentary assessment may be required to identify factors and contexts associated with behaviors undertaken in different domains or types in future studies.

The main strengths of the present study are the use of accelerometry to measure the 24-hour movement behaviors, which precisely measures each behavior in every second of the day. Another strength is the inclusion of several factors that may influence each of the 24-hour movement behaviors rather than a focus on one single exposure variable. Finally, analyzing the behaviors in a middle-income setting (Brazil) is also worthy of note, as most evidence available in the literature comes from high-income settings. However, one main limitation is the use of self-reported dietary and substance use behaviors, as they are prone to memory and social desirability bias. Yet, direct observation or other methods to assess these behaviors are not easily available for survey studies. Another limitation of this study was the lack of qualitative information on the context and type of the 24-hour movement behaviors since leisure and non-leisure activities might be associated differently with sociodemographic factors. Lastly, the cross-sectional design of this study limits our understanding of the direction of the associations, and prospective studies are needed to confirm the findings.

Conclusion

Findings from this study with a sample of Brazilian adolescents show that sex, age, and dietary behaviors, but not SES or substance use, are associated with the 24-hour movement behaviors. In particular, females sleep more and engage in more LPA than males, but males engage in more sedentary behaviors and MVPA than females. Age was positively associated with sedentary behaviors, meaning that more sedentary

activities are undertaken as students get older. Consuming more unprocessed food was associated with more LPA, whereas consuming more processed food was associated with lower MVPA. Sex, age, and dietary behaviors are important factors to consider in intervention, policy, and practice related to the 24-hour movement behaviors. Future research should aim to measure qualitative aspects of the 24-hour movement behaviors and test the associations longitudinally.

Supplementary Table 1. Factor analysis of the dietary patterns of a sample of Brazilian adolescents (n=615).

Latent Variables	**Indicator variables**	**Unstandardized Factor loading**	**Standardized factor loading**	**p-value**
F1: Unprocessed food	Vegetables (days/week)	1	0.879	
	Fresh fruits (days/week)	0.541	0.486	0.006
	Salted fried food (days/week)	1	0.509	
	Sweets (days/week)	0.924	0.384	< 0.001
F2: Processed food	Soda (days/week)	1.02	0.437	< 0.001
	Ultra-processed sausages (days/week)	1.388	0.531	< 0.001
	Fast Food (days/week)	0.793	0.504	< 0.001

Root mean square error of approximation: 0.048; Standardized root mean square residual: 0.038

3.2. ARTICLE 2: ASSOCIATION BETWEEN SCREEN TIME AND ACCELEROMETER-MEASURED 24-HOUR MOVEMENT BEHAVIORS IN A SAMPLE OF BRAZILIAN ADOLESCENTS

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Association between screen time and accelerometer-measured 24-hour movement behaviors in a sample of Brazilian adolescents

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Abstract

Objectives

Different screen time activities may be related to sleep, physical activity, and sedentary behavior. The objective was to examine the association between self-reported screen time activities and accelerometer-measured 24-hour movement behaviors.

Study design

Cross-sectional.

Methods

Adolescents' (n=718, 50.4% girls, 16 years) sleep duration, sedentary behavior, light physical activity (LPA), and moderate-to-vigorous physical activity (MVPA) were estimated with wrist-worn accelerometry. Time spent on screen time activities related to studying, working, watching videos, playing video games, and using social media, sex, age, and maternal education were self-reported.

Results

Boys and girls slept 6.4 and 6.7 hours/night, spent 10.4 and 10.1 hours/day in sedentary behavior, 4.0 and 4.4 hours/day in LPA, and 34.7 and 29.2 minutes/day in MVPA, respectively. Studying was inversely related to LPA and MVPA. Working was inversely related to sleep and positively related to LPA. Watching videos was associated with lower LPA and MVPA. For boys, videogames were associated with increased sedentary behavior and lower LPA and MVPA. For girls, studying and/or using social media were associated with lower LPA and MVPA.

Conclusions

In conclusion, indicators of screen time were associated with different accelerometer-measured 24-hour movement behaviors.

Keywords: physical activity, sleep, sedentary behavior, public health, youth

Introduction

Achieving adequate levels of physical activity, sedentary behavior, and sleep is associated with many health benefits among adolescents, impacting the physical, psychological, and social well-being.[58,70] These behaviors compose the 24-hour

movement behaviors due to their co-dependent nature (they add up to 1440 minutes in a day), and time spent in one of them is directly related to less time spent in one or more of the others.[142] The 24-hour movement behaviors are influenced by many factors, including screen time behaviors, or time spent using screen-based electronic devices.[29] Screen time is a subcomponent of total sedentary behavior, and indicators such as time watching television or using the computer are used for simultaneously measuring screen time and sedentary behavior,[143] as these behaviors are expected to be conducted while sitting or lying.[29] Such studies show that screen time is generally associated with short sleep duration [144] and lower physical activity levels,[52] which is expected considering the co-dependent relationship of sedentary behavior with sleep and physical activity. However, these measures fail to account for qualitative information on the type of activity being done (e.g., it is unknown what activity is done when using the computer), which also may affect the 24-hour behaviors differently. Activities such as watching movies and series, playing videogames, and accessing social media can be done using smartphones, tablets, and other gadgets, and are not contemplated in available instruments to measure sedentary behavior.[145,146] Studies using newer forms of screen time are needed to provide a more up-to-date picture of their influence on health and related behaviors, especially among adolescents as this age group is certainly keeping up with new technologies.[145,146]

Cellphone use has been shown to be higher compared to television, computer, and videogame use in a study including Brazilian adolescents [147]. Considering the possibility of using new gadgets, self-reported screen time may include watching videos on a tablet while doing the dishes, or using social media on a smartphone while commuting, and even playing active videogames, which would not concur with accelerometer-measured sedentary behavior. In addition, due to different content and stimuli, specific screen time activities may associate differently with accelerometer-measured 24-hour movement behaviors. For example, using social media has been shown to be negatively associated with sleep quality,[148] but positively associated with moderate-to-vigorous physical activity (MVPA).[149] Playing videogames can negatively affect sleep duration;[150] however, some evidence suggests that its content may stimulate physical activity as well.[151] Distinguishing how different screen time activities are related to objectively-measured 24-hour movement behaviors is important and can help tailor more successful interventions to help adolescents reach healthy levels of

physical activity, sedentary behavior and sleep, as many interventions are not successful in changing those behaviors.[152,153] Studying, working, watching videos, playing videogames, and using social media in screen-based devices provide different stimuli and require different postures; however, it is unclear if they are associated to the 24-hour movement behaviors and to what extent. In addition, most studies analyzing these relationships were conducted in high-income countries, and findings may not be translated to middle-income settings such as Brazil. Thus, the objective of the current study was to examine the association between different self-reported screen time activities and accelerometer-measured 24-hour movement behaviors in a sample of Brazilian adolescents.

Methods

Study design

The present cross-sectional study analyzed the baseline sample of the *Estudo Longitudinal do Estilo de Vida de Adolescentes* (ELEVA, translated as Longitudinal Study of the Lifestyle of Adolescents), conducted between August and December of 2019. The study population was composed of students enrolled in the high school courses integrated to professional courses (age range: 14-18 years). All public schools offering these courses in the mesoregion *Grande Florianópolis* in 2018 were invited and included (n=3). These courses have a duration of four years, and students from the first to the third year were eligible and were invited to participate (n=1618). Participants had to provide consent terms signed by parents and/or legal guardians (n=1010, 62.4% of the eligible students). The present research project was approved by the Ethics Committee in Research with Human Beings of the *Universidade Federal de Santa Catarina* (protocol number: 3.168.745).

Assessment and measurements

The 24-hour movement behaviors were assessed by accelerometry. Participants were given Actigraph Gt3x+ (ActiGraph Corporation, Pensacola, Florida, USA) accelerometers by trained researchers, during class time, and received instructions to wear it on the non-dominant wrist for seven consecutive days. A 24-hour

protocol was employed, and students were asked to take the accelerometer off only for swimming or doing water-based activities where the accelerometer would be submerged (e.g., in pools or in the sea), but not for other water-based activities such as showering or doing the dishes. Data were collected in 30 Hz, and analyzed in 5-second epochs. Participants with at least four days of 16 hours of valid accelerometer wear time were included in the analyses. Activities were classified as sedentary (<35.6 mg), light-intensity physical activity (LPA) (between 35.6 mg and 201.4 mg), and MVPA (≥201.4 mg) using the cut-offs of Hildebrand *et al*.[102,103] Sleep duration was estimated using the Heuristic algorithm looking at Distribution of Change in Z-Angle.[93] Analyses of raw accelerometer data were conducted using the GGIR package, version 1.11.[101]

A web questionnaire was used to assess sex and screen time activities. Participants answered the *online* questionnaire during class time, using smartphones, tablets or computers (average completion time was 24 minutes). The screen time variable was measured across five possible activities: studying (e.g., doing school homework), doing work-related activities (e.g., working on spreadsheets), watching videos (e.g., series, news, sports, streams, movies), playing videogames, and using social media and chat applications. The questions did not discriminate if activities were undertaken using a television, computer, smartphone, tablet or other screen-based device. Participants answered the time (hours and minutes) they engaged in each activity in a typical weekday and weekend day. Daily screen time was estimated by weighting the answers ([volume on weekdays*5 + volume on weekend days*2]/7), and classifying each construct in categories including: <2 h/day, ≥2 h and <4 h/day, and ≥4 h/day. The screen time questions were validated in a previous pilot study.[90]

Statistical analyses

Descriptive statistics (means and standard deviations or absolute and relative frequencies) were used to describe the sample characteristics. Multilevel linear regression analyses were used to test the association between screen time indicators (studying, working, watching videos, playing videogames, using social media) and sleep duration, sedentary behavior, LPA, and MVPA. The analyses were adjusted for age and mother's education and considered the hierarchical structure of data, with participants nested within schools. When interaction effects between sex and screen time indicators were observed, screen time slopes for each level of sex were computed

by linear combination of coefficients. The variable of MVPA was log-transformed to correct skewness. Analyses were performed in R version 3.6.2 for Windows, using the statistical package *lme4*, version 1.1, for the multilevel regressions. Statistical significance was set at $p<0.05$ (two-tailed).

Results

A total of 718 participants (78% of the total 1010 students) provided valid accelerometer (≥4 days with ≥16 hours of wear time) and questionnaire data. Participants characteristics are displayed in Table 1. Briefly, participants were 16.3-year-old on average and 50.4% were girls. Girls slept approximately 6.7 hours/night, spent 10.1 hours/day in sedentary behavior, 4.4 hours/day in LPA, and 29.2 minutes/day in MVPA, while boys slept approximately 6.4 hours/night, spent 10.4 hours/day in sedentary behavior, 4.0 hours/day in LPA, and 34.7 minutes/day in MVPA. Descriptive characteristics of excluded participants did not significantly differ compared to those included in the present analyses.

Table 1. Characteristics of the sample (n=718).

	Girls (n = 362)		Boys (n = 356)	
	Mean	SD	Mean	SD
Age (years)	16.4	1.1	16.3	1.1
Sleep duration (minutes/night)	402.4	52.3	384.8	46.7
Sedentary behavior (minutes/day)	607.1	77.4	624.9	84.7
Light physical activity (minutes/day)	263.7	53.4	242.2	61.7
Moderate-to-vigorous physical activity (logs of minutes/day)	29.2	14.8	34.7	20.9
	n	%	n	%
Mother's education				
>11 years	188	51.9	182	51.1
8-11 years	126	34.8	125	35.1
<8 years	38	10.5	35	9.8
Unknown	10	2.8	14	3.9
Screen time indicators				
Studying				
<2h/d	205	56.6	223	62.6
2-4h/d	92	25.4	89	25
≥4h/d	65	18	44	12.4
Working				
<2h/d	310	85.6	303	85.1
2-4h/d	37	10.2	41	11.5
≥4h/d	15	4.1	12	3.4
Watching videos				
<2h/d	142	39.2	120	33.7
2-4h/d	144	39.8	144	40.4
≥4h/d	76	21	92	25.8
*Playing videogames**				
<2h/d	322	89	171	48
2-4h/d	23	6.4	94	26.4
≥4h/d	17	4.7	91	25.6
*Using social media**				
<2h/d	93	25.7	158	44.4
2-4h/d	117	32.3	101	28.4

≥4h/d	152	42	97	27.2

*: Difference at p<0.05, Chi Squared Test

The association between screen time indicators with sleep duration is displayed in Table 2. A significant sex-interaction was observed for studying, but when the simple effects were calculated, no significant associations were observed. Working for 2-4 h/d and ≥4 h/d were inversely associated with sleep duration (β=-12.52, 95% CI -24.05; -0.98 and β=-24.95, 95% -43.87; -6.02 minutes/night, respectively). No statistically significant associations were observed between watching videos, playing videogames, and using social media with sleep duration.

Table 2. Association between screen time indicators and accelerometer-measured sleep duration in a sample of Brazilian adolescents.

	Sleep duration (minutes/night)					
	Total (n= 718)		Girls (n= 362)		Boys (n= 356)	
	Coef	95%CI	Coef	95%CI	Coef	95%CI
Screen time indicators						
Studying						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	3.38	(-5.21; 11.98)	0.01	(-12.13; 12.16)	6.37	(-5.72; 18.45)
≥4h/d	1.31	(-9.03; 11.64)	-8.02	(-21.69; 5.65)	13.64	(-2.19; 29.47)
Working						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	**-12.52**	**(-24.05; -0.98)**	-	-	-	-
≥4h/d	**-24.95**	**(-43.87; -6.02)**	-	-	-	-
Watching videos						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	0.05	(-8.15; 8.25)	-	-	-	-
≥4h/d	0.03	(-9.58; 9.64)	-	-	-	-
Playing videogames						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	-6.54	(-17.17; 4.10)	-	-	-	-
≥4h/d	2.79	(-8.14; 13.73)	-	-	-	-
Using social media						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	-0.92	(-9.94; 8.11)	-	-	-	-
≥4h/d	-2.17	(-11.06; 6.71)	-	-	-	-

Ref: Reference group; Bold values indicate statistical significance (p<0.05); Coef: regression beta coefficients in minutes/day;

Between-sex comparisons were presented when significant sex-interaction terms were identified at p<0.05; Models were adjusted for age, sex, and mother's education.

In relation to sedentary behavior, girls who studied for ≥4 h/d had increased sedentary behavior compared to studying for <2 h/d (β=32.57, 95% CI 10.35; 54.80, Table 2). Playing videogames for 2-4 h/d (β=28.02, 95% CI 8.09; 47.94 minutes/day) and ≥4 h/d (β= 51.44, 95% CI 31.40; 71.49 minutes/day) was associated with increased sedentary behavior in boys. No significant associations were found for working, watching videos, or using social media.

Table 3. Association between screen time indicators and accelerometer-measured sedentary behavior in a sample of Brazilian adolescents.

	Sedentary behavior (minutes/day)					
	Total (n= 718)		Girls (n= 362)		Boys (n= 356)	
	Coef	95%CI	Coef	95%CI	Coef	95%CI
Screen time indicators						
Studying						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	-2.19	(-16.19; 11.81)	-6.86	(-26.60; 12.88)	3.16	(-16.48; 22.81)
≥4h/d	16.03	(-0.80; 32.86)	**32.57**	**(10.35; 54.8)**	-7.44	(-33.16; 18.28)
Working						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	5.88	(-13.08; 24.84)	-	-	-	-
≥4h/d	-8.58	(-39.69; 22.53)	-	-	-	-
Watching videos						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	2.48	(-10.86; 15.82)	-	-	-	-
≥4h/d	15.29	(-0.35; 30.93)	-	-	-	-
Playing videogames						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	**19.03**	**(1.92; 36.15)**	-0.47	(-33.85; 32.91)	**28.02**	**(8.09; 47.94)**
≥4h/d	**41.46**	**(23.86; 59.06)**	12.16	(-26.13; 50.45)	**51.44**	**(31.40; 71.49)**
Using social media						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	6.75	(-7.97; 21.47)	-	-	-	-
≥4h/d	4.93	(-9.58; 19.43)	-	-	-	-

Ref: Reference group; Bold values indicate statistical significance (p<0.05); Coef: regression beta coefficients in minutes/day;

Between-sex comparisons were presented when significant sex-interaction terms were identified at p<0.05; Models were adjusted for age, sex, and mother's education.

The association of screen time with LPA is presented in Table 4. Studying for ≥4 h/d was associated with lower LPA (β= -16.93, 95% CI -28.87; -4.99 minutes/day), and working for 2-4 h/d was associated with increased LPA (β = 17.76, 95% CI 4.32; 31.20 minutes/day). Watching videos was associated with lower LPA (β=-10.00, 95% CI -19.42 -0.58 minutes/day for 2-4 h/d, and β=-22.97, 95% CI -34.01; -11.93 for ≥4 h/d). Playing videogames for 2-4 h/d (β=-18.72, 95% CI -32.97; -4.48 minutes/day) and ≥4 h/d (β=-32.58, 95% CI -46.92; -18.25 minutes/day) was negatively associated with LPA in boys. No significant association was observed for social media.

Table 4. Association between screen time indicators and accelerometer-measured light-intensity physical activity in a sample of Brazilian adolescents.

	Light-intensity physical activity (minutes/day)					
	Total (n= 718)		Girls (n= 362)		Boys (n= 356)	
	Coef	95%CI	Coef	95%CI	Coef	95%CI
Screen time indicators						
Studying						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	3.74	(-6.19; 13.67)	-	-	-	-
≥4h/d	**-16.93**	**(-28.87; -4.99)**	-	-	-	-
Working						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	**17.76**	**(4.32; 31.20)**	-	-	-	-
≥4h/d	13.22	(-8.83; 35.27)	-	-	-	-
Watching videos						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	**-10.00**	**(-19.42; -0.58)**	-	-	-	-
≥4h/d	**-22.97**	**(-34.01; -11.93)**	-	-	-	-
Playing videogames						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	-11.10	(-23.37; 1.17)	4.55	(-19.31; 28.42)	**-18.72**	**(-32.97; -4.48)**
≥4h/d	**-23.09**	**(-35.71; -10.48)**	5.88	(-21.50; 33.26)	**-32.58**	**(-46.92; -18.25)**
Using social media						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	-1.47	(-11.97; 9.02)	-	-	-	-
≥4h/d	-2.69	(-13.03; 7.64)	-	-	-	-

Ref: Reference group; Bold values indicate statistical significance (p<0.05); Coef: regression beta coefficients in minutes/day;

Between-sex comparisons were presented when significant sex-interaction terms were identified at p<0.05; Models were adjusted for age, sex, and mother's education.

Table 5 shows the associations between screen time indicators and MVPA. Studying and watching videos for ≥4 h/d was associated with lower MVPA (β= -0.15, 95% CI -0.26; -0.04 and β=-0.15, 95% CI -0.26; -0.04 log of minutes/day, respectively). For boys, playing videogames for 2-4 h/d (β=-0.18, 95% CI -0.31; -0.05) and ≥4 h/d (β=-0.22, 95% CI -0.36; -0.09), while for girls, using social media for ≥4 h/d was associated with lower MVPA (β=-0.15, 95% CI -0.28; -0.01). No significant association was observed for working.

Table 5. Association between screen time indicators and accelerometer-measured moderate-to-vigorous physical activity in a sample of Brazilian adolescents.

	Moderate-to-vigorous physical activity (log of minutes/day)					
	Total (n= 718)		Girls (n= 362)		Boys (n= 356)	
	Coef	95%CI	Coef	95%CI	Coef	95%CI
Screen time indicators						
Studying						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	-0.08	(-0.17; 0.01)	-	-	-	-
≥4h/d	**-0.15**	**(-0.26; -0.04)**	-	-	-	-
Working						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	0.08	(-0.04; 0.21)	-	-	-	-
≥4h/d	0.06	(-0.14; 0.27)	-	-	-	-
Watching videos						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	-0.04	(-0.12; 0.05)	-	-	-	-
≥4h/d	**-0.16**	**(-0.26; -0.05)**	-	-	-	-
Playing videogames						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	-0.10	(-0.22; 0.01)	0.06	(-0.16; 0.28)	**-0.18**	**(-0.31; -0.05)**
≥4h/d	**-0.14**	**(-0.26; -0.03)**	0.09	(-0.17; 0.34)	**-0.22**	**(-0.36; -0.09)**
Using social media						
<2h/d	Ref	Ref	Ref	Ref	Ref	Ref
2-4h/d	-0.01	(-0.11; 0.09)	-0.12	(-0.26; 0.02)	0.06	(-0.07; 0.19)
≥4h/d	-0.01	(-0.10; 0.09)	**0.15**	**(-0.28; -0.01)**	0.12	(-0.01; 0.26)

Ref: Reference group; Bold values indicate statistical significance (p<0.05); Coef: regression beta coefficients in minutes/day;

Between-sex comparisons were presented when significant sex-interaction terms were identified at p<0.05; Models were adjusted for age, sex, and mother's education.

Discussion

The key finding of this study is that, in this sample of Brazilian adolescents, different indicators of screen time were associated with different accelerometer-

measured 24-hour movement behaviors, and these associations were sex-specific. Regardless of sex, studying was inversely related to LPA and MVPA, working was inversely related to sleep duration and positively related to LPA, and watching videos was associated with lower LPA and MVPA. Additionally, for boys, videogames were associated with increased sedentary behavior and lower LPA and MVPA, while girls who spent four or more hours studying and/or using social media had lower LPA and MVPA, respectively. These results suggest that what adolescents do while using screen time devices matters in relation to how they move, and the screen time content is important to better understand how these behaviors are tied together.

Studying was associated with increased sedentary behavior in girls and lower LPA and MVPA in both boys and girls. In the present sample, more girls studied for four or more hours per day than boys, which was also observed in studies in the United States [154] and Germany,[155] and this may partially explain why this impacted sedentary behavior among them. Time dedicated to studying is mostly spent while sitting on a desk for long periods of time, and this may not be easily changed, which displaces time that could be spent on LPA and MVPA among adolescents. Implementing standing desks in classrooms has been reported to help reduce sedentary behavior;[156] however, its impact on academic achievement is not clear, and it may not be feasible for students when studying outside the classroom.

Working was inversely related to sleep duration, and those who worked for 2-4 h per day had increased LPA. While it is not clear why the relationship with LPA was observed, it is hypothesized that students who work for two to four hours per day may also engage in increased LPA to commute to work and may be doing non-screen time activities while working. This relationship may not be observed for those who do not work (<2 h/d) and for those who spend more than 4 h in screen time while working, as this may be compensated by increased time in sedentary activities in this situation. As for the relationship with sleep, students who work may have less time to dedicate to sleeping, as they have to attend school, work, and do homework and enjoy some leisure activities, while adolescents who do not work have more free time and can go earlier to bed. In addition, the shorter sleep duration may be related to increased time exposed to screens when working in addition to leisure-time activities. This increased

exposition to artificial light, compared to those who only manage leisure-time screen time, may negatively impact their sleep duration.[157]

Watching videos was negatively associated with LPA and MVPA in both boys and girls. This concurs with studies included in a review that analyzed TV and found a negative association between physical activity and this indicator.[52] Although watching videos can improve motivation and satisfaction when exercising on a treadmill,[158] this scenario is unlikely to be common. Watching videos seems to be a safe and easily accessible leisure activity, since it can be done with a TV or smartphone and almost in any place. Environmental factors may play a role, as increased insecurity, physical and social disorders, and other environmental factors[159] may impose barriers to practice physical activity and make activities such as watching TV more convenient. Interventions to reduce this construct of screen time have had limited results,[152] but displacing sedentary behavior for physical activity may have important impacts on the health of adolescents[160], and new policies and interventions are needed.

While playing videogames was associated with increased sedentary behavior and decreased LPA and MVPA in boys, this association was not observed among girls. This may be explained by the low proportion of girls that played as much videogames as boys, and they do not seem to play for enough time to impact sedentary behavior, LPA, and MVPA, while boys who play excessively have unhealthier patterns of these behaviors. In addition, preferences in types and content of games could also explain the sex difference, as boys may for example prefer sports games which are associated with increased physical activity compared to strategy games.[161] Also, some games require full attention, while others can be played on smartphone devices while multitasking, which could impact movement behaviors. These differences may partially explain the sex interaction found, yet, these hypotheses have to be tested by assessing more qualitative information related to the game preference. Although videogames may also provide benefits for health,[162] and active videogames may be a fun way to stimulate physical activity,[151] playing videogames has not only been associated with an unhealthier movement pattern, but videogame addiction is also a disorder [163] which is far more common in boys, and excessive time playing may negatively affect health. Thus, boys could benefit most from interventions targeting to decrease time spent in videogames.

The use of social media and chat apps for four or more hours per day was negatively related with MVPA in girls but not in boys. It is unclear why this difference was observed, and one possible explanation is that while girls have some interests related to chatting and overall socializing[164] using these apps, boys who use social media may use it to encourage each other's and access content that motivates them to practice sports and other physical activities. As boys generally are more active than girls,[72] it may be that they use social media at the expense of other activities (e.g., studying) but not physical activity.

Overall, the constructs of screen time were differently associated with the 24-hour movement behaviors. While using social media for 2-4 h per day was not associated with any movement behavior among boys or girls, playing videogames for that long was associated with unhealthier patterns of movement among boys. From this perspective, reducing the engagement of those who spend more than 4 hours/day in social media and videos may be already enough to support a more active lifestyle, while for games, reducing it for less than 2 hours/day may be necessary. It is important to note that many of these behaviors can also provide benefits when practiced in a healthy way. For example, playing videogames can provide psychosocial benefits was well,[162] and using social media to promote healthy behaviors can also benefit students.[165] Therefore, tailoring sex-specific strategies for each construct of screen time may be needed to achieve optimal health benefits among adolescents.

Strengths of the present study are the novel screen time constructs analyzed and the measurement of the 24-hour movement behaviors with accelerometers in a sample from a middle-income country, which is underrepresented in current scientific literature. However, limitations of the present study include the cross-sectional design, which limits the observation of causality; the self-reported nature of the screen time indicators, which are not easily measured using objective instruments; and the limitation of the accelerometers to classify some physical activities such as cycling or weight lifting precisely. Lastly, the present study was conducted in only three schools from three cities in one Brazilian state, and this may limit the generalizability of the results.

Conclusion

The present study found that different indicators of screen time were associated with different accelerometer-measured 24-hour movement behaviors, and some of these associations were sex-specific. Overall, studying was inversely related to LPA and MVPA, working was inversely related to sleep duration and positively related to LPA, watching videos was associated with lower LPA and MVPA, and videogames were associated with increased sedentary behavior and lower LPA and MVPA. Taken together, these results suggest that boys and girls could benefit from specific interventions for screen time behaviors. Future research is needed to establish the causal directions between these behaviors to determine which interventions may be most effective.

3.3. ARTICLE 3: ASSOCIATIONS BETWEEN SOCIODEMOGRAPHIC, DIETARY, AND SUBSTANCE USE FACTORS WITH SELF-REPORTED 24-HOUR MOVEMENT BEHAVIORS IN A SAMPLE OF BRAZILIAN ADOLESCENTS

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Associations between sociodemographic, dietary, and substance use factors with self-reported 24-hour movement behaviors in a sample of Brazilian adolescents

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Abstract

We aimed to identify sociodemographic, dietary, and substance use factors associated with self-reported sleep duration, physical activity (PA), and sedentary behavior (SB) indicators in a sample of Brazilian adolescents. Adolescents (n=731, 51% female, mean age: 16.4 years) answered a questionnaire. The volume of total PA, sports, non-

sports, total SB, leisure-time SB, involuntary SB, sleep duration, dietary behaviors, sociodemographic, and substance use indicators were self-reported. Multilevel linear models were fit. Females engaged in less total PA, sports, total SB, and leisure-time SB, but in more involuntary SB than males. Age was positively associated with non-sports and involuntary SB. Socioeconomic status was positively associated with total PA. Adolescents who lived with the mother only practiced more sports compared to those living with two parents. Unprocessed food was positively associated with total PA and sports. Processed food was inversely associated with total PA and non-sports and positively associated with total SB and leisure-time SB. Alcohol use was positively associated with total PA, and tobacco smoking was negatively associated with total PA. No associations were observed for sleep duration. In conclusion, sociodemographic, dietary, and substance use factors are associated with the 24-hour movement behaviors among Brazilian adolescents, and some associations are type-specific.

Keywords: physical activity, sedentary behavior, sleep, public health, 24-hour movement behaviors

Introduction

The 24-hour movement behaviors, composed of sleep duration, sedentary behavior and physical activity, are associated with several health outcomes among adolescents,[63] and engaging in adequate volumes of each behavior has been shown to provide multiple health-related benefits during adolescence.[70,110,111,166,167] The importance of these behaviors has been highlighted in integrated 24-hour movement recommendations[105], and policies and interventions have aimed to increase physical activity,[153] decrease sedentary behaviors,[152] and promote adequate sleep[168] among adolescents and reported modest changes.[152,153,168] Adolescents' engagement in physical activity is low,[169] a large proportion of their day is spent sedentary,[30] and inadequate sleep is common,[114] culminating in unhealthy patterns of the 24-hour movement behaviors.[63] In fact, the adherence of adolescents with the 24-hour movement behavior guidelines has been very low, ranging from 1.6% to 9.7%,[63] and intrapersonal factors such as sociodemographic, dietary, and substance use can be related to guideline adherence.[72,118,125,141]

Previous studies have shown that females are less active[72], sleep more,[134] and commonly engage in less sedentary behavior than boys.[30] Age has also been negatively associated with physical activity,[72] sleep,[170] and positively related to sedentary behavior in adolescents,[39] while socioeconomic status (SES) is related to these behaviors depending on the country setting, and the domain of physical activity.[171,172] Family structure has also been shown to play a role in some behaviors, with conflicting evidence pointing that either single-parent[173] and two-parent[174] families having more active children. Dietary behavior may also play a role, as it has been associated with physical activity,[121,141] sedentary behavior[118,141] and sleep[116] in previous studies. Besides that, diet impacts physiological mechanisms related to hormones and availability of nutrients, which may be associated with the 24-hour movement behaviors.[69,175] Alcohol use, tobacco smoking,[125] and with less evidence illicit drug experimentation[68], have also been associated with physical activity,[68,125] sedentary behavior[125] and sleep.[128] Overall, lifestyle behaviors and sociodemographic characteristics seem to be linked to the 24-hour movement behaviors, but there are only a few studies available on the topic[68,72,141], and most of them come from high-income countries, which may not be applicable to lower- and middle-income settings.[115]

In addition to the relationship with the volume (amount) of physical activity and sedentary behavior, some sociodemographic, dietary, and substance use factors may be related to specific types of physical activity and sedentary behaviors.[66,67] For example, alcohol use has been linked specifically with participation in sports among adolescents in a review of longitudinal studies.[68] This relationship may not be observed for other physical activities, such as commuting or doing chores. Drawing a parallel with sedentary behavior, unhealthy snacking has been linked specifically to increased television viewing,[69] but may not be observed with mandatory or involuntary screen time such as the time spent studying or working with screen-based devices. Identifying factors associated with specific subtypes of physical activity and sedentary behavior may be helpful, as some subgroups such as females may need specific interventions to engage in more sports,[70] while males may need specific strategies to reduce leisure-time sedentary behaviors.[30]

Considering that most adolescents do not simultaneously engage in healthy levels of physical activity, sedentary behavior, and sleep duration,[63] identifying correlates of these behaviors is desirable for research, practice, and policy. Furthermore, investigating several sociodemographic and lifestyle behaviors in a middle-income setting is desirable to broaden the understanding of how adolescents from these countries behave, and how these behaviors are linked, which is not consistently depicted in the scientific literature. Thus, the present study aimed to identify sociodemographic, dietary and substance use factors associated with self-reported sleep duration, physical activity, and sedentary behavior indicators in a sample of Brazilian adolescents.

Materials and methods

Participants

This study used data from adolescents aged 14-18 years that participated in the baseline of the ELEVA project (*Estudo Longitudinal do Estilo de Vida de Adolescentes*/Longitudinal Study of the Lifestyle of Adolescents), conducted between August and December 2019. All three public schools offering professional courses integrated with high school in the mesoregion Grande Florianópolis, southern Brazil, were invited and accepted to participate in the project. A census method was adopted, and all high school students who did not have any disability that prevented them from participating in the study were invited to participate. A total of 1618 students were enlisted in the schools of whom 1269 were present in classes during the data collection period and were invited to participate. The study was explained by trained researchers during school hours, and informed consent forms were given to students for their parents or legal guardians to sign, and an assent form was given to all students to sign. A total of 1010 students provided written informed consent and participated in the study. The present research project was approved by the Ethics Committee in Research with Human Beings of the *Universidade Federal de Santa Catarina* (protocol number: 3.168.745).

Measures

Participants answered a standardized survey, hosted on an online platform, using smartphones, tablets, and/or computers. Students could use either their own

device and internet connection, but devices and wireless internet were also offered by the research team. The average time to complete the survey was 24 minutes.

24-hour movement behaviors

Physical activity was assessed using an adapted version of the *Self-assessed physical activity checklist.*[176] The questionnaire is composed of the following question: *In general, which of the following activities do you practice? Report how many days in a typical week and for how long each a day do you engage in any of the activities*, followed by a list of 22 activities, where participants reported the weekly frequency (0-7) and the duration in minutes of each session of each activity. Three variables were calculated: the total volume of physical activity (sum of the volume of each activity), the volume of sports (comprising soccer, futsal, basketball, handball, volleyball, tennis, table tennis, swimming, athletics, combat sports, gymnastics, cycling, skating, and surfing), and the volume of non-sport activities (comprising capoeira, dancing, collective gymnastics and gym going, weight lifting, walking, jogging, and active play). This questionnaire was validated for Brazilian adolescents,[177] and the classification of sports and non-sport activities was previously used in research with adolescents.[70,167]

Sedentary behavior was measured by proxy of screen time across four variables: time spent studying, working, watching videos (e.g., series, news, sports, streams, and movies), and playing video games using screen-based devices. Participants reported the time in hours and minutes (in blocks of 10 minutes) they engaged per day on each of those activities during weekdays (Mondays to Fridays), and weekend days (Saturdays and Sundays). Daily screen time was calculated by weighting the volume on weekends by 2 and on weekdays by 5. Three variables were calculated: the total volume of sedentary behavior, by summing the daily volume of the four indicators; the involuntary sedentary behavior, by summing time spent studying and working; and the leisure-time sedentary behavior, by summing the time spent watching videos and playing video games.

Finally, participants reported the time they habitually went to bed and woke up on weekdays and weekend days, and sleep duration was calculated as the difference

between both. The habitual sleep duration was calculated by weighting the volume on weekends by 2 and on weekdays by 5.

Dietary patterns

The weekly frequency of consumption of beans, vegetables, fresh fruits, salted fried food, sweets, soda, ultra-processed sausages, and fast food was reported by participants. This questionnaire was previously validated for Brazilian adolescents.[98] For each item, answers ranging from 0-7 days/week were used to create two scores using Confirmatory Factor Analyses. The first score was named 'Unprocessed food', comprised of the indicators of vegetables and fresh fruits, and the second score was named 'Processed food', and calculated based on salted fried food, sweets, soda, ultra-processed sausages, and fast food. The standardized scores were calculated using standardized variables, but for ease of interpretation, they were scaled from 0 to 10, where 10 means the highest consumption of each food group.

Substance use

Alcohol use and tobacco smoking were reported for the last 30 days before data collection. The indicator variable was coded as a dichotomous variable, with participants being classified as smokers (*vs* non-smokers) and drinkers (*vs* non-drinkers) if they answered smoking and/or drinking at least once in the 30-day window before data collection. For illicit drug experimentation, participants reported if they have used any illicit drug in their lifetime (yes or no). These questions have been previously used in *Pesquisa Nacional de Saúde do Escola* (PeNSE).[178]

Sociodemographic variables

Participants reported their sex (male/female), age (completed years), family structure, and socioeconomic status (SES). The family structure indicator had four possible categories: living with either mother, father, both, or none. For the SES indicator, participants reported the number (0-4 or more) of several household belongings (e.g., television, computer, fridges, stoves), if they had treated water, if the street where they lived was paved, and the highest education of their parents. These indicators were used to calculate a nationally standardized score that ranged from 0 to 100, with 100 being the highest SES, according to the guidelines of the Brazilian Association of Research Companies.[106]

Statistical analyses

The characteristics of the sample are described using means and standard deviations, and absolute and relative frequencies. To test the associations between sociodemographic (sex, age, SES, family structure), dietary (unprocessed food score, processed food score), and substance use (alcohol use, tobacco use, illicit drugs experimentation) with sleep duration, total sedentary behavior, leisure-time sedentary behavior, and involuntary sedentary behavior, multilevel linear regression models were estimated using Restricted Maximum Likelihood approach, and 95% confidence intervals were also estimated. For total physical activity, sports, and non-sports physical activity, generalized linear multilevel models with the Gamma family were fit using the Adaptive Gauss-Hermite Quadrature, and 95% confidence intervals were calculated. This was used as all physical activity indicators were right-skewed, and the Gamma models are recommended for such distributions and provided better residuals.[108] All models were mutually adjusted for all independent variables, and a random intercept for each school was estimated to take into account the hierarchical structure of the data, with students nested within schools. The analyses were conducted using R, version 4.0 for Windows (R Foundation for Statistical Computing, Vienna, Austria), using the *lme4* package.

Results

Of the total of 1010 participants who provided written informed consent, 731 (72%) had complete data in all survey variables and were included in the present analyses. The characteristics of the participants can be observed in Table 1.

Table 1. Characteristics of the sample (mean ± SD or n (%)).

	Total sample (n=731)	**Females (n=375)**	**Males (n=356)**
Age (years)	16.37 ±1.04	16.35 ±1.04	16.38 ±1.04
SES score (0-100)	48.97 ±9.98	48.33 ±9.66	49.63 ±10.28
Family structure [n (%)]			
Live with both parents	467 (63.9)	234 (62.4)	233 (65.4)
Live with mother	195 (26.7)	104 (27.8)	91 (25.6)
Live with father	30 (4.1)	17 (4.5)	13 (3.7)
Other	39 (5.3)	20 (5.3)	19 (5.3)
Dietary behavior			
Unprocessed food (0-10)	5.93 ±2.68	6.20 ±2.74	5.66 ±2.59
Processed food (0-10)	3.76 ±1.86	3.66 ±1.88	3.86 ±1.82
Alcohol use in the last 30 days [n (%)]			
No	415 (56.8)	207 (55.2)	208 (58.4)
Yes	316 (43.2)	168 (44.8)	148 (41.6)
Tobacco use in the last 30 days [n (%)]			
No	677 (92.6)	344 (91.7)	333 (93.5)
Yes	54 (7.4)	31 (8.3)	23 (6.5)
Illicit drug experimentation [n (%)]			
No	594 (81.3)	286 (76.3)	308 (86.5)
Yes	137 (18.7)	89 (23.7)	48 (13.5)
Sleep duration (hours/night)	8.02 ±1.30	8.05 ±1.26	7.98 ±1.34
Physical activity (minutes/day)			
Total physical activity	37.30 ±37.44	30.90 ±34.11	44.03 ±39.60
Sports	18.27 ±31.06	9.48 ±18.40	27.53 ±38.20
Non-sports	20.75 ±31.18	21.67 ±30.80	19.79 ±31.58
Sedentary behavior (hours/day)			
Total sedentary behavior	7.56 ±4.06	6.90 ±3.82	8.25 ±4.19
Leisure-time sedentary behavior	4.68 ±3.30	3.72 ±2.79	5.69 ±3.50
Involuntary sedentary behavior	2.76 ±2.29	3.05 ±2.34	2.45 ±2.19

SES: Socioeconomic status; SD: standard deviation.

The association between sociodemographic, dietary, and substance use factors with physical activity, sports, and non-sports physical activity is displayed in Table 2. Females engaged in less total physical activity (β=-16.75, 95%CI -22.12; -11.37) and sports (β=-20.34, 95%CI -25.32; -15.36) compared to males, while a positive relationship was observed between age and non-sports physical activity (β=3.25, 95%CI 1.43; 5.06). The SES score was positively associated with total physical activity (β=0.30, 95%CI 0.07; 0.53), and family structure was associated with sports, with participants living with their mother engaging in more sports than those living with both parents (β=3.25, 95%CI 0.16; 6.33). Unprocessed food was positively related to total physical activity (β=2.06, 95%CI 1.16; 2.96) and sports (β=0.92, 95%CI 0.49; 1.35), while processed food was inversely related to total physical activity (β=-1.91, 95%CI -3.01; -0.82) and non-sports physical activity (β=-1.03, 95%CI -1.98; -0.08). Alcohol intake was positively associated with total physical activity (β=5.95, 95%CI 1.05; 10.84), and tobacco use was negatively related with total physical activity (β= -11.54, 95%CI -17.13; -5.96). Illicit drug experimentation was not significantly associated with any physical activity indicator.

Table 2. Association between sociodemographic, dietary, and substance use factors with physical activity, sports, and non-sport practice in a sample of Brazilian adolescents (n=731).

	Total physical activity (minutes/day)	**Sports (minutes/day)**	**Non-sports (minutes/day)**
	Coefficient (95%CI)	**Coefficient (95%CI)**	**Coefficient (95%CI)**
Sex			
Male	Reference	Reference	Reference
Female	**-16.75 (-22.12; -11.37)**	**-20.34 (-25.32; -15.36)**	0.83 (-2.53; 4.18)
Age (years)	-0.61 (-2.40; 1.18)	0.44 (-0.57; 1.45)	**3.25 (1.43; 5.06)**
SES score (0-100)	**0.30 (0.07; 0.53)**	0.00 (-0.10; 0.10)	0.02 (-0.15; 0.19)
Family structure			
Live with both parents	Reference	Reference	Reference
Live with mother	5.51 (0.41; 10.61)	**3.25 (0.16; 6.33)**	-0.50 (-5.15; 4.14)
Live with father	4.66 (-7.87; 17.19)	0.08 (-3.00; 3.15)	-1.26 (-8.52; 6.00)
Other	0.85 (-5.16; 6.85)	2.73 (-0.90; 6.36)	0.26 (-7.48; 8.01)
Dietary behavior			
Unprocessed food (0-10)	**2.06 (1.16; 2.96)**	**0.92 (0.49; 1.35)**	0.33 (-0.35; 1.00)
Processed food (0-10)	**-1.91 (-3.01; -0.82)**	0.42 (-0.18; 1.02)	**-1.03 (-1.98; -0.08)**
Alcohol use in the last 30 days			
No	Reference	Reference	Reference
Yes	**5.95 (1.05; 10.84)**	1.68 (-0.46; 3.81)	-0.94 (-4.7; 2.83)
Tobacco use in the last 30 days			
No	Reference	Reference	Reference
Yes	**-11.54 (-17.13; -5.96)**	-2.40 (-5.61; 0.81)	5.36 (-2.88; 13.60)
Illicit drug experimentation			
No	Reference	Reference	Reference
Yes	-0.80 (-6.67; 5.07)	0.39 (-2.71; 3.49)	3.50 (-2.33; 9.34)

Associations were testes using Generalized Linear Multilevel Models using Gamma family.

95%CI: 95% confidence intervals; SES: socioeconomic status.

Bold values refer to significant associations at $p < 0.05$.

The association between sociodemographic, dietary, and substance use factors with sedentary behavior indicators can be observed in Table 3. Females spent less time in total (β=-1.21, 95%CI -1.8; -0.65) and leisure-time (β=-1.87, 95%CI -2.32; -1.42), but more time in involuntary (β=0.61, 95%CI 0.28; 0.94) sedentary behavior than males. Age was positively associated with involuntary sedentary behavior (β=-0.27, 95%CI 0.11; 0.43). Processed food was positively related to total (β= 0.45, 95%CI 0.28; 0.62) and leisure-time (β= 0.36, 95%CI 0.23; 0.49) sedentary behavior. SES, family structure, unprocessed food score, tobacco use, alcohol consumption, and illicit drug experimentation were not significantly associated with sedentary behavior indicators.

Table 3. Association between sociodemographic, dietary, and substance use factors with total, leisure, and involuntary sedentary behavior in a sample of Brazilian adolescents (n=731).

	Total sedentary behavior (minutes/day) Coefficient (95%CI)	**Leisure-time sedentary behavior (minutes/day) Coefficient (95%CI)**	**Involuntary sedentary behavior (minutes/day) Coefficient (95%CI)**
Sex			
Male	Reference	Reference	Reference
Female	**-1.21 (-1.8; -0.65)**	**-1.87 (-2.32; -1.42)**	**0.61 (0.28; 0.94)**
Age (years)	0.22 (-0.06; 0.50)	-0.08 (-0.30; 0.13)	**0.27 (0.11; 0.43)**
SES score (0-100)	0.02 (-0.01; 0.05)	0.01 (-0.01; 0.04)	0.00 (-0.02; 0.02)
Family structure			
Live with both parents	Reference	Reference	Reference
Live with mother	0.28 (-0.39; 0.96)	0.27 (-0.26; 0.8)	-0.04 (-0.42; 0.35)
Live with father	0.60 (-0.85; 2.05)	-0.20 (-1.33; 0.94)	0.64 (-0.19; 1.48)
Other	0.22 (-1.07; 1.51)	0.11 (-0.90; 1.12)	-0.05 (-0.79; 0.69)
Dietary behavior			
Unprocessed food (0-10)	-0.05 (-0.17; 0.07)	-0.05 (-0.15; 0.04)	0.02 (-0.05; 0.08)
Processed food (0-10)	**0.45 (0.28; 0.62)**	**0.36 (0.23; 0.49)**	0.08 (-0.01; 0.18)
Alcohol use in the last 30 days			
No	Reference	Reference	Reference
Yes	-0.22 (-0.83; 0.39)	0.10 (-0.38; 0.58)	-0.33 (-0.69; 0.02)
Tobacco use in the last 30 days			
No	Reference	Reference	Reference
Yes	-0.34 (-1.58; 0.86)	0.52 (-0.45; 1.46)	-0.79 (-1.49; -0.09)
Illicit drug experimentation			
No	Reference	Reference	Reference
Yes	0.43 (-0.44; 1.29)	0.14 (-0.54; 0.81)	0.31 (-0.19; 0.80)

Associations were testes using Linear Multilevel Regression models.
95%CI: 95% confidence intervals; SES: socioeconomic status.
Bold values refer to significant associations at $p < 0.05$.

Table 4 shows that the sociodemographic, dietary, and substance use factors were not significantly associated with sleep duration in the present study.

Table 4. Association between sociodemographic, dietary, and substance use factors with sleep duration in a sample of Brazilian adolescents (n=731).

	Sleep duration (hours/night) Coefficient (95%CI)
Sex	
Male	Reference
Female	0.10 (-0.10; 0.29)
Age (years)	-0.08 (-0.17; 0.01)
SES score (0-100)	0.00 (-0.01; 0.01)
Family structure	
Live with both parents	Reference
Live with mother	0.07 (-0.15; 0.29)
Live with father	-0.05 (-0.52; 0.43)
Other	-0.26 (-0.68; 0.17)
Dietary behavior	
Unprocessed food (0-10)	-0.03 (-0.07; 0.01)
Processed food (0-10)	-0.05 (-0.10; 0.01)
Alcohol use in the last 30 days	
No	Reference
Yes	-0.16 (-0.36; 0.04)
Tobacco use in the last 30 days	
No	Reference
Yes	-0.06 (-0.46; 0.34)
Illicit drug experimentation	
No	Reference
Yes	-0.04 (-0.32; 0.25)

Associations were tested using Linear Multilevel Regression models.

95%CI: profile 95% confidence intervals; SES: socioeconomic status.

Discussion

The aim of the current study was to evaluate the associations between sociodemographic, dietary, and substance use factors with self-reported sleep duration, physical activity, and sedentary behavior indicators in a sample of Brazilian adolescents. In general, we found that the relationships between sociodemographic, dietary, and substance use factors with physical activity and sedentary behavior are type-specific, and no associations were observed for sleep.

Our findings show that females engage in less total physical activity and sports, but not non-sport activities, compared to males. A review showed that females are usually less active than males in most scientific studies;[72] however, this may also be dependent on the way physical activity is measured, as some evidence shows that this relationship is not true for all domains of physical activity.[66] Non-sport activities include activities such as walking and engaging in gymnastics, which are typically preferred by females,[179] whereas boys may opt to engage in more sports due their preference for this kind of leisure activity. Evidence shows that boys overall prefer practicing physical activity over other leisure time activities, and that they enjoy practicing physical activity better compared to their female counterparts.[180]

The results of our study also show that similar associations were observed for sedentary behaviors, as females engaged in less total and leisure sedentary behaviors, but more in involuntary sedentary behaviors compared to males. When domain-specific sedentary behaviors were analyzed in a sample of 9218 adolescents and adults from 8 Latin American countries, associations between sex and sedentary activities were domain-dependent, and in some cases country-dependent.[181] For example, males engaged in more total sedentary behavior than females, but no differences were found for reading or talking on the phone, and videogame use was higher for males in some countries but not others.[181] One reason as to why females in our study engaged in more involuntary sedentary activities than boys relates to a higher volume of time spent studying, but may also be due to the fact that they engage in more sedentary work-related activities compared to males. These hypotheses have to be further explored in future studies. Further, limiting involuntary sedentary

behaviors may not always be an option, as working and studying using screens may be required even more with the advancement of technologies and applications.

In relation to age, SES, and family structure, no associations were observed for total physical activity, total sedentary behavior, or sleep duration. However, age was positively associated with non-sports activities and involuntary sedentary behaviors. This may be explained by increased autonomy and responsibilities given to adolescents with age, as they join the workforce and may have increased loads of activities at school, while also more safely being able to actively commute. Similar trends were observed in Chinese children and adolescents between 2004 and 2011,[66] showing an increase in domestic physical activity and in computer use. As for SES, a positive relation was observed for total physical activity, which may be associated with increased opportunities to buy equipment (e.g., bicycles) and afford clubs or gyms; however, as this association was not observed for either the non-sport or sport variable, this relation is not entirely clear. The association between SES and physical activity has been highlighted in previous studies, but the direction of the association may not be the same across countries,[115] although evidence suggests that higher SES is associated with higher physical activity in Latin American countries.[67] Lastly, family structure was associated with sports, with adolescents living only with their mothers reporting spending more time practicing sports compared to their peers living with both father and mother. This finding is in line with results observed in a study with Chinese adolescents, where those who lived with single-parents were more active than those living in two-parent homes[173]. However, a study involving Norwegian adolescents observed that single-parent families were unfavorable for physical activity and sport participation compared to two-parent homes.[174] A hypothesis is that adolescents in single-parent families may have more unsupervised time and autonomy to engage in other activities such as sports. However, it is difficult to determine how the family structure impacts behaviors such as physical activity, as it may be determined by social and cultural factors that vary between nations.

Our results also indicate significant associations between dietary behaviors and physical activity and sedentary behavior, but not with sleep duration. Adolescents who reported eating more unprocessed foods had higher physical activity and sports participation, which may be attributed to a preference for healthy behaviors. Previous studies have shown that these behaviors tend to cluster among adolescents.[141] This

corroborates with the positive associations observed in the present study between processed food scores and sedentary behaviors, and the negative association of this score with physical activity indicators. This is supported by a recent review that found that lower vegetable and fruit consumption, and higher consumption of energy-dense snacks and sugar-sweetened beverages, were associated with higher levels of sedentary behavior in pediatric populations.[118] Snacking and unhealthy eating have been associated with time watching television[69] and playing videogames,[175] which may be explained by mental stress and cognitive processes related to reward systems.[175] Additionally, experimental studies have shown that eating while watching television may cause a delay in satiation and a reduction in internal satiety signals.[182,183] Another possible explanation is that depending on the content and quantity of meals, postprandial sleepiness may occur, and adolescents may opt to engage in sedentary activities rather than physical activities if they are feeling tired or somnolent.[184]

In relation to substance use, associations between alcohol and tobacco use and physical activity were observed, but not for sleep or sedentary behaviors. While a positive relationship was observed between alcohol and total physical activity, no associations were observed for either sports or non-sports. The use of alcohol has been positively associated with physical activity among adolescents in other studies,[68] and this relation has been at least partially attributed to sport participation, as increased social activities after practice or during competitions would serve as opportunities for adolescents to experiment and drink alcoholic beverages. However, our results do not support this hypothesis, as we have not observed a significant association between sports and alcohol intake. It is not clear why this relationship was observed, and future studies should include more detailed questions in longitudinal designs to clarify this finding. With regard to tobacco, a negative association with total physical activity was observed, which has also been observed among youth before.[185] Independently of the modality, practicing physical activity is usually associated with a healthier lifestyle, which would also predispose participants to not engage in smoking. In relation to illicit drugs, we have observed no significant associations. A review has shown that results of this association are mixed,[68] with varying results regarding experimentation and use, and by type of drug.[68]

There are several strengths with the present study, including the use of several independent variables that are not commonly analyzed together in studies with adolescents. Secondly, the inclusion of subtypes of physical activities and sedentary behaviors can provide additional useful information that cannot be obtained with the use of device-based measures. Thirdly, the inclusion of a sample of adolescents living in a middle-income setting is worth of note, as most of the evidence in this field is from studies conducted in high-income countries. This study also has limitations important to mention, such as the cross-sectional design, which precludes cause-and-effect associations to be drawn. The use of self-reported instruments, although necessary for the identification of types of activities, may be prone to memory and social desirability biases. Lastly, we have not included a non-screen based sedentary behavior indicator, which may have underestimated sedentary behaviors.

In conclusion, we found that the association between sociodemographic, dietary, and substance use factors with the 24-hour movement behaviors not only depend on the volume of the behavior, but also on its type, which can be identified as “sports” and “non-sports” for physical activity, and “leisure” and “involuntary” for sedentary behaviors in the present study. Sex, age, and dietary behaviors were associated with physical activity and sedentary behaviors, while SES, family structure, use of alcohol, and use of tobacco were only associated with physical activity. Finally, no significant associations were found for sleep duration. Future studies should confirm these associations and determine the directionality using longitudinal designs, and these factors should be taken into consideration when planning interventions and policies among adolescents.

3.4. ARTICLE 4: PREVALENCE AND SOCIODEMOGRAPHIC FACTORS ASSOCIATED WITH MEETING THE 24-HOUR MOVEMENT GUIDELINES IN A SAMPLE OF BRAZILIAN ADOLESCENTS

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Prevalence and sociodemographic factors associated with meeting the 24-hour movement guidelines in a sample of Brazilian adolescents

Short title: 24-hour movement behaviors in adolescents

Manuscript type: Original research

Key-words: physical activity, sleep, sedentary behavior, public health, recommendations

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Abstract

Background: The present cross-sectional study aimed to determine the proportion of adolescents meeting the 24-hour movement guidelines, and investigate sociodemographic factors associated with meeting them. Methods: Self-reported (average daily volume of MVPA, sleep duration, and time watching videos and playing videogames) and accelerometer-measured (MVPA and sleep duration) 24-hour movement behaviors were classified according to recommendations, and sex, age, socioeconomic status (SES), family structure, parental education, and number of people in the household were tested as correlates of meeting recommendations using multilevel logistic regressions. Results: The proportion of adolescents (n=867, mean age: 16.4 years, 50.3% girls) meeting the MVPA, ST, and sleep duration guidelines was of 25%, 28%, and 41%, respectively, for self-reported data. From accelerometer data (n=688), 7.1% met MVPA and 31.7% met sleep duration recommendations. Adherence to all three recommendations was 3% with self-report and 0.2% with accelerometer data. Boys were more likely to meet MVPA, but not ST and sleep-duration recommendations. A positive relationship was observed between age and meeting the ST recommendation. Conclusions: Adherence to the sleep duration recommendation was higher than to the screen-time and MVPA recommendations and few in this sample of Brazilian adolescents achieved the 24-hour guidelines. Efforts are needed to improve 24-hour movement behaviors.

Introduction

Physical activity, sedentary behavior, and sleep are important behaviors that are each associated with cardiometabolic and mental health of children and adolescents[5,111,186–188]. The benefits of practicing regular physical activity, preventing excessive sedentary behavior, and having adequate sleep have resulted in the publication of specific guidelines for each of these behaviors after reviewing the best available evidence[109–111,189,190]. The world's first 24-hour movement guidelines that integrate physical activity, sedentary, and sleep behavior recommendations were published in 2016 by Canada[105], and soon after by New Zealand, Australia[44], and others[186]. These guidelines suggest that adolescents should engage in 60 minutes of moderate-and-vigorous intensity physical activity (MVPA) daily[12,44,105], should avoid

spending more than 2 hours per day in leisure-time screen activities[44,105] (such as watching television or playing videogames), and should accumulate enough sleep (8-10 hours per night for adolescents between 14 and 17 years)[105]. However, when assessing behaviors according to these criteria, many adolescents do not engage in enough MVPA[113,191], spend excessive time on screen-based activities[191], and do not obtain sufficient sleep[192,193].

Adhering to all guidelines is associated with more health benefits compared to meeting just one or none[194–196]; however, adherence to 24-hour movement guidelines is low. Only 7.2% of 9-11 year-olds were found to meet all three recommendations in a study with 12 countries between 2011 and 2013[195], while 3% met all recommendations in a study with 22,115 Canadian adolescents (10-17 years) in 2016[197], and 5% of adolescents from the United States[198]. Furthermore, some population subgroups may be at increased risk of not meeting one[72] or all guideline recommendations. For example, boys commonly engage in more MVPA[72] and sleep better[170,199–201] when compared to girls. Age is inversely associated with physical activity[72] and sleep duration[170] through adolescence, while an increase in recreational screen time is observed[135]. Lower socioeconomic status (SES) is also associated with less physical activity[72], less screentime[135], and poorer sleep[79,202]. And recently, the family structure (e.g., living with both parents or single parent) has also been shown to be associated with screen time[203]. Fewer girls and fewer older adolescents seem to meet all 24-hour movement recommendations compared to boys and younger peers in the United States[198], while age was also inversely related to meeting all the guidelines simultaneously among Canadian adolescents[197].

Evidence on correlates of the 24-hour movement behaviors are from studies conducted predominantly on high-income countries[72,197,198], and may not reflect behaviors in middle- and low-income countries. This difference can be illustrated by the relationship with SES, that may be positively or negatively related with MVPA[72] or screen time[137] depending on the level of country development[136]. The aims of the present study were to i) determine the proportion of adolescents from Florianopolis, Brazil meeting the 24-hour movement guidelines; and ii) investigate sociodemographic factors associated with meeting the 24-hour movement guidelines.

Material and Methods

Population and Sample

Cross-sectional data from the baseline sample of the *Estudo Longitudinal do Estilo de Vida de Adolescentes* (ELEVA: Longitudinal study of the lifestyle of adolescents) was used. All adolescents (age range: 14-18 years) enrolled in public high schools integrated with professional courses of all schools in the mesoregion of Florianópolis, southern Brazil, were invited to participate. Data collection was conducted between August and December 2019. A total of 1618 students were listed by the schools (n=3), and 1269 were at the school during data collection visits and were invited to participate. Informed consent forms were given to students for their parents or legal guardians to sign, and an assent form was given to all students to sign. A total of 1010 students and parents signed the forms and were thus able to take part in the study. The research project was approved by the Ethics Committee in Research with Human Beings of the *Universidade Federal de Santa Catarina* (protocol number: 3.168.745).

Measures

Physical activity and sleep duration were measured using Actigraph GT3x+ and wGT3x+ accelerometers. Trained researchers instructed the participants to wear the accelerometer 24-hours per day for one week on the non-dominant wrist, secured by a disposable PVC band. Participants were oriented to remove the accelerometer during water activities if the monitor would be submerged (e.g., surfing, swimming), but not for other water-based activities such as showering or washing the dishes. Accelerometers were programmed using a 30 Hz sampling frequency, and data were analyzed using 5-second *epochs*. Valid wear-time was identified using an adapted version of the analysis described by Van Hees et al. (2011).[204] This algorithm looks at blocks of 15 minutes within each 60 minute windows, and classifies each block as non-wear if the standard deviation of the 60-minute window is less than 13.0 m*g* (1m*g*=0.00981m/s^2) for at least two out of the three axes or if the value range, for at least two out of three axes, was less than 50 m*g*. Participants were included in the analyses if they provided 4 days with 16 hours of valid accelerometer data after

exclusion of non-wear time. Acceleration of the vector magnitude was analyzed, and activities above 201.4 mg per epoch were classified as MVPA.[102] Sleep duration was derived from the accelerometry data using the Heuristic algorithm looking at Distribution of Change in Z-Angle presented by Van Hees (2018)[93]. The sleep duration variable was estimated using the difference between sleep onset and wake-up, without excluding awakening periods. Analyses of raw accelerometer data were conducted using the GGIR package[104].

Self-reported physical activity was measured using the *Self-Assessed Physical Activity Questionnaire*, where participants reported weekly frequency (number of days/week) and duration (minutes/day) they practiced physical activity from a list of 22 activities, with a space for adding non-listed activities. This instrument has been validated for Brazilian adolescents[177]. The weekly volume of MVPA was calculated by summing the volume (frequency*duration) of the listed activities, and the cut-off of 420 minutes/week was used as equivalent to 60 minutes/day according to the guidelines for this age group.

Screen time was assessed using two questions where participants answered the total hours and minutes per weekday or weekend day that they spend watching videos (e.g., movies, series, news) and playing videogames. The questions stated that they should consider time spent watching videos or playing on a smartphone, television, computer, tablet or any other electronic device. The answers were weighted using the following formula: ([volume on weekdays*5 + volume on weekend days*2]/7), and classified using the cut-off point of 2 h/day. This procedure was validated in a previous pilot study (n = 104 adolescents), yielding Gwet's agreement coefficient of 0.79.

Sleep duration was estimated using the difference between the self-reported sleep onset (hour and minutes) and wake-up during weekdays. This question has been used in previous studies with Brazilian adolescents[205,206]. Implausible sleep duration values (<1 or >20, n=3) were interpreted as errors and dropped. Sleep duration was classified into meeting vs. not meeting the recommendations of 8-10 hours of sleep per night, as recommended for this age group[105].

Sociodemographic variables included sex, age, SES, parental education, family structure (i.e., live with both parents, live with mother, live with father, live without father and mother), and number of people living in the same household. SES was calculated using a score derived from ownership of the following household items: bathrooms, housemaids, cars, computers, dish washers, fridges, freezers, washing machines, DVD players, microwave ovens, motorcycles, drying machines; highest education level of the family; having white water, and living on a paved street. The weight of each item was according to the Brazilian Association of Research Companies[106].

Statistical Analyses

Participants' characteristics were described using means and standard deviations, and relative and absolute frequencies for continuous and categorical variables, respectively. Comparison of characteristics between those who provided valid accelerometer data and those who did not was conducted using Student's *t*-tests and Pearson's Chi Squared tests.

Mixed-effects logistic regression analyses were fit using adherence of all and each 24-hour movement behavior variables as dependent variables, and sociodemographic variables as independent variables considering the hierarchical structure of the data, where adolescents were nested within schools. Categorical variables were sex, family structure, and parental education, whereas age (in years), SES (in 0-100 score), and number of people in the household (count of people) were continuous. Analyses were conducted with R, version 3.6.0 for Windows, using the *lme4* package. Significance was set at $p<0.05$ (two-tailed).

Results

Of the total of 1010 participants who provided consent and were authorized to participate, 837 (82.9%) provided responses for all questionnaire variables included in the present analyzes, and 688 (68.1%) provided valid accelerometer data on 4 or more days. Participants were 16.4±1.1 years old, and half (50.3%) were girls. Most participants (63.2%) lived with both parents, and had at least one parent with more than 11 years of education (60.1%). The sleep duration had the highest proportion of meeting the recommendation (41%), followed by screen time (28.6%) and MVPA

(25.1%), when self-report data were analyzed. When accelerometer data were analyzed, 7% met the MVPA guideline recommendation while 31.6% met the sleep duration recommendation (Table 1). No differences were found by sex, SES, family structure, parental education, self-reported sedentary behavior, and self-reported sleep duration between those who provided valid accelerometer data and those who did not. However, the proportion of physically active participants with self-reported data was higher (34.9% *vs* 23.0%, $p<0.05$), and they were on average 0.36 years older ($p<0.05$, Supplementary table 1).

Table 1. Descriptive characteristics of the sample.

	n (%) / Mean ± SD
Sex	
Girls	421 (50.3)
Boys	416 (49.7)
Age (years)*	16.4 ±1.1
SES score [0-100]*	48.9 ±10.0
Number of people in the household*	3.8 ±1.2
Family structure	
Live with both parents	529 (63.2)
Single parent	267 (31.9)
Does not live with parents	41 (4.9)
Highest education among parents	
>11 years	503 (60.1)
8-11 years	275 (32.9)
<8 years	44 (5.3)
Unknown	15 (1.8)
Recommendations using self-report	
MVPA (≥60 minutes/day)	210 (25.1)
Screen time (≤2 hours/day)	239 (28.6)
Sleep duration (8-10 hours/night)	345 (41.2)
Recommendations using accelerometer data (n=688)	
MVPA (≥ 60minutes/day)	49 (7.1)
Sleep duration (8-10 hours/night)	218 (31.7)

*Mean and standard deviation (SD).

MVPA: Moderate-to-vigorous physical activity; SES: Socioeconomic status.

The proportion of participants meeting each combination of the 24-hour movement guidelines is presented in Table 2. When self-report data were analyzed, one third of students did not meet any of the guidelines, 42.3% met one

recommendation, 21.6% met two recommendations, and only 3.1% met all recommendations. When MVPA and sleep duration were measured using accelerometers, 45.5% of the participants did not meet any of the guidelines, 41.6% met one (20.5% met sleep duration only), 12.8% met two (9.5% met sleep duration and screen time only), and 0.2% met all three recommendations.

Table 2. Proportion of participants meeting the MVPA, screen time, and sleep duration recommendations and various combinations based on self-report and accelerometer data.

	Self-report (n=837)	Accelerometer-measured PA & Sleep (n=688)
Recommendations	n (%)	n (%)
All three	26 (3.11)	1 (0.15)
Two Only		
Sleep duration & SB only	77 (9.2)	65 (9.45)
Sleep duration & PA only	68 (8.12)	11 (1.6)
PA & SB only	36 (4.3)	12 (1.74)
One only		
Sleep duration only	174 (20.79)	141 (20.49)
PA only	80 (9.56)	25 (3.63)
SB only	100 (11.95)	120 (17.44)
None	276 (32.97)	313 (45.49)

PA: Physical activity; SB: Sedentary behavior

The association between sociodemographic indicators and meeting all three and each of the 24-hour movement guideline recommendations measured with self-report data can be observed in Table 3. Boys were more likely to meet MVPA guidelines (OR=1.75, 95% CI: 1.28-2.40) compared to girls, but less likely to meet the

screen time guidelines (OR=0.40, 95% CI: 0.29-0.55). A positive relationship was found for age and odds of meeting the screen time guidelines (OR=1.15, 95% CI: 1.00-1.32). No statistically significant associations were observed for the other sociodemographic indicators and meeting any or all of the 24-hour movement behavior guidelines.

Table 3. Sociodemographic correlates of meeting each and all of the 24-hour movement behavior guidelines using self-reported data (n=837 adolescents).

	All		MVPA		Screen time		Sleep duration	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Sex								
Girls (ref)	1	1	1	1	1	1	1	1
Boys	0.72	(0.32-1.61)	**1.75**	**(1.28-2.40)**	**0.40**	**(0.29-0.55)**	1.04	(0.79-1.37)
Age (years)	0.89	(0.62-1.26)	1.11	(0.88-1.16)	**1.15**	**(1.01-1.32)**	0.89	(0.77-1.02)
SES score	1.02	(0.98-1.06)	1.01	(0.99-1.03)	0.99	(0.97-1.01)	1.00	(0.98-1.02)
Number of people in the household	1.00	(0.70-1.42)	1.05	(0.92-1.21)	1.09	(0.95-1.26)	0.96	(0.85-1.08)
Family structure								
Live with both parents (ref)	1	1	1	1	1	1	1	1
Single-parent	0.79	(0.32-2.00)	1.13	(0.78-1.64)	0.86	(0.60-1.22)	0.86	(0.62-1.20)
Does not live with parents	x	x	0.75	(0.33-1.70)	0.84	(0.40-1.78)	0.89	(0.46-1.73)
Highest education among parents								
>11 years (ref)	1	1	1	1	1	1	1	1
8-11 years	1.09	(0.46-2.59)	0.74	(0.51-1.08)	0.84	(0.59-1.19)	0.86	(0.63-1.18)
<8 years	0.85	(0.10-6.94)	0.55	(0.24-1.26)	0.84	(0.41-1.74)	1.02	(0.53-1.95)
Unknown	x	x	0.47	(0.10-2.16)	0.79	(0.24-2.60)	1.67	(0.57-4.89)

All: Meet simultaneously the MVPA, screen-time, and sleep duration guidelines; MVPA: Moderate-to-vigorous physical activity; OR: Odds ratio; CI: Confidence Interval;

Bold values indicate statistical significance at p<0.05.

The association between sociodemographic factors and meeting the MVPA and sleep duration recommendations measured by accelerometers can be observed in Table 4. Boys were more likely to meet the MVPA recommendation compared to girls (OR=2.72, 95% CI: 1.42-5.19), but had lower odds of meeting the sleep duration recommendation (OR=0.56, 95% CI: 0.40-0.78). No statistically significant associations were found for age, SES, number of people in the same household, family structure, and parental education with meeting the MVPA or sleep duration recommendations.

Table 4. Sociodemographic correlates of meeting the physical activity and sleep duration guidelines using accelerometer data. (n=688 adolescents)

	Physical activity		Sleep duration	
	OR	95%CI	OR	95%CI
Sex				
Girls (ref)	1	1	1	1
Boys	**2.72**	**(1.42; 5.19)**	**0.56**	**(0.4; 0.78)**
Age (years)	0.76	(0.58; 1.00)	0.91	(0.78; 1.07)
SES score	0.99	(0.95; 1.03)	1.00	(0.98; 1.02)
Number of people in the household	0.99	(0.77; 1.28)	0.96	(0.84; 1.1)
Family structure				
Live with both parents (ref)	1	1	1	1
Single-parent	1.05	(0.53; 2.09)	1.14	(0.78; 1.65)
Does not live with parents	0.7	(0.16; 3.19)	1.22	(0.58; 2.57)
Highest education among parents				
>11 years (ref)	1	1	1	1
8-11 years	-	-	1.16	(0.8; 1.69)
<8 years	-	-	0.93	(0.43; 2.04)
Unknown	-	-	1.36	(0.43; 4.33)

OR: Odds ratio; CI: Confidence Interval;

The variable of parental education has been omitted from the physical activity regression model, as no participants in the 'Unknown' category were inactive, and convergence was not achieved;

Bold values indicate statistical significance at $p<0.05$.

Discussion

In the present study, we aimed to describe the prevalence and identify sociodemographic factors associated with meeting each and all of the 24-hour movement guidelines in a sample of Brazilian adolescents. Although no sociodemographic factors were associated with meeting all guidelines, some differences were observed for specific recommendations, with boys being more active than girls but with shorter sleep duration. These findings suggest that although no

differences are observed for the three recommendations concurrently, specific age and sex subgroups may need different approaches to meet all. These results differ from international studies, where older adolescents[197,198] and girls[195,198] were less likely to meet all guidelines than their counterparts. Overall, the low number of adolescents that met all three guidelines (3.1% of the sample when using self-report and 0.2% when using accelerometer data) suggests that greater efforts are needed to change behaviors. This prevalence is similar to that found in a study with Canadian 10-17 year-olds (3%)[197], but lower than observed in the United States (7%)[198], and in a study with 9-11 year-olds from 12 countries[195] (7.2%). With such a low number of adolescents adhering to the 24-hour movement guidelines, efforts should be made to promote the adoption of healthy 24-hour movement behaviors among adolescents across many regions of the world.

The MVPA recommendation was achieved by 25% of the participants (7.1% when accelerometer data were used) and was lower than screen time and sleep duration recommendations. Low adherence to the MVPA recommendation has been previously reported among adolescents[113], and more specifically among girls[72]. Increasing MVPA levels would be beneficial for the population[207] and healthcare systems[208], and would also increase the proportion of adolescents meeting all 24-hour movement guidelines, as the combination of meeting sleep duration and screen time is most prevalent compared to those including MVPA. Although most interventions in low- and middle-income countries have not been successful[153], new policies and action plans are needed to promote MVPA in this populational subgroup.

Screen time recommendations were achieved by 28% of the participants. Two indicators of screen-time were used in this study, i.e., time watching videos (e.g., movies, series, news), and playing videogames, irrespective if these activities were performed using smartphones, tablets, computers or any other electronic device. This has to be taken into account when comparing the results with other studies, as the metric of screen-time varies with differences in measurement instruments[143]. Large variability has been observed with studies analyzing screen time in Brazilian samples of adolescents, with proportions of non-adherence with the guidelines varying between 9.4% and 68%[143], which may be at least partly attributable to different measures (e.g.,

only television, or television *and* computer use) and cut-offs used to classify adolescents (e.g., 2 or 4 h/day). Even considering that the evidence for screen-time guidelines is limited[111], the benchmark of 2 h/day is important for research and public health policy[209], and for monitoring this behavior in research. In this study, boys were less likely to meet the screen-time recommendation compared to girls, similar to a study across 12 countries[30]. An inverse relationship was found with age, which is not consistent with current literature[135,210]. One possible explanation for this finding is that as adolescents age, they seem to engage in higher volumes of social media[211] (not currently captured with many screen-time instruments), which may displace time watching videos and playing videogames, giving the wrong impression that time spent on screen-time is diminishing.

Meeting the sleep duration recommendation had the highest adherence compared to MVPA and screen-time, with 41% and 31.7% of participants meeting the guideline when questionnaire and accelerometer data were analyzed, respectively. In a longitudinal study with 11,016 children and adolescents (6-17 years), Faught et al. found that 54.9% of the sample met the sleep duration guidelines in both survey years, while a national-wide study in Canada found that 66.2% of the 22,115 participants met the sleep duration recommendations, a higher proportion compared to MVPA and screen-time recommendations[197]. Although sleep duration was adequate for a higher proportion of adolescents compared to screen-time and MVPA in the present sample of Brazilian adolescents, less than half of the participants slept adequately regularly, which may negatively affect their health. Interventions targeting screen-time may be effective for positively impacting sleep, due to decreasing exposition to blue light[212], and displacing one behavior for the other, which simultaneously helps increase adherence to both and possibly to all 24-hour movement behaviors.

Differences between actigraphy and self-reported measures of sleep in adolescents have been shown to differ greatly[213], which concurs with the difference between the adherence to sleep duration recommendations observed in the present study. Most studies reviewed for the publication of the Canadian 24-hour movement guidelines were from studies that used self-reported sleep[109]and may not be comparable to actigraphy measures of sleep duration. For example, as actigraphy records sleep duration and awakenings with more precision than self-reported instruments, it may be that the equivalent recommended sleep duration when using

accelerometers would be lower compared to the value using self-reported instruments. More studies with actigraphy and polysomnography are needed to provide accurate estimates of adequate sleep on health outcomes to support future guidelines.

Parental education, SES, and family structure were not correlated with any of the 24-hour movement behaviors in the present study. These indicators have been associated with the 24-hour movement guidelines in other studies[72], and are useful for identifying underlying inequities in health indicators. However, based on our results, parental education, SES, and family structure may not reflect inequities within the mesoregion where our sample is inserted, but could differ from other cities and states within the country. Although girls could benefit from specific PA interventions, and boys for sleep and screen time interventions, based on our sociodemographic indicators, policies and interventions aiming at the 24-hour movement behaviors should target adolescents from all social backgrounds.

A limitation of the present study is the small size of the sample, which limits the power of inferential statistics (in the case of accelerometer data). Another limitation is the use of self-report instruments to measure habitual behaviors, which are prone to recall limitation and social desirability bias. To address that, we have also included accelerometer measures of sleep duration and MVPA, but it was not possible for screen time, as this behavior can be undertaken using many devices making it challenging to measure with precision. In addition, the cut-off used for classifying MVPA and the algorithm used to identify sleep from accelerometer data were not validated with a wide age group of adolescents, which may limit the accuracy of the estimates for these behaviors in this target population. The main strength of the present study was the use of standard measures to analyze all 24-hour movement behaviors in a sample of adolescents from a middle-income country.

Conclusions

Approximately 3% of the participants met the MVPA, screen-time, and sleep duration recommendations simultaneously, while this proportion was 0.2% when accelerometer data were used for MVPA and sleep duration. Adherence to the sleep duration recommendation was higher than to the screen-time or MVPA

recommendations. Boys were more likely to meet the MVPA recommendations, but less likely to meet sleep duration and scree-time recommendations, and age was positively associated with adhering to the screen-time recommendation. Future policies and interventions should promote adherence to 24-hours movement behaviors in an integrated manner.

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4. FINAL CONSIDERATIONS

The present thesis aimed to analyze sociodemographic and behavioral correlates of accelerometer-measured and self-reported 24-hour movement behaviors in a sample of Brazilian adolescents. The results suggest that sex, age, socioeconomic status, family structure, screen time, dietary behavior, alcohol use, and tobacco use are associated with the 24-hour movement behaviors, and that associations may be behavior-specific, type-specific, and/or instrument specific.

In relation to sex, this study adds to a broad body of evidence that suggests that males are more active than females. In addition to confirming this association with both accelerometer-measured and self-reported instruments, it was observed that this difference was intensity-specific when accelerometer-measured physical activity was analyzed, with females engaging in more light-intensity activities but less in moderate and vigorous activities. When a self-reported instrument was analyzed, it was observed that females engage in less sports and total physical activity, but not in non-sport

activities. The adherence to physical activity guidelines was also higher among males compared to females when using both self-reported and accelerometer data. Taken together, these results suggest that although females may need further incentives to be more active, this may be achieved with more domain-specific interventions, and for activities of higher intensities.

When sedentary behavior was analyzed, females engaged in less accelerometer-measured sedentary behavior, less total screen time, less leisure-time screen time, but more involuntary sedentary behaviors (e.g. work and study). Taken together, females may need to reduce social media use, and males may need to reduce videogame use, while both could benefit in reducing the time watching videos. Finally, in relation to sleep, the only association observed suggested that females slept for longer than boys when accelerometer-measured sleep was observed. However, this difference was not observed for self-reported data or did not impact the adherence to guidelines. Both sexes could improve sleep duration, and males may need more incentives in this matter.

In contrast to most of the available evidence, age was positively associated with non-sport physical activity, but not with any other indicator of physical activity. Age was positively related to sedentary behavior measured by accelerometer, with involuntary screen time, and with the odds of meeting screen time guidelines, but not with leisure-time sedentary behaviors. Additionally, no associations were found between age and sleep.

Socioeconomic status was positively associated with self-reported total physical activity, but no other association was observed. Similarly, adolescents living only with the mother practiced more sports than those living with two-parents, but not with any other 24-hour movement behavior indicator.

Screen time indicators, when analyzed as independent variables for the accelerometer-measured outcomes, were sex- and type-specific related to the 24-hour movement behaviors. Studying was related with higher sedentary behavior among females and less moderate-to-vigorous physical activity, while working was associated with lower sleep duration and higher light physical activity. As for the leisure-time screen time activities, watching videos was associated with higher sedentary behavior

among males, and less light and moderate-to-vigorous physical activity among both males and females. Videogames were associated with less light and moderate-to-vigorous physical activity among males, and social media use was associated with less moderate-to-vigorous physical activity among females. These results suggest that how adolescents spend their time and the content they have access to might have a role in their behavior pattern throughout the day, and may need specific interventions to reduce screen time activities that they are used to.

Regarding the dietary behaviors, it was observed that a higher ingestion of unprocessed foods, or fruits and vegetables, was associated with higher light physical activity, increased sport participation, and increased total self-reported physical activity. On the other hand, processed foods were related to increased accelerometer-measured and self-reported sedentary behaviors, and negatively associated with accelerometer-measured and self-reported physical activity, including non-sport activities. This suggests that interventions may need to target both dietary behaviors and 24-hour movement behaviors among adolescents, as their impact on health are important for a healthy development, but they are also strongly related.

The relationship between substance use and the 24-hour movement behaviors was also explored, and a positive relationship between alcohol intake and total self-reported physical activity was observed, and an inverse relationship between tobacco use and self-reported physical activity was also observed. No other associations with any other 24-hour movement behaviors were observed, and illicit drug experimentation was not significantly associated with any indicator.

Regardless of sex, age, socioeconomic status and other behavioral factors, adherence to 24-hour movement behavior guidelines was low, and increasing physical activity, getting adequate sleep, and reducing sedentary behavior should be the goal of policies aimed at all adolescents.

This study has several limitations that need to be taken into account. Although a combination of methods was used, and recommended protocols followed, some analyzes, such as the estimation of sleep behaviors with accelerometry, were validated for adults, and not adolescents, and may not be as accurate in this specific subgroup. For the self-reported behaviors, memory and social desirability bias may be an issue, although it is not easy to prevent in surveys with low-cost instruments. The local characteristics of the sample may impair generalizability, as the adolescents that

compose the sample may be within similar environmental and social factors such as climate and local policies. Finally, the cross-sectional design precludes inferences about directionality and causality. Although the study has several limitations, some strengths are also worth mentioning, such as the use of self-reported and accelerometer measures of the outcomes, which allows a better characterization of the outcomes. The novelty of studying a population of high school students integrated with professional courses brings more evidence to the literature that is scarce in this population. Finally, the analyses of a middle-income setting, specifically Brazil, which is severely underrepresented in the literature, as highlighted in recent reviews that analyzed the 24-hour movement behaviors of adolescents.[63,214]

In conclusion, the results of this thesis suggest that the 24-hour movement behaviors of adolescents are influenced by several sociodemographic and behavioral factors. The relationships involving the 24-hour movement behaviors appear to be type-specific, and that information may be of special interest when planning and optimizing future studies, interventions, policies, and practice.

The present study adds to the existing literature by showing that the factors that are associated with the bodily movement, that being the act of moving measured by the accelerometer, are not necessarily determinants of how these movements are being made, in what context, and how they relate to the individuals that are moving. These relationships can be observed by mixing qualitative and quantitative information, and have been hypothesized before, but only a few studies have combined the 24-hour accelerometer protocol and informative self-reported data with information about the types of activities like in the present study. Our data supports this hypothesis that the types of activities are as important as the amount of movement. This is not only the main strength of the present study, but the results suggest that novel studies need to address this hypothesis in order to advance the field. Summing screen time indicators in one volume variable and using it as a proxy of sedentary behavior has limitations, as screen time activities do not completely translate to sedentary behavior, and they are also determined by different factors (e.g., females engaged in more involuntary screen time, but less in leisure screen time). The same concept applies to other the 24-hour movement behaviors.

This change in paradigm, by looking not only at how much movement is being made by focusing on energy expenditure, acceleration, and posture, may provide novel insights that will inform research, interventions, theories, guidelines, and practice. The present study has provided insights about the type of activities made, and this may play a role in future interventions as for example, it may be easier to reduce social media use by some hours a day, but not so easy to reduce the time watching videos. Similarly, promoting specific sport activities may be an easier way to promote more intense activities compared to promoting active commuting. Future studies are also needed to clarify if qualitative differences also impact health. For example, is it plausible that playing 30 minutes of soccer at an average 4 METs can provide more benefits for health compared to cycling for 30 minutes at the same average intensity? What activity can be more easily promoted or adopted by individuals, and which determinants play a role in that?

Other aspects outside the scope of the present study, such as environmental indicators, timing indicators, among others, will also need to be investigated in an integrated way, as they may have a meaningful information for research aiming at understanding determinants of the 24-hour movement behaviors. New studies adopting this new approach, combining qualitative information from self-reported instruments (e.g., type, content, timing, environment, domain) and accelerometer-measured indicators (e.g., frequency, duration, timing, volume) are recommended for future studies with other populational subgroups as well, as adults may relate differently to screen time activities, physical activities, and sleep patterns.

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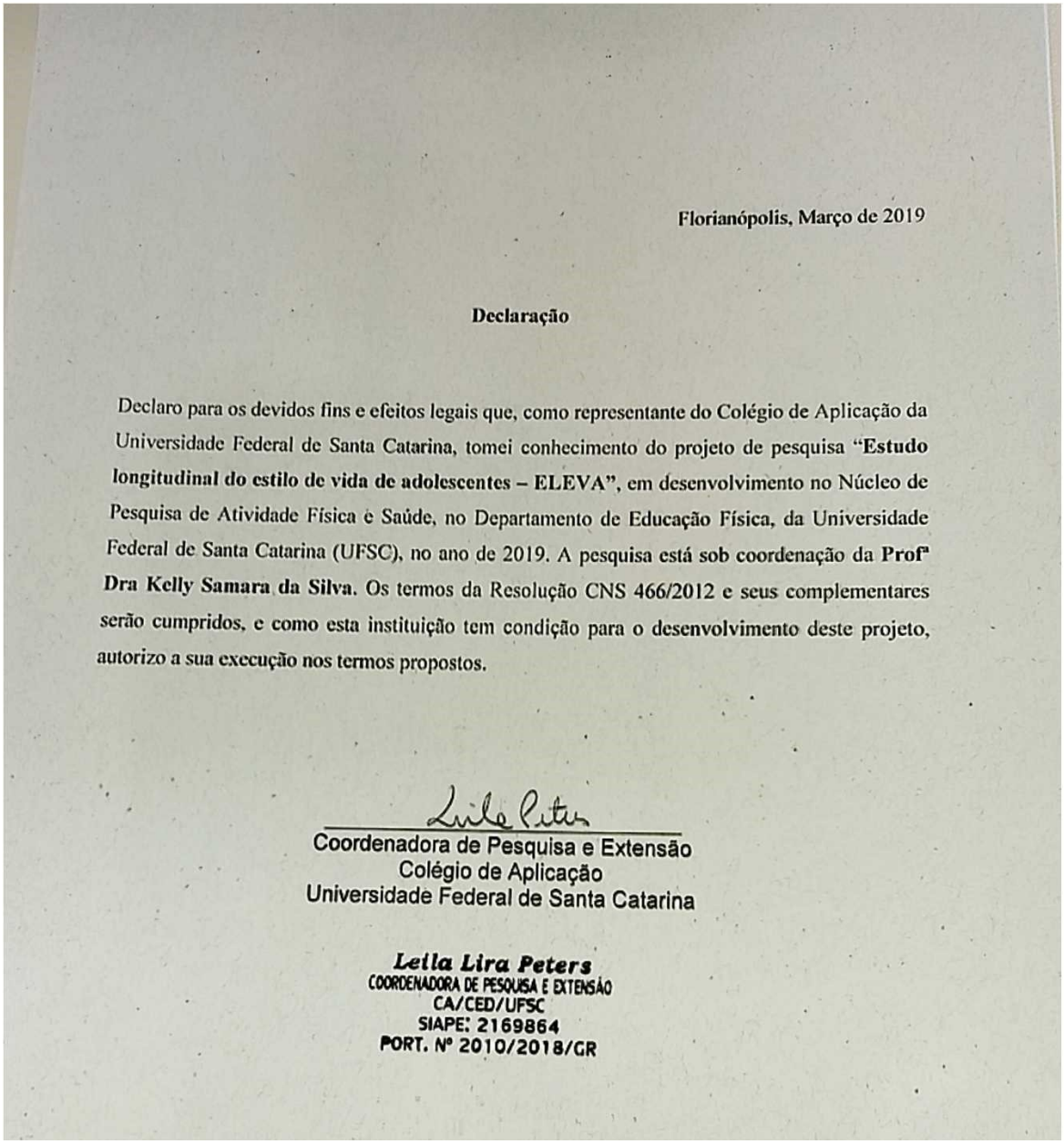
APPENDIX A. Authorization Term of the Colégio de Aplicação



Florianópolis, Março de 2019

Declaração

Declaro para os devidos fins e efeitos legais que, como representante do Colégio de Aplicação da Universidade Federal de Santa Catarina, tomei conhecimento do projeto de pesquisa "**Estudo longitudinal do estilo de vida de adolescentes – ELEVA**", em desenvolvimento no Núcleo de Pesquisa de Atividade Física e Saúde, no Departamento de Educação Física, da Universidade Federal de Santa Catarina (UFSC), no ano de 2019. A pesquisa está sob coordenação da **Profª Dra Kelly Samara da Silva**. Os termos da Resolução CNS 466/2012 e seus complementares serão cumpridos, e como esta instituição tem condição para o desenvolvimento deste projeto, autorizo a sua execução nos termos propostos.

Coordenadora de Pesquisa e Extensão
Colégio de Aplicação
Universidade Federal de Santa Catarina

Leila Lira Peters
COORDENADORA DE PESQUISA E EXTENSÃO
CA/CED/UFSC
SIAPE: 2169864
PORT. Nº 2010/2018/GR

Source: Prepared by the author (2019).

APPENDIX B. Authorization Term of IFSC Campus São José

São José, Outubro de 2018

Declaração

Declaro para os devidos fins e efeitos legais que, objetivando atender as exigências para a obtenção de parecer do Comitê de Ética em Pesquisa com Seres Humanos, e como representante do Instituto Federal de Santa Catarina, Campus São José, tomei conhecimento do projeto de pesquisa "**Estudo longitudinal do estilo de vida de adolescentes – ELEVA"**, em desenvolvimento no Núcleo de Pesquisa de Atividade Física e Saúde, no Departamento de Educação Física, da Universidade Federal de Santa Catarina (UFSC), no período de 2019 a 2022. A pesquisa está sob coordenação da **Profª Dra Kelly Samara da Silva**. Os termos da Resolução CNS 466/2012 e seus complementares serão cumpridos, e como esta instituição tem condição para o desenvolvimento deste projeto, autorizo a sua execução nos termos propostos.

Saul Silva Caetano
Direção Geral do Câmpus São José
Instituto Federal de Santa Catarina - IFSC

Prof. Antonio Galdino da Costa
Diretor de Ensino, Pesquisa e Extensão
IFSC - Campus São José

Source: Prepared by the author (2018).

APPENDIX C. Authorization Term of the IFSC Campus Palhoça

Palhoça, Outubro de 2018

Declaração

Declaro para os devidos fins e efeitos legais que, objetivando atender as exigências para a obtenção de parecer do Comitê de Ética em Pesquisa com Seres Humanos, e como representante do Instituto Federal de Santa Catarina, Campus Palhoça Bilingue, tomei conhecimento do projeto de pesquisa "**Estudo longitudinal do estilo de vida de adolescentes – ELEVA"**, em desenvolvimento no Núcleo de Pesquisa de Atividade Física e Saúde, no Departamento de Educação Física, da Universidade Federal de Santa Catarina (UFSC), no período de 2019 a 2022. A pesquisa está sob coordenação da **Profª Dra Kelly Samara da Silva**. Os termos da Resolução CNS 466/2012 e seus complementares serão cumpridos, e como esta instituição tem condição para o desenvolvimento deste projeto, autorizo a sua execução nos termos propostos.

Carmem Cristina Beck
Direção Geral do Câmpus Palhoça Bilingue
Instituto Federal de Santa Catarina - IFSC

Carmem Cristina Beck
Diretora Geral
Portaria nº21, DOU 01/02/2016
IFSC - Câmpus Palhoça Bilingue

1

Source: Prepared by the author (2018).

APPENDIX D. Authorization Term of the IFSC Campus Mauro Ramos

São José, Outubro de 2018

Declaração

Declaro para os devidos fins e efeitos legais que, objetivando atender as exigências para a obtenção de parecer do Comitê de Ética em Pesquisa com Seres Humanos, e como representante do Instituto Federal de Santa Catarina, Campus Florianópolis – Mauro Ramos, tomei conhecimento do projeto de pesquisa "**Estudo longitudinal do estilo de vida de adolescentes – ELEVA**", em desenvolvimento no Núcleo de Pesquisa de Atividade Física e Saúde, no Departamento de Educação Física, da Universidade Federal de Santa Catarina (UFSC), no período de 2019 a 2022. A pesquisa está sob coordenação da **Profª Dra Kelly Samara da Silva**. Os termos da Resolução CNS 466/2012 e seus complementares serão cumpridos, e como esta instituição tem condição para o desenvolvimento deste projeto, autorizo a sua execução nos termos propostos.

Andrea Martins Andujar
Direção Geral do Câmpus Florianópolis – Mauro Ramos
Instituto Federal de Santa Catarina - IFSC

Clóvis Antônio Petry
Diretoria Pesquisa, Pós-graduação e extensão
Instituto Federal de Santa Catarina – IFSC – Câmpus Florianópolis

Bruno Gonçalves Lopes
Chefe de Departamento - DALTEC
Instituto Federal de Santa Catarina – IFSC – Câmpus Florianópolis

Source: Prepared by the author (2018).

APPENDIX E. Authorization Term of Pro-Rectory of Research, Graduate and Innovation of the IFSC

MINISTÉRIO DA EDUCAÇÃO
SECRETARIA DE EDUCAÇÃO PROFISSIONAL E TECNOLÓGICA
INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DE SANTA CATARINA

DECLARAÇÃO

Declaro para os devidos fins e efeitos legais que tenho conhecimento da pesquisa intitulada "ESTUDO LONGITUDINAL DO ESTILO DE VIDA DE ADOLESCENTES – ELEVA ", sob a responsabilidade de BRUNO GONÇALVES GALDINO DA COSTA . Diante da análise da proposta de pesquisa, realizada pela Pró-Reitoria de Pesquisa, Pós-Graduação e Inovação, autorizo a sua execução. Esta autorização não exime, contudo, a responsabilidade do pesquisador em atender à Resolução CNS 466/12, de 12/12/2012, e à Resolução CNS 510/16, de 07/04/2016 e complementares.

CLODOALDO MACHADO
Pró-Reitor de Pesquisa, Pós-Graduação e Inovação do IFSC
Portaria n. 479 dou de 02/02/2016

Clodoaldo Machado
Pró-Reitor de Pesquisa, Pós-Graduação e Inovação
Conforme Portaria n°2484 de 05/08/2017

Florianópolis, 04 de dezembro de 2018.

Instituto Federal de Santa Catarina – Reitoria
Rua: 14 de julho, 150 | Coqueiros | Florianópolis /SC | CEP: 88.075-010
Fone: (48) 3877-9000 | www.ifsc.edu.br | CNPJ 11.402.887/0001-60

Source: Prepared by the author (2018).

APPENDIX F. Consent forms for the parents/guardians

UNIVERSIDADE FEDERAL DE SANTA CATARINA
CENTRO DE DESPORTOS
DEPARTAMENTO DE EDUCAÇÃO FÍSICA
Campus Universitário João David Ferreira Lima, s/n Trindade, Florianópolis, CEP 880
Núcleo de Pesquisa em Atividade Física e Saúde

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Prezado(a) Responsável

Seu filho(a) está sendo convidado(a) para participar do Estudo Longitudinal do Estilo de Vida de Adolescentes – ELEVA, uma pesquisa que será realizada na escola por pesquisadores da Universidade Federal de Santa Catarina. O ELEVA tem como objetivo analisar possíveis mudanças nos indicadores de estilo de vida para a saúde de adolescentes ao longo do ensino médio integrado ao ensino profissionalizante. A participação na pesquisa é voluntária, e o senhor(a) e/ou o seu filho(a) poderá desistir de participar e retirar seu consentimento antes ou em qualquer outra etapa da pesquisa. Caso autorize a participação do(a) seu(sua) filho(a), por favor assine no final do documento, porém, antes de assinar este termo, é importante que o(a) senhor(a) entenda todas as informações e esclareça as dúvidas com os pesquisadores.

Este documento deverá ser feito em duas vias, sendo um para o senhor(a) e um para os pesquisadores responsáveis. Todas as páginas estão numeradas e devem ser rubricadas pelas partes interessadas. Ao final do documento, deve-se constar a assinatura do convidado e do pesquisador responsável.

Protocolo de pesquisa e métodos

O protocolo da presente pesquisa está fundamentado em princípios e pressupostos científicos, os métodos e instrumentos empregados foram previamente validados, e os pesquisadores treinados para conduzir as avaliações. A equipe de pesquisadores, os materiais e os instrumentos foram selecionados e preparados para assegurar o bem-estar do(a) seu(sua) filho(a) nesta pesquisa. A presente pesquisa se pautou na Resolução CNS 466/12.5, que descreve as obrigações dos pesquisadores e diretrizes a serem seguidas.

Todas as coletas de dados serão conduzidas no primeiro semestre do ano de 2019. As medidas inclusas nas coletas de dados da presente pesquisa incluem:

1. Um questionário *online*, onde haverá perguntas relacionadas à qualidade e o estilo de vida, como a prática de atividade física e comportamento sedentário, alimentação, sono, assim como questões relacionadas à qualidade de vida, relações de sintomas depressivos e *bullying*.
2. Medidas de massa corporal e estatura, que serão feitos em uma sala reservada, por uma equipe de pesquisadores treinados e experientes.
3. Uso de um equipamento eletrônico no punho para mensuração de atividades físicas, sono, e comportamentos sedentários ao longo de uma semana. É importante destacar que o aparelho se assemelha a um relógio em termos de tamanho, formato e peso.

Risco da pesquisa

As avaliações foram pensadas a fim de minimizar os desconfortos. Embora pequenos, ao longo da pesquisa é possível que se tenham alguns desconfortos, como cansaço, aborrecimento e/ou constrangimentos ao responder o questionário. Entretanto, durante todos os procedimentos de coletas de dados, estarão presentes pesquisadores treinados para prestar a assistência necessária e/ou acionar órgãos competentes para isso. Para as medidas de massa corporal e estatura pesquisadores do mesmo sexo farão as medidas em sala reservada para minimizar possíveis constrangimentos. Irritações na pele podem raramente ocorrer em decorrência do uso do acelerômetro no punho, e neste caso, seu uso deverá ser cessado, como será orientado pela equipe de pesquisadores.

Caso ocorra qualquer desconforto dentre os citados acima ou outros, você poderá comunicar o pesquisador presente, que estará pronto para prestar toda a assistência, de maneira gratuita. Além disto, você pode interromper qualquer medida, e se abster

desta ou de toda a pesquisa a qualquer momento, sem prejuízo ou danos.

Assistência

No caso de qualquer incidente associado ou decorrente da pesquisa, os pesquisadores prestarão assistência imediata, quando possível, acionando órgãos responsáveis, se e quando necessário. Também será prestada assistência integral, se e quando houverem complicações. Adicionalmente, mesmo se todos os esforços para o evitar falharem e seu(sua) filho(a) tenha algum prejuízo em decorrência de sua participação no estudo, será possível solicitar indenização, de acordo com a legislação vigente.

Ressarcimento

A pesquisa foi organizada para que a coleta de dados seja realizada toda na instituição de ensino onde seu filho(a) estuda, de modo a evitar quaisquer gastos adicionais. Entretanto, em casos de possíveis despesas mesmo que não previstas e/ou em caso de dano material ou imaterial, serão garantidas ressarcimentos e indenizações, quando necessárias. Embora improváveis, possíveis gastos com transporte e alimentação podem acontecer.

Benefícios da pesquisa

Dentre os benefícios de sua participação no ELEVA, destaca-se o conhecimento adquirido acerca da atual condição física do seu(sua) filho(a), de acordo com as medidas obtidas no protocolo da pesquisa. Informações adicionais serão fornecidas, referente aos relatórios institucionais de cada escola participante, que poderão contribuir para a compreensão da saúde e qualidade de vida dos alunos de cada escola.

Achados da pesquisa

Os achados do ELEVA serão divulgados por meio de relatórios parciais e no relatório final, também em artigos científicos, e apresentações em congressos científicos. Os relatórios serão enviados às instituições participantes, aos órgãos de fomento, além do Comitê de Ética em Pesquisa com Seres Humanos. Estes documentos serão enviados aos participantes por e-mail, mediante ao fornecimento desta informação para contato ao final do questionário de pesquisa.

Privacidade

Para todas as medidas feitas no presente estudo, será criado uma identificação numérica para cada participante, a fim de preservar a identidade e privacidade das informações coletadas. Nenhum participante será identificado em nenhuma publicação, relatório ou qualquer forma de divulgação dos resultados da pesquisa. Se houver, porém, quebra não-intencional e involuntária de sigilo, a situação será resolvida de acordo com a legislação vigente.

Instituição

A concepção e o desenvolvimento deste projeto de pesquisa encontram-se vinculados ao Núcleo de Pesquisa em Atividade Física e Saúde, da Universidade Federal de Santa Catarina (NuPAF/UFSC), em uma de suas linhas de pesquisa prioritárias, intitulada "Educação Física, Condições de Vida e Saúde".

Pesquisadores e contato

A pesquisadora responsável (coordenadora) do ELEVA é a Professora Doutora Kelly Samara da Silva, do Departamento de Educação Física da UFSC, e coordenadora do NuPAF/UFSC. Ela e os demais pesquisadores vinculados ao ELEVA ficam a sua disposição para o esclarecimento de dúvidas, e na necessidade de qualquer assistência: Professora Kelly (kelly.samara@ufsc.br ou 48 3721-8519), Bruno (bruno.g.costa@posgrad.ufsc.br ou 48 99928-5288).

O endereço para contato com os pesquisadores responsáveis é:

Núcleo de Pesquisa em Atividade Física e Saúde, Sala 48, Centro de Desportos, Campus Universitário Reitor João David Ferreira Lima s/n, Trindade, Florianópolis, SC, Brasil. CEP 88036-400. Telefone: 48 3721-8519.

Você também pode entrar em contato por telefone, e-mail ou fisicamente com o **Comitê de Ética em Pesquisa com Seres Humanos.** O projeto foi avaliado pelo Comitê de Ética em Pesquisa com Seres Humanos (CEPSH) da Universidade Federal de Santa Catarina (Prédio Reitoria II, R: Desembargador Vitor Lima, nº 222, sala 401, Trindade, Florianópolis/SC, CEP 88.040-400, Contato: (48) 3721-6094, cep.propesq@contato.ufsc.br). O CEPSH avaliou o presente projeto e poderá esclarecer quaisquer

dúvidas e dar-lhe suporte em qualquer caso necessário.

Consentimento

Eu,_____, RG_____ li este documento e entendi todas as informações contidas nesse termo e, assino abaixo, confirmando através deste documento que

( ) : Obtive dos pesquisadores todas as informações que julguei necessárias para me sentir esclarecido e optar por livre e espontânea vontade autorizar a participação do _____ no estudo ELEVA.

_____
Assinatura do(a) responsável(a)

Declaração do pesquisador

Declaro, para fins da realização da pesquisa, que cumprirei todas as exigências acima, na qual obtive de forma apropriada e voluntária, o consentimento livre e esclarecido do declarante.

_____
Profª Drª Kelly Samara da Silva
Coordenadora do Projeto
Professora da UFSC

Florianópolis - SC, Maio de 2019.

Source: Prepared by the author (2018).

APPENDIX G. Consent forms for the participants

UNIVERSIDADE FEDERAL DE SANTA CATARINA
CENTRO DE DESPORTOS
DEPARTAMENTO DE EDUCAÇÃO FÍSICA
Campus Universitário João David Ferreira Lima, s/n Trindade, Florianópolis, CEP 88040-900
Núcleo de Pesquisa em Atividade Física e Saúde

TERMO DE ASCENTIMENTO LIVRE E ESCLARECIDO

Prezado(a) aluno(a)

Você está sendo convidado(a) para participar do Estudo Longitudinal do Estilo de Vida de Adolescentes – ELEVA, uma pesquisa que será realizada na sua escola por pesquisadores da Universidade Federal de Santa Catarina. O ELEVA tem como objetivo de analisar possíveis mudanças nos indicadores de estilo de vida para a saúde de adolescentes ao longo do ensino médio integrado ao ensino profissionalizante. A participação na pesquisa é voluntária, e você poderá desistir de participar e retirar seu consentimento antes ou em qualquer outra etapa da pesquisa. Caso aceite participar, por favor assine no final do documento, porém, antes de assinar este termo, é importante que você entenda todas as informações e esclareça as dúvidas com os pesquisadores.

Este documento deverá ser feito em duas vias, sendo um para o senhor(a) e um para os pesquisadores responsáveis. Todas as páginas estão numeradas e devem ser rubricadas pelas partes interessadas. Ao final do documento, deve-se constar a assinatura do convidado e do pesquisador responsável.

Protocolo de pesquisa e métodos

O protocolo da presente pesquisa está fundamentado em princípios e pressupostos científicos, e os métodos e instrumentos empregados foram previamente validados e os pesquisadores treinados para conduzir as avaliações. A equipe de pesquisadores, os materiais e os instrumentos foram selecionados e preparados para assegurar o seu bem-estar nesta pesquisa. A presente pesquisa se pautou na Resolução CNS 466/12.5, que descreve as obrigações dos pesquisadores e diretrizes a serem seguidas.

Todas as coletas de dados serão conduzidas no primeiro semestre do ano de 2019. As medidas inclusas nas coletas de dados da presente pesquisa incluem:

1. Um questionário *online*, onde haverá perguntas relacionadas à qualidade e o estilo de vida, como a prática de atividade física e comportamento sedentário, alimentação, sono, assim como questões relacionadas à qualidade de vida, relações de sintomas depressivos e *bullying*.
2. Medidas de massa corporal e estatura, que serão feitos em uma sala reservada, por uma equipe de pesquisadores treinados e experientes.
3. Uso de um equipamento eletrônico no punho para mensuração de atividades físicas, sono, e comportamentos sedentários ao longo de uma semana. É importante destacar que o aparelho se assemelha a um relógio em termos de tamanho, formato e peso.

Risco da pesquisa

As avaliações foram pensadas a fim de minimizar os desconfortos. Embora pequenos, ao longo da pesquisa é possível que se tenham alguns desconfortos, como cansaço, aborrecimento e/ou constrangimentos ao responder o questionário. Entretanto, durante todos os procedimentos de coletas de dados, estarão presentes pesquisadores treinados para prestar a assistência necessária e/ou acionar órgãos competentes para isso. Para as medidas de massa corporal e estatura pesquisadores do mesmo sexo farão as medidas em sala reservada para minimizar possíveis constrangimentos. Irritações na pele podem raramente ocorrer em decorrência do uso do acelerômetro no punho, e neste caso, seu uso deverá ser cessado, como será orientado pela equipe de pesquisadores.

Caso ocorra qualquer desconforto dentre os citados acima ou outros, você poderá comunicar o

pesquisador presente, que estará pronto para prestar toda a assistência, de maneira gratuita. Além disto, você pode interromper qualquer medida, e se abster desta ou de toda a pesquisa a qualquer momento, sem prejuízo ou danos.

Assistência

No caso de qualquer incidente associado ou decorrente da pesquisa, os pesquisadores prestarão assistência imediata, quando possível, acionando órgãos responsáveis, se e quando necessário. Também será prestada assistência integral, se e quando houverem complicações. Adicionalmente, mesmo se todos os esforços para o evitar falharem e você tenha algum prejuízo em decorrência de sua participação no estudo, será possível solicitar indenização, de acordo com a legislação vigente.

Ressarcimento

A pesquisa foi organizada para que a coleta de dados seja realizada toda na instituição de ensino onde seu filho(a) estuda, de modo a evitar quaisquer gastos adicionais. Entretanto, em casos de possíveis despesas mesmo que não previstas e/ou em caso de dano material ou imaterial, serão garantidas ressarcimentos e indenizações, quando necessárias. Embora improváveis, possíveis gastos com transporte e alimentação podem acontecer.

Benefícios da pesquisa

Dentre os benefícios de sua participação no ELEVA, destaca-se o conhecimento adquirido acerca da sua atual condição física, de acordo com as medidas obtidas no protocolo da pesquisa. Informações adicionais serão fornecidas, referente aos relatórios institucionais de cada escola participante, que poderão contribuir para a compreensão da saúde e qualidade de vida dos alunos de cada escola.

Achados da pesquisa

Os achados do ELEVA serão divulgados por meio de relatórios parciais e no relatório final, também em artigos científicos, e apresentações em congressos científicos. Os relatórios serão enviados às instituições participantes, aos órgãos de fomento, além do Comitê de Ética em Pesquisa com Seres Humanos. Estes documentos serão enviados aos participantes por e-mail, mediante ao fornecimento desta informação para contato ao final do questionário de pesquisa.

Privacidade

Para todas as medidas feitas no presente estudo, será criado uma identificação numérica para cada participante, afim de preservar a identidade e privacidade das informações coletadas. Nenhum participante será identificado em nenhuma publicação, relatório ou qualquer forma de divulgação dos resultados da pesquisa. Se houver, porém, quebra não-intencional e involuntária de sigilo, a situação será resolvida de acordo com a legislação vigente.

Instituição

A concepção e o desenvolvimento deste projeto de pesquisa encontram-se vinculados ao Núcleo de Pesquisa em Atividade Física e Saúde, da Universidade Federal de Santa Catarina (NuPAF/UFSC), em uma de suas linhas de pesquisa prioritárias, intitulada "Educação Física, Condições de Vida e Saúde".

Pesquisadores e contato

A pesquisadora responsável (coordenadora) do ELEVA é a Professora Doutora Kelly Samara da Silva, do Departamento de Educação Física da UFSC, e coordenadora do NuPAF/UFSC. Ela e os demais pesquisadores vinculados ao ELEVA ficam a sua disposição para o esclarecimento de dúvidas, e na necessidade de qualquer assistência: Professora Kelly (kelly.samara@ufsc.br ou 48 3721-8519), Bruno (bruno.g.costa@posgrad.ufsc.br ou 48 99928-5288).

O endereço para contato com os pesquisadores responsáveis é:

Núcleo de Pesquisa em Atividade Física e Saúde, Sala 48, Centro de Desportos, Campus Universitário Reitor João David Ferreira Lima s/n, Trindade, Florianópolis, SC, Brasil. CEP 88036-400. Telefone: 48 3721-8519.

Você também pode entrar em contato por telefone, e-mail ou fisicamente com o **Comitê de Ética em Pesquisa com Seres Humanos** (CEPSH) da Universidade Federal de Santa Catarina (Prédio Reitoria II, R: Desembargador Vitor Lima, nº 222, sala 401, Trindade, Florianópolis/SC, CEP 88.040-400, Contato: (48) 3721-6094, cep.propesq@contato.ufsc.br). O CEPSH avaliou o presente projeto e poderá esclarecer quaisquer dúvidas e dar-lhe suporte em qualquer caso necessário.

Consentimento

Eu,_____, RG_____ li este documento e entendi todas as informações contidas nesse termo e, assino abaixo, confirmando através deste documento que

( ) : Obtive dos pesquisadores todas as informações que julguei necessárias para me sentir esclarecido e optar por livre e espontânea vontade participar no estudo ELEVA.

_____
Assinatura do(a) aluno(a)

Declaração do pesquisador

Declaro, para fins da realização da pesquisa, que cumprirei todas as exigências acima, na qual obtive de forma apropriada e voluntária, o consentimento livre e esclarecido do declarante.

Profª Drª Kelly Samara da Silva
Coordenadora do Projeto
Professora da UFSC

Florianópolis - SC, Maio de 2019.

Source: Prepared by the author (2018).

APPENDIX H. Protocol of the Ethics Committee in Research with Human Beings of the UFSC

UNIVERSIDADE FEDERAL DE SANTA CATARINA - UFSC

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: ESTUDO LONGITUDINAL DO ESTILO DE VIDA DE ADOLESCENTES ¿ ELEVA
Pesquisador: Kelly Samara da Silva
Área Temática:
Versão: 1
CAAE: 07073018.1.0000.0121
Instituição Proponente: Universidade Federal de Santa Catarina
Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 3.168.745

Apresentação do Projeto:
O projeto intitulado "ESTUDO LONGITUDINAL DO ESTILO DE VIDA DE ADOLESCENTES – ELEVA", objetiva analisar possíveis mudanças nos indicadores de estilo de vida para a saúde de adolescentes ao longo do ensino médio integrado ao ensino profissionalizante. Estudantes do ensino médio integrado de três Institutos Federais de Educação Tecnológica de Santa Catarina (IF) serão convidados a participar do estudo ELEVA. Um estudo piloto será conduzido no primeiro semestre de 2019, e as avaliações nos IFs serão realizadas nos segundos semestres de 2019, 2020, 2021 e 2022.
Características sociodemográficas e econômicas, assim como indicadores de comportamento sedentário, atividade física, sono, comportamento alimentar, consumo de álcool e fumo serão mensurados com um questionário online. Participantes irão utilizar um acelerômetro no punho para medir objetivamente níveis habituais de atividade física, comportamento sedentário e sono. Estatura, massa corporal e perímetro da cintura serão aferidos por pesquisadores treinados. Os estudantes ainda participarão em um teste de vai-e-vem de 20 metros para estimar o consumo máximo de oxigênio e terão sua força de preensão manual aferidas com um dinamômetro. Os dados serão analisados com regressões lineares e logísticas binárias brutas e ajustadas. Devido a organização hierárquica da amostra, com alunos sendo agrupados em turmas, cursos e campus, análises multinível serão conduzidas para serem levadas em conta as variabilidades destes níveis. Variáveis co-dependentes serão analisadas com compositional analyses. Todas as análises serão

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UF: SC **Município:** FLORIANOPOLIS
Telefone: (48)3721-6094 **E-mail:** cep.propesq@contato.ufsc.br

conduzidas no software R.

Objetivo da Pesquisa:

Objetivo Primário:

1.2.1. Objetivo GeralAnalisar possíveis mudanças nos indicadores de estilo de vida para a saúde de adolescentes ao longo do ensino médio integrado ao ensino profissionalizante.

Objetivo Secundário:

1.2.2. Objetivos Específicos

a) Identificar, na linha de base, indicadores de comportamento de consumo de alimentos in natura e processados, do tempo dispendido em atividades físicas em intensidades diferentes e comportamentos sedentários medidos objetivamente, das práticas de atividades físicas relatadas e tempo de tela, da duração e qualidade do sono, do consumo de álcool e hábito de fumar;

b) Analisar as relações entre diferentes indicadores do estilo de vida, e seus fatores sociodemográficos associados;

c) Analisar possíveis mudanças dos indicadores do estilo de vida após um, dois, três e quatro anos e identificar moderadores sociodemográficos dessas mudanças;

d) Verificar a influência dos indicadores do estilo de vida uns sobre os outros em relação à mudanças e estabilidade ao longo de quatro anos.

Avaliação dos Riscos e Benefícios:

Riscos:

Risco da pesquisa

As avaliações foram pensadas a fim de minimizar os desconfortos. Embora pequenos, ao longo da pesquisa é possível que se tenham alguns desconfortos, como constrangimentos ao responder o questionário e desconfortos físicos temporários ao realizar os testes físicos. Entretanto, durante todos os procedimentos de coletas de dados, estarão presentes pesquisadores treinados para prestar a assistência necessária e/ou acionar órgãos competentes para isso. Para as medidas de massa corporal, estatura, e perímetro da cintura, pesquisadores do mesmo sexo farão as medidas em sala reservada para minimizar possíveis constrangimentos. No teste submáximo de corrida, poderão ocorrer desconfortos musculares agudos ou tardios, de caráter temporário. Porém, esse teste será conduzido em nível de esforço seguro, de acordo com a capacidade individual. Irritações na pele podem raramente ocorrer em decorrência do uso do acelerômetro no punho, e neste caso, seu uso deverá ser cessado, como será orientado pela equipe de pesquisadores. Caso ocorra

qualquer desconforto decorrente dos procedimentos citados acima ou outros, seu(sua) filho(a) poderá comunicar o pesquisador presente, que estará pronto para prestar toda a assistência de maneira gratuita. Além disto, seu(sua) filho(a) pode interromper qualquer medida, e se abster desta ou de toda a pesquisa a qualquer momento, sem prejuízo ou danos.

Assistência

No caso de qualquer incidente associado ou decorrente da pesquisa, os pesquisadores prestarão assistência imediata, quando possível, acionando órgãos responsáveis, se e quando necessário. Também será prestada assistência integral, se e quando houverem complicações. Adicionalmente, mesmo se todos os esforços para o evitar falharem e seu(sua) filho(a) tenha algum prejuízo em decorrência de sua participação no estudo, será possível solicitar indenização, de acordo com a legislação vigente.

Benefícios:

Benefícios da pesquisa

Dentre os benefícios de sua participação no ELEVA, destaca-se o conhecimento adquirido acerca da atual condição física do seu(sua) filho(a), de acordo com as medidas obtidas no protocolo da pesquisa. Informações adicionais serão fornecidas, referente aos relatórios institucionais de cada escola participante, que poderão contribuir para a compreensão da saúde e qualidade de vida dos alunos de cada escola.

Achados da pesquisa

Os achados do ELEVA serão divulgados por meio de relatórios parciais e no relatório final, também em artigos científicos, e apresentações em congressos científicos. Os relatórios serão enviados às instituições participantes, aos órgãos de fomento, além do Comitê de Ética em Pesquisa com Seres Humanos. Estes documentos serão enviados aos participantes por e-mail, mediante ao fornecimento desta informação para contato ao final do questionário de pesquisa.

Privacidade

Para todas as medidas feitas no presente estudo, será criado uma identificação numérica para cada participante, a fim de preservar a identidade e privacidade das informações coletadas. Nenhum participante será identificado em nenhuma publicação, relatório ou qualquer forma de divulgação dos resultados da pesquisa. Se houver, porém, quebra não-intencional e involuntária de sigilo, a situação será resolvida de acordo com a legislação vigente.

Comentários e Considerações sobre a Pesquisa:

A pesquisa apresenta clareza, fundamentação bibliográfica, objetividade e uma vez obtido os

dados conclusivos possibilitará ações que trarão benefícios aos participantes da pesquisa.

Considerações sobre os Termos de apresentação obrigatória:

Documentos de acordo com as solicitações do CEPSH.

Recomendações:

Não se aplica.

Conclusões ou Pendências e Lista de Inadequações:

A pesquisa não apresenta inadequações ou impedimentos a realização da mesma.

Considerações Finais a critério do CEP:

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_1275335.pdf	05/02/2019 13:07:24		Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	Termos.doc	05/02/2019 13:07:01	Kelly Samara da Silva	Aceito
Projeto Detalhado / Brochura Investigador	Projeto.docx	05/02/2019 12:47:41	Kelly Samara da Silva	Aceito
Folha de Rosto	FolhadeRosto.pdf	12/12/2018 12:11:01	Kelly Samara da Silva	Aceito

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

UNIVERSIDADE FEDERAL DE SANTA CATARINA - UFSC

Continuação do Parecer: 3.168.745

FLORIANOPOLIS, 25 de Fevereiro de 2019

Assinado por:
Nelson Canzian da Silva
(Coordenador(a))

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Bairro: Trindade **CEP:** 88.040-400
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Telefone: (48)3721-6094 **E-mail:** cep.propesq@contato.ufsc.br

Source: Prepared by the author (2019).

APPENDIX E. Research questionnaire (version used in Campus São José, downloaded from the SurveyMonkey platform

Estudo Longitudinal do Estilo de Vida de Adolescentes - IFSC-SJ

Apresentação

Prezado(a) aluno(a),

Agradecemos antecipadamente o interesse em participar do ELEVA. Sua participação é muito importante para o sucesso desta pesquisa, que tem como objetivo monitorar mudanças no estilo de vida ao longo da formação no ensino médio.
O questionário a seguir aborda itens relacionados as suas características, hábitos e percepções. Caso tenha alguma dúvida, chame um pesquisador da equipe para lhe auxiliar.

Atenciosamente,

Equipe do ELEVA

Estudo Longitudinal do Estilo de Vida de Adolescentes - IFSC-SJ

Parte 1: Características demográficas

*** 1. Qual é a sua matrícula?**

Insira apenas números.

*** 2. Em qual curso você está matriculado?**

- ◯ TELE
- ◯ RAC

*** 3. Em qual fase você estuda atualmente?**

◯ Primeira ◯ Segunda ◯ Terceira ◯ Quarta ◯ Quinta ◯ Sexta ◯ Sétima ◯ Oitava

*** 4. Qual é o seu sexo?**

Assinale a alternativa que melhor lhe representa.

- ◯ Masculino
- ◯ Feminino

*** 5. Qual é a sua idade?**

- ◯ 13 ou menos
- ◯ 14
- ◯ 15
- ◯ 16
- ◯ 17
- ◯ 18
- ◯ 19
- ◯ 20
- ◯ 21 ou mais

*** 6. Qual é sua cor ou raça?**

- ◯ Branca
- ◯ Preta
- ◯ Amarela
- ◯ Outro (especifique)
- ◯ Parda
- ◯ Indígena

*** 7. Em que turno você estuda?**

- ◯ Manhã
- ◯ Tarde
- ◯ Noite
- ◯ Integral

*** 8. Você mora com seu pai?**

- ◯ Sim
- ◯ Não

*** 9. Você mora com sua mãe?**

- ◯ Sim
- ◯ Não

10. Contando você, quantas pessoas moram na sua casa ou apartamento?

*** 11. Qual é a escolaridade do seu pai e da sua mãe?**

	Não estudou	Ensino fundamental incompleto	Ensino fundamental completo	Ensino médio completo	Ensino superior incompleto	Ensino superior completo	Não sei
Pai	◯	◯	◯	◯	◯	◯	◯
Mãe	◯	◯	◯	◯	◯	◯	◯

*** 12. Você tem algum trabalho, emprego ou negócio atualmente?**

◯ Sim ◯ Não

Estudo Longitudinal do Estilo de Vida de Adolescentes - IFSC-SJ

1. Você recebe dinheiro por esse trabalho, emprego ou negócio?

◯ Sim ◯ Não

*** 2. Assinale os itens e as quantidades que você tem em sua casa:**

Assinale apenas aparelhos que vocês possuem, e que estejam funcionando.

	0	1	2	3	4 ou mais
Automóveis de passeio exclusivamente para uso particular	◯	◯	◯	◯	◯
Empregados mensalistas, considerando apenas os que trabalham pelo menos cinco dias por semana	◯	◯	◯	◯	◯
Maquina de lavar roupa, excluindo tanquinho	◯	◯	◯	◯	◯
Banheiros	◯	◯	◯	◯	◯

	0	1	2	3	4 ou mais
DVD, incluindo qualquer dispositivo que leia DVD e desconsiderando DVD de automóvel	◯	◯	◯	◯	◯
Geladeiras	◯	◯	◯	◯	◯
Freezers (aparelho independente/ geladeira duplex)	◯	◯	◯	◯	◯
Microcomputadores, considerando computadores de mesa, laptops, notebooks e netbooks e desconsiderando tablets, palms ou smartphones	◯	◯	◯	◯	◯
Lavadoura de louças	◯	◯	◯	◯	◯
Fornos Micro-ondas	◯	◯	◯	◯	◯
Motocicletas, desconsiderando as usadas exclusivamente para uso profissional	◯	◯	◯	◯	◯
Máquinas secadoras de roupa, considerando lava e seca	◯	◯	◯	◯	◯
Aparelhos televisores	◯	◯	◯	◯	◯
Videogame	◯	◯	◯	◯	◯
Tablet	◯	◯	◯	◯	◯

3. Se souber, informe o nome da sua rua e/ou CEP

* 4. A água no seu domicílio é proveniente de?

- ◯ Rede geral de distribuição
- ◯ Poço ou nascente
- ◯ Outro meio

* 5. Considerando o trecho da rua do seu domicílio, você diria que a rua é?

- ◯ Asfaltada/Pavimentada
- ◯ Terra/Cascalho

Estudo Longitudinal do Estilo de Vida de Adolescentes - IFSC-SJ

Parte 2: Atividades físicas

* 1. **Em uma semana habitual, você pratica alguma atividade física regularmente?** Considere atividade física qualquer atividade que te deixe cansado, aumente sua frequênica cardíaca e/ou deixe sua respiração ofegante. Exemplos são esportes como futebol, natação, atividades de deslocamento como andar de bicicleta para a escola, e/ou atividades recreativas como dançar.

- ◯ Sim
- ◯ Não

Estudo Longitudinal do Estilo de Vida de Adolescentes - IFSC-SJ

1. Em geral, quais atividades físicas listadas abaixo você pratica? Informe QUANTOS DIAS DA SEMANA e QUANTO TEMPO POR DIA você pratica essas atividades.

	Frequência (dias por semana, 0-7)	Duração, em minutos, de cada sessão desta atividade (exemplo: 45 minutos de voleibol)
Futebol		
Futsal		
Basquetebol		
Handebol		
Voleibol		
Tênis (de quadra)		
Tênis de mesa		
Natação		
Atletismo		
Lutas		
Capoeira		
Dança		
Ginástica Rítmica/Olímpica		
Ginástica de academia, ginástica aeróbia		
Musculação		
Andar de bicicleta		
Caminhar		
Correr/trotar		
Patins/skate		
Surfe/Bodyboard		
Brincadeira ativas		
Outras		

*** 2. Como você normalmente se desloca para ir para escola?**

- ◯ À pé
- ◯ De bicicleta
- ◯ De carro
- ◯ De moto
- ◯ De ônibus

3. Durante OS ÚLTIMOS 7 DIAS, em quantos dias você andou a pé ou de bicicleta no seu trajeto para a escola?

	0	1	2	3	4	5	6	7
Nos trajetos de **ida**	◯	◯	◯	◯	◯	◯	◯	◯
Nos trajetos de **volta**	◯	◯	◯	◯	◯	◯	◯	◯

4. Durante OS ÚLTIMOS 7 DIAS, em média, quanto tempo por dia você gastou para ir de casa para escola e voltar até a sua casa (some o tempo que você leva para ir e para voltar)?
Insira apenas números.

	Tempo em minutos
Tempo de ida	
Tempo de volta	

Estudo Longitudinal do Estilo de Vida de Adolescentes - IFSC-SJ

Parte 3: Comportamentos de tela e Alimentação

* 1. Em um dia de **semana normal**, quanto tempo você passa **estudando, vendo videoaulas, lendo, fazendo pesquisas ou trabalhos da escola** no computador, televisão, tablet, celular ou outro aparelho eletrônico?

Insira zero caso não faça estas atividades.
Exemplo: Estudo por uma hora e meia por dia (inserir 1 no campo horas, e 30 no campo minutos)

	Horas (0-23)	Minutos (0-50)
Em um dia de semana		
Em um dia de final de semana		

* 2. Em um dia de **semana normal**, quanto tempo você passa **realizando trabalhos relacionados a emprego ou estágio** no computador, televisão, tablet, celular ou outro aparelho eletrônico? (Caso não trabalhe responda zero horas e zero minutos)

	Horas (0-23)	Minutos (0-50)
Em um dia de semana		
Em um dia de final de semana		

* 3. Em um dia de **semana normal**, quanto tempo você passa **assistindo séries, filmes, novelas, jornais, esportes, programas ou outros vídeos** no computador, televisão, tablet, celular ou outro aparelho eletrônico?

Insira zero caso não faça estas atividades.
Exemplo: Assisto séries por uma hora e meia por dia (inserir 1 no campo horas, e 30 no campo minutos)

	Horas (0-23)	Minutos (0-59)
Em um dia de semana		
Em um dia de final de semana		

* **4. Em um dia de semana normal, quanto tempo você passa jogando jogos eletrônicos no videogame, computador, televisão, tablet, celular ou outro aparelho eletrônico?**

Insira e zero caso não faça estas atividades.
Exemplo: Jogo uma hora e meia de videogame por dia (inserir 1 no campo horas, e 30 no campo minutos)

	Horas (0-23)	Minutos (0-59)
Em um dia de semana		
Em um dia de final de semana		

* **5. Em um dia de semana normal, quanto tempo você passa utilizando mídias sociais como Facebook, Instagram, Twitter, Snapchat e aplicativos de conversa como Whatsapp, Telegram, Messenger no computador, celular, televisão, tablet ou outro aparelho eletrônico?**

Insira zero caso não faça estas atividades.
Exemplo: Passo uma hora e meia usando mídias sociais e falando com amigos em aplicativos por dia (inserir 1 no campo horas, e 30 no campo minutos)

	Horas (0-23)	Minutos (0-59)
Em um dia de semana		
Em um dia de final de semana		

* **6. Sua escola oferece comida (merenda escolar/almoço) aos alunos da sua turma? (Não considerar lanches/comida comprados na cantina)?**

◯ Sim ◯ Não ◯ Não sei

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*** 1. Você costuma comer a comida (merenda/almoço) oferecida pela escola? (Não considerar lanches/comida comprados na cantina)**

- ◯ Sim, todos os dias
- ◯ Sim, 1 a 2 dias por semana
- ◯ Sim, 3 a 4 dias por semana
- ◯ Raramente
- ◯ Não

*** 2. NOS ÚLTIMOS 7 DIAS, em quantos dias você comeu feijão?**

- ◯ Não comi feijão nos últimos 7 dias (0 dia)
- ◯ 1 dia nos últimos 7 dias
- ◯ 2 dias nos últimos 7 dias
- ◯ 3 dias nos últimos 7 dias
- ◯ 4 dias nos últimos 7 dias
- ◯ 5 dias nos últimos 7 dias
- ◯ 6 dias nos últimos 7 dias
- ◯ Todos os dias nos últimos 7 dias

*** 3. NOS ÚLTIMOS 7 DIAS, em quantos dias você comeu salgados fritos? Exemplo: batata frita (sem contar a batata de pacote) ou salgados fritos como coxinha de galinha, quibe frito, pastel frito, acarajé etc.**

- ◯ Não comi salgados fritos nos últimos 7 dias (0 dia)
- ◯ 1 dia nos últimos 7 dias
- ◯ 2 dias nos últimos 7 dias
- ◯ 3 dias nos últimos 7 dias
- ◯ 4 dias nos últimos 7 dias
- ◯ 5 dias nos últimos 7 dias
- ◯ 6 dias nos últimos 7 dias
- ◯ Todos os dias nos últimos 7 dias

* 4. **NOS ÚLTIMOS 7 DIAS, em quantos dias você comeu pelo menos um tipo de legume ou verdura? Exemplos: alface, abóbora, brócolis, cebola, cenoura, chuchu, couve, espinafre, pepino, tomate etc. Não inclua batata e aipim (mandioca/macaxeira).**

- ◯ Não comi nenhum tipo de legume ou verdura nos últimos 7 dias (0 dia)
- ◯ 1 dia nos últimos 7 dias
- ◯ 2 dias nos últimos 7 dias
- ◯ 3 dias nos últimos 7 dias
- ◯ 4 dias nos últimos 7 dias
- ◯ 5 dias nos últimos 7 dias
- ◯ 6 dias nos últimos 7 dias
- ◯ Todos os dias nos últimos 7 dias

* 5. **NOS ÚLTIMOS 7 DIAS, em quantos dias você comeu guloseimas (doces, balas, chocolates, chicletes, bombons ou pirulitos)?**

- ◯ Não comi guloseimas nos últimos 7 dias (0 dia)
- ◯ 1 dia nos últimos 7 dias
- ◯ 2 dias nos últimos 7 dias
- ◯ 3 dias nos últimos 7 dias
- ◯ 4 dias nos últimos 7 dias
- ◯ 5 dias nos últimos 7 dias
- ◯ 6 dias nos últimos 7 dias
- ◯ Todos os dias nos últimos 7 dias

* 6. **NOS ÚLTIMOS 7 DIAS, em quantos dias você comeu frutas frescas ou salada de frutas?**

- ◯ Não comi frutas frescas ou salada de frutas nos últimos 7 dias (0 dia)
- ◯ 1 dia nos últimos 7 dias
- ◯ 2 dias nos últimos 7 dias
- ◯ 3 dias nos últimos 7 dias
- ◯ 4 dias nos últimos 7 dias
- ◯ 5 dias nos últimos 7 dias
- ◯ 6 dias nos últimos 7 dias
- ◯ Todos os dias nos últimos 7 dias

*** 7. NOS ÚLTIMOS 7 DIAS, em quantos dias você tomou refrigerante?**

- ◯ Não tomei refrigerante nos últimos 7 dias (0 dia)
- ◯ 1 dia nos últimos 7 dias
- ◯ 2 dias nos últimos 7 dias
- ◯ 3 dias nos últimos 7 dias
- ◯ 4 dias nos últimos 7 dias
- ◯ 5 dias nos últimos 7 dias
- ◯ 6 dias nos últimos 7 dias
- ◯ Todos os dias nos últimos 7 dias

*** 8. NOS ÚLTIMOS 7 DIAS, em quantos dias você comeu alimentos industrializados/ ultraprocessados salgados, como hambúrguer, presunto, mortadela, salame, linguiça, salsicha, macarrão instantâneo, salgadinho de pacote, biscoitos salgados?**

- ◯ Não comi alimentos industrializados/ ultraprocessados salgados nos últimos 7 dias (0 dia)
- ◯ 1 dia nos últimos 7 dias
- ◯ 2 dias nos últimos 7 dias
- ◯ 3 dias nos últimos 7 dias
- ◯ 4 dias nos últimos 7 dias
- ◯ 5 dias nos últimos 7 dias
- ◯ 6 dias nos últimos 7 dias
- ◯ Todos os dias nos últimos 7 dias

*** 9. NOS ÚLTIMOS 7 DIAS, em quantos dias você comeu em restaurantes fast food, tais como lanchonetes, barracas de cachorro quentes, pizzaria etc.?**

- ◯ Não comi em restaurantes fast food nos últimos 7 dias (0 dia)
- ◯ 1 dia nos últimos 7 dias
- ◯ 2 dias nos últimos 7 dias
- ◯ 3 dias nos últimos 7 dias
- ◯ 4 dias nos últimos 7 dias
- ◯ 5 dias nos últimos 7 dias
- ◯ 6 dias nos últimos 7 dias
- ◯ Todos os dias nos últimos 7 dias

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Parte 4: Sono e comportamentos de risco

*** 1. Em relação à seus hábitos de sono responda:**

Exemplo:
Vou dormir as 22:30, insira 22 no campo Hora e 30 no campo minuto
Acordo 6:45, insira 6 no campo hora e 45 no campo minuto

	Hora (0-23)	Minuto (0-59)
Que horas você costuma ir dormir em dias de semana?		
Que horas você costuma acordar em dias de semana?		
Que horas você costuma ir dormir em finais de semana?		
Que horas você costuma acordar em finais de semana?		

*** 2. Questionário de Sonolência Diurna**

	Sempre	Frequentemente	Às vezes	Quase nunca	Nunca
Com qual frequência você dorme ou sente sono em sala de aula?	○	○	○	○	○
Com qual frequência você fica com sono ao fazer a lição de casa?	○	○	○	○	○
Você está atento/alerta na maior parte do dia?	○	○	○	○	○

	Sempre	Frequentemente	Às vezes	Quase nunca	Nunca
Com qual frequência você se sente cansado e mal humorado durante o dia?	◯	◯	◯	◯	◯
Com qual frequência você tem dificuldades para sair da cama de manhã?	◯	◯	◯	◯	◯
Com qual frequência você volta a dormir depois de acordar de manhã?	◯	◯	◯	◯	◯
Com qual frequência você precisa de alguém ou de auxílio de despertador para te acordar de manhã?	◯	◯	◯	◯	◯
Com que frequência você acha que precisa dormir mais?	◯	◯	◯	◯	◯

*** 3. Alguma vez na vida, você já fumou cigarro, mesmo uma ou duas tragadas?**

◯ Sim ◯ Não

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1. Que idade você tinha quando experimentou fumar cigarro pela primeira vez?

2. NOS ÚLTIMOS 30 DIAS, em quantos dias você fumou cigarros?

Assinale apenas um alternativa.

- ◯ Nenhum dia nos últimos 30 dias (0 dia)
- ◯ 1 ou 2 dias nos últimos 30 dias
- ◯ 3 a 5 dias nos últimos 30 dias
- ◯ 6 a 9 dias nos últimos 30 dias
- ◯ 10 a 19 dias nos últimos 30 dias
- ◯ 20 a 29 dias nos últimos 30 dias
- ◯ Todos os dias nos últimos 30 dias

*** 3. Algum de seus pais ou responsáveis fuma?**

Assinale apenas uma alternativa.

- ◯ Nenhum deles
- ◯ Só meu pai ou responsável do sexo masculino
- ◯ Só minha mãe ou responsável do sexo feminino
- ◯ Meu pai e minha mãe ou responsáveis
- ◯ Não sei

*** 4. NOS ÚLTIMOS 7 DIAS, em quantos dias pessoas fumaram na sua presença?**

Assinale apenas uma alternativa.

- ◯ Nenhum dia nos últimos 7 dias (0 dia)
- ◯ 1 ou 2 dias nos últimos 7 dias
- ◯ 3 ou 4 dias nos últimos 7 dias
- ◯ 5 ou 6 dias nos últimos 7 dias
- ◯ Todos os 7 dias

*** 5. Alguma vez na vida você tomou uma dose de bebida alcoólica (uma dose equivale a uma lata de cerveja ou uma taça de vinho ou uma dose de cachaça ou uísque etc.)?**

- ◯ Sim
- ◯ Não

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1. Que idade você tinha quando tomou a primeira dose de bebida alcoólica (uma dose equivale a uma lata de cerveja ou uma taça de vinho ou uma dose de cachaça ou uísque etc.)?

2. NOS ÚLTIMOS 30 DIAS, em quantos dias você tomou pelo menos um copo ou uma dose de bebida alcoólica (uma dose equivale a uma lata de cerveja ou uma taça de vinho ou uma dose de cachaça ou uísque etc.)?

Assinale apenas um alternativa.

- ◯ Nenhum dia nos últimos 30 dias (0 dia)
- ◯ 1 ou 2 dias nos últimos 30 dias
- ◯ 3 a 5 dias nos últimos 30 dias
- ◯ 6 a 9 dias nos últimos 30 dias
- ◯ 10 a 19 dias nos últimos 30 dias
- ◯ 20 a 29 dias nos últimos 30 dias
- ◯ Todos os dias nos últimos 30 dias

3. NOS ÚLTIMOS 30 DIAS, nos dias em que você tomou alguma bebida alcoólica, quantos copos ou doses você tomou por dia?

Assinale apenas um alternativa.

- ◯ Não tomei bebida alcoólica nos últimos 30 dias (0 dia)
- ◯ Menos de um copo ou dose nos últimos 30 dias
- ◯ 1 copo ou 1 doses nos últimos 30 dias
- ◯ 2 copos ou 2 doses nos últimos 30 dias
- ◯ 3 copos ou 3 doses nos últimos 30 dias
- ◯ 4 copos ou 4 doses nos últimos 30 dias
- ◯ 5 copos ou mais ou 5 doses ou mais nos últimos 30 dias

4. Na sua vida, quantas vezes você bebeu tanto que ficou realmente bêbado(a)?

Assinale apenas uma alternativa.

- ◯ Nenhuma vez na vida (0 vez)
- ◯ 1 ou 2 vezes na vida
- ◯ 3 a 5 vezes na vida
- ◯ 6 a 9 vezes na vida
- ◯ 10 ou mais vezes na vida

5. Na sua vida, quantas vezes você teve problemas com sua família ou amigos, perdeu aulas ou brigou por que tinha bebido?

Assinale apenas uma alternativa.

- ◯ Nenhuma vez na vida (0 vez)
- ◯ 1 ou 2 vezes na vida
- ◯ 3 a 5 vezes na vida
- ◯ 6 a 9 vezes na vida
- ◯ 10 ou mais vezes na vida

6. Quantos amigos seus consomem bebida alcoólica?

Assinale apenas uma alternativa.

- ◯ Nenhum
- ◯ Poucos
- ◯ Alguns
- ◯ A maioria
- ◯ Todos
- ◯ Não sei

7. Alguma vez na vida, você já usou alguma droga como: maconha, cocaína, crack, cola, loló, lança-perfume, ecstasy, oxy etc.?

- ◯ Sim
- ◯ Não

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Parte 5: Qualidade de vida e relação com colegas

1. Que idade você tinha quando usou alguma droga como: maconha, cocaína, crack, cola, loló, lança-perfume, ecstasy, oxy ou outra pela primeira vez?

*** 2. Segue abaixo uma lista de tipos de sentimentos e comportamentos. Solicitamos que você assinale a frequência com que tenha se sentido desta maneira durante a semana passada.**

	Raramente ou Nunca (menos que 1 dia)	Durante pouco ou algum tempo (1 ou 2 dias)	Ocasionalmente ou durante um tempo moderado (3 a 4 dias)	Durante a maior parte do tempo ou todo o tempo (5 a 7 dias)
Senti-me incomodado com coisas que habitualmente não me incomodam.	○	○	○	○
Não tive vontade de comer; tive pouco apetite.	○	○	○	○
Senti não conseguir melhorar meu estado de ânimo mesmo com a ajuda de familiares e amigos.	○	○	○	○
Senti-me,comparando-me às outras pessoas, tendo tanto valor quanto a maioria delas.	○	○	○	○
Senti dificuldade em me concentrar no que estava fazendo.	○	○	○	○
Senti-me deprimido.	○	○	○	○

	Raramente ou Nunca (menos que 1 dia)	Durante pouco ou algum tempo (1 ou 2 dias)	Ocasionalmente ou durante um tempo moderado (3 a 4 dias)	Durante a maior parte do tempo ou todo o tempo (5 a 7 dias)
Senti que tive que fazer esforço para dar conta das minhas tarefas habituais.	○	○	○	○
Senti-me otimista com relação ao futuro.	○	○	○	○
Considerei que minha vida tinha sido um fracasso.	○	○	○	○
Senti-me amedrontado.	○	○	○	○
Meu sono não foi repousante.	○	○	○	○
Estive feliz.	○	○	○	○
Falei menos que o habitual.	○	○	○	○
Senti-me sozinho.	○	○	○	○
As pessoas não foram amistosas comigo.	○	○	○	○
Aproveitei minha vida.	○	○	○	○
Tive crises de choro.	○	○	○	○
Senti-me triste.	○	○	○	○
Senti que as pessoas não gostavam de mim.	○	○	○	○
Nào consegui levar adiante minhas coisas.	○	○	○	○

*** 3. Pense NA ÚLTIMA SEMANA, você:**

	Nada	Pouco	Moderadamente	Muito	Extremamente
Você se sentiu com muita energia/disposição?	◯	◯	◯	◯	◯
Você se sentiu triste?	◯	◯	◯	◯	◯
Você se sentiu sozinho?	◯	◯	◯	◯	◯
Você teve tempo suficiente para você mesmo?	◯	◯	◯	◯	◯
Você fez o que gosta de fazer no seu tempo livre?	◯	◯	◯	◯	◯
Seus pais trataram você de forma justa?	◯	◯	◯	◯	◯
Você se divertiu com seus amigos/as?	◯	◯	◯	◯	◯
Você teve uma boa relação com seus professores?	◯	◯	◯	◯	◯

*** 4. Pensando sobre a semana passada...**
Você se sentiu bem e em boa forma física?

◯ Nada
◯ Pouco
◯ Moderadamente
◯ Muito
◯ Totalmente

*** 5. Pensando sobre a semana passada...**
Você foi bom/boa aluno/a na escola?

☐ Nada
☐ Pouco
☐ Moderadamente
☐ Muito
☐ Totalmente

* **6. NOS ÚLTIMOS 30 DIAS, com que frequência os colegas de sua escola trataram você bem e/ou foram prestativos contigo?**

- ◯ Nunca
- ◯ Raramente
- ◯ Às vezes
- ◯ Na maior parte do tempo
- ◯ Sempre

* **7. NOS ÚLTIMOS 30 DIAS, com que frequência algum dos seus colegas de escola te esculacharam, zoaram, mangaram, intimidaram ou caçoaram tanto que você ficou magoado, incomodado, aborrecido, ofendido ou humilhado?**

- ◯ Nunca
- ◯ Raramente
- ◯ Às vezes
- ◯ Na maior parte do tempo
- ◯ Sempre

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1. NOS ÚLTIMOS 30 DIAS, qual o motivo/causa de seus colegas terem te esculachado, zombado, zoado, caçoado, mangado, intimidado ou humilhado?

- ◯ A minha cor ou raça
- ◯ A minha religião
- ◯ A aparência do meu rosto
- ◯ A aparência do meu corpo
- ◯ A minha orientação sexual
- ◯ A minha região de origem
- ◯ Outros motivos/causas

* 2. **NOS ÚLTIMOS 30 DIAS, você esculachou, zombou, mangou, intimidou ou caçoou algum de seus colegas da escola tanto que ele ficou magoado, aborrecido, ofendido ou humilhado?**

◯ Sim

◯ Não

3. **Você já sofreu bullying?**

Assinale apenas uma alternativa.

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Obrigado pela sua participação!

Sua participação neste estudo é muito importante para nós. Mais informações sobre o projeto podem ser encontradas no endereço eletrônico **www.elevasc.wordpress.com**
Caso tenha dúvidas, críticas e/ou sugestões, pode entrar em contato no e-mail **projetoeleva@gmail.com**

1. **Caso queira receber resultados da pequisa, deixe seu e-mail no campo abaixo**

Source: Prepared by the author (2019).

APPENDIX F. Submission of article 1 to Applied Physiology, Nutrition, and Metabolism

Applied Physiology, Nutrition, and Metabolism

Applied Physiology, Nutrition, and Metal

Association between sociodemographic, dietary, and substance use factors and accelerometer-measured 24-hour movement behaviors in a sample of Brazilian adolescents

Journal:	*Applied Physiology, Nutrition, and Metabolism*
Manuscript ID	apnm-2020-0839
Manuscript Type:	Article
Date Submitted by the Author:	23-Sep-2020
Complete List of Authors:	da Costa, Bruno; Universidade Federal de Santa Catarina, Centro de Desportos Chaput, Jean-Philippe; Children's Hospital of Eastern Ontario Research Institute Lopes, Marcus ; Universidade Federal de Santa Catarina Gaya, Anelise; Universidade Federal do Rio Grande do Sul Silva, Diego Augusto Santos; Universidade Federal de Santa Catarina Silva, Kelly; Universidade Federal de Santa Catarina
Novelty bullets: points that summarize the key findings in the work:	• A typical day of a high school student is composed by 30.5% sleep, 47.6% sedentary behavior, 19.5% LPA, and 2.4% MVPA, • Unprocessed food was associated with LPA, and processed food was unfavorably associated with sedentary behavior and MVPA;, Family structure, SES, alcohol use, tobacco use, and drug experimentation are not related to the 24-hour movement behaviors
Keyword:	physical activity < exercise, sedentary behavior, sleep, public health, accelerometry, adolescent
Is the invited manuscript for consideration in a Special Issue? :	Not applicable (regular submission)

Appendix G. Submission of Article 2 to Public Health

Elsevier Editorial System(tm) for Public Health

Manuscript Draft

Manuscript Number:

Title: Association between screen time and accelerometer-measured 24-hour movement behaviors in a sample of Brazilian adolescents

Article Type: Original Research

Keywords: physical activity, sleep, sedentary behavior, public health, youth

Corresponding Author: Mr. Bruno Gonçalves Galdino da Costa, M.D.

Corresponding Author's Institution: Federal University of Santa Catarina

First Author: Bruno Gonçalves Galdino da Costa, M.D.

Order of Authors: Bruno Gonçalves Galdino da Costa, M.D.; Jean-Philippe Chaput, PhD; Marcus Vinicius V Lopes, MSc; Luis Eduardo A Malheiros, BPe; Inácio Crochemore-Silva, Phd; Kelly S Silva, PhD

Abstract: Objectives
Different screen time activities may be related to sleep, physical activity, and sedentary behavior. The objective was to examine the association between self-reported screen time activities and accelerometer-measured 24-hour movement behaviors.
Study design
Cross-sectional.
Methods

Appendix H. Submission of Article 3 to the Journal of Sports Sciences

Journal of Sports Sciences

Associations between sociodemographic, dietary, and substance use factors with self-reported 24-hour movement behaviors in a sample of Brazilian adolescents

--Manuscript Draft--

Full Title:	Associations between sociodemographic, dietary, and substance use factors with self-reported 24-hour movement behaviors in a sample of Brazilian adolescents
Manuscript Number:	RJSP-2020-2295
Article Type:	Original Manuscript
Keywords:	physical activity, sedentary behavior, sleep, public health, 24-hour movement behaviors
Abstract:	We aimed to identify sociodemographic, dietary, and substance use factors associated with self-reported sleep duration, physical activity (PA), and sedentary behavior (SB) indicators in a sample of Brazilian adolescents. Adolescents (n=731, 51% female, mean age: 16.4 years) answered a questionnaire. The volume of total PA, sports, non-sports, total SB, leisure-time SB, involuntary SB, sleep duration, dietary behaviors, sociodemographic, and substance use indicators were self-reported. Multilevel linear models were fit. Females engaged in less total PA, sports, total SB, and leisure-time SB, but in more involuntary SB than males. Age was positively associated with non-sports and involuntary SB. Socioeconomic status was positively associated with total PA. Adolescents who lived with the mother only practiced more sports compared to those living with two parents. Unprocessed food was positively associated with total PA and sports. Processed food was inversely associated with total PA and non-sports and positively associated with total SB and leisure-time SB. Alcohol use was positively associated with total PA, and tobacco smoking was negatively associated with total PA. No associations were observed for sleep duration. In conclusion, sociodemographic, dietary, and substance use factors are associated with the 24-hour movement behaviors among Brazilian adolescents, and some associations are type-specific.
Order of Authors:	Bruno Gonçalves Galdino da Costa, MsC
	Jean-Philippe Chaput, PhD
	Marcus Vinicius Veber Lopes, MSc
	Luis Eduardo Argenta Malheiros, BPe
	Kelly Samara Silva, PhD

Appendix I. First page of Article 4, published at PLOS ONE.

PLOS ONE

RESEARCH ARTICLE

Prevalence and sociodemographic factors associated with meeting the 24-hour movement guidelines in a sample of Brazilian adolescents

Bruno G. G. da Costa[1]*, Jean-Philippe Chaput[2], Marcus V. V. Lopes[1], Luis E. A. Malheiros[1], Mark S. Tremblay[2], Kelly S. Silva[1]

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OPEN ACCESS

Citation: da Costa BGG, Chaput J-P, Lopes MVV, Malheiros LEA, Tremblay MS, Silva KS (2020) Prevalence and sociodemographic factors

Abstract

Background

The present cross-sectional study aimed to determine the proportion of adolescents meeting the 24-hour movement guidelines, and investigate sociodemographic factors associated with meeting them