

## Physical exercise and sedentary lifestyle: health consequences

### Ejercicio físico y estilo de vida sedentario: consecuencias para la salud

Diogo Monteiro<sup>1, 2</sup>, Sergio Machado<sup>3</sup>, João Moutão<sup>1,2</sup>, Teresa Bento<sup>1,2</sup>, Anabela Vitorino<sup>1</sup>, Susana Alves<sup>1,4</sup>, Filipe Rodrigues<sup>1,5</sup>, João Lucas Maciel de Lima<sup>3</sup>, Diogo Teixeira<sup>6</sup>, Eric Murillo- Rodriguez<sup>7</sup>, y Luis Cid<sup>1,2</sup>

<sup>1</sup>Escola Superior de Desporto de Rio Maior (ESDRM – IPSantarém), Portugal; <sup>2</sup>Research Center in Sports Science, Health Sciences and Human Development (CIDESD), Portugal; <sup>3</sup>Universidade Salgado de Oliveira, Brasil; <sup>4</sup>Centro de Investigação em Qualidade de Vida (CIEQV), Portugal; <sup>5</sup>Universidade da Beira Interior (UBI), Portugal; <sup>6</sup>Universidade Lusófona de Humanidades e Tecnologia (ULHT), Portugal; <sup>7</sup>Universidad Anahuac Mayab, México

#### Abstract

Perhaps the greatest barriers for achieving major advances in public health in the twenty-first century result from the paralysis of the pandemic paradigm or from the widespread inability to envision alternative or new models of thought. Human movement represents a complex behavior that is influenced by personal motivation, health and mobility problems, genetic factors, and social and physical environments in which people live. These factors influence the propensity to engage in sedentary behaviors or in physical activity. However, the biological, social, and environmental pathways leading to sedentary behavior versus physical activity may be different. In addition, the health effects associated with sedentary behavior and physical activity may be the result of different biological mechanisms. Thus, our objective was to discuss the importance of physical exercise on health-related outcomes and the consequences of sedentary lifestyles. Research on sedentary behavior has been growing; however, the evidence for its determinants is relatively sparse. More studies are needed to obtain more conclusive results, because it is fundamental to understand these complex relationships related to the practice and the acquisition of active and healthy lifestyles as opposed to a sedentary lifestyle.

**Keywords:** Physical activity, active lifestyle, sedentary behavior.

#### Resumen

Tal vez las mayores barreras para alcanzar grandes avances en la salud pública en el siglo XXI resulten de la parálisis del paradigma de la pandemia o de la incapacidad generalizada de pensar en modelos alternativos o nuevos de pensamiento. El movimiento humano representa un comportamiento complejo que es influenciado por la motivación personal, los problemas de salud y movilidad, los factores genéticos y los ambientes sociales y físicos en los que las personas viven. Estos factores ejercen una influencia sobre la propensión de involucrarse en comportamientos sedentarios, así como en la actividad física. Sin embargo, las vías biológicas, sociales y ambientales que conducen al comportamiento sedentario frente a la actividad física pueden ser diferentes. Además, los efectos en la salud asociados al comportamiento sedentario ya la actividad física puede ser el resultado de diferentes mecanismos biológicos. Así, nuestro objetivo fue discutir la importancia del ejercicio físico para la salud y las consecuencias de un estilo de vida sedentario. Las investigaciones sobre el comportamiento sedentario vienen creciendo; sin embargo, la evidencia para sus determinantes es relativamente escasa. Más estudios son necesarios para obtener resultados más concluyentes, pues es fundamental entender esas complejas relaciones relacionadas con la práctica y la adquisición de estilos de vida activos y saludables en contraposición a un estilo de vida sedentario.

**Palabras clave:** actividad física, estilo de vida activo, comportamiento sedentario.

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Correspondencia: Diogo Monteiro, Escola Superior de Desporto de Rio Maior (ESDRM – IPSantarém), (Portugal); E-mail: [diogomonteiro@esdrm.ipsantarem](mailto:diogomonteiro@esdrm.ipsantarem)

## Introduction

Perhaps the greatest barriers for achieving major advances in public health in the twenty-first century result from the paralysis of the pandemic paradigm or from the widespread inability to envision alternative or new models of thought. A potential example of this phenomenon could be the continued focus on moderate and vigorous physical activity as the dominant aspect related to the health of human movement. The current model of physical activity and health is well supported by over 60 years of scientific research, and the beneficial effects of moderate to vigorous physical activity have been defined more clearly in recent years (Bouchard, 2001). However, if we are compliant with the existing paradigm - that increasing levels of moderate and vigorous levels of physical activity could result in greater improvements in public health - then we may not get the total return on investment in relation to improving quality of life and expectation of life through human movement patterns. Emerging evidence on the role of sedentary behavior in health, which can be independent of physical activity per se, puts us at a crossroads in regard to the prescription of daily ideal human movement patterns for health.

Human movement represents a complex behavior that is influenced by personal motivation, health and mobility problems, genetic factors, and the social and physical environments in which people live. These factors undoubtedly exert an influence on the propensity to engage in sedentary behaviors as well as on physical activity. However, the biological, social, and environmental pathways leading to sedentary behaviors versus physical activity may be different. In addition, the health effects associated with sedentary behaviors and physical activity may be the result of different biological mechanisms (Hamilton et al., 2007). Thus, the objective of the present study is to discuss the importance of physical exercise for health and the consequences of a sedentary lifestyle.

To carry out this narrative review several online databases were consulted that group a great amount of work. A search was performed and ended in December 2018. Articles with the terms "physical activity; physical exercise; sedentary lifestyle; and, health consequences" were searched in the databases of PubMed and Web of Science. These terms were searched in the "title", "key-words" and "summary" search fields of each database. Within this context, articles that discuss the importance of physical exercise for health, consequences of a sedentary lifestyle, and new possible hypotheses for future studies on the subject were selected. Only articles in English and focused on these subjects were included.

## Development

Several evidences indicate that an active lifestyle helps to preserve and maintain functional capacity and independent living in older adults (Buchner et al., 1992). Despite these well-known benefits of exercise, only one-fifth of adults in the US engage in regular, sustained, and vigorous exercise practices, and these data have not increased since the mid-1980s (Centers for Disease Control and Prevention, 1996). Therefore, understanding the causes of sedentary behavior can help the development of effective physical exercise programs on increasing the number of inactive or inadequately active people to meet exercise recommendations of 150 minutes or more at moderate intensity, or 75 minutes of vigorous intensity exercise, if possible every other week (Centers for Disease Control and Prevention, 1996; Pate et al., 1995). In this review, several studies were found discussing different points about the relationship between physical exercise and sedentary lifestyle; both important to better understand this complex issue. These studies deal with the changes in contemporary society and their implications in the people's lifestyle, the impact of sedentary behaviors and its prevalence on population, the potential adverse effects of sedentary behaviors and an ecological model of the sedentary behaviors, and a synthesis of studies about sedentary behaviors in different age groups.

## Discussion

The objective of this review was to discuss the importance of physical exercise on health-related outcomes and the consequences of sedentary lifestyles. Thus, due to the complexity of this issue, discussion was split into five sections.

### Changes in contemporary society and their implications in the lifestyle of populations

In contemporary society, the development of people's knowledge and the advancement of technology have radically transformed people's daily lives. Nowadays, communication and information technologies, as well as the equipment that saves us work, are now present in several sectors of society. Thus, this transformation has reduced substantially physical requirements, and consequently, energy expenditure. These changes that have taken place in workplaces, in displacements, in domestic tasks, in occupations, and in leisure periods are also relatable to a more comfortable, sedentary and consequently less active lifestyle, leading to a decrease in metabolic expenditure (Klain et al. 2015). An example of this change is the decrease in the percentage of people with physically demanding active jobs, which has declined substantially over the past five decades, and consequently, increased the number of workers in services where people spend most of their time sitting (Church et al., 2011).

For adults, this change is reflected in the amount of time spend sitting or in sedentary behaviors engagement (e.g. watching television, being in front of the PC, etc.) (Thorp et al., 2011). Most adults work in places where they are forced to sit continuously for a large part of the day. In this sense, it is important to realize the potential adverse effects of sedentary health behaviors (Maher et al., 2014).

### Sedentary behaviors

According to the systematic review by Thorp et al. (2011), considering longitudinal studies between 1996 and 2011, the most common sedentary behaviors were the time spent sitting, and behaviors that involved watching television (TV) or other screens. Pate et al. (2011) identified that some of these more relevant sedentary behaviors include watching television, computer use to play videogames or to “surf” the internet, desktop work, and seated socializing time. These behaviors have as nuclear characteristic, the fact that the individual remains seated and physically inactive.

It is important to note here that sedentary behavior should not be understood or confused with non-compliance with physical activity recommendations (Pate et al., 2011). That is, a subject can meet recommendations of moderate and vigorous physical activity and still remain a large part of his day in sedentary activities (Pate et al., 2008). Sedentary behavior is thus, a term used today to characterize low energy expenditure behaviors, including prolonged sitting in traffic, at work, at home, and at leisure (Owen et al., 2009).

It should also be noted that some studies in the field of physiology (Owen et al., 2011) have indicated that standing may not have the same negative metabolic effects as sitting because it involves large muscles of the lower body, indicating some degree of energy expenditure. Hence, more studies are needed to better define the boundaries of sedentary behavior, that is, sitting, but moving the arms or swinging the legs is enough to mitigate the negative effects of just sitting. Owen et al. (2009) emphasizes that sedentary behaviors are an important new predictor of chronic disease and that researchers should pay more attention to sedentary lifestyle as it represents the fourth largest worldwide mortality risk (6%), and the fifth largest disability precursor in the post-industrialized world (Owen et al., 2011).

### Most common sedentary behaviors and their prevalence in the population

In this way, it is crucial to identify the most common sedentary behaviors and to understand what leads individuals to adopt this type of behavior, in order to counteract the tendency that has been registered and to intervene in order to promote changes in the people's lifestyles. In a study conducted by Colley et al. (2011) in Canada, the authors concluded that children and adolescents spend on average 8.6 hours per day, or 62% of the time they are awake in sedentary behaviors (e.g., watching television,

playing computer and video games). Similar results were also recorded in the United States (Matthews et al., 2008; Norman et al., 2005), in which children and young people aged 8-18 years spend on average five hours a day on sedentary behavior (sitting and/or watching television). Likewise, in Europe a large percentage of children and young people spend most of their time (about 8 hours a day) on sedentary behaviors, such as watching television and playing computer (Verloigne et al., 2012).

In another study conducted by Lepp et al. (2013) analyzing the relationship between mobile phone use, physical activity, sedentary lifestyle, and cardiorespiratory fitness in a sample of university students from the United States, have shown that high levels of mobile phone usage indicate an extremely broad pattern of sedentary behavior (e.g. watching TV).

These studies indicate that nearly one third of the young population in developed countries watches television more than four hours a day (Gorely et al., 2009), that is, double the limit recommended by several professional health organizations, such as the Academy American Association of Pediatricians and the Canadian Pediatric Society, who advise children to spend no more than two hours a day in sedentary activities, such as screen time (Tremblay et al., 2011). Pate et al. (2011) also add that there is strong evidence for children to adopt more and more sedentary behaviors as they age.

### **Potential adverse effects of sedentary behaviors**

In a systematic review by Tremblay et al. (2011), which included 232 studies on sedentary behavior and six health indicators (i.e., body composition, fitness, metabolic syndromes and cardiovascular diseases, and self-esteem) it was found that sedentary behaviors, assessed mainly by the number of hours of television, are associated with an unfavorable body composition, a reduction in physical fitness, a decrease in self-esteem and of social behavior, in children and young people aged between 5 and 17 years. These evidences indicate that excess television viewing (higher than the 2h per day limit)) is linked to physical and psychosocial health reduction. This issue is of particular relevance since children and young people nowadays have easy access to sedentary behaviors, such as playing computer games, Internet surfing to access social networks, and telephone use (Gorely et al., 2009). In terms of sedentary behavior, the systematic review by Rhodes et al. (2012) points out "watching television" as the most frequent behavior among adults.

All of these studies evidence that a large population is sedentary or does not meet recommendations for physical activity based on the American College of Sports Medicine (ACSM) and the American Heart Association (AHA) guidelines (Haskell et al., 2007). However, it is important to note that, although it is known that physical activity is extremely beneficial, a lifestyle that is not active, characterized by the adoption of sedentary behaviors (e.g., being on the computer and watching television) has negative repercussions on health, independently of physical activity.

This has been shown in several studies where, regardless of physical activity levels, sedentary behaviors are associated with an increase in cardio-metabolic diseases, all causes of death and a variety of physiological and psychological problems (Thorp et al., 2011; Owen et al., 2011; Sisson et al., 2009). To this end, it is extremely pertinent to build strong evidence-based approaches to address sedentary behaviors, and research to develop high-quality measures to understand the personal, social, and environmental factors that influence sedentary behaviors and consequently to test relevant interventions (Owen et al., 2011).

### **Ecological model of the sedentary behaviors and synthesis of studies with sedentary behaviors in different age groups**

According to Owen et al. (2011), the ecological model assumes great importance to explain the determinants of sedentary behavior. Sallis et al. (2008) point out that an ecological approach to understanding influences on behavior assumes different levels of influence, including individual, social, and organizational/community, environmental, and political. Of particular importance is to understand the configuration of behavior, that is, the physical and social context in which it occurs (Barker, 1968). Within the generic class of behaviors, which can be described as sedentary, there are specific sedentary behaviors that commonly occur in a variety of settings: watching television, other leisure behaviors involving screens (e.g., computer and TV), in domestic settings, jobs that require



prolonged sitting time (which are based on increased computer use), prolonged time in transport, especially in car. Time spent in these behaviors is likely to lead to distinct determinants, shaping the attributes of the settings in which they occur and the social framework around these same configurations (Sallis, 2008; Owen et al., 2000).

Associations between environmental attributes and specific domains of physical activity (transport, recreation, occupation) are supported by theoretical and empirical evidence, hence, the same principle should be applied to sedentary behavior (Sallis, 2008; Saelens et al., 2008). In this way it becomes crucial to understand the correlations of sedentary behaviors, which occur in specific contexts, in order to develop more effective interventions. However, understanding the factors related to high levels of total sedentary behaviors requires attention and research, as it could help target interventions for high-risk subgroups (Owen et al., 2011). For example, a person who lives in a developed residence to a person who lives in an older neighborhood, experience daily different behavioral patterns. For example, suburban residents are more likely to spend longer periods of time driving (to get to work, to get home, travelling with family, to run errands), while an urban resident usually has more options, including walking or cycling. In addition, where there are fewer outdoor areas and parks, within walking distance, there is a greater likelihood of spending more time at home and watching television (Sugiyama et al., 2007).

The ecological model of sedentary behavior encompasses multiple factors relevant to most age groups. Many influences lead to sedentary behaviors which are propitious to operate in the same way for children, adolescents, youth, adults, and the elderly. On the other hand, other influences may be different for these age groups: for example, school-based initiatives (e.g. ease of walking in the neighborhood, bicycle infrastructure, physical education programs, and programs that allow students to walk school) can positively affect children, parents, and other adults in the local neighborhood; other factors, such as reduced sitting time in physical education practice, may affect children in particular (Salmon et al., 2011).

Environmental and transport infrastructures of communities are not the only factors that act as determinants of sedentary behaviors. The motivations and preferences of individuals, their families, broad social circumstances, the normative climate of the neighborhood, social networks, available material resources, and many other factors are also important elements that can influence the choices of sedentary behavior. For example, there is a strong social norm for people to sit in meetings, classes, theaters, and at home when they relax. These norms are also established by environmental stimuli, such as the provision of chairs and by policies such as example standing prohibition in a classroom or theatre, (Owen et al., 2011). According to several reviews (Owen et al., 2004; Trost et al., 2002) there is a plausible case that it is not feasible to identify factors generally related to behaviors encompassing the exercising or being physically active. On the contrary, the major focus of research now focuses on specific behaviors of physical activity in particular contexts: walking for recreation, exercising in green places, walking for transportation (Owen et al., 2004; Giles-Corti et al., 2005). Thus, it is believed that this specific behavioral principle also serves as the basis for research on sedentary behavior (Sallis et al., 2008). Thus, by employing a specific behavioral perspective, ecological models of health behavior propose several levels of influence on specific settings that may influence specific behaviors (Sallis et al., 2008; Trost et al., 2002). Barker (2000) points out that the central feature of ecological models focuses on behavioral configurations, emphasizing in this way the influence of specific contexts where behaviors emerge, that is, the construction that is at the core of ecological models refers to the fact that people are only a component of the general behavioral system, which restricts the attainment of certain behaviors by promoting and demanding certain actions, discouraging and forbidding others (Wicker, 1979).

For Owen et al. (2011) sedentary behaviors can be strongly influenced by environmental attributes in specific contexts (e.g. time spent at home in the bedroom, screen behaviors, workplaces with tables and chairs only, use of transport for work because of the lack of public transport). Given these conditions, total sitting time may be the most viable option, as opportunities to stand are limited by the environmental context. The most extreme example is the long time spent in automobiles, where sitting is the only option available to thousands of individuals. However, research related to sedentary

behavior is still at an early stage, with most of the available information focusing on sitting down to watch television. However, the psychosocial variables reported in relation to physical activity were not correlated with TV time (Williams et al., 1999). The attributes of the built environment were examined as correlates of sedentary behavior. For example, watching TV was associated with low levels of good target areas (poorly connected streets, low residual density, limited used land diversity, and large parking lots for retail access) in a study in Adelaide. Australian women living in areas where there is not much to walk showed significantly more daily minutes watching TV. Research focused on specific sedentary behaviors in particular contexts is needed to better understand the correlations between car sitting time and premature mortality in the light of recent evidence of this relationship. Studies on transportation and urban planning in the United States already show relevant findings, although their focus is mainly on the kilometers made and not the time spent. More kilometers traveled were associated with people living in the suburbs in contrast to traditional neighborhoods and where they can walk, with limited traffic availability and low population density. Another study in the USA showed that time spent on cars is negatively associated with ease-of-floor components such as higher levels of mix of land use, connectivity, and residential density (Owen et al., 2011). To further enhance the earlier claim, Frank et al. (2007) studied the associations of attributes of the built environment, neighborhood travel preferences, physical activity, and automobiles with obesity. Car use among those who preferred and lived in areas with greater ease of walking was lower (26 miles per day, on average) compared to those who preferred and lived in areas that depended on cars (43 miles per day), which suggests a potentially important contribution of sedentary time to the relationship between the built environment and obesity. Still, the studies discussed here were conducted in the US, where car use prevails to travel daily and go shopping. It is necessary to investigate other countries to identify correlations between the time spent in automobiles in different social environments and situations (Owen et al., 2011). A study by Van Dyck et al. (2010), aimed at studying the associations between walking facilities in the neighborhood and the time of sedentary in Belgian adults, has given rise to intriguing findings, as far as possible in which neighborhoods with a high ease of walking were related to higher amounts of self-reports of total seated time and objectively observed sedentary time. In contrast to the Australian results mentioned above. In this Belgian example, residents in areas with a high ease of walking reported significantly more sitting time than residents of areas with less facility to walk (472 vs 418 minutes on weekdays, 440 vs 403 minutes on weekends). Living in a walkable area was also associated with more sedentary time. Remarkably, the Belgian discoveries were made with self-reports of total sitting time. The Belgian findings contrast with what would be predicted from the US and Australian studies. Research from several countries suggests that the attributes of the built environment can influence behavior differently in dense and compact European cities, and also point to potential social and cultural differences that require further investigation. However, Bauman et al. (2011), in a study analyzing the sitting epidemiology, comparing 20 countries through the use of the international physical activity questionnaire, contrasts to a certain extent, the Belgian data. Insofar, in the 20 countries examined, they show some differences in the prevalence and gender variations in total time seated.. Although the authors have some reservations not to speculate, their conclusions suggest that there may be merit in examining correlations of sedentary behavior in countries that have different built environments, transport infrastructures, and social and cultural attributes.

On the other hand, in another study by Isasi et al. (2013) on the association of the regulation of emotions with lifestyle behaviors in city center adolescents, the authors have drawn important conclusions: self-regulation are emerging as important influences on dietary choices and the risk of obesity in young people. Previous studies indicate that children with greater exercise capacity are more likely to adopt healthy behaviors. Deficits in self-control characteristics, such as the need for immediate gratification or high impulsivity, are associated with greater risks of obesity and unhealthy behaviors. Findings of this study suggest that emotional regulation plays a crucial role in healthy lifestyles. Adolescents with better ability to regulate their emotions show higher levels of self-efficacy and healthier behaviors (greater consumption of fruit and vegetables, and more physical activity). Among girls, less ability to regulate emotions was associated with higher levels of depressive symptoms, which in turn is associated with decreased levels of healthy lifestyles (higher consumption of unhealthy food and sedentary

behaviors). On the other hand, a deficit in the regulation of emotions may be associated with an increased vulnerability in depression, and individuals may use food to deal with negative emotions, or adopt sedentary behaviors (such as watching television) as a way to experience some type of comfort. Findings in this article support these results, but only for girls. According to Blissett et al. (2010), another potential explanation for the role of regulating emotion in food consumption is that children have learned to use food as a strategy for regulating emotions very early when parents used candy as a way of manipulating children's behavior. Wills et al. (2013) add that better regulation of emotions can increase general feelings of efficacy, which can lead to healthier behaviors. In conclusion, this study shows that the ability to regulate emotions is inversely related to unhealthy behaviors. Obesity prevention interventions may have to use emotion-related processes for best results.

Based on the statement by Blissett et al. (2010) regarding the influence of parents in manipulating children's behavior, Gustafson and Rhodes (2006) affirmed that parental influence can facilitate or prevent behavior such as playing actively or watch TV. Levine (2007) reinforce that parents have a critical role in adolescents in terms of physical activity and sedentary behaviors. In a study carried out by Jago et al. (2010) in the United Kingdom with children between 10 and 11 years of age, it was shown that there was an association between the sedentary time of the girls and their mothers. Also, a high number of parents watching hours of television was associated with childrens' screen time. In a longitudinal study (Pahkala et al., 2010) on overweight comparing active and sedentary adolescents, found that girls at thirteen years of age had the highest overweight prevalence. In addition, sedentary girls had more often an overweight mother than active girls, thus, overweight mothers had more often daughters who were prone to a sedentary lifestyle at puberty than normal-weight mothers. In a study carried out by Meizi et al. (2010), in order to demonstrate the intra and interpersonal aspects related to sedentary behavior, in 508 students (mean ages 10.7), concluded that during the week children spent on average 3.3 hours per day on sedentary activities related to screen time. Specifically, children spend significantly more time at weekends in this type of activity, about 3.6 hours, compared to 3.1 hours during weekdays. Entertainment, spending more time with family and boredom were the top three reasons to watch television and play video games. Compared with the low computer and TV users (less than 2 hours), the larger users (more than 2 hours), results revealed a less negative attitude towards excessive screen time and less rules on the part of the parents to use. Significantly fewer children who spent many hours in front of the screen had impositions of limits on the part of the parents at the level of time of tv, video games or computer use for entertainment, at the weekend and significantly more parents who spent long time ahead to the screen indicated that they dined in front of the tv and spent more time in the free time watching TV or playing video games with their children. In short, most children and parents recognize the importance of PA and are aware of the negative health effects of excessive screen hours, which reveal that there are opportunities to change attitudes related to this issue (Meizi et al., 2010). Thus, in order to develop strategies for effective interventions, regarding the role of parents in regulating sedentary behavior related to screen time, children's beliefs must be considered, as well as attitudes and motivations for excessive screen use (Meizi et al., 2010).

On the other hand, family circumstances like whether it is a single-parent family, biparental, presence or absence of siblings, and socioeconomic status, influence health behavior, thus, allowing researchers to create and adopt appropriate interventions (Gorely et al., 2009). There is strong evidence that young single-parent families see more TV than young people living with both parents, yet associations with other sedentary behaviors have not been studied (Gorely et al., 2004). Hardy et al. (2006), showed that adolescents with siblings were more likely to watch more than 2h of TV per day, however, a study by Gorely et al. (2004) concluded precisely the opposite. In addition, authors also concluded that socioeconomic status (education or parental income) is consistent and inversely proportional to TV viewing in young people. However, associations with other indicators of socioeconomic status (the father's and the mother's profession) were incongruous. These data reveal that research addressing socio-economic status in other sedentary behaviors is still very limited. In a study by Gorely et al. (2009), it was shown that girls with a lower socioeconomic status gave more TV time at the weekend and more total time during the week in sedentary behaviors in for girls with a higher

socio-economic status. On the other hand, boys from single-parent families have higher total sedentary behaviors compared to boys living with both parents. In summary, this study shows that these groups may have an increased risk of adopting sedentary behaviors, suggesting that they should be target of specific interventions aimed at counteracting this trend (Gorely et al., 2009). In a more recent study by Quarmby et al. (2011), researchers also found identical results, that is, boys and girls from single-parent families spent more time on sedentary behaviors during the week and at the weekend than those living with both parents. Moreover, in situations where only the mother or the father is present, children have less family support, which is due to lack of time, since transportation and the additional responsibilities of the mother or father create a favorable environment for the development of sedentary behaviors. In addition, families where the father and the mother live together, children remembered more time in the accomplishment of the daily activities.

According to Carson et al. (2010), in a study where the associations between the socioeconomic status of the neighborhood and the time of the screen in pre-school children (4-5 years of age) were assessed, authors concluded that during weekends the time spent watching TV, playing video games and being on the computer was higher than during weekdays. They also found gender differences as boys spent more time watching television and playing video games during the week. Children living in an average socio-economic context used the computer less compared to children with high socioeconomic. Children living in lower socioeconomic contexts were more involved in sedentary, screen-related behaviors. Hence, these authors have concluded that the main origins of sedentary behavior in children are: time spent watching television, playing video games and using a computer. It is thus important to understand the determinants, in the time spent watching television. For Gorely et al. (2004) socioeconomic status, ethnicity, body weight, presence of parents at home, parents' habits of watching television, weekends, and the fact of having television in the bedroom are factors who are directly linked with time spent watching television, in children and adolescents between 2 and 18 years (Burdette & Whitaker, 2005; Macleod et al., 2008), but also in adults (Sugiyama et al., 2007). This way, it is possible for children living in lower socio-economic contexts to spend more time in front of the screen in relation to children with higher socioeconomic status, because these children not only have fewer resources to attend post-school programs (Shann, 2001), as well as less recreational accessibility in their neighborhoods (Macleod et al., 2008). The perceived lack of safety in neighborhoods with lower socioeconomic status may restrict children from leaving home, creating an environment conducive to adopting sedentary behaviors (Molnar et al., 2004; Weir et al., 2006). Thus, high socioeconomic contexts, which generally have more resources, accessibility and practice areas, offer more alternatives to sedentary activities related to the screen (Macleod et al., 2008; Holt et al., 2009).

Opinions on this issue are generating some controversy, according to a recent study (Atkin et al., 2013). These authors analyzed the determinants of post-school sedentary behaviors, concluding that children with high socioeconomic status adopt sedentary behaviors compared to those with low socioeconomic status. Also, children with a high number of friends, as well as children with more electronic resources in their bedroom, showed an increase in sedentary behaviors. Similar results were verified in a study conducted by Granich et al. (2011). In addition, Atkin et al. (2013) found differences in sedentary behavior related to the period of the week, that is, at the weekend, children with high socioeconomic status adopt more sedentary behaviors than children with low socioeconomic status. Children whose parents spend more time watching TV or the computer over the weekend have also shown more sedentary behaviors. In a study by Mitchell et al. (2012), authors concluded that older mothers with higher levels of education are associated with a greater expenditure of sedentary behaviors. Older mothers may be less prone to participate in physical activity with their children, leaving more time for them to be sedentary. Therefore, parents age can be an important predictor of sedentary behaviors among children.

Family factors related to the time that parents spend watching television or the computer, family participation in sports or recreation, as well as the rules that defined the time when children could leave the house to play in the street are factors that can prevent or reduce sedentary behavior. The authors also report the need to better understand the determinants of sedentary behaviors in order to develop



interventions that minimize or reduce sedentary behavior. The influence of family factors, as well as the housing environment on sedentary behavior is consistent in the literature, thus supporting the importance of family strategies in intervention programs. This study also concluded that in 10-year-old children, an increase in sedentary behavior was observed in the post-school period over one year. This may be a predictor of increased sedentary behavior over time. Finally, reducing the time that parents spend in front of the screen, increasing family participation in sports and recreation activities, promoting children's freedom, giving them autonomy to play in the street, can be an enabler of prevention or even reduction of age-related sedentary behaviors (Atkin et al., 2013). In an investigation by Cillero et al. (2011), where authors measured individual and social predictors of screen viewing among Spanish school-aged children, the authors realized that family and friends are associated with the first time children start to watch television, so it becomes important to realize the dynamics on which this association is established in order to delineate an appropriate intervention. The rules of friends regarding television time are important predictors of sedentary behavior, with more sedentary group norms being associated with higher levels of screen viewing. Results of this research suggest that children's perceptions of parents' time-of-screen rules, as well as family television viewing habits are significant determinants that operate differently in children and adolescents. One of the interesting discoveries was that parents often use "TV time" as a way to spend time with their children. The effects on the female gender are different depending on the person who establishes the rules, thus, rules established by the mother are less effective compared to the father.

Cillero et al. (2011) concluded that low values of self-efficacy to reduce screen behavior were associated with higher periods in front of the screen. Older children perceived a high behavioral capacity compared to younger children, which is in line with the construct of the interactive psychological structure of development Bandura (1994). According to this structure, different periods of children's lives, these present certain patterns of competence requirements for functional success, and that experiences that test the effectiveness of children change substantially (Bandura, 1994). Although older children exhibit more autonomy and self-direction ability, in relation to behavioral choices, this is not in congruence with screen behavior (Cillero et al., 2011). Older children spend more time on screen behaviors than younger children, this fact can be explained, at least partially, by fewer rules for viewing the screen and more time of visualization together with family. These findings indicate that parents can influence children's screen viewing through example and thus interventions that target children and parents together may be more useful (Cillero et al., 2011). So, given that children move a lot in their teens, they have a lot of time that is not supervised, making rules less rigid, creating opportunities for autonomy/self-direction for screen behaviors. Focusing on individual factors may be important and future interventions may focus on children's self-efficacy and behavioral abilities to help them gain the confidence and skills needed to reduce screen viewing time (Cillero et al., 2011). In 42-year-old women, having a poor social background was a predictor of sedentary behavior. Individuals with self-efficacious personality, characterized by high levels of rebelliousness and hostility, spend more time restless, thus, remaining less time in sedentary behaviors.

Still in Cillero's (2011) study parents and friends are key social influences and as such there is a need to realize the dynamics of friends and family if we want to succeed in designing effective interventions to reduce screen visualization. These results are in line with other studies, addressing gender differences in different countries (Colwell & Kato, 2005). However, two studies did not find significant differences in gender over time to watch television (Gorely et al., 2004; Marshall et al., 2006). In another study by Decker et al. (2012), in which authors studied screen time factors in pre-school children (4-6 years of age) in six European countries (i.e., Belgium, Bulgaria, Germany, Greece, Poland and Spain), authors concluded that children are not only exposed to on-screen behaviors, but also in the pre-school period, inconclusive results were found in relation to the influence of friends in the time spent on children's screen behavior in most of the countries analyzed. Only parents in Germany, Spain, and Bulgaria did state that friends were a determining factor for adopting behavior. Parents' at home habits, as well as weather conditions for predicting children's screen time. Parents' education as well as their habits, children's health, television and computer availability at home, and the physical space at home were associated with

the residence. According to Cillero et al. (2011), living in a house where there is a lot of time to watch television, where there are few rules regarding time on screen, and parents with high are related to children having higher periods of screen time behaviors. In Belgium and Spain, parents of low socioeconomic status spent more hours watching television than parents with medium and high socioeconomic status (Decker et al., 2012). In short, since parents are not too concerned about how long their children are looking at screens, it is important to include recommendations on this topic in interventions in order to raise parents' awareness about television and time spent in front of screens. It is also important in this sense to explain well the reasons for these behaviors being considered unhealthy. Among all groups in this study, parents considered that television is a good way to educate children and as such interventions should indicate the negative cognitive and behavioral effects of spending a lot of time watching television, such as prevalence of overweight, more aggressive and antisocial behaviors, and adverse consequences on educational levels later. To reduce the time of physical inactivity, it is suggested that children spend more time helping their parents in daily tasks, such as cooking, tidying, and more. Throughout this work, studies have been reviewed involving children, adolescents, and adults. However, there is still a need to address studies involving the elderly group. The elderly is the most sedentary segment of society, thus, to date no study has investigated the determinants of sedentary behavior in this age group (Chastin et al., 2014). In the United Kingdom and the United States, the elderly spends about 70 percent of his time awake in sedentary behaviors, and at least half of them aged over seventy years are seated 80 percent of the day (Matthews et al., 2008; Stamatakis et al., 2012).

According to Bauman et al. (2012) and Owen et al. (2011), sedentary behavior is determined by a complex interconnection between personal, environmental, and social circumstantial factors. In a study conducted by Chastin et al. (2014), all participants addressed the context in which they lived, arguing that it did not adequately offer the stimulus that encourages them to be active. They also reported the lack of resting places away from home as strong limiting limitations towards their motivation to be active. Participants felt that activities provided for the elderly are generally, if not always, designed for them to stay for long periods of time. Society, families, and friends have similar thoughts about this age group, that is, they conceive the way of life of the elderly as sedentary. In addition to the lack of confidence and motivation caused by depression, other reasons of the mental state were also pointed out as determinants of the sedentary lifestyle. The seven main reasons for standing were: relief of physical discomfort, boredom, depression, personal characteristics (e.g. if they felt energetic), habits, social leisure activities, and environmental factors. Standing was reported regularly as a necessity by most participants, so as to relieve pain and stiffness after long sitting periods. On the other hand, the perception of being useful, personal care and with others were the strongest motivations to interrupt periods in which they were sitting. The stimuli of the environment, the community and the social circle, as well as the safety of the environment, are key factors that were mentioned by the participants as predictors of getting up and standing. Some participants also recognized the benefits of standing, yet it was something they could not do for long given their mental and physical conditions. In addition, participants mentioned six reasons for standing: community and social opportunities; safety of their environment and transportation; motivation; tailor-made activities; and, caring for others. Results from previous studies found differences in relationship to the period of the day most indicated to change the behavior of being seated. Participants also mentioned that a good strategy for promoting sedentary behavior change should involve thinking about the shorter and simpler activities especially at home. The elderly during the time they were seated, did not see this behavior as unhealthy, but as a strategy that made them functional and independent. All participants felt that there was a social stigma inherent in the sedentary behavior of the elderly. Most of the older women said they are encouraged or even forced to sit more than they want. This is not only because of available accessibility and the social and urban social environment, but also because family and friends often encourage the elderly to sit down (Chastin et al., 2014). To date, it has been possible to report some perceived determinants of sedentary behavior that fit personal, interpersonal and environmental characteristics of the ecological model of sedentary behavior (Bauman et al., 2012; Bennie et al., 2013; Owen et al., 2011). Mobility has also been reported

as a primary reason for remaining seated (Chastin et al., 2014). Depression is another well-known personal trait of sedentary behavior (Hamer et al., 2013). Participants explain that depression affects their motivation to get up and to be active (Chastin et al., 2014). In the interpersonal category, the inherent stereotypes of aging that promote the promotion of physical activity in the elderly also seem to act as predictors of sedentary behavior. Meteorological conditions and urban design are also predictors in the environmental category. The desire for social interaction, as well as searching for purpose within society, as well as caring for others seem to be encouraging factors for behavioral change (Chastin et al., 2014).

## Conclusion

In sum, research on sedentary behavior has been increasing. However, evidences for its determinants continue to be relatively incongruent (Uijtdewilligen et al., 2011). In fact, Owen et al. (2011) set forth five future research priorities assessing the determinants as well as the type of intervention inherent in the behavioral epidemiological framework in the context of sedentarism:

1- Identify the correlations at multiple levels of time sitting in different contexts. For example, the time spent sitting in the car has already been associated with urban design as well as the factors that pertain to transportation;

2- Analyze the signs that lead people to remain seated and their relation to the contextual characteristics;

3- Conduct controlled interventions to determine the validity of reducing or eliminating prolonged periods of time sitting in different groups (elderly and young) and contexts (work, housing, transportation), through interventions aimed at identifying the most relevant correlations;

4- Gather evidence of changes in sedentary behavior from natural experiences;

5- Gather evidence from several countries whose environmental, social and cultural attributes may influence sedentary behavior in different ways.

In any case, more studies are needed to obtain more conclusive results, because it is fundamental to understand these complex relationships better, since as professionals of physical activity and health, we have a responsibility to promote and influence children, youth, adults and the elderly to practice and acquire an active and healthy lifestyle, as opposed to a sedentary lifestyle. Future research should continue to focus on specific, high-prevalence sedentary behaviors as well as their association with psychological, social, and environmental variables.

## Conflict of interest

The authors have not conflict of interest.

## Author participation

DM, JM, TB, AV, SA, LC developed the idea and reviewed the literature and DM, JLML, SM, LC, DT, FR, EMR discussed the data and approved the final version of the article.

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