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## THE TWO SIDES OF SEDENTARY BEHAVIOR

### OS DOIS LADOS DO COMPORTAMENTO SEDENTÁRIO

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#### RESUMO

O comportamento sedentário (CS) se tornou prevalente entre vários grupos populacionais em todas as partes do mundo. O aumento em CS é alarmante, já que este comportamento é associado com desfechos adversos em saúde. Com avanço da tecnologia, a relação de indivíduos com CS se torna cada vez mais complexa, e instrumentos disponíveis, teorias, e o desenvolvimento de pesquisa encaram desafios para se equiparar com esta evolução. Quatro tópicos sobre pesquisa em CS são discutidos neste artigo de opinião: (i) avanços na tipologia e mensuração; (ii) impacto na saúde de indicadores quantitativos e qualitativos de CS; (iii) o lado bom do CS; e (iv) desafios e direções futuras em estudos neste campo do conhecimento. Este artigo de opinião oferece algumas provocações baseadas em limitações de pesquisas contemporâneas, seus avanços, e suas lacunas. Alguns desafios em pesquisa com CS e recomendações são compiladas, e outras podem ser inferidas das crescentes evidências científicas relacionadas a CS entre diferentes campos do conhecimento.

**Palavras-chave:** saúde pública; atividade motora; mídia social

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#### ABSTRACT

Sedentary behavior (SB) has become a prevalent behavior amongst several population subgroups worldwide. This increase in SB is alarming, as this behavior has been associated with several adverse health outcomes. With the advancement of technology, the relationship of individuals with SB has become increasingly complex, and available instruments, theories, and research face challenges to keep up with this evolution. Four issues regarding research on SB are discussed in this opinion article: (i) advances in its typology and measure; (ii) health impact of quantitative and qualitative indicators of SB; (iii) the good side of SB; and (iv) challenges and future directions of studies in this field of knowledge. This opinion article raises some questions based on the limitations of current research with its advances and gaps. Some challenges and research recommendations are compiled, and other can be drawn from the ever-growing scientific evidence related to SB across different fields.

**Keywords:** public health; motor activity; social media

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#### Introduction

Sedentary behavior (SB) is the term used to describe any waking behavior characterized by an energy expenditure of  $\leq 1.5$  metabolic equivalents while in a sitting, reclining, or lying posture.<sup>1</sup> This behavior has been a major focus of research in the last two decades and has been linked to many health outcomes in all population subgroups, as documented in several literature reviews.<sup>2-6</sup> The evidence linking SB to cardiometabolic risk, all-cause mortality, mental health, work productivity, postural problems, and cognitive function has received great attention in the media, who mistakenly denominated SB ‘the new smoking’, which was later debunked by researchers.<sup>7,8</sup> Although the media hyperbole on the impact of SB on health has been criticized, the evidence linking this behavior to adverse health outcomes has been shown to be strong in the literature. For instance, a systematic review showed that 3.8% of all-cause mortality among 54 countries in 2015 has been attributable to sitting time alone.<sup>6</sup> One year later, with a pooled sample of over a million adults, another article has suggested that the impact of sitting time on mortality can be attenuated by enough physical activity, but most people are not physically active enough.<sup>9</sup> This difference in conclusions exemplifies how complex the relationship between SB and health can be, and in order to broaden our understanding on these relations, other facets of SB besides the posture and energy demand have to be taken into account.

The consensus statement of the Sedentary Behavior Research Network (SBRN) includes the definition of different components and behaviors that are related to SB. Screen

time, for example, refers to the time spent on screen-based behaviors, but they can be performed both while sedentary (e.g., watching TV on a couch) or while being physically active (e.g., watching TV while running on a treadmill).<sup>1</sup> Similarly, non-screen-based sedentary time refers to sedentary behaviors that do not involve the use of screens (e.g., reading a book or driving a car).<sup>1</sup> These distinctions are important to consider during the operationalization of SB and other behaviors in research, including when choosing instruments to measure it in studies and interpreting the findings.<sup>10,11</sup> The coexistence and overlapping of these behaviors could be the root of several confusions and inconsistencies in this field of research. For example, the time watching TV has been related to unhealthy body composition, and this relationship may be explained directly through the lack of movement when sitting and consequent decrease in muscle activity, energy expenditure, and enzymatic activity.<sup>4</sup> However, the content of the TV programs and the snacking in front of it during the time watching may be responsible for a poorer diet and energy imbalance, which may also explain the effects on the metabolism and body composition.<sup>12</sup> Measuring both the time sitting watching TV and the content of what is being watched can be tricky and invasive, but not identifying these indicators can mislead the conclusions reported in publications.

Keeping up with the advancement of technology, the changes in behaviors and the creation of new concepts can be challenging for researchers and practitioners. This opinion article highlights key challenges in research, possible solutions and future directions as of discussion of four important issues on SB: (i) advances in its typology and measure; (ii) health impact of quantitative and qualitative indicators of SB; (iii) the good side of SB; and (iv) challenges and future directions of studies in this field of knowledge.

## Discussion Topics

*Energy expenditure, movement, posture, domain, device, and activity type and content: what is being measured?*

Two important systematic reviews were published in 2017 and identified instruments for the measurement of SB in surveys,<sup>10,11</sup> and similar results were observed in both studies: most instruments have been poorly validated and most measures are focused on a few indicators of SB. Watching TV, using the computer, and playing videogames are by far the most frequent indicators of SB, and time spent sitting is also worthy of notice. This is intuitive, as these activities commonly do not require a lot of physical effort to be performed, which means they are very similar to simply resting.<sup>13</sup> They are mostly undertaken in seated, pronated, or lying positions, requiring low muscle activity and energy expenditure, which are important components of the SB concept.<sup>1</sup> In this sense, measuring indicators like the time watching TV has several perks, as it can be interpreted as a proxy for energy expenditure, posture, screen time, (lack of) movement, and the domain of the activity (e.g., leisure).

Although assessing the time watching TV is convenient in surveys, this behavior has been declining,<sup>14</sup> as computers and other devices have advanced and may serve the same purpose that was exclusive to the TV devices. Video streaming services allow people to watch the same content of TV across several devices, including smartphones, tablets, and laptops. The same can be said for video game consoles, books, pen and paper notebooks, all of which lost their almost complete exclusivity to the activities they were created for. With advanced devices, and possibly more to come, measuring the time spent using specific devices may not be as informative as in previous studies. Time watching TV and using the computer may sum up to zero hours among individuals who spend more than 10 hours daily on their smartphones performing the same activities.

The operationalization of what is to be measured in any given study or during professional practice has gotten more complex. While the time watching TV could provide an approximation of time seated or recreational screen time for example, now this measure is more elusive, and

specific instruments may be needed to assess each variable of interest. Energy expenditure can be measured by breath analyzers, double-labeled water, and indirect calorimetry. Movement or the lack of movement can be estimated using accelerometers. Posture can be measured by inclinometers, glued to the thigh or elsewhere. As for self-reported measures, several decisions have to be made to specify what is to be measured. The type of activity may be of use in some studies and may include studying, working, watching videos, playing video games, using social media, reading, and may even include novel activities such as using meditation applications, using applications for exercising, or online shopping. The activity domain can also be complicated to predict as computers can be used for working, studying, commerce, playing games, watching videos, socializing, and several of these activities may have different classifications (e.g., some people get paid to play games). The timing of each behavior may be of use, as using screens before bedtime may specifically impair sleep,<sup>15</sup> and watching videos during meals can also affect satiation.<sup>16</sup> Contextual information may also be of interest, as activities done at school may be different from those in the bedroom, during the commute, at work, with peers, or with family. In some cases, the device being used may be of interest, and on top of the classic TVs, computers, and video games, there is a vast and growing list of possible screen-devices, including fridges, watches, virtual reality headsets, glasses or hubs that may be of important for research. Lastly, for specific activities, the content can also be assessed. For TV and videos, this can be identified in the form of news, sports, series, movies or marketing, if it has violent or adult content, if it has alcohol or tobacco content, etc. Similarly, this can also be identified for games, which can be a puzzle game, gambling game, sport, strategy, action, shooting, horror, etc. This can also be determined for other behaviors such as studying (e.g., the subject), reading books (e.g., the genre), working (e.g., writing reports), and using social media (e.g., creating content).

In summary, SB can be represented through several indicators and measures, which can be more or less important for each research question or professional practice. Several instruments can be used in research, including questionnaires, logs, devices (e.g., accelerometers, inclinometers), ecological momentary assessments (EMAs), cameras, direct observation, smartphone applications, and any combinations of these.<sup>10,11,17,18</sup>

### *Beyond energy expenditure, posture, and cardiometabolic health*

The impact of SB on body composition and cardiometabolic health has been covered by several studies, and the pathways and biomarkers involved have also been investigated.<sup>2-4</sup> Reducing prolonged sitting would provide health benefits in this regard and may also help prevent other mobility limitations, such as limited hip mobility<sup>19</sup> and back pain.<sup>20</sup> Some solutions have been proposed to address the deleterious effects of continuous sitting. Fidgeting, for example, has been shown to discreetly increase energy expenditure while sedentary, which may mitigate the effects of long periods of sitting such as long work shifts.<sup>21</sup> The use of standing desks has been tested in interventions and gained popularity for decreasing sitting time, but more evidence is needed to determine long-term impacts on health, productivity, and educational indicators.<sup>22,23</sup>

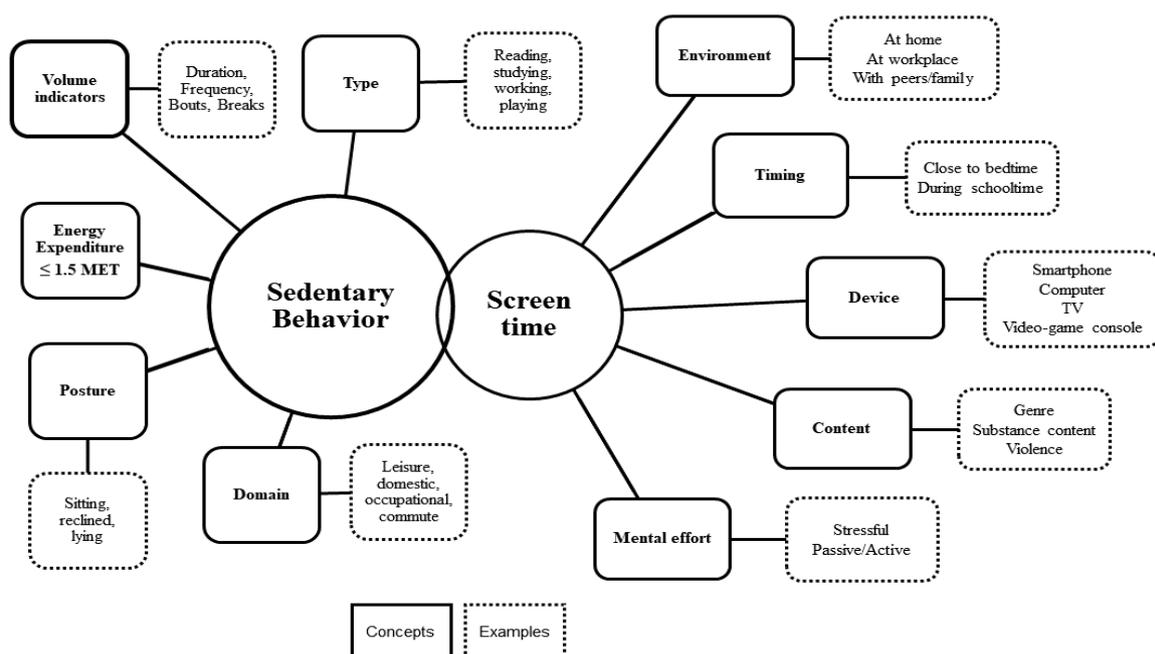
However, SB, and more so screen time SB, may also impact health through other pathways. Several other indicators of SB and screen time SB (e.g., type, device, timing, content) have received less attention and much ground has to be covered to understand how they relate to our behaviors and health outcomes. For screen time SB, the light emitted from the screen may affect eyesight and has been linked to myopia in children.<sup>24</sup> Also, exposure to blue light, especially near bedtime, suppresses melatonin secretion and can reduce sleep duration and quality, further disrupting circadian rhythms.<sup>15</sup> Not only the physical demand but also the cognitive demand of activities can impact health in different ways. A framework that has been proposed by Hallgren et al.<sup>25</sup> suggests that mentally active SB, such as reading, playing games

that require problem-solving, studying, and working, can be healthier compared to mentally passive SB, like listening to music or watching TV. The proposal is supported by empirical observations as well, but more evidence is needed to confirm the findings and clarify underlying mechanisms. For example, other studies have also shown that mentally demanding activities such as doing homework<sup>26</sup> and playing videogames<sup>27</sup> also lead to increased food intake.

Each type of SB and their combination may also predispose people to different outcomes. For example, the use of social media has been linked to depressive symptoms in one study with adolescents, but playing video games and watching videos has not.<sup>28</sup> The impact of social media on health can be complex, with evidence ranging from problems related to social harassment and low self-esteem<sup>29</sup> to what was called “Snapchat Dysmorphia” in 2018, which describes the desire for plastic surgeries to alter appearance to look similar to unrealistic photos with digital “filters” used in social media.<sup>30</sup> Besides the impacts of social media on health, other screen time SB activities can be addictive or contribute to preexisting disorders. For example, online shopping has been shown to be associated with more severe cases of buying-shopping disorder.<sup>31</sup> Gaming disorder has recently been recognized as a health condition and has been included in the International Classification of Diseases (ICD-11).<sup>32</sup>

The content in videos, social media, games, and ads may also influence other lifestyle behaviors. Previous findings have shown that preference for sport-themed video games is associated with increased physical activity compared to other game types such as strategy games.<sup>33</sup> Also, according to a recent systematic review, there is a positive relationship between alcohol marketing in different types of media and alcohol use among adolescents.<sup>34</sup> That may also be verified in games, as a study that analyzed the alcohol and tobacco content on the 32 best-selling games in the UK in 2012/2013 found they were associated with alcohol and tobacco experimentation among youth.<sup>35</sup>

These examples highlight how not only the posture, or energy expenditure, or type, or content of SB, but that all of these different aspects of SB interact and impact health in different ways. Being aware and accounting for these interactions is needed to advance the field and improve our understanding of how each outcome is affected by each behavior and their interconnections to promote a healthier relationship with SB.



**Figure 1.** Conceptual diagram of sedentary behavior and screen time indicators  
 Source: authors

### *The good side of sedentary behavior*

Screen time has become inevitable in modern life, and aside from the negative health outcomes associated with it, its application has improved education and several aspects of modern life, including health to some extent. To illustrate that, a new term has been defined to describe the practice of medicine and public health supported by mobile devices: mHealth. In 2015, a repository of mobile applications already listed more than 60,000 of these apps.<sup>36</sup> The impacts of these specific applications are hard to estimate, but they support an array of services and help promote information to patients and practitioners in a cheap and accessible way.

Social media has increased socialization among people, which can yield many benefits on its own, but it is also a channel for government and health agencies to interact with citizens.<sup>37</sup> Its application has also been commended for healthcare, as it promotes cheap, fast, and clear communication, allowing for the collaboration of several public and private agencies and users.<sup>38</sup>

Video games have been shown to improve several health-related outcomes,<sup>39</sup> with usage also in education.<sup>40</sup> Games and other applications have been successful even for promoting physical activity, which has been typically depicted as a rival behavior of SB. Pokémon Go has caused an increase in physical activity on a large scale upon its release,<sup>41</sup> and several other apps are available for promoting physical activity.<sup>42</sup>

Sitting has been linked to unhealthy outcomes and premature mortality,<sup>4,9</sup> and given the fact that many people spend too much time sitting uninterrupted, such as drivers or in office workers, reducing sitting time has been a priority to public health. However, breaking prolonged sitting time may already reduce the health risks considerably,<sup>43</sup> and some sitting might not be as bad for health if it is interrupted by breaks.<sup>4</sup> A recent study with over 44 thousand adults from Sweden has shown that sitting for 25 to 75% of the work time, as well as taking breaks from prolonged sitting has been shown to be related to lower odds of back of neck pain compared to those who sat for the whole shift.<sup>44</sup> Another point is that occupational physical activity has also been linked to unhealth outcomes, as paradoxical as it may seem, considering all the benefits of leisure-time physical activity for health.<sup>45</sup> Constructors, cleaners and other workers may be exposed to long periods of physical activities of low to vigorous intensity every day, frequently in bad postures, and without appropriate time for recovery, which may predispose them to chronic inflammation, postural problems, and increased risk for cardiometabolic illnesses.<sup>45,46</sup> It is still uncertain what the health combination of sitting time and physical activity looks like, as evidence for establishing a dose-response curve for sedentary behavior is lacking,<sup>47</sup> but novel evidence suggests a balance of 2.5 or more minutes of moderate-and-vigorous intensity physical activity for every hour of sedentary behavior in order to reduce the risk of early mortality.<sup>48</sup> For children and adolescents, some specific types sedentary behavior such as reading without a screen, studying, and crafting have been shown to be related to cognitive function and academic achievement, as well as other health benefits.<sup>49</sup> Taken together, the evidence shows that although reducing population's level of sitting time is needed, some sitting can still be good for health if it is occasionally interrupted, and balanced with an active lifestyle.

During the COVID-19 pandemic outbreak, measures to avoid contamination made it impossible for schools to conduct in-person classes, and online teaching and learning has become a necessity.<sup>50</sup> This illustrates how technology, sometimes in the form of screen time and SB, can also be necessary and beneficial to individuals. Recognizing its applications for health and education are also important. Because screens are everywhere now, we also need to recognize that "normal" does not mean "healthy"; a balance is still required. In research, when participants are asked how long in a day they spend sitting, that could include several different activities that impact their lives beyond what is implied in the postural and energy expenditure aspects alone.

## Conclusion

The advancement of technology and its consequences in the lives of people are fast-paced and inevitable. Research in SB has provided insights on the different impacts of some of these changes, but evidence in this field can become outdated and may not apply to our daily life. The dynamics of different behaviors are influenced by the development of new gadgets and the release of new content, such as new sports events, new series, new gaming consoles, new smartphone apps, etc. One of the main challenges that researchers and practitioners face is being able to account for these dynamics, and current instruments available for research may fall behind on this matter.

The second challenge is to separate what behaviors may be good, what behaviors may be bad, and what is the best way to manage them. At the same time, playing games can improve several aspects of health, but they also can be addictive, promote unhealthy behaviors, and ultimately be the cause of illnesses. More research needs to be conducted to clarify this type of dilemma in several contexts related to SB.

The last, and maybe the hardest challenge, is changing behavior related to SB. Reducing SB has been the objective of several studies, and modest results have been observed so far. Models and frameworks for behavior change may not be applicable for all and every SB, and even using technology may be one of the most effective ways to reduce it.<sup>51</sup> Future studies in this field are extremely necessary to clarify the real possibility of intervening in SB.

This opinion article offers a non-exhaustive discussion based on the limitations of current research with its advances and gaps related to SB and health. Some challenges and research recommendations are compiled, but several other concerns can be drawn from the ever-growing scientific evidence related to SB across different fields. Health, education, and technology journals have articles addressing screen time and SB, and with very specialized uses, it has become increasingly complicated to consider its multiple facets in research and practice.

In conclusion, SB is a complex behavior that encompasses many different activities that should be addressed in future research and practice. The development and adaptation of instruments to measure it is urgently necessary, and addressing the dynamic nature of SB is a problem that requires innovative solutions. Identifying which SB can benefit health and quality of life, and which ones are harmful, and how these can be managed is necessary to avoid confusion and promote a healthy lifestyle. Lastly, interventions aiming at changing SB have faced several problems and have shown modest results. New strategies and actions based on proper behavior change theories are needed to propel the SB field to new horizons.

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Received on Mar, 01, 2021.

Reviewed on Jun, 05, 2021.

Accepted Jun, 23, 2021.

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