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Review

# Sedentary Behaviour as an Emerging Risk Factor for Cardiometabolic Diseases in Children and Youth

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ABSTRACT

Sedentary behaviour (e.g. TV viewing, seated video game playing, prolonged sitting) has recently emerged as a distinct risk factor for cardiometabolic diseases in children and youth. This narrative review provides an overview of recent evidence in this area and highlights research gaps. Current evidence suggests that North American children and youth spend between 40% and 60% of their waking hours engaging in sedentary pursuits. Although data are lacking concerning temporal trends of objectively measured sedentary time, self-reported sedentary behaviours have increased over the past half century, with a rapid increase since the late 1990s. Excessive sedentary behaviour has been found to have independent and deleterious associations with markers of adiposity and cardiometabolic disease risk. These associations are especially consistent for screen-based sedentary behaviours (TV viewing, computer games, etc), with more conflicting findings observed for overall sedentary time. The above associations are possibly mediated by the influence of screen-based sedentary behaviours on energy intake. Although excessive sitting has been reported to have adverse acute and chronic metabolic impacts in adults, research on children is lacking. Research is particularly needed to investigate the impact of characteristics of sedentary behaviour (i.e. type/context, sedentary bout length, breaks in sedentary time, etc), as well as interventions that examine the health and behavioural impacts of sitting per se.


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RÉSUMÉ

Le comportement sédentaire (p. ex. l'écoute de la télévision, la pratique des jeux vidéo en position assise, la position assise prolongée) s'est récemment imposé comme un facteur de risque distinct des maladies cardiométaboliques chez les enfants et les jeunes. Cette revue narrative offre un aperçu des données scientifiques récentes dans ce domaine et souligne les lacunes en matière de recherche. Les données scientifiques actuelles montrent que les enfants et les jeunes de l'Amérique du Nord passent entre 40 % et 60 % de leur journée à faire des activités sédentaires. Bien qu'il manque de données sur les tendances temporelles du temps consacré à des activités sédentaires mesurées de manière objective, les comportements sédentaires qui sont rapportés ont augmenté au cours de la seconde moitié du siècle dernier, et ce, plus rapidement depuis la fin des années 1990. Le comportement sédentaire excessif a montré des liens indépendants et délétères avec les marqueurs de l'adiposité et du risque de maladie cardiométabolique. Ces liens sont particulièrement cohérents pour ce qui est des comportements sédentaires liés au temps passé devant un écran (écoute de la télévision, jeux sur ordinateur, etc.), et des résultats plus contradictoires ont été observés pour l'ensemble du temps consacré à des activités sédentaires. Les liens susmentionnés sont possiblement influencés par les comportements sédentaires liés au temps passé devant un écran. Bien que la position assise excessive soit rapportée comme ayant des conséquences métaboliques indésirables à court et à long terme chez les adultes, il manque de recherches en ce qui a trait aux enfants. La recherche est nécessaire en particulier pour étudier les conséquences des caractéristiques du comportement sédentaire (c.-à-d. type/contexte, durée des périodes de sédentarité, pauses durant le temps consacré à des activités sédentaires, etc.) ainsi que les interventions qui examinent les conséquences sur la santé et le comportement de la position assise en soi.


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## Introduction

It is well established that high levels of physical activity are associated with reduced health risk in children and youth (1–3). Physical activity exhibits a dose-response relationship with health indicators in the pediatric population, and even modest amounts of physical activity can result in improved health for those at greatest risk (1). However, in addition to the consistent association between physical activity and health in the pediatric population, accumulating evidence suggests that the amount of time children and youth spend engaging in sedentary behaviours (i.e. activities that involve sitting or reclining while expending ≤1.5 metabolic equivalents [4]) may be associated with increased cardiometabolic disease risk independent of other factors, such as physical activity and abdominal obesity (5–12). In response to this new research, Canada has recently created pediatric sedentary behaviour guidelines, which are separate from (but complementary to) physical activity guidelines for this age group (11). These guidelines recommend that school-aged children and youth accumulate no more than 2 hours of recreational screen time each day and that they also limit periods of prolonged sitting and motorized transport (11). Although a number of recent narrative reviews have examined the health impacts of sedentary behaviour in adults (13–17), there is a lack of such a review in the pediatric population. Thus, this article aims to provide a comprehensive overview of the available evidence concerning sedentary behaviour and markers of cardiometabolic disease risk in school-aged children and youth.

### *What is sedentary behaviour?*

The meaning of the word *sedentary* has evolved rapidly in recent years (18). Although the Latin root of the word *sedentary* literally means *to sit* (15), the term has historically been used by health researchers to refer to an individual who is not sufficiently physically active (4). Similarly, the phrase *sedentary lifestyle* has typically been used to refer to a lifestyle that includes little or no physical activity (19). It has, therefore, been relatively common for researchers to refer to individuals as sedentary because of their lack of physical activity, rather than the amount of time they spend sitting. However, recent evidence suggests that sitting too much and exercising too little are separate and distinct risk factors for chronic diseases, including cancer, cardiovascular disease and diabetes (15,16,20,21). Further, individuals can easily meet physical activity guidelines while spending the vast majority of their days engaging in seated activities or vice versa (Figure 1). As a result, it has been proposed that the term *sedentary* should be used to refer only to activities that are defined by both seated and reclining postures and energy expenditures at or near resting levels (4). Therefore, in this review the term *sedentary* is used to refer specifically to waking behaviours characterized by energy expenditure ≤1.5 metabolic equivalents while in a sitting or reclining posture (4). In contrast, the term *inactive* is used to refer to an individual who is not sufficiently physically active (e.g. not meeting physical activity guidelines).

### *How is pediatric sedentary behaviour measured?*

As with physical activity, sedentary behaviour can be assessed using a variety of self- and proxy-report questionnaires or by direct measurement tools (15,22,23). Self- and proxy-report tools typically take 1 of 2 approaches: 1) asking children or their parents to estimate the amount of time they spend engaging in common sedentary behaviours (e.g. watching television, using a computer, playing passive video games, driving in a car, etc), which may be reflective of total sedentary time or 2) asking them to estimate the amount of total time, on a daily basis, they spend sitting. These

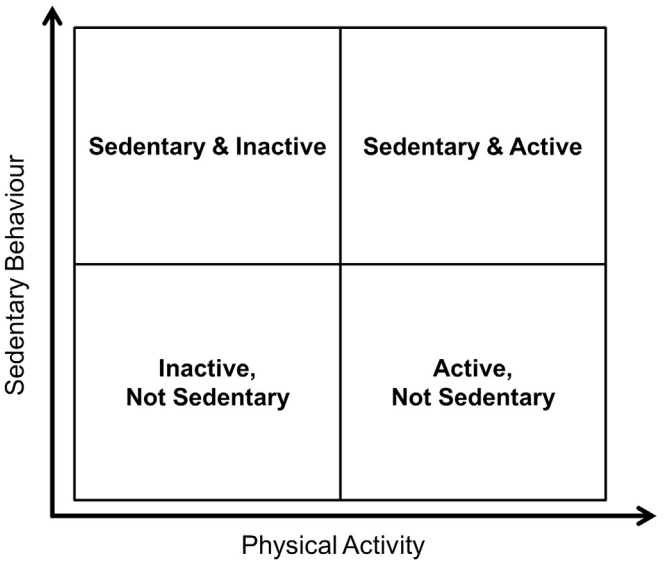


**Figure 1.** Sedentary behaviour and physical activity as distinct constructs.

tools are attractive because they are inexpensive and result in data that are relatively simple to analyze while providing information related to specific modalities or contexts of sedentary behaviours (e.g. television viewing vs. reading). A recent systematic review suggests that self- and proxy-report tools generally display acceptable reliability and validity in assessing sedentary behaviour (22). However, these measures have a number of limitations. First and foremost, they are known to be limited by high levels of error and recall bias (23–26). Further, no single sedentary activity is representative of an individual's total sedentary behaviour profile (23,27,28), which can pose an issue when data collection focuses on a limited number of sedentary behaviour modalities.

In contrast to self-report tools, accelerometers and inclinometers allow for the direct measurement of sedentary behaviour in childhood (15,22,23). Accelerometers assess the number of movement "counts" in a given time period, and their use has increased rapidly in recent years (29). A variety of thresholds have been proposed to distinguish between sedentary behaviour and light-intensity physical activity, with a threshold of 100 counts per minute (CPM) being shown to have high sensitivity and specificity for the measurement of sedentary behaviour in pediatric populations using both ActiGraph (ActiGraph, Pensacola, FL, US) and Actical (Philips Respironics, Andover, MA, US) accelerometers (22,30–36). Accelerometers can also be used to assess the frequency of breaks in sedentary time and the duration of sedentary bouts, neither of which can be determined easily via self-report tools (37–39). However, a key limitation of accelerometers is their inability to distinguish between sitting and stationary standing (40) and the lack of information regarding the modality of sedentary behaviour (e.g. TV viewing vs. reading). Inclinometers such as the activPAL (PAL Technologies, Glasgow, UK) have been reported to be more accurate than accelerometers in differentiating between sitting and standing (40,41), with Aminian and Hinckson reporting that the activPAL was able to distinguish perfectly between the 2 postures in healthy elementary school children (41). As with accelerometers, however, inclinometers are unable to provide information on the modality of sedentary behaviour and have been used far less frequently. As a result of the limitations of both self-report and direct-measurement tools, researchers have, therefore, advocated for the concurrent use of both strategies whenever possible (22,23).