

# Physical Exercise and Health, 5:

## Sedentary Time, Independent of Health-Related Physical Activity, as a Risk Factor for Adverse Physical Health and Mental Health Outcomes

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### Abstract

Medical and neuropsychiatric benefits associated with physical exercise and activity are well recognized. It is less well known that time spent in sedentary behaviors, such as television-viewing or sitting at a desk, are associated with adverse health outcomes even after taking into consideration health-related physical activity. Although sedentary behaviors have become common in daily life, people tend to substantially underestimate how sedentary they actually are. The average person spends nearly 10 hours per day in a sedentary state, during leisure activities

or work; sedentariness is even greater in persons with major mental illness such as psychosis. This article explains what sedentariness is, why sedentary behaviors are common in daily life, and how sedentariness is defined and assessed. Sedentariness is an important concept in its own right; it is not merely an absence of health-related physical activity. Sedentariness is associated with adverse outcomes in children and adolescents, adults, and older adults. Examples are provided of associations between sedentariness and adverse medical outcomes such as the metabolic syndrome, cardiovascular disease, stroke, and all cause mortality. Examples

are also provided of associations between sedentariness and adverse mental health outcomes such as anxiety, depression, and dementia. Importantly, the adverse associations are independent of health-related physical activity; however, higher levels of physical activity may attenuate or offset the adverse effects of sedentariness. It is hoped that this article will encourage readers to reduce sedentary behaviors with a view to improve long-term physical and mental health.

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The World Health Organization 2020 guidelines on physical activity and sedentary behavior<sup>1</sup> discourage sedentariness and recommend at least 150–300 minutes of moderate intensity aerobic exercise per week, or at least 75–150 minutes of vigorous aerobic exercise per week, or equivalent combinations thereof, for the promotion and maintenance of health. If we ambitiously take the highest number, 300 minutes per week, it averages to nearly 45 minutes of exercise per day; that still leaves us with about 23 hours remaining in the day. If we remove a further 9–10 hours for sleeping, eating, and other basic daily activities, we're left with 13–14 waking hours.

In present day life, most of these 13–14 hours are spent in sitting or other sedentary behavior. As examples, many people work at a desk and so sit for perhaps 6–8 hours per day. Many people commute to work, seated in private or public transport, for 1–2 hours per day. Many children and adults use smartphones, watch television, play video games, or merely read, seated, for several hours a day; so, even leisure and pleasure recreational activity

is sedentary. At best, these 13–14 hours may include fidgeting, or short periods of walking inside a house or the workplace, or walking to and from transport points.

Studies confirm that, among adults, including older adults, sedentary behavior occupies much of waking life. For example, in a nationwide survey<sup>2</sup> of 2,640 US adults (mean age, 45 years; 51% female), mean sedentary time was 9.5 h/d, as assessed using a validated, self-administered, previous-day recall questionnaire. Most of the sedentary time was accumulated during leisure (47%) and work (16%). In a large study<sup>3</sup> of 49,841 older adults (mean age, 67 years; 55% female) in the UK Biobank, the findings were almost identical: the median sedentary time was 9.3 h/d. Readers may note that these data indicate that half of the sample in each study was sedentary for approximately 9.5 h/d or longer; in persons with psychosis, higher levels of sedentariness, up to an average of 12 h/d, are reported.<sup>4</sup>

Given the importance of physical activity for health, explained in earlier articles in this series,<sup>5,6</sup> it would seem that excessive sitting and sedentary time, as the

Each month in his online column, Dr Andrade considers theoretical and practical ideas in clinical psychopharmacology with a view to update the knowledge and skills of medical practitioners who treat patients with psychiatric conditions.



Read the Column

**Box 1.****Sedentariness and Physical Activities That Contribute to Health<sup>a</sup>**

**Sedentariness describes any waking hours activity or behavior that has an energy expenditure  $\leq 1.5$  METs.**

Watching television while seated or lying in bed, use of electronic gadgets such as smartphones and laptops while seated or in bed, and sitting at a desk or during commutes are examples of sedentary activities and behaviors.

**Physical activity that contributes to health is any activity with an energy expenditure of 3 METs and more. Moderate exercise is any 3–6 METs activity and vigorous exercise is any  $\geq 6$  METs activity.**

Walking at 3–5 kmph and cycling at 10–15 kmph are examples of moderate exercise, and running and skipping rope are examples of vigorous physical exercise.

**Light physical activity, with an energy expenditure of 1.5–3.0 METs, is not sedentariness, nor is it physical activity that contributes to activity targets prescribed for health.**

Cooking, ironing clothes, and strolling leisurely in a park are examples of light physical activity.

<sup>a</sup>Based on Bull et al<sup>1</sup> and Jetté et al.<sup>7</sup>

Abbreviation: MET = metabolic equivalent.

**Box 2.****Metabolic Equivalents (METs) Explained**

One MET is the energy expenditure of an individual who is seated and at rest. METs are commonly expressed in units of oxygen utilization per kilogram body weight per minute.

A person engaged in a 1.5 MET activity expends 50% more energy than when seated and at rest. A person engaged in a 5 MET activity expends 5 times as much energy than when seated and at rest.

MET values vary as a function of the physical activity, but also as a function of variables such as age, sex, and body weight. So, MET values for a stated activity are approximations.

Abbreviation: MET = metabolic equivalent.

opposite of physical activity, could be detrimental to health. This has indeed been suggested. The present article therefore explains what sedentariness is, what behaviors do and do not comprise sedentariness, and how sedentariness is assessed. Examples are provided of associations between sedentariness and adverse physical and mental health outcomes. The purpose of this article is to encourage reductions in sedentary behaviors and not to comprehensively review the literature in the field.

**What Sedentariness Is**

It may seem that sedentariness is merely the absence of physical activity and so does not need to be independently researched; that is, measuring and studying sedentariness is merely measuring and studying physical activity in a different way. This is not true because there are distinct definitions for what constitutes sedentariness and for what constitutes physical activity that contributes to health. This is explained in Box 1; the concept of metabolic equivalents, explained in Box 2, is invoked. Metabolic equivalent values for a wide range of activities have been published.<sup>7</sup>

It is important to observe that a lifestyle replete with light physical activity, such as putting around in the house or garden, or frequently moving around at the place of work, may not meet physical activity targets prescribed for health; however, such a lifestyle is not sedentary, either. The distinction is important because sedentariness, independent of levels of health-related physical activity, has been associated with adverse health outcomes in observational studies. This is why sedentariness and physical activity need to be independently researched in health-related contexts.

**Assessment of Sedentariness**

Sedentariness is best assessed by actimetry, using standardized electronic devices. This is because people often underestimate how sedentary their lifestyle is. For example, in a systematic review and meta-analysis of 123 studies (pooled  $N = 55,199$ ), Prince et al<sup>8</sup> found that, on average, relative to device measures, people underestimated their sedentariness by 105 min/d. This is easily explained; detailed daily logs of physical activity are necessary to accurately capture the extent of sedentariness, and people do not keep such logs. So, their guesstimates are inaccurate. This means that there is no room for complacency; people may be more sedentary than they realize they are.

It may be noted that commercial devices that measure activity may not be accurate; different manufacturers use different algorithms that were differently validated; and there may be inaccuracies related to where on the body the device is worn, how well-fitting it is, whether body sweat interferes with signal detection, and other matters. In contrast, actimeters or accelerometers used in research are usually standardized before use.

**Sedentariness and Physical Health**

Sedentary time is a risk factor for the metabolic syndrome (MetS), a condition that lies along the path to many health disorders. In a systematic review and meta-analysis of 4 prospective cohort studies and 22 cross-sectional studies ( $N = 105,239$ ), Wu et al<sup>9</sup> found that total sedentary time was associated with an increased risk of MetS at both intermediate (median, 4.1 h/d; odds ratio [OR], 1.17; 95% confidence interval [CI], 1.08–1.26) and high (median, 7.3 h/d; OR, 1.71; 95% CI, 1.43–2.04) levels. Total screen time was also associated with an increased risk of MetS at both intermediate (median, 2.2 h/d; OR, 1.20; 95% CI, 1.10–1.32) and high (median, 3.4 h/d; OR, 1.63, 95% CI, 1.44–1.86) levels. The association between sedentariness and MetS was stronger in women.

Sedentariness has been associated with an increased risk of medical conditions and premature mortality. For example, in a systematic review and meta-analysis of sedentary time and the risk of cardiovascular disease, Pandey et al<sup>10</sup> identified 9 prospective cohort studies (pooled  $N = 720,425$ ) with a median follow-up of 11

years. Subjects in the highest sedentary time category (median, 12.5 h/d) were at increased risk of incident cardiovascular disease events (hazard ratio [HR], 1.14; 95% CI, 1.09–1.19) relative to subjects in the lowest sedentary time category (median, 2.5 h/d). Increased risk was observed only at higher (sedentary time > 10 h/d) levels of sedentariness. In another systematic review and meta-analysis of 7 prospective cohort studies (pooled N = 677,614) with a median follow-up of 12.2 years, Wang et al<sup>11</sup> found that sedentariness was associated with an increased risk of stroke only from a threshold sedentary time of 11 h/d (HR, 1.21; 95% CI, 1.12–1.31).

Ekelund et al<sup>12</sup> described a methodologically important systematic review and meta-analysis of 8 prospective cohort studies (pooled N = 36,383) with a median follow-up of 5.8 years. This study was unique because the authors of each of the contributing studies were asked to harmonize their accelerometry-based information and to redo their analyses in accordance with uniform definitions and methods provided to them by the meta-analysis authors. There was a clear dose-response effect. Relative to the least sedentary quartile, the all cause mortality risk increased, quartile by quartile, to HR = 1.28 (95% CI, 1.09–1.51), HR = 1.71 (95% CI, 1.36–2.15), and HR = 2.63 (95% CI, 1.94–3.56). Relative to a sedentary time of 7.5 h/d, increased all cause mortality reached statistical significance at a threshold of about 9.5 h/d. The HRs were 1.48 (95% CI, 1.22–1.79) at a sedentary time of 10 h/d and 2.92 (95% CI, 2.24–3.83) at 12 h/d. These results remained similar in analyses that addressed reverse causation, in which deaths during the first 2 years of follow-up were excluded.

## Sedentariness and Mental Health

Sedentariness has been associated with an increased risk of psychiatric disorders in children as well as in adults. For example, in a systematic review and meta-analysis of 13 observational studies (pooled N = 70,425) conducted in pediatric (5 studies) and adult (8 studies) subjects, in both unadjusted (OR, 1.33; 95% CI, 1.14–1.55; 7 studies) and adjusted (OR, 1.48; 95% CI, 1.25–1.75; 7 studies) analyses sedentariness was found to be associated with anxiety symptoms or anxiety disorder.<sup>13</sup>

In another systematic review and meta-analysis of 16 observational studies (pooled N = 221,599) subjects, the highest vs lowest category of sedentary behavior (relative risk [RR], 1.42; 95% CI, 1.22–1.67; 9 studies) and the highest vs lowest category of television-watching time (RR, 1.26; 95% CI, 1.14–1.40; 5 studies) were both associated with a higher risk of depression. In both analyses, the risks were dose-dependent.<sup>14</sup>

In a systematic review and meta-analysis of 58 longitudinal studies conducted specifically in children and adolescents, sedentary behavior and television-watching were associated with an increased risk of anxiety (OR, 1.23; 95% CI, 1.11–1.35) as well as depression (OR, 1.14; 95% CI, 1.08–1.20).<sup>15</sup>

In these meta-analyses, although the pooled risks are small, they are clinically significant because anxiety and depression are common in the population; so, even a small increase in risk translates into a meaningful increase in population prevalences.

Sedentary behavior has also been associated with an increased risk of incident dementia among older adults<sup>3</sup>; this study has many points of interest and will be the subject of discussion in the next article in this column.

## Offsetting Sedentariness Risks Through Physical Activity

Some sedentariness is inevitable in daily life. Most people sit when they eat, commute, and work for their living. Most people sit when engaged in necessary phone-related activity. Many people unwind seated, by engaging in screen time with their smartphones or television sets. As reviewed in earlier sections, such sedentariness is associated with adverse physical and mental health outcomes regardless of health-related physical activity. However, can increased physical activity offset the harms of sedentariness? If yes, this would be of comfort to those who cannot avoid sedentariness in their daily life.

In this regard, in a meta-analysis of 9 prospective cohort studies (pooled N = 44,370), Ekelund et al<sup>16</sup> harmonized accelerometry assessments and data analyses. They found that, in subjects with low levels of physical activity, low (HR, 1.65; 95% CI, 1.25–2.19), medium (HR, 1.65; 95% CI, 1.24–2.21), and high (HR, 2.63; 95% CI, 1.93–3.57) sedentariness were associated with a significantly increased risk of all cause mortality. Importantly, they also found that, in subjects with high levels of physical activity, neither medium (HR, 1.16; 95% CI, 0.87–1.54) nor high (HR, 1.40; 95% CI, 0.87–2.26) sedentariness was associated with a significantly increased risk of all cause mortality.

In these analyses, the reference group comprised the ideal: subjects with the lowest level of sedentariness combined with the highest level of moderate to vigorous physical activity. The median sedentary time (min/d) was 8.5, 9.5, and 10.7 h/d across tertiles, and the median moderate to vigorous physical activity time was 2.3, 11.2, and 34.3 min/d across tertiles.

Physical activity may offset adverse health outcome associations with sedentary time in pediatric populations, as well. For example, in a systematic review and meta-analysis of 8 studies of the International Children's Accelerometry Database (pooled N = 6,009), Renninger et al<sup>17</sup> found that a per-day 10-minute increase in moderate to vigorous physical activity (OR, 0.88; 95% CI, 0.82–0.94) and vigorous physical activity (OR, 0.80; 95% CI, 0.70–0.92) were each associated with lower risk of the MetS; in contrast, a 1-hour increase in sedentary time was associated with an increased risk of the MetS (OR, 1.29; 95% CI, 1.13–1.45). Importantly, the benefits associated with moderate to vigorous physical activity persisted after adjustment for sedentary time (OR, 0.91;

## Box 3.

## Addressing Sedentary Behaviors in Daily Life

**Behaviors that contribute to sedentariness in daily life need to be identified. Examples include:**

- Lazing in bed after awaking in the morning
- Lazing in bed anytime during the day
- Sitting while waiting for transport and during commutes
- Sitting at a desk at the workplace
- Sitting and thinking
- Sitting with screens, especially smartphones and television, as leisure/pleasure activity

**Action points are:**

- Reduce time spent lazing in bed
- Reduce sitting time while waiting; walk, stretch, or perform other light physical activity
- Walk, stretch, or perform other light physical activity while taking work breaks at the workplace instead of chatting on a phone, watching videos, or playing games on a screen
- Walk while thinking
- Reduce time spent with screens; switch to recreational activities that require movement

95% CI, 0.84–0.99); and the harms associated with sedentary time were attenuated after adjustment for moderate to vigorous physical activity (OR, 1.14; 95% CI, 0.96–1.36).

### Take-Home Message

Increased sedentary time is associated with poorer physical and mental health outcomes even in people who exercise regularly. Although this conclusion is based on the findings of observational studies, it would be prudent to reduce sedentary behaviors (Box 3). Some sedentariness is unavoidable, such as sedentariness associated with commuting or working at a desk. However, it is possible to attenuate the possible adverse health outcomes of sedentariness by increased engagement in physical activity.

### Parting Notes

Many studies have demonstrated adverse health outcomes associated with sitting time,<sup>18</sup> screen-viewing time,<sup>19</sup> and, more specifically, even television-viewing time.<sup>20</sup> Sitting time is a subset of sedentariness; it would not include, for example, time spent in bed after awaking or time spent lying in bed and reading or viewing a screen device. Screen time is (largely) a subset of sitting time and television time is a subset of screen time.

Sitting time, screen time, and television time studies are important because they draw attention to specific problematic lifestyle activities. The sedentariness studies are important because they draw attention to overall lifestyle behavior.

Finally: the focus of this article is on sedentariness as inactivity, and so this article does not address potentially harmful changes in mental health that have been associated with different kinds of screen time and different screen time contents and activities. Such effects merit independent consideration.

### Article Information

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