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# Review of Sedentary Behaviors and Depressive Symptoms in Older Adults

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Depression is a common mental problem and is also a leading cause of disability, which serves as an important contributor to the overall global burden of disease. It may lead to serious consequences including increased risk of morbidity and mortality. This warrants the need to identify correlates such as modifiable lifestyle behaviors that can prevent or delay the onset of depressive symptoms in aging populations. Sedentary behaviors such as TV viewing, reading, mobile phone/computer use, social chatting, and passive transport etc. are prevalent among older adults. Unfortunately, sedentary behaviors have been increasingly recognized as an independent risk factor for different health outcomes. Although the link between sedentary behaviors and several geriatric health outcomes including all-cause mortality, cardio-metabolic diseases and obesity in later life has been established, the associations of sedentary behaviors with depressive symptoms have not been comprehensively investigated. Therefore, this study aimed to provide a narrative review by scrutinizing the recent epidemiologic evidence for prospective cohort studies of sedentary behaviors and depressive symptoms in older adults. To fulfill the aim, the following issues were raised and analyzed in an effort to disentangle the complex relationships between late-life sedentary behaviors and depressive symptoms. First, the prevalence and correlates of geriatric depressive symptoms were presented and discussed. Second, the definition of sedentary behaviors and the prevalence of late-life sedentary behaviors were described. Third, the relevant issues of measuring sedentary behaviors were addressed. Fourth, the effects of sedentary behaviors on various health outcomes were identified. Fifth, the prospective studies regarding sedentary behaviors and depressive symptoms in older adults were examined based on epidemiological perspectives. Sixth, based on the preceding information, research gaps in the literature were identified and discussed. Conclusions and suggestions for future research on this topic were proposed. Based on limited evidence, late-life sedentary behaviors are associated with higher risk of depressive symptoms. Future studies on the current topic are recommended to conduct large-scale prospective cohort studies with multiple waves of data collection employs a combination of subjective and objective measures of sedentary behaviors, such as a questionnaire and accelerometry, by which studies could explore the bi-directional relationships of different types of sedentary behaviors with depressive symptoms in older adults and the mechanism between them.

***Keywords:*** *Aging, depression, follow-up study, inactivity, prolonged sitting*

## Extended Abstract

Depression is a common mental health problem and a leading cause of disability. It is an important contributor to the overall global burden of disease and may have serious consequences such as increased risk of morbidity and mortality. Thus, it is necessary to identify correlates of depression such as modifiable lifestyle behaviors that

can prevent or delay the onset of depressive symptoms in aging populations. Sedentary behaviors such as TV viewing, reading, mobile phone/computer use, social chatting, passive transport, etc. are prevalent among older adults. Unfortunately, sedentary behaviors have been increasingly recognized as an independent risk factor for a variety of health outcomes. Although the links between sedentary behaviors and several geriatric health outcomes including all-cause mortality, cardio-metabolic diseases, and obesity in later life have been established, the association of sedentary behaviors with depressive symptoms has not been comprehensively investigated. Therefore, this study conducted a narrative review of recent epidemiologic evidence from prospective cohort studies of the relationship between sedentary behaviors and depressive symptoms in older adults. The following issues are raised and analyzed in an effort to disentangle the complex relationships between late-life sedentary behaviors and depressive symptoms. First, the prevalence and correlates of geriatric depressive symptoms are presented and discussed. Second, the definition of sedentary behaviors and the prevalence of late-life sedentary behaviors are described. Third, the problems of measuring sedentary behaviors are addressed. Fourth, the effects of sedentary behaviors on various health outcomes are identified. Fifth, the prospective studies of sedentary behaviors and depressive symptoms in older adults are examined from several epidemiological perspectives. Sixth, based on the preceding information, research gaps in the literature are identified and discussed.

## Literature Review

### Prevalence and correlates of geriatric depressive symptoms

A systematic review combined with a meta-analysis found that the pooled prevalence of depressive symptoms in community-based older adults was 17.1%. This estimated prevalence is similar to those among Taiwanese. For example, the *Taiwan's Health and Living Status of the Elderly Survey 1996-2003* found that the prevalence of depressive symptoms in Taiwanese older adults (age ≥ 60 years) was 16.5%. The 2005 Taiwan National Health Interview Survey reported that the overall prevalence of depressive symptoms slightly increased to 20.6% in Taiwanese older adults aged above 65 years.

Several factors may lead to depressive symptoms in older adults. For example, a cross-sectional study using representative community residents in the United States ($n$ = 2517, age ≥ 55 years) demonstrated that older age, lower educational levels, lower income, being separated/divorced/widowed, worse quality of life, and worse health status were associated with depressive symptoms in later life. Among these correlates, worse health status and multiple chronic diseases were the strongest risk factors for depressive symptoms. Moreover, the 2005 Taiwan National Health Interview Survey of 2,727 Taiwanese older adults (age ≥ 65 years) found that depressive symptoms were associated with lower educational levels, being separated/divorced, lower-income, lower frequency of physical activity, more chronic diseases, and greater difficulties in activities of daily living (ADL).

### Definition of sedentary behaviors and the prevalence of late-life sedentary behaviors

Sedentary behavior refers to "any waking behavior characterized by an energy expenditure ≤ 1.5 metabolic equivalents (METs) while in a sitting or reclining posture." Specifically, sedentary behavior involves three components: (a) waking behavior (not sleep or napping); (b) energy expenditure ≤ 1.5 METs; and (c) sitting or lying posture. The terms sedentary behavior, sitting behavior, and prolonged sitting behavior are often used interchangeably in some studies; however, sitting behavior and prolonged sitting behavior do not include activities conducted while in a lying posture. Therefore, we use the term "sedentary behavior" throughout this review.

Technological advances and changes in lifestyle have not only decreased opportunities to engage in physical activity in daily life, they have also increased sedentary behaviors such as TV watching, smartphone/tablet use, reading, passive transport, and eating. A review of studies of objectively assessed sedentary behaviors showed that older adults spend an average of 9.4 hours a day engaged in sedentary activities.

Older adults tend to spend most of their sedentary time watching TV, but also engage in several other types of sedentary behavior such as reading a newspaper, doing hobbies, listening to music, or using a computer/the Internet.

## Approaches to measuring sedentary behaviors

There are two general approaches to measuring sedentary behavior in older adults: subjective (self-reported) measures and objective device measures. Most studies have used self-reported measures such as questionnaires. The advantage of self-reported measures is their low cost. However, self-reported measures suffer from some serious disadvantages. First, self-reported measures may lead to recall bias, especially for older adults who are more likely than younger adults to miscalculate the time spent sitting. Second, compared with objective device measures, self-reported measures have been shown to be relatively less valid.

Some objective device measures (i.e., pedometers, accelerometers, heart rate monitors, smartphones, and smartwatches) have been used in studies of physical activity and sedentary behavior. In particular, accelerometers have been widely used. For example, triaxial accelerometry (GT3X+, ActiGraph, Pensacola, FL, USA) with analysis software "ActiLife" can record and analyze important parameters of physical activity (i.e., total steps, energy expenditure, sedentary time, light physical activity time, moderate-intensity physical activity time, and vigorous-intensity physical activity). However, the objective device measures have some limitations. First, national studies measuring sedentary behavior with objective devices are difficult to conduct because the devices are more expensive than questionnaires. Second, the time spent on different types of sedentary behavior cannot be determined using these devices (e.g., how much sedentary time was spent watching TV vs. reading?). Third, the different devices do not use consistent definitions of sedentary behavior, which makes comparisons of different studies more difficult. Fourth, the literature on the objective measures of sedentary behavior has focused on adults. These findings cannot be applied to older adults due to the different patterns of sedentary behaviors in adults and older adults. Finally, most objective devices cannot distinguish between standing and sitting postures.

## Effects of sedentary behaviors on various health outcomes

A meta-analysis that synthesized data from 54 countries found that sedentary behavior increased all-cause mortality risk by 3.8%. Some researchers have described the deleterious effects of sedentary behavior using the phrase "Sitting is the new smoking," suggesting that the adverse effects of sedentary behavior on health are similar to the effects of smoking. Notably, the effect of sedentary behavior on all-cause mortality was independent of physical activity. Another meta-analysis study demonstrated that higher levels of moderate-intensity physical activity could attenuate, but not eliminate the increased risk of all-cause mortality that is related to sedentary behavior.

A search of the literature as of April 2019 identified 29 systematic review or meta-analysis studies of the association between sedentary behavior and health outcomes. We synthesized the findings of these 29 studies and found the following main points. (a) Sedentary behavior is positively associated with the risk of all-cause mortality, cardiovascular diseases, metabolic syndrome, diabetes, gallstone, cancers, and difficulties in ADLs. (b) Few studies have investigated the effects of sedentary behavior on mental health; findings on the associations between sedentary behavior and depression, subjective well-being, and cognitive ability have been inconsistent. (c) Future studies should investigate the relations between objectively measured sedentary behaviors and mental health outcomes by conducting prospective or experimental studies.

## Prospective studies of sedentary behaviors and depressive symptoms

This review explored prospective studies of the association between sedentary behaviors and depressive symptoms in older adults. PubMed, Medline, Scopus, EMBASE, Web of Science, and Google Scholar were searched for relevant studies. Eligibility for inclusion

were based on the following criteria: (a) a prospective cohort design; (b) participants were aged 65 years and older or the mean age of participants was over 65 years; (c) independent variables included at least one type of sedentary behavior (e.g., watching TV, reading) or sedentary time; (d) dependent variables included measures of depression-related outcomes (e.g., depressive symptoms, depression); and (e) participants were community-based older adults. The exclusion criteria were as follows: (a) samples involved a specific population (e.g., older adults with diabetes); (b) were not published in English; and (c) were not published in a journal (i.e., theses, dissertations, conference proceedings, and government reports were excluded). Five prospective studies were identified.

Overall, the findings of the five prospective studies investigating associations between sedentary behaviors and depressive symptoms were inconsistent. For example, one study did not find any significant associations between sedentary behavior and depressive symptoms. However, a second study found that individuals engaged in sedentary behavior for more than 4 hours per day had an increased risk of depressive symptoms. Moreover, various types of sedentary behaviors may influence risk of depressive symptoms differently. For example, some studies demonstrated that watching TV increased the risk of depressive symptoms, but reading or using a computer/ the Internet decreased the risk. It is possible that different types of sedentary behaviors have different effects on the risk of depressive symptoms in older adults.

### Research gaps

Although sedentary behaviors may have deleterious effects on physiological health, it is unclear whether sedentary behavior is prospectively associated with depressive symptoms in older adults. The insights provided by this review suggest that future studies could (a) investigate the reciprocal associations between sedentary time and depressive symptoms; (b) explore the recommended threshold of daily sedentary time above which mental health is impaired in older adults; (c) examine the effects of different types of sedentary behavior (e.g., reading a newspaper, watching TV, listening to music) on mental health outcomes; (d) conduct prospective studies using three or more waves of measurement; (e) assess sedentary behaviors using both objective and subjective measures; (f) conduct studies on this topic using qualitative approaches; and (g) explore the underlying mechanisms through which sedentary behavior influences mental health outcomes including depressive symptoms.

## Conclusion

Based on limited evidence, it is plausible that late-life sedentary behaviors are associated with a higher risk of depressive symptoms, although there are some questions that remain open. Future research on this topic should include large-scale prospective cohort studies with multiple waves of data collection. These studies should use a combination of subjective and objective measures of sedentary behaviors, such as a questionnaires and accelerometry, to explore the bi-directional relationships of different types of sedentary behaviors with depressive symptoms in older adults and the underlying mechanisms of these effects.