Chapter 19
Approaches to Decrease Sedentary Behaviour Among the Elderly

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Abstract The elderly are one of the most sedentary groups of the population and they have the highest rates of chronic acquired disease and disability. Research suggests a link between time spent being sedentary and ill health. Therefore, there is an immediate and urgent need to understand how to decrease the amount of sedentary behaviour in which an elderly individual engages. However, to date, very few studies have attempted to reduce sedentary time in the elderly, with half focusing primarily on reducing sedentary time and half focusing on increasing physical activity. Within these interventions, there are striking similarities in design of the study as well as primary purpose of the study. However, large variation in methodology such as measurement tools used to assess sedentary behaviour, theoretical grounding of the interventions, and interventional structure is apparent. Results of these studies have shown that sedentary behaviour can change. Interventions have shown these decreases in sedentary behaviours to be about 30 min, a relatively small portion of the waking day (~3%). The changes in sedentary behaviour can happen rapidly, but it is not fully understood whether these changes can be enhanced with the application of different behavioural theories or interventional techniques. Further, it is not known whether these changes in sedentary behaviour can be sustained.

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19.1 Introduction

Our waking hours are spent in both sedentary and active behaviours, from walking to sitting and eating to socializing with friends to cleaning the house. We are either active or sedentary depending on what we need to accomplish, what constraints we have on our time, the habits we have formed, the people we surround ourselves with, the environment we live in, and the policies and infrastructure in which we reside. Elderly adults are a unique segment of our population. A large majority of the elderly population are retired and, therefore, have lower levels of occupational physical activity or sitting and have more choice in how to occupy their time. Having control over their full daily schedule allows elderly adults to make choices to be active or to be sedentary. Now that they have the time, they may choose to spend the day playing 18 holes of golf, or kayaking down the river, finish reading the book that they started earlier that week, watch a television (TV) programme, or start a hobby they have always wanted to try, but never had the time. The environment they live in, and in particular, their residence, also plays a large role in their decision to be active or sedentary by providing opportunities to be active or encourages one into sedentary pursuits. The elderly have developed habits over their lifetime that have evolved out of necessity or the experiences they have lived in their country, city/town/village, and home with their family, friends, and acquaintances. This lifetime of experience paired with knowledge and current life situation has cultivated into their current lifestyle behaviours, or how they interact with the world on a regular basis.

On average, elderly adults spend approximately 8–9 h (55–65%) of their waking day (approximately 15 h) in sedentary pursuits such as watching TV, reading, and working on the computer [1]. This means that elderly adults are moving for only about 6 h per day and remaining idle for the other (approximately) 9 h of the day that they are awake [1]. It is important to remember that these data provide a time allocation picture for the average elderly individual. When looking at distributions of sitting time from meta-prevalence data showing that about 60% of elderly adults sit for 4 h or more, 27% sit for 6 h or more, and 5% sit for more than 10 h per day (Harvey, 2013), we are reminded that some will remain sedentary for more than 9 h, and some will move more than 6 h per day. Additionally, it is important to note that sedentary behaviour has been shown to increase with age, increasing by 5% each year after age 65 years [2]. Please refer to Chap. 4 for further detail on the prevalence of sedentary behaviour among older adults.

As has been shown in Part II of this book, higher levels of sedentary behaviour are associated with higher rates of chronic acquired diseases, poorer physical functioning, and higher rates of disability which can lead to an inability to complete activities of daily living (ADLs) and instrumental activities of daily living (IADLs) [3–5]. These negative health complications that result from too much sedentary behaviour appear to be independent of health enhancing physical activity, at least in the adult [3, 6–10] and elderly adult populations [5].

Despite the fact that the field of sedentary behaviour research is in its infancy, scientists, healthcare providers, and public health officials have begun to intervene

on the amount of time that elderly adults spend in sedentary pursuits. However, work in this area has just begun and there is much more to learn. This chapter aims to review the current knowledge focusing on approaches to reduce sedentary behaviour among the elderly. Specifically, this chapter will detail interventions that aim to reduce sedentary behaviour as well as interventions that aim to increase physical activity, but also assess the impact on sedentary behaviour. For further details on sedentary behaviour and ageing, please refer to Chap. 13.

19.2 Interventions to Reduce Sedentary Behaviour in Elderly Adults

Despite the large portion of the day that the elderly spend in sedentary behaviour, and the ill effects of sitting that have been documented in the elderly, there are few interventions that aim to reduce sedentary behaviour in this segment of the population. Within these interventions, there were striking similarities in design of the study as well as primary purpose of the study. However, large variation in methodology such as measurement tools used to assess sedentary behaviour, theoretical grounding of the interventions, and interventional structure is also present. Considering these similarities and despite these variations, changes to sedentary behaviour are fairly homogenous.

19.2.1 Design of Studies to Reduce Sedentary Behaviour

One of the notable similarities of these interventions was the design of the studies. All of these studies were pre-post experimental [11–15], assessing within subject change over time in response to the intervention. Only one of the studies included here employed a control group that provided usual care for hypertension, allowing more robust conclusions to be drawn regarding the effectiveness of the intervention [11]. In addition to the similar designs of these studies, four of the five studies that have intervened on sedentary behaviour were designed to determine the feasibility of an intervention to reduce sedentary behaviour [12–15], which is an important first step in interventional research before applying the intervention to a larger group. Only one study was designed to specifically reduce sedentary behaviour [11] in the elderly. As this area of inquiry matures, it is important for scientists to design studies that include a control group to allow stronger and more resilient conclusions to be drawn about this important topic.

Interventions to reduce sedentary behaviour have included sample sizes of less than 70 individuals, with one of the five studies including fewer than 50 participants [11] and two including 25 or fewer participants [13, 14]. Four of the five studies included samples with a mean age of 68 years or older [11–14], and one study reported a mean age of 59 years and included individuals aged 45 and older

[15]. Three studies included a majority of participants being female, ranging from 70 to 75% [12, 14, 15] female, with the other studies having approximately half the sample being female (40% female, Fitzsimons et al.; 56% female Chang et al.). Two studies explicitly recruited sedentary individuals [12, 14], and all were community dwelling. Therefore, interpretation of the results of these studies must take into account the participant characteristics. Future studies should screen for time spent in sedentary behaviour to ensure that those in need of a reduction in sedentary behaviour are the recipients of the interventions. Additionally, there is little data examining the effect of interventions to reduce or disrupt sedentary time on adults aged 80 years and older.

19.2.2 Methodologies Utilized to Assess Sedentary Behaviour Intervention Response

Sedentary behaviour can be a difficult behaviour to measure, because individuals do not choose to be sedentary for the purpose of being sedentary; it is usually for another reason: enjoyment of watching their favourite TV show, rest and rejuvenation, or sitting to visit with friends. Therefore, the tool used to assess sedentary behaviour and changes in sedentary behaviour as a response to intervention is important. In the studies that intervened to reduce sedentary behaviour in the elderly, a variety of subjective and objective assessments were employed. Objective tools included the Actigraph accelerometer (GT1M- [12], GT3X- [14]) and the ActivPAL inclinometer [13, 14]. Subjective tools also varied, including the Measure of Older Adults' Sedentary Time (MOST; [15]), the Sedentary Behaviour Questionnaire [13], the International Physical Activity Questionnaire (IPAQ) [11, 14], and a diary [11]. Given the variation in the validity of these sedentary behaviour assessment methods (see Chap. 2), comparison of intervention responsiveness and efficacy becomes difficult and warrants consideration.

19.2.3 Theories Employed in Sedentary Behaviour Interventions

Most current interventions designed to disrupt sedentary behaviour have been guided by theory, with the Behavioural Choice [12, 14] and Social Cognitive [12, 14, 15] theories being the most popular. For further details on models and theories applied to sedentary behaviour research, please refer to Chaps. 15 and 16. The Empowerment Theory [11] and the Ecological Model [13] have also been applied, with other studies contrasting different theoretical approaches, such as by King et al. who examined social cognitive theory and self-regulatory principles of behaviour change, social influence theory, and operant conditioning principles and emotional transference within a technology platform [15]. As is typical in physical

activity interventions, these interventions largely, but not exclusively [13, 15], focused on individual level factors that determine behaviour. Because the number of factors that shape behaviour and interplay of these factors is so complex, determining the best theory or theories to change sedentary behaviour is still in its infancy [16].

19.2.4 Sedentary Behavioural Intervention Length and Characteristics

In addition to similarities and differences in methodology, there are also similarities and differences in the interventional structure and the length of the interventions. Two interventions were 7 days in length and applied different interventional structures [12, 13]. Gardiner et al. [12] employed the "Stand Up for Your Health" intervention where participants were encouraged to stand up every 30 min throughout their waking day. Participants completed one face-to-face goal setting consultation and received one individually tailored educational mailing. Fitzsimons et al. employed a consultation, based on the Ecological Model and the participant's baseline data, to reduce their sedentary behaviour [13]. Participants set their own goal as to where, when, and how much they would reduce their sedentary behaviour. Three interventions were 8 weeks in duration and also applied very different interventional structures [11, 14, 15]. Rosenberg et al. delivered a modified version of the "Stand Up for Your Health" intervention through five 20-min phone calls delivered at baseline, and weeks 2, 3, 5, and 7, with the goals of reducing sitting time by 2 h per day and increasing the number of sit-to-stand transitions by 15 per day [14]. Chang et al. delivered an intervention that included weekly meetings lasting 110 min that included lifestyle modification education, group discussion, and an exercise session. Participants were also instructed to exercise 2 days per week at home. Finally, King et al. reported the results of three theoretically guided interventions delivered through smartphone applications ("apps") [15]. The apps were either analytically, socially, or affectively framed custom apps that could be used by the participant on a daily basis. Therefore, in addition to numerous theories employed by this small number of interventions, there was large variation in intervention structure, goals for reducing sedentary behaviour, and participant contact with other participants or study staff.

19.2.5 Effectiveness of Interventions to Reduce Sedentary Behaviour

Despite the variations in study methodology, length of the intervention, theory employed, and interventional structure and tools, results show promise that sedentary behaviour can be reduced in this population subgroup. On average, it appears

that reductions in sedentary behaviour are quite homogenous, regardless of intervention, resulting in reductions in sedentary behaviour of about 30 min or approximately 3% of the waking day. Of course, the data is variable, but these results are seen after short-term and longer duration interventions and with subjective and objective methods of assessing sedentary behaviour. Gardiner et al. [12] showed a decrease in accelerometer-measured sedentary behaviour by 3.7% of the waking day, which equated to a reduction in sedentary behaviour by approximately 40 min, and Fitzsimons et al. [13] demonstrated a significant decrease in ActivPAL-assessed sitting or lying time by 24 min/day or 2.2% of the waking day, both after a 7-day intervention. Similarly, Rosenberg et al. [14] showed a decrease in ActivPAL-assessed sedentary behaviour by 27 min/day (−3% of waking day) after an 8-week intervention. Sedentary behaviour changes measured by questionnaire varied substantially, with King et al. reporting a decrease in TV viewing (assessed by MOST) of 29 min per day after an 8-week intervention [15]. Chang et al. [11] reported a much larger decrease in IPAQ sitting time of 76 min/day after an 8-week intervention, over double the amount seen in the other studies. This larger decrease in sedentary time could be due to the tool used to assess sedentary behaviour or the fact that the intervention focused on exercise rather than physical activity. Taken together, it appears that changes in sedentary time on the order of 30 min, over a short period of time, can be expected from interventions that reduce sedentary behaviour. Whether this change in sedentary time is sufficient to impact health in this population, and whether this change in sedentary behaviour can be sustained long term, remains to be determined.

Because waking hours are filled either with sedentary pursuits or active behaviours, when sedentary behaviour is decreased, it must be replaced with activity of some level. As a result of the reduction in sedentary behaviour seen in Gardiner et al. [12], the sedentary behaviour was replaced almost entirely with moderate-to-vigorous physical activity (moderate-to-vigorous physical activity increased from 3.6 to 4.6%). King et al., Fitzsimons et al., and Chang et al. also showed increases in physical activity as a result of the decrease in sedentary behaviour, with King et al. [15] showing increases in walking by 14 min/day and moderate-to-vigorous physical activity by 27 min/day as assessed by the CHAMPS[1] Activities questionnaire for older adults; Fitzsimons et al. [13] showed increases in stepping by 13 min/day with no change in standing, steps/d, or sit–stand transitions, and Chang et al. [11] showed substantial increases in physical activity equating to approximately 107 min/day at 3 metabolic equivalents (METs) or 53 min/day at 6 METs. However, it should be noted that the control group in Chang et al. [11] also showed substantial increases in physical activity. In contrast, Rosenberg et al. showed similar magnitude increases in standing (+25 min) as to the decrease in sitting (−27 min), with no changes in walking, steps, or sit-to-stand transitions [14]. Therefore, there is no clear activity (standing or moving) or intensity of activity (light or moderate-to-vigorous) that replaces sedentary pursuits in the elderly population.

[1]CHAMPS—Community Healthy Activities Model Program for Seniors

19.3 Interventions that Focus on Changing Physical Activity Level, But also Reduce Sedentary Behaviour

19.3.1 Design of Studies to Change Physical Activity Level that also Impact Sedentary Behaviour

In addition to studies that aim to change sedentary behaviour, there are a handful of studies that aim to change physical activity behaviours by (1) increasing physical activity behaviour [17, 18]; (2) improving both physical activity and nutrition behaviours [19]; (3) changing both physical activity and sedentary behaviour [20]; (4) examining the feasibility of a physical activity intervention [21]; or (5) to improve cardiometabolic risk [22]. In addition to assessing their primary aim, these studies also measure the interventional impact on sedentary behaviour. All of these studies have used a randomized control trial study design to assess their primary question [17–22], but the intervention length varied, ranging from 12 weeks [18, 21], to 24 weeks [20], to 6 months [17, 19, 22]. Most studies included participants with a mean age in the 1960s [18–20, 22], with one study including participants with a mean age in the 1970s [21] and one with the mean age in the 1980s [17]. Two studies included overweight or obese elderly adults with type 2 diabetes [18, 20], one included overweight or obese participants [22] and one included elderly living in a nursing home or care facility [17].

19.3.2 Methodologies Utilized to Assess Sedentary Behaviour Intervention Response in Physical Activity Studies

Similar to the interventions specifically designed to alter sedentary behaviour, interventions in this area have also employed a wide variety of assessment tools. Objective tools included the Actigraph accelerometer (7164) [18, 20] and the ActivPAL inclinometer [21]. Subjective assessment tools include the IPAQ [19, 22] and the Longitudinal Aging Study Amsterdam questionnaire [17]. Therefore, due to the variety of both objective and subjective tools employed, direct comparisons of changes in sedentary behaviour become more difficult.

19.3.3 Theories Employed in Physical Activity Interventions that also Impact Sedentary Behaviour

The interventions employed a variety of theories to change physical activity behaviour or physical activity and sedentary behaviours, with similarities to those studies with a primary aim to change sedentary behaviour. Theories included the

Cognitive Behavioural theory [18, 20] and Social Cognitive theory [19, 21]. Only one study did not explicitly state the theory applied [17]. Two studies also used Motivational Interviewing [18, 20, 22] as a technique to change physical activity behaviour. Therefore, despite the fact that when you change sedentary behaviour, you are trying to remove a negative behaviour and when changing physical activity behaviour, this incorporates the process of adding a positive behaviour; these results suggest that theories that have been applied to change physical activity behaviours may be transferable to assist in changing sedentary behaviours.

19.3.4 Intervention Length and Characteristics

The structures of the interventions also varied. Mutrie et al. [21] aimed to increase walking through the use of a pedometer, a walking programme, and two consultations with a trained professional over the 12-week intervention. De Greef and colleagues [5] delivered 5 cognitive-behavioural group lifestyle intervention sessions in 12 weeks, with a booster session after 22 weeks in addition to a pedometer to change physical activity and sedentary behaviour. In a follow-up study in 2011, DeGreef and colleagues [6] again aimed to change physical activity and sedentary behaviour through a 24-week intervention that included a pedometer, a single face-to-face session, and seven telephone consultations. Burke et al. [1] aimed to change physical activity and nutritional behaviours through education, goal setting, and 6–10 phone calls and/or 2–5 emails over the 6 month intervention. Kallings and colleagues delivered a 6-month physical activity prescription intervention that included patient centred counselling where they were provided an individualized exercise prescription and counselling to help them set their own goals [22]. Finally, Chin A Paw and colleagues [3] assigned participants to a twice a week resistance training programme, a functional skills training programme, or a combination of the two over a 6-month period. Most of these studies included frequent contact with study staff and some form of goal setting, while only a few gave explicit instructions to change sedentary behaviour.

19.3.5 Effectiveness of Physical Activity Interventions to Reduce Sedentary Behaviour

Overall, there was a large range in the magnitude of change in sedentary behaviour, extending from no significant change in sedentary behaviour to a decrease of 1 h and 15 min. Of those studies that showed a significant change (compared to the control group) in sedentary behaviour, decreases ranged from a reduction in Actigraph-measured sedentary behaviour of 23 min after a 24-week intervention [20] to a 72 min/day decrease in Actigraph-measured sedentary behaviour after a

12-week intervention [18]. Mutrie et al. showed a significant decrease in ActivPAL-measured sedentary behaviour by 48 min over 12 weeks (compared to control group) [21]. Finally, Burke et al. showed a 50.7 min/day decrease in IPAQ-assessed sedentary behaviour after a 6-month intervention [19]. Only one study did not show a change in sedentary behaviour as a result of the 6-month intervention [17]. However, this intervention focused on changing habitual physical activity through engaging in strength and/or functional training two times per week. Additionally, although Kallings et al. showed a significant within group decrease in IPAQ[2]-reported sedentary behaviour (−2 h/day), the change was not significantly different than the control group (−1 h/day) [22]. Therefore, it appears that interventions that aim to change physical activity or both physical activity and sedentary behaviour through an increase in aerobic-style physical activity will significantly reduce sedentary time in as little as 12 weeks, regardless of the subjective or objective sedentary behaviour assessment tool employed.

19.3.6 Sustainability of Changes in Sedentary Behaviour in Response to Physical Activity Interventions

A few studies followed up on the sustainability of the intervention. Mutrie et al. showed a 41-min reduction in sedentary behaviour after a 12-week intervention and a 12-week follow-up period, only a 7-min increase in sedentary behaviour from the end of the intervention to the end of the follow-up period [21]. De Greef and colleagues showed a significant decrease in sedentary behaviour (−23 min/day) after a 4-week intervention focusing on physical activity and sedentary behaviour [20]. The reduction in sedentary behaviour was still significantly lower (−12 min/day) than baseline after 1 year, albeit an attenuated effect. Alternatively, results from De Greef et al. were not as favourable [18]. Despite showing a significant reduction in sedentary time (−72 min) in the intervention group compared with controls after the 12-week intervention, after 1 year sedentary behaviour levels of both the intervention (−6 min from baseline) and control (−15 min from baseline), groups returned to baseline levels of physical activity. Therefore, based on the results from these studies, the sustainability of changes in sedentary behaviour as a result of these interventions remains inconclusive.

According to accelerometer data, most of the change in sedentary behaviour was largely replaced with light-intensity physical activity [18, 20]. According to self-report, changes in sedentary behaviour were accounted for by increased strength exercises, walking, and vigorous intensity activity [19] or by physical activity of at least moderate intensity [22]. Therefore, similar to interventions that primarily aim to change sedentary behaviours, these interventions that focus on physical activity show that there is variation in the activity behaviour and intensity that replaces

[2]IPAQ—International Physical Activity Questionnaire

sedentary behaviour, and this replacement behaviour is likely dependent on the physical activity intervention applied.

A few studies evaluated the effects of changes in sedentary and physical activity behaviours on cardiometabolic risk factors [18, 22] or constipation [17]. Although favourable changes were seen in some cardiometabolic risk factors [22], due to changes in both physical activity and sedentary behaviour, the effect of sedentary behaviour cannot be determined.

19.4 Summary

Very few studies have attempted to reduce sedentary time in the elderly, with half focusing primarily on reducing sedentary time and half focusing on increasing physical activity. Studies have shown that sedentary behaviour can change. To date, interventions have shown these decreases in sedentary behaviours to be a small portion of the waking day (~3% or a 30 min change). The changes can happen rapidly, but it is not fully understood whether these changes can be increased with the application of different behavioural theories or interventional techniques. Further, it is not known whether these changes in sedentary behaviour can be sustained.

There are many questions that remain to be answered. Probably the most important, but difficult to answer, *What is the optimal amount of daily sedentary behaviour that an elderly should engage in?* Some sitting is healthy and restorative for the mental, emotional, or physical well-being. Some sitting is necessary and done for a purpose. But research suggests there is a point where one sits too much and for too long a duration. Secondly, *Can changing sedentary behaviour have an impact on the health and well-being of an individual?* We should not strive to change a behaviour for the sake of changing that behaviour. There needs to be a physical, cognitive, emotional, or social benefit to the change in behaviour. Third, *What types of interventions will produce the largest and most sustainable change in sedentary behaviour?* The studies reviewed in this chapter have not included interventions that have attempted to alter the social or physical environment for an elderly to reduce sedentary time—most have relied on education, self-regulation, and goal setting. Changing the cues to be sedentary may have a substantial impact on daily sedentary behaviour; however, we have yet to experimentally determine this. This has been shown to be particularly effective with worksite interventions (sit-stand work stations). Therefore, future interventions should focus on altering social and environmental aspects to reduce sedentary behaviour. Finally, *What behavioural change theories will be most successful in changing sedentary behaviour?* We do not know the most effective behaviour change theories, techniques, or intervention components to reduce sedentary behaviour, although recommendations have been made for adults [16]. Interventions within the elderly have relied on Social-cognitive theory, Behavioural choice theory, and Empowerment theory, with some studies not mentioning the theory(ies) employed. Therefore, future

research should focus on determining those theories, techniques, and intervention components that have the largest impact on sedentary behaviour.

Given that the elderly are one of the most sedentary segments of the population, and they have the highest rates of chronic acquired disease and disability, there is an immediate and urgent need to understand how to change these behaviours. The human body is designed to be moving and active, and there are negative consequences of inactivity as is evidenced by our growing epidemic of chronic disease in our population. Additionally, our environment and modern day lifestyles are designed for us to move as little as possible; therefore, there is a great need for further research in this area.

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