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An investigation of the Sled-Push Exercise in Older Adults: Physiological Quantification, Perceived Enjoyment and Body Discomfort

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Healthy aging is defined as the process of maintaining and developing functional ability that allows a state of mental and physical wellbeing. Physical activity, particularly exercise training, has been highly recommended for individuals of all ages, especially older adults, as way to maintain, improve or restore functional ability and health. Different modalities and types of exercise have been successfully tested in older adults but not much is known about the potential of the sled-push exercise in this population, a modality that has been highly used among athletes to improve cardiorespiratory fitness, muscle strength and endurance, and core stability.

PURPOSE: The present study examined physiological and psychological changes during an acute progressive session of sled-push exercise among older adults and compared that to a walking session. METHODS: 40 apparently healthy older adults of both genders were enrolled in the study but the final analytical sample comprised 36 individuals due to data loss of 4 participants. Participants were randomly assigned to either the sled-push or walking group. Both groups exercised at similar relative velocities, pushing the sled equipment or walking a 30-meter course 6 times with 2-minute resting between each exercise bout. Participants pace during each velocity was monitored and controlled using an online metronome connected via Bluetooth to a
phone. Exercise session lasted about 75 minutes. Physiological measures included: heart rate (HR), blood pressure (BP), blood lactate (LAC), rate of perceived exertion (RPE), and body discomfort immediately after, 24- and 48-hours post-exercise. Psychological measures included: enjoyment, which was measured during and post-exercise session, and feeling. Data analysis was conducted using SPSS version 26, and significance was set at $p < .05$. Mixed-factor ANOVA was used to test differences between exercise groups and velocities with partial-eta squared and Cohen’s $d$ used as effect sizes. RESULTS: Significant differences ($p < .05$) between the sled-push and walking group and within different velocities were observed for HR, systolic BP, LAC and RPE with moderate-to-large effect sized being observed ($\eta^2_p = .34 – .64$). Body discomfort was observed in only $1/3$ ($n = 6$) of the participants in the sled-push group with the intensity of the discomfort being relatively low (1-3 out of 10-point scale). No significant difference ($p > .05$) was observed between groups or velocities for enjoyment (during or post-exercise session) or feeling. CONCLUSION: The findings of the present study demonstrate that an acute session of progressive sled-push exercise may be able to elucidate positive physiological adaptations to cardiorespiratory and neuromuscular system that are superior to the walking, while producing minimal (although expected) discomfort. In addition, participants’ feelings during the exercise session of the acute progressive sled-push session remained in the positive category, and the session further revealed to be as enjoyable as the walking session, with values that can be considered important for exercise adherence.

**Keywords:** Elderly, exercise prescription, healthy aging, physical activity
AN INVESTIGATION OF THE SLED-PUSH EXERCISE IN OLDER ADULTS:
PHYSIOLOGICAL QUANTIFICATION, PERCEIVED ENJOYMENT,
AND BODY DISCOMFORT

BY
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Dr. Emerson Sebastião
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CHAPTER 1
INTRODUCTION

The average age of the population is only expected to become older. The number of those aged 60 years and older is expected to increase between the years 2015-2050 from 12 percent to 22 percent, and by the year 2020 it was expected that peoples aged 60 and older would outnumber those that are 5 years and younger (WHO, 2018). In the United States, the population aged 65 years and over currently comprises 16.5% of the total US population and is predicted to be 20.6% by the year 2030 and 22% by the year 2050 (Statista.com, 2021).

Aging is a natural process characterized by a progressive decline on all physiological systems, including the cardiovascular and neuromuscular system, leading to reduced function and increased vulnerability to disease development and death (Knapowski et al., 2002). People worldwide are living longer, and the majority can expect to live beyond 60 years of age however, this does not mean that they are necessarily healthier than their parents were at the same age. Significant proportion of older adults can still develop one or more chronic condition, experience functional limitations, and difficulties in performing activities of daily living (WHO, 2018). The World Health Organization (WHO) defines healthy aging as the process of maintaining and developing functional ability that allows a state of mental and physical wellbeing (WHO, 2020). To this end, preserving function is an important challenge for countries presenting with a fast-aging population.

Functional ability is determined by the individual’s intrinsic capacity, and it is strongly associated with behavioral factors such as physical activity. There is compelling evidence
describing the benefits and the importance of physical activity, particularly exercise training for older adults (Chodzko-Zajko et al. 2009; Langhammer et al. 2018). In addition, the WHO recently issued new recommendations for physical activity for individuals of all ages to achieve health and quality of life (WHO, 2020). However, physical activity levels tend to decrease with aging, with older adults presenting with lower level of physical activity participation compared to young individuals. For instance, a study conducted by Troiano and colleagues performed research with approximately 7,000 individuals showed that children 6-11 years of age average 10-16 minutes of vigorous physical activity per day whereas adults aged 60 and older did not differ from zero. The authors also observed lower adherence to physical activity guidelines measured through accelerometry among adults (less than 5%) (Troiano et al., 2008).

There is a link between aging and physical inactivity that has a profound decrement on older adult’s capacity to perform satisfactorily activities of daily living. Physical inactivity accelerates the reductions in the cardiorespiratory capacity, the loss of muscle mass and muscle strength, resulting in frailty (Merchant et al., 2021). Frailty leads to a loss of independence, creating loss of mobility, reduced quality of life, and worsening of other diseases such as cardiovascular diseases and the inability to tolerate different physical exertion (Paneni et al., 2017). Regular exercise training has the potential to mitigate and even reverse frailty. In terms of exercise, it has been shown to improve functional ability, prevent or delay the onset of chronic diseases and other debilitating conditions, and decrease all-cause mortality (Chodzko-Zajko et al., 2009). However, older adults’ participation in exercise program is very low, and those who start an exercise regimen tend to quit within 6 months. One possible explanation could be related
to the lack of enjoyment, an important variable within exercise adherence. Thus, given the well-known benefits of exercise training for this population, it is important to examine the potential of other exercise modalities to provide an expanded “menu of exercise options”.

One such exercise modality is the sled-push exercise. This is an easy-to-perform exercise that requires an individual to push a resisted sled for a short distance (e.g., 10-30 meters) for repetitive times. The sled push has been highly used among athletes for the development of cardiovascular and muscular fitness and elicits the core musculature in a similar manner as a barbell squat (Maddigan et al., 2014). This modality could also be potentially suitable for older adults, even among those making use of assistive devices for locomotion, such as walkers. However, we did not find any study using the sled-push exercise among older adults. Should the sled push produce similar results for older adults as it does for athletes, then this type of exercise would be one additional exercise option for this population. Although it would seem logical to extrapolate out that the sled-push would engender similar results for older adults like those observed in athletes, it is important to examine whether or not it would engender physiological stress at levels recommended for physiological adaptations, mostly because the type of intervention would require adaptions. As well as perhaps most important, whether or not older adults enjoy this type of exercise. Enjoyment is a key component to exercise adherence (Datta, 2016). Further it is also important to investigate whether such exercise modality is safe for this population.

Based on the aforementioned, the purpose of the present study is to quantify physiological and psychological changes during an acute session of sled-push exercise among older adults and compare that to a walking exercise session. Specifically, this study will examine changes in heart rate (HR), blood pressure (BP), blood lactate (LAC), rate of perceived exertion
(RPE), perceived level of enjoyment and body discomfort. We hypothesize that a single bout of progressive sled-push exercise will produce physiological changes that are superior to the walking session, and that chronically are capable of engendering physiological adaptations in this population based on the assessment of selected physiological markers. We also hypothesize that levels of enjoyment will decrease as the intensity of the exercise session increases; and that participants in the sled-push exercise will report low levels of body discomfort immediately after, and 24 and 48h post-exercise session.
CHAPTER 2

Literature Review

This study will investigate sled-push exercise for older adults while quantifying the specific physiological markers and psychological assessments of enjoyment and body discomfort and compare that to a walking exercise session. The Review of literature comprises the following sections, (1) Aging population and definitions, (2) Cardiovascular and neuromuscular changes with Aging, (3) The importance of exercise for older adults, (4) Exercise prescription for older adults, (5) Sled-push and inter-related terms, and (6) Exercise and enjoyment.

2.1 Aging Population and Definitions

In general, aging is viewed as changes that take place in the organism throughout the life span. Such changes can be good, bad or neutral. One of the definitions of aging brought by the Merriam-Webster defines aging as “to become old” and “show the effects or characteristics of increasing age.” However, other literature looks more towards the physiological functioning to define what aging is. Aging is marked with a gradual decline in many organ functional reserve systems, which cause a lowered ability to maintain homeostasis, as well as a decline in both afferent and efferent pathways (Knapowski et al., 2002). Other authors concluded a similar definition of aging in that, aging is distinguished by a decline in skeletal muscle, cardiac, and respiratory functioning, thus leading a toward a decline in levels of daily physical activity and an increase risk in the development of diseases (Morrison & Newell, 2012).

The United Nations define older person as those who is over 60 years of age. In 2017 the United Nation (UN) released a report about the global shift that is, has been, and will continue to
occur, the aging of persons throughout the globe. According to the report, those aged 60 years and over were 962 million persons, and by 2030 this number is expected to increase to a total of 1.41 billion persons – expecting to outnumber those 10-24 years of age (United Nations, 2017).

It is important to highlight that not all parts of the globe are aging at the same rate, and this is due to different reasons. This demographic transformation caused by a rapidly aging population is new for the United States but not for other countries like Japan - the world’s oldest population, and certain European countries. In the United States, there are more than 46 million older adults aged 65 and older; by 2050, this number is expected to grow to almost 90 million. An interesting data point that between 2020 and 2030 alone, the time the last of the baby boom cohorts reach age 65, the number of older adults is projected to increase to 77 million as compared to under 18 which is projected to be 76.5 million person. By the year 2060 it is projected that one in four Americans will be over the age of 65 (Nasser, 2021). Currently, older adults in the United States account for approximately 16% of the American population, and by the year of 2060, this number is projected to reach 23.4% (Figure 1). For the first time in US history, older adults are projected to outnumber children by the year of 2034.

Figure 1. Percentage and number of children and older adults in the United States over the years and projections to 2060.
2.2 Cardiovascular and Neuromuscular Changes with Aging

Age is a key component in the development of cardiovascular disease (CVD), and this is due to a host of physiological changes that typically present. These changes include changes in aorta stiffness, endothelial functioning in the vasculature, myocardial perfusion, aortic pulse wave, left ventricle remodeling, and decrease in diastolic pressure. Aortic stiffness happening in the absence of disease is thought to be due to two primary factors. These factors are a decrease in elastin and increase in collagen. When this happens, this can lead to a rise in aortic wave velocity and pulse pressure which can naturally lead to a cardiac event. The fall diastolic pressure affects the ability of the heart to perfuse the necessary amount of oxygen rich blood. This change not only affects the arteries but can also create changes in the tunica intima of the cardiac arterioles, only furthering the limitation of much need oxygen rich blood. Left ventricle pressure increases left ventricular afterload, which is a determining factor of needing oxygen demand for the left ventricle. If the left ventricle is subject enough to a sustained increase in systolic pressure, the left ventricle will experience an unhealthy hypertrophy. It has also been found that there is reduced bioavailability of nitric oxide (NO), which is a vasodilator. Endothelial dysfunction and artery stiffness are interconnected and expose the arteries to pressures that can lead to damage, which only further compound the risk for CVD and cardiac events, impacts quality of life and abilities to perform physical activity and exercise (Craighead et al., 2019; Kovacic et al., 2011; Paneni et al., 2017).

A literature review conducted by Paneni and colleagues provides a detailed demonstration of the changes occurring in the cardiovascular system during the aging process (Panini et al., 2017). Figure 2 summarizes main changes highlighted in their study. Briefly, it is possible to observed that throughout the aging process, changes in the left ventricle such as non-
healthy hypertrophy, increase in systolic blood pressure, as well as less elastin being produced with a concomitant increase in collage production in the aorta which increases the stiffness. This increases the risk of damage to the cardiovascular system. There is also a decrease in diastolic blood pressure, which leads to less perfusion of the cardiac musculature, which increases the risk of heart attack.

Changes in the neuromuscular systems are also very significant during the aging process. In a study by Zeynep and colleagues, the authors recruited and enrolled 20 participants, where 10 for the young group (20-37 years old) and 10 for the elderly group (65-88 years old). All subjects were ruled out to have any neurological issues that would interfere with the testing protocol and results obtained from the study. The authors used an intramuscular needle to record the EMG signals. The results that the authors found were that, are structural changes i.e. (atrophy or sarcopenia), decreases in fast twitch motor units, motor unit size, with an increase in slow twitch motor units (Erim et al., 1999). Similarly, Pratt and colleagues in their review noted that there are also structural changes that occur at the neuromuscular junction itself. These changes include

Adapted from Panini et al. (2017)

**Figure 2.** Structural and physiological changes to the aging cardiovascular system.
presynaptic area i.e. (increase in length and number of the terminal branches), however, this is thought to be due to less acetylcholine (ACh) being produced, there is a concomitant restructuring of the folds, on the motor end plat folds i.e. (postsynaptic area, which creates less ACh receptors being available. There are also mitochondrial structural changes that can have a deleterious effect on cholinergic transmission. Though there is a paucity of evidence in the human model as compared to the rodent model (Pratt et al., 2021).

A study by Hunter and colleagues (2016) didactically demonstrates changes occurring in the neuromuscular system and motor performance during the aging process. Figure 3 below modified from the original article, summarizes such changes.

<table>
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<th>MOTOR NEURON</th>
<th>NEUROMUSCULAR JUNCTION</th>
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<tr>
<td>MU number</td>
<td>Pre-synaptic vesicles</td>
<td>Fiber number</td>
</tr>
<tr>
<td>Collateral sprouting</td>
<td>Overlap of pre-synaptic vesicles &amp; post-synaptic receptors</td>
<td>Satellite cell number</td>
</tr>
<tr>
<td>MU size</td>
<td>Pre-synaptic branching</td>
<td>Fiber size</td>
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**Physiology & Function**
- Voluntary activation
- Conduction velocity
- MU discharge rate
- MU recruitment range
- Synaptic noise
- Voluntary activation variability
- MU discharge rate variability

**Motor Performance**
- Maximal Force
- Maximal Shortening Velocity
- Rate of Force Development
- Maximal Power
- Force Steadiness
- Fatigability: Isometric ~30 yrs.
- Fatigability: Fast Dynamic
- Variability in Fatigability

![Figure 3](image.png)

**Figure 3.** Structural and physiological changes to the aging motor unit (MU) and motor performance outcomes.
2.3 The Importance of Exercise for Older Adults

As people age there is a natural decline in physiological, and mental health. As these declines happen, older adults tend become less active, and perform less physically demanding forms of physical activity and exercise. Morrison & Newell found that there is a general decrement in skeletal muscle as people age, which can have significant effects on lean muscle mass, increasing the risk for the development of diseases (Morrison & Newell, 2012). In a review by Kovacic and colleagues it was noted that as persons age, the pulse wave that normally is reflected back towards the heart in younger people tends to be reflected more away from the heart. A cascade of effects follows, which can lead towards a higher workload for the heart during systole, stiffing of arteries i.e. (loss of production of vascular endothelial dilator NO), ventricular hypertrophy, an increase in BP, and other critical organs such as the kidneys and brain (Kovacic et al., 2011). In another study it was also found that the cardiovascular system is impacted by the normative aging process and found similar dysfunction such as ventricular hypertrophy, stiffing of arteries, increase in BP (Craighead et al., 2019). However, Craighead and colleagues also reported in his review that continuous aerobic training elicited cardiovascular benefits for middle and older adults, including a reduction of systolic BP in both normotensive and hypertensive people, preserving atrial elasticity and endothelial dysfunction. It was also found that time-efficient work outs i.e. (HIIT and SIT) produced similar results in SBP, cardiac ejection fraction at rest, and vascular function i.e. (arterial stiffness in middle aged persons), however, it he found mixed results for older adults (pp. 1428-1430). Likewise, in the ACSM position stand Chodzko-Zajko and cohort suggested that cardiovascular training in middle aged and older adult population i.e. (normotensive individuals), a smaller rise in systolic and diastolic
BP, reduction in large artery stiffness, improvements in baroreflex and endothelial function (Chodzko-Zajko et al., 2009).

Stensvold and colleagues performed a randomized controlled trial investigating the exercise effects of five years on all-cause mortality, known as The Generation 100 Study (Stensvold et al., 2020). Participants in this study were free from cardiac dysfunction i.e. (hypertension, symptomatic valvular disease, hypertrophic cardiomyopathy, heart failure), diagnosed dementia, cancer (that made the participants participation non-viable), illness, chronic communicable disease, or disability that would preclude exercise participation, and were enrolled in another study. The participants were randomized using a 2:1:1 ratio based on cohabitation i.e. (living with someone or living alone), and by sex. They were place in either, the control group (n=780) which followed the Norwegian national guidelines for physical activity (30 minutes of exercise at a moderate intensity on most days and no other oversight happened), for moderate continuous intensity training (MCIT) (n=387), and high intensity interval training (HIIT) (n=400). The MCIT and HIIT groups were asked to give 2 of the five days of the Norwegian guidelines with either a 4x4 minute at an intensity of 90% of peak HR, which was corresponded to the RPE rating of about 16, or two 50-minute bouts of MICT style training around 70% of peak heart rate, again corresponding to RPE of around 13 for the rating. All three groups were asked to maintain this for five years respectively. Both MICT and HIIT groups were to meet separately with and train with an exercise physiologist every six weeks. While in that training session both RPE and HR monitor were used to assess proper exercise intensity for both groups. Both MICT and HIIT also had the ability to train with an exercise physiologist twice a week in several outdoor areas. Adherence to all three groups was determined by a validated questionnaire at three separate times, i.e. (at one, three, and five years). Ergo-spirometry was
used to determine the participants peak O2 uptake, this was done at baseline testing at one-, three-, and five-year marks. Peak HR was determined using the Polar Electro, Finland. Peak HR was determined by 5 beats above what was observed during the peak O2 uptake with use of an ergo-spirometry test. Quality of life (QOL) was assessed by use the SF-8, which the authors stated is a valuable tool to detect small changes and is useful for interventional studies such as this one. The authors of this study found no significant difference between the control group and the combined MICT and HIIT group, they also did not find significant difference between MICT and HIIT group in all-cause mortality. These finding suggest that depending on the individual’s personal preferences, either of the three modalities would engender a decrease to all-cause mortality rates. The control was at 4.7% and the combination of HIIT and MICT was at 4.5% as compared to the 10% all-cause mortality rate found throughout Norway (Stensvold et al., 2020). Researchers have also focused on those in the population that have chronic disease such as cardiovascular, metabolic i.e. (type II diabetes mellites), pulmonary dysfunction and how exercise can be used a medicine to help enhance or preserve functioning of cardiovascular, pulmonary, and skeletal muscular systems. As people age, they are predisposed towards greater potential to the development of these disease. While MICT has been studied for its ability to help in the mitigation and rehabilitation of chronic diseases and the effects of aging, Ross and cohort in their review set out to elucidate the role of HIIT in the rehabilitation of the aforementioned chronic conditions. Their findings suggest that there is a growing body of evidence for the use of HIIT as a safe and effective therapy for cardiovascular disease persons, however, there is not as much data on HIIT therapy for pulmonary dysfunction, however the current literature suggests that HIIT is at least just as effective as MICT, and that HIIT was just as effective at helping to alter body composition for those with type II diabetes mellitus (Ross et al., 2016). Similarly, in a
study by Rognmo and colleagues performed a random control trial with 21 participants with patients with cardiovascular disease (CAD), looked at the effects of two different training modalities of HIIT and MICT on VO$_2$ peak. All subjects were randomly placed in either HIIT or MICT protocols respectively. The authors found that while both HIIT and MICT produced beneficial results in the VO$_2$ peak, the HIIT protocol produced greater benefits in the patients as compared to the MICT (2004). This study holds important weight for the older adult community as Paneni and colleagues through their review suggest that age is a dominant factor for the development of CAD, as well as the development of CAD being a predictor of the development of developing fragility (Paneni et al., 2017).

Researchers also are focused on functional mobility and balance training for the older adult population, as one of the greatest risks and fears for an older adult is falling. Functional training and balance training is linked directly to older adults’ ability to maintain independence and be physically active. Woollcott and Shumway-Cook suggest that postural control is determined primarily by the activation of gastrocnemius (GA) and tibialis anterior (TA) lower limb musculature (Woollacott & Shumway-Cook, 2002). In their study Maddigan and colleagues used a randomized cross-over design with n = 10 healthy weight trained males, all had at least 2 years of resistance training experience and were familiar with the sled-pushing style of exercise. All 10 participants partook in both exercises (squat and sled-push protocols). EMG was used on GA, lower quadriceps, lower abdominals (internal obliques and transverse abdominus). The results suggest there was greater activation of the GA during the sled-push as compared to the squat and that there was statistically similar activation of the quadriceps for during the squat and sled-push protocols. The authors concluded that the sled-push modality was effective at eliciting muscle activation that enhances muscular strength of the lower limbs.
(Maddigan et al., 2014). In another study by Rosario and Rosario and Mathis that looked at muscular activation time between pushing the XPO trainer (sled on wheels with automatic break, that increases resistance as speed increases). In their respective studies used both males and females 24.6 ±3.6 years of age with the purpose of determining the impact of XPO trainer (sled-push) at both self-selected low and fast-paced pushing on neuromuscular activation on young and apparently healthy adults. The authors found a greater i.e. (quicker) neuromuscular activation of GA and, but not as great for the TA. The authors suggest that their findings prove that the sled-pushing affected the gait parameters with run pushing the sled having a faster gait cadence than pushing as compared to walk pushing. However, there was increased neuromuscular activation with both speeds and that the XPO sled- push modality is a viable RE training option that can enhance both neuromuscular and gait parameters (Rosario, 2020; Rosario & Mathis, 2020).

The studies compiled in this sections demonstrated that exercise is important to help promote healthy aging, help mitigate and reverse several chronic conditions that people tend to be more at risk for developing through the natural aging process. It has also been demonstrated that the sled-push exercise modality may at least offer neuromuscular benefits that can improve gait parameters, which may have an effect of those with impairments in their gait capabilities. Exercise is pivotal in maintaining one’s health, so an assessment of available options and standard practice is needed.

2.4 Exercise Prescription for Older Adults

Age is a primary factor in the status of people baseline health. As people age, they typically at a higher risk for the development of chronic conditions. However, it is possible to
age healthfully, mitigate, and even reserves some of these chronic conditions by staying physically active and utilizing exercise is key to helping older adults live full independent lives, maintain mobility for longer, and increase healthful life span (Hurst et al., 2019).

The ACSM in its position stand in 2009 presented a special report detailing its guidelines for physical activity and exercise for older adults. The position stand states that for aerobic i.e. (endurance) exercise older adults should accumulate through a minimum of 10-minute bouts 3 times a day or 30 minutes of continuous exercise of moderate intensities on most days of the week. This should total 150 minutes per week, or 75 minutes a week at higher intensities of exercise. In particular the authors found that aerobic exercise training at an intensity of ≥60 of VO$_{2\text{max}}$ 30 minutes a day was sufficient to produce benefits in overall VO$_{2\text{max}}$ and found that sex differences do occur with males seeing an increase in maximal cardiac output, as well as systemic arteriovenous O$_2$ difference. Whereas females almost exclusively rely on the widening i.e. (greater) arteriovenous O$_2$ difference. More benefits occur when this population goes above the recommended daily and weekly minimum. However, it is important to note that this must be done with care as severely deconditioned individuals will need less and be able to tolerate less as they start this style of exercise. The suggested modalities for aerobic training are walking, aquatics, or bike exercises. Resistance training it is recommended that older adults should be done a minimum of 2 days a week at moderate (5-6) or vigorous (7-8) out of 10 intensities. Weight bearing exercises can utilized, as well as use of weights and machines. Between 8 to 10 exercise that utilize major muscle groups with a repetition range from 8 to 12 should be utilized to incur health benefits. Flexibility should be performed at least 2 days a week and should focus on static rather than ballistic. The type of the flexibility training should be any activity that either maintains or increases flexibility and should be done at moderate intensities of (5-6) out of 10.
The ACSM, as of this writing does not hold any specific recommendations for balance guidelines the authors do suggest that it should be done by individuals that have a high falling risk or have falling history, as well as those with mobility issues. The position stand suggests using progressively harder balancing poses as well as challenging sensory postural muscle groups (Chodzko-Zajko et al., 2009).

The WHO presented its guidelines on physical activity and sedentary behavior has similar thoughts on physical activity and exercise prescription. It posits that all older adults should undertake physical activity. That some is better than none and that perform at least 150 to 300 minutes of moderate aerobic activities i.e. (exercise) at moderate intensity or at least 75 to 150 minutes of vigorous intensity of physical activity. Older adults are also encouraged to blend to the two intensities during the week to help elicit health benefits. The WHO also suggest performing strengthening activities i.e. (resistance exercises, such as body weight, weight machines), at least two days a week or more. This is because doing more has shown to produce greater health benefits than just accumulating the minimum, and this holds true when blending both moderate and vigorous intensities. It is also suggested that older adults should do a varied physical activity that is multicomponent in nature and emphasizes balance in a functional capacity. (Bull et al., 2020).

In a review of time-efficient physical training for older adults Craighead and colleagues found that the commonly studied HIIT protocol of 4x4, 4-minutes of exercise at high intensity intervals combine with 3 minutes of active recovery was effective at saving time, build cardiorespiratory fitness, and improving cardiovascular functioning. It was also noted that that HIIT training with older adults has not been as well studied in older adults as compared to athletes, and suggested ideas for future studies that include sex differences, what specific
interval protocols would be beneficial, assess the cellular mechanisms by which adaptations CV happen, identifying appropriate modalities i.e. (stair climbing walking, bike riding) that would work best for those with mobility issues (Craighead et al., 2019). However, Hurst and colleges performed a study a 12-week randomized study on HIIT protocol and both upper and lower body strength and endurance. 36 individuals (adult males) aged 50-81 who were healthy, not on medication that could alter findings or exercise ability and who had not for the previous year been enrolled in a structured exercise program were randomly assigned to either no exercise control group CON (n=18) or to the high intensity interval training HIT (n=18). The HIT intervention was performed with the novel double-concentric, hydraulic resistance ergometer (Speedflex, AlphaTech Inc, Nelson, NC, USA). The HIT group performed two session per week with 72 hours between sessions. Every session was supervised, and all participants had an approximate 6-minute warm-up that consisted of full-body exercise that were used as the HIT training i.e. (upper-body: should press, bent over row, lower body: squat, split squat, Full body: pulldown to squat, high pull, power clean and press, and step and press). Participants performed 4 sets of high intensity training. Each repetition at the begging was 45 seconds long, followed by 15 seconds to transition to the next exercise. All the warm-up exercises were used in the HIIT protocol; however, order of the exercises was changed throughout session and not every exercise was done every session by the participants as long as a full-body workout was completed. Through the duration of the study, the length of the repetitions got longer, up to 75 seconds, so the exercise session went from 12 to 20 minutes with a 4 min cool down after. The overall findings of this research we possible trivial when looking at both dominant and non-dominant leg power, for handgrip strength it was likely trivial, for predicted VO\textsubscript{2max} there was a likely small benefit. For health-related quality of life, there was thought to be a small benefit effects vitality,
mental health, and general health. The authors of this study suggest that this supports a HIT style of training or RE for adults >50 and older adults >65 years of age, and gives further confidence in HIIT style being a viable option for the older adult population (Hurst et al., 2019). With the physiological aspects of exercise have been determined a look at exercise enjoyment is needed.

2.5 Sled-Push and Inter-Related Terms

Sled-pushing can be defined as a specifically as a weighted or resisted sprint training (Cahill et al., 2019), and has been used as well for the development of cardiovascular fitness and strength enhancements in athletes (Maddigan et al., 2014). However, for the purpose of this research it should be thought of as resistant exercise, as means to develop cardiovascular fitness and strength. Resistance exercise is an umbrella term, used to describe exercise that requires the production of force developed against resistance (Rosario, 2020; Brown et al., 2017). This training modality has been utilized by practitioners for people of all ages to help incur health benefits. Cardiovascular fitness is defined as the body’s ability of the circulatory, respiratory, and muscular systems to supply oxygen to sustained physical activity and exercise i.e. (aerobic training) (American College of Sports Medicine, 2013). Aerobic training is defined as bodily movement of large muscles for a prolonged period of time, and exercise is defined as any planned, structured, and repetitive movement to improve or maintain any or all components of physical health (Chodzko-Zajko et al., 2009). Cardiorespiratory fitness is typically achieved through two main exercise modalities, the first one being moderate continuous training (MICT), which is per the ACSM guidelines of 150 minutes of moderate intensity or aerobic training or 75 minutes of vigorous aerobic training throughout the week (Lee et al., 2017), and the second most common way is through high intensity interval training, which is interspersed bouts of high
intensity of 75% or greater of VO$_{2\text{max}}$ with accompanying lower levels of activity between 40-50% of VO$_{2\text{max}}$ or passive rest (Hurst et al., 2019; Ross et al., 2016). The development of cardiorespiratory fitness and specifically peak VO$_2$ is especially important for older adults as it is one of the best markers of health and risk of mortality for individuals and especially for the aging individual (Imboden et al., 2018; Kavanagh et al., 2002) This leads naturally to the idea of what aging is.

The aforementioned briefly defines sled-push and inter-related terms that will be used throughout this document.

**2.6 Exercise and Enjoyment**

Enjoyment should be thought of as an immediate reward that brings about a psychological state that is linked to feelings such as fun, liking, and pleasure. This can be tied to and applied towards exercising behavior as people will exercise in the forms that they find enjoyable (Datta, 2016). In a study done by Datta and colleagues done on exercise enjoyment, personality and physical activity on young adults, they enrolled 53 undergraduates 22 were males and 31 were females. Exercise enjoyment was quantified using the physical activity enjoyment scale (PACES), personality was quantified using the NEO- Five Factor Inventory (NEO-OFFI), and physical activity was quantified using the IPAQ. Physical activity preparedness was assessed using the (PAR-Q), and mood was assessed by using Exercise - Induced Feeling Inventory (EFI). Exercise was performed on a stationary bike i.e. (Monark model 818E, Varburg Sweden), with blood pressure measured by use of an automatic BP machine, i.e. (Omron BP monitor, Model CVSBPAUTO), and heart rate was measured using a Polar HR monitor, where it was measured to keep the participants at a moderate HR that
corresponded to 65% of their maximal HR. The exercise session was 30 minutes with five minutes for both warm-up and cool down. The results they found were that there was a strong correlation between physical activity and enjoyment of exercise. Specifically, that, higher level of physically active people enjoyed exercise more than moderately active participants (Datta, 2016).

Similarly, another study that looked at the importance of enjoyment when promoting physical exercise by Hagberg and colleagues. There were 101 participants that complete the study and follow-up. All participants were at least 19 years of age and had some medical issue(s) i.e. (diabetes, cardiovascular disease, mental illness, obesity). They were offered three weekly group setting session. Enjoyment of exercise was measured at baseline, 3-, 6-, and 12-months follow-up. What they found was that there is that there was a strong association with exercise and level and overall enjoyment of exercise. The authors also found that exercise enjoyment started to decline as the months went on past the intervention. This is thought to be in part by the fact the intervention group had to then establish their own exercise regimen, and select their own exercise, so a change in environment, along with a change in the actual exercise taking place (Hagberg et al., 2009). The two studies in the section give a brief look into the well-established truth that those that enjoy exercise tend to be more physically active as compared to those that enjoy physical activity less. This also plays into how exercise enjoyment interplays with adherence to being physically active and exercising. A study by Heisz and cohort looked at the difference of enjoyment between HIT and MCT in regard to exercise adherence. They used a randomized control study with HIT (n=17), MCT (n=19). What the authors found was that as the training adaptations increased through the six-week study, HIT became significantly more enjoyable than MCT at week five. The study also suggest that the selection of the exercise
intensity is also important in determining how enjoyable a HIT can be. Because drop out rates are highest during the first eight or so weeks when starting an exercise program, enjoyment plays a pivotal role in exercise adherence (Heisz et al., 2016).

These studies show that enjoyment is an important variable when promoting physical activity and exercise. Enjoyment has been found to be linked to higher levels of physical activity, and exercise adherence. Promotion and adaptation of healthy exercise habits is depended on people enjoying the overall activity, as many people will not do an activity that they deem unenjoyable.

This literature review briefly describes the aging population and its challenges, the impact of aging in important physiological systems, and the importance of exercise for this age group. Healthy aging is critical as the population shifts towards becoming older, and vital importance of maintaining good health and independence later in life. It is possible however, to observe that researchers have place great emphasis in research to help elicit gains for athletes by using newer modalities of exercise, to enhance muscle activation, acceleration, strength, and stability. Compared to young age groups, older adults present with one of the least active. While current literature points practitioners of exercise prescription in the direction of eliciting healthful benefits for older adults, there is still a large potential of knowledge to be gained through studies attempting to investigate potential benefits of non-traditional exercise modalities for older adults (like the present study) with the idea of promoting long lasting exercise participation in this population. A first step for the introduction of a new exercise modality lies on testing its safety, enjoyment, and potential for physiological adaptation.
CHAPTER 3

METHODOLOGY

This chapter describes in detail the research methodology that was used in the study. It consists of a description of the research design, research measures, participants and site, data collection procedures, and data analysis. This study was approved by the Northern Illinois University’s Institution Review Board (IRB), and approval notice can be viewed in appendix “B”. In addition, all participants signed an informed consent prior to data collection appendix “C”

3.1 Research Design

The aim of the present research study was to quantify physiological and psychological changes during an acute progressive session of sled-push exercise among older adults. This study used a mixed-repeated measures design. As a type of experimental design, mixed repeated measures design involves multiple measures of the same variable taken on the same or matched subjects either under different conditions or over two or more time periods (Thomas et al., 2005). To this end, the subjects were randomly allocated into either the sled-push or walking control group using a simple randomization procedure. The randomization procedure helped to eliminate any selection bias that could have occurred in either group, as well as helps to maintain the internal validity of the study (Thomas et al., 2005).

3.1.1 Instruments of Data Collection

To assess the selected physiological and psychological variables employed in the study, we used a collection of instruments and techniques. The instruments and techniques are described below and were grouped into physiological variables, psychological variables, and
other variables. Variables included in the other variables category, were collected for sample characterization purposes.

**Physiological variables**

**Heart Rate (HR).** HR was objectively assessed using a Polar HR monitor. This instrument has shown good validity and reliability in the assessment of HR among older adults and clinical populations (Etiwy et al., 2019). A wireless chest strap monitor was placed on participants around the chest (i.e., just below the sternum), and a display watch was attached to participant’s wrist in the non-dominant hand. The wireless chest strap monitor fed information to participant’s display watch and was read from to collect the HR information at the different assessment periods.

**Blood Pressure (BP).** Blood pressure was assessed manually using recommendations published elsewhere (Muntner et al., 2019; Sharman & Lagerche, 2015). Briefly, BP was measured by a research staff with experience in the assessment of BP in different populations, including older adults, and used a correct cuff size to ensure accuracy of the measure and safety of the participant. In addition, the measurement was taken with participant in the seated position and feet flat on the floor, with the BP cuff placed on the arm at the approximate (i.e., center of BP cuff in approximate middle of the arm) level of the participants’ right atrium; and the cuffed arm held by the assessor.

**Blood Lactate (LAC).** LAC was assessed using a valid and reliable commercially available handheld device that is able to measure lactate levels in the blood (Hart et al., 2013). The lactate portable device uses a procedure similar to those used for diabetic patients monitoring their
glucose levels at home. The study used the Nova biomedical lactate plus monitor, that utilizes testing strips to collect blood sample. Before data collection, the referred device was properly calibrated following manufacturer instructions. Participants were given the option of which hand they would like to have used to have the blood sample collected. The collection site (i.e., fingertips) was cleaned using alcohol wipe, allowed to dry before the research staff used the lancet to open the collection site. The first blood sample was discarded, and only the second sample was collected and used for analysis purposes. This procedure is done to ensure the blood sample is not contaminated.

**Rate of Perceived Exertion (RPE).** RPE was assessed using the Omni 10-point scale. This scale has been found to be both a valid and reliable for different populations, including older adults (Morishita et al., 2019; Eston, 2012). In fact, the OMNI scale been shown to be a valid and reliable instrument for use in the older adult population for aerobic exercise, as well as it has been found valid and reliable for resistance training using both weights (i.e., barbells loaded and dumbbells) and resistant band exercise (Colado et al., 2012). This instrument uses an integrated approach that utilizes the afferent feedback system (i.e., cardiorespiratory, thermal, and metabolic stimuli), as well as feed-forward system to help participants of exercise determine how hard they believe they are working (Eston, 2012). This instrument has been widely used in different settings, such as in human performance testing and in people with chronic conditions. Participants were explained to verbally say and physically point at their RPE when asked (*How hard was this bout of exercise?*) during the data collection process.
**Psychological Assessments**

**Enjoyment.** Enjoyment was assessed during the exercise session using a visual analogue scale (VAS) and immediate after the exercise session being completed using the Physical Activity Enjoyment Scale (PACES) 8-item proposed by Mullen et al., 2011.

- **VAS** is a measurement instrument that tries to measure a characteristic or attitude that is believed to range across a continuum of values and cannot easily be directly measured (Gould et al., 2001). It is often used in epidemiologic and clinical research to measure the intensity or frequency of various symptoms (Dauphin et al., 1999). We developed a 10-point enjoyment scale with “0” representing "I am NOT ENJOYING it at all" and “10” representing "The MOST ENJOYABLE activity I ever did". A research staff presented the scale to the participant with the following question: *How enjoyable was this bout of exercise?* Participants were explained to verbally say out loud while pointing to a number from 0 to 10 so the information could be recorded.

- **PACES 8-item.** The PACES 8-item is a tool that tries to measure the characteristics of enjoyment of physical activity that has just been complete. The values range through a continuum that is not easily measured and is highly subjective to the participant. Overall, a higher score indicates more enjoyment has been had and a lower score indicates a lower level of enjoyment has been had with the physical activity. The scale runs from 1 to 7, with the association of the higher score demonstrating a higher level of enjoyment and a lower score demonstrating a lower level of enjoyment (Mullen et al., 2011). There are two questions that are reversed scored, as this is to ensure that the participants are reading the questions and marking the most accurate scores.
**Feeling.** Feeling was assessed using a visual analogue scale (VAS) using positive and negative anchors. The feeling scale was a 10-point, single-item, bipolar scale from – 5 (very bad) to + 5 (very good) with verbal anchors attached to all odd integers (i.e., 1 okay, 3 good, 5 very good, -1 somewhat bad, -3 bad, -5 very bad), and 0 (neutral feeling anchor). The scale measures how the participant is feeling by rating feelings both mentally and physically from the exercise. A research staff presented the scale to the participant with the following question: *How are you feeling right now?* Participants were explained to verbally say out loud while pointing to the corresponding number with their feeling.

**Body Discomfort.** Body discomfort was assessed using a body diagram commonly used in clinical settings with fibromyalgia patients (Staud et al., 2006), along with a scale ranging from 0 (no pain/discomfort) to 10 (worst imaginable pain/discomfort). Using the body diagram comprising a picture of the human figure (front and back view) separated by numbered body regions, participants were asked to identify areas of body where discomfort/pain were present and subsequently used the 10-point scale to rate the level/intensity of the discomfort and/or pain. Because delayed onset muscle soreness (DOMS) can appear hours after an exercise session, participants were also assessed at 24 and 48 hours post exercise session. Assessment at 24- and 48-hours post-exercise consisted of the researcher calling the participant who received a printed copy of the diagram and attached pain scale. The participant then reported to the researcher on all discomfort (or no discomfort) and the intensity.

**Other Variables**

We collected other variables for characterization purposes. The other variables include physical activity (IPAQ) and Godin questionnaire, mini nutrition assessment. The IPAQ
questionnaire allowed us to analyze the amount of time spent performing physical activity (i.e., vigorous, moderate, walking (per week)), and the amount of time being sedentary (i.e., sitting (minutes per day)). The Godin questionnaire allowed us to look further into the typical 7-day period of the participant and analyze the amount of physical activity within that time frame (i.e., vigorous, moderate, mild). We also had our participants answer a mini nutritional assessment to see how well-nourished our sample was. Also included in the questionnaires were questions related to the participants’ health in general, physical and mental health, as well as questions asked about any assistance needed with activities of daily living (ADL). We also collected sociodemographic information to provide a greater depth of understanding of the sample (i.e., education level, marital status, gender). These were all self-reported by the participants, with the researcher nearby to answer any questions that the participants had.

3.2 Participants and Study Site

We recruited 40 participants aged 65 years and over. This number was not based on power analysis due to the exploratory, feasibility and pilot nature of the study. Participants were recruited using a varied of methods, such as: 1) advertisements in the health and exercise research group website, 2) posts on Facebook and Instagram social media accounts, 3) flyers posted in places in the community such as near senior centers and assisted living facilities, 4) snowball technique, where participants enrolled in the study were asked to invite friends that they feel would meet the inclusion criteria, and 5) press-release posted in the Daily Chronicle. Upon enrollment, participants were randomly assigned into one of the two possible groups: sled-push exercise (SLP; n = 20) or walking control (WKC; n = 20). Participants were required to
complete and sign an informed consent form prior to data collection. The entire study took place in the Motor Behavior Laboratory and other adequate facilities in Anderson Hall.

### 3.2.1 Inclusion and Exclusion Criteria

Inclusion criteria included a) individuals aged 60 years and older; b) asymptomatic (i.e., one or fewer affirmatives on the Physical Activity Readiness Questionnaire (PAR-Q); c) medical clearance (email or a written note from a doctor stating that the person could safely engaged in moderate-to-vigorous exercise); d) willingness to complete the in-person exercise session and related assessments in a university research setting (i.e., Motor Behavior Laboratory - Department of Kinesiology and Physical Education). Of note, participants interested in participating in the study were screened via telephone in order to determine participants' eligibility to participate or not in the study. This was administered before the inform consent. Finally, the informed consent document clearly stated that participation was voluntary and could be discontinued at any time and without penalty.

Exclusion criteria included: a) individuals using wheelchair, walker, or crutches for locomotion; b) individuals with acute or chronic conditions that were not controlled (e.g., hypertension, cardiovascular disease, diabetes, chronic obstructive pulmonary disease); c) individuals that recently (last 3 months) underwent surgery in the legs or arms; and d) individuals with conditions that could have been made worse when engaging in exercise.
3.3 Data Collection

3.3.1 Step One: Inform consent, Sociodemographic and Health Data

Before participation in the study, participants were asked to sign an inform consent and complete a health and demographic questionnaire in the Motor Behavior Laboratory. The consent form instructed the participant in their legal rights as a subject during their participation in the study, predominantly that their participation was completely voluntary and may be terminated at any time for any reason of their choosing. The inform consent also provided the participant with an overview of the study protocol. The demographic and health questionnaires were designed to collect demographic and health information that was used for sample characterization.

All selected physiological and psychological assessments were performed by a trained research staff, with experience in these type of assessments. HR, BP, RPE, LAC, enjoyment and feeling were collected: 1) at rest, 2) after the 5-minute warm up period on the cycle-ergometer, 3) within the 2-min rest between each sled-push or walking bout and, 4) after 5 minutes post-exercise session. Body discomfort was assessed immediately after the exercise session, and at 24- and 48-hours post-exercise session. Figure 4 below provides a visual illustration of a participant’s visit.
3.3.2 Step Two: Determining The Sled-Push Or Walking Speeds For The Exercise Session

This study used a motorized sled-push equipment for the exercise session. The determination of the sled-push velocities that were used during the exercise session were based on the normal pace sled-push velocity measured using the sled-pushcart without any resistance (i.e., motor disconnected). The referred equipment uses an exponential resistance curve to build resistance. This means that the faster one pushes the sled, more resistance is imposed by the motor. To assess participant’s normal pace sled-push velocity, we disconnected the motor responsible for creating resistance. Participants were then asked to push the sled through a 30-meter course at their normal comfortable pace. The time to complete the course, along with the 30-meter distance was used to calculate participant’s average velocity using the following formula: $v_{av} = \Delta s/\Delta t$. This was done to individually determine the different velocities that comprised the sled-push exercise session (i.e., 75, 85, 100, and 125% of normal velocity). For the walking group, participants were asked to cover the same distance walking at their normal comfortable pace, but without the sled apparatus. Participants’ normal walking velocity was used
to individually determine the different velocities (same as the sled-push group) that comprised the walking exercise session.

### 3.3.3 Sled-Push and Walking control Progressive Exercise Session

Participants performed 6 work bouts of sled-pushing at different velocities, which were determined based on the normal comfortable pace sled-push velocity previously calculated. However, with the motor resistance connected. The velocities adopted were: 75, 85, 100, 100, 125, and 125% of the normal comfortable sled-push velocity assessed at the beginning of participant’s visit to the laboratory. We created an excel calculator to perform the calculations of meters per second, to miles per hour (MPH). From there the excel calculator computed the average MPH to the appropriate MPH for velocities of 75, 85, 100, and 125% of the normal velocities. The Excel calculator also converted the velocities in MPH to beats per min (BPM). For that, we use the known conversion values of 3 MPH being equivalent to 120 BPM on a metronome. Because the sled equipment does not have a speed sensor to track and monitor velocity to provide real time feedback to the participant and researcher, the speed was controlled using an external sensory stimulus (i.e., metronome) that matched the velocity in MPH to beats per minute (BPM). The online metronome was connected (via Bluetooth) with a speaker, which was attached to the sled-push apparatus so participants could have clear and proper audio feedback of their pace throughout the 30-meter course. A 2-minute rest was given to all participants between each work stimulus. During the 2-minute resting period, the selected physiological and psychological data were collected. All 6-work bout stimulus were performed in a 30-meter course marked in a well-suitable hallway located on the first floor of Anderson
Hall. The course was marked centered in the hallway for safety purposes, and to provide participants enough space for deceleration and sled maneuvering.

Participants in the walking control group underwent the same procedures of the sled-push group, however, without the sled. For clear and proper audio feedback of their pace throughout the 30-meter course, a spotter was walking about one foot away/behind from the participant holding the speaker and to also ensure safety during the session.

For both groups, the velocities adopted were later combined to create intensity categories: subnormal (75% and 85%), normal (100% trial 1 plus trial 2), and supranormal (125% trial 1 plus trial 2). This was done to data collection purposes.

3.4 Data Analysis

All data collected was first entered in a Microsoft Excel spreadsheet for data quality check. After the database had been cleaned, the file was exported to a more appropriate data analysis software. Data analysis was conducted using SPSS version 26 (IBM Corporation, Armory, N.Y) and significant level was set at $p < .05$ for all pertinent analysis. Data analysis was performed in different steps. First, the data was tested for normality using the Shapiro Wilk test. For normal distributed data descriptive statistics (e.g., mean, standard deviation, percentage) was used to analyze demographic and health data for sample characterization; otherwise, median and range was adopted. Mixed-factor ANOVA was used to test differences between exercise groups and velocities, and all post hoc tests were conducted using the Bonferroni correction. For the Mixed-factor ANOVA exercise modality (sled-push x walking) was the between-subject factor and velocity was the within-subject factor. Follow-up analysis was performed when appropriate. Partial Eta-squared and Cohen’s $d$ were used to compute the effect size.
Chapter 4

RESULTS

This study sought to quantify physiological and psychological changes during an acute progressive session of sled-push exercise among older adults and compare that to a walking exercise session. Specifically, this study examined changes in heart rate (HR), blood pressure (BP), blood lactate (LAC), rate of perceived exertion (RPE), perceived level of enjoyment, feeling and body discomfort. For a better understanding and visualization of the results, data are presented separated by domain: general characteristics of the sample, physiological data, and psychological data.

4.1 General Characteristics of the Sample

A total of 40 older adults were enrolled in the present study. However, we were unable to use data from four participants (SLP, n = 2; and WKC, n = 2). This was due to malfunction of the HR device, or too many missing information during the exercise session. Thus, the final analytical sample consisted of 36 older adults. Table 1 displays in detail the information of the sample regarding sociodemographic, anthropometric, health and behavior characteristics for the entire sample and separated by exercise modality (sled-push vs. walking). Briefly, the average age of the participants was 69.2±4.7 years with no significant difference ($p > .159$) between groups. The majority of the participants were female (60%) with an average body mass index (BMI) of 27.3±5.9 kg/m$^2$. Additionally, the median number of chronic diseases was one with half or more of the participants reporting their overall, physical, and mental health as very good.
Overall, participants further reported high levels of physical activity and approximately 6 hours per day of sitting time.

Table 1. General sociodemographic, anthropometric, health and behavior characteristics of the sample overall and separated by exercise group.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Overall (n=36)</th>
<th>Sled-Push (n=18)</th>
<th>Walking (n=18)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sociodemographic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, years</td>
<td>69.2 (4.7)</td>
<td>68.11 (4.4)</td>
<td>70.33 (4.8)</td>
<td>.159</td>
</tr>
<tr>
<td>Sex, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>15 (39.5)</td>
<td>5 (27.7)</td>
<td>10 (55.5)</td>
<td>.091</td>
</tr>
<tr>
<td>Female</td>
<td>23 (60.5)</td>
<td>13 (72.2)</td>
<td>8 (44.4)</td>
<td></td>
</tr>
<tr>
<td>Race, n (%) of white</td>
<td>36 (100)</td>
<td>18 (50)</td>
<td>18 (50)</td>
<td></td>
</tr>
<tr>
<td><strong>Anthropometric</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height, m</td>
<td>1.70 (0.1)</td>
<td>1.68 (0.09)</td>
<td>1.72 (0.1)</td>
<td>.304</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>79.56 (19.3)</td>
<td>78.87 (20.1)</td>
<td>80.25 (19.1)</td>
<td>.834</td>
</tr>
<tr>
<td>Leg Length, cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>79.90 (6.3)</td>
<td>79.39 (6.7)</td>
<td>80.41 (6.1)</td>
<td>.635</td>
</tr>
<tr>
<td>Left</td>
<td>79.73 (6.2)</td>
<td>79.22 (6.6)</td>
<td>80.25 (5.9)</td>
<td>.627</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>27.3 (5.9)</td>
<td>27.6 (5.9)</td>
<td>27.1 (6.0)</td>
<td>.786</td>
</tr>
<tr>
<td><strong>Health</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MNA score</td>
<td>13.34 (1.2)</td>
<td>13.78 (0.4)</td>
<td>12.88 (1.5)</td>
<td>.103</td>
</tr>
<tr>
<td>Chronic disease, mdn (min-max)</td>
<td>1 (0-5)</td>
<td>1 (0-5)</td>
<td>1 (0-4)</td>
<td>.683</td>
</tr>
<tr>
<td>Medications, number</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTC</td>
<td>1.83 (2.4)</td>
<td>1.72 (1.7)</td>
<td>1.94 (3.1)</td>
<td>.352</td>
</tr>
<tr>
<td>Prescribed</td>
<td>2.20 (1.6)</td>
<td>1.94 (1.3)</td>
<td>2.47 (1.9)</td>
<td>.798</td>
</tr>
<tr>
<td>Overall Health’, n (%)</td>
<td></td>
<td></td>
<td></td>
<td>.985</td>
</tr>
<tr>
<td>Excellent</td>
<td>10 (28.5)</td>
<td>5 (27.7)</td>
<td>5 (29.4)</td>
<td></td>
</tr>
<tr>
<td>Very good</td>
<td>17 (48.5)</td>
<td>9 (50)</td>
<td>8 (47.1)</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>8 (22.8)</td>
<td>4 (22.3)</td>
<td>4 (23.5)</td>
<td></td>
</tr>
<tr>
<td>Physical Health’, n (%)</td>
<td></td>
<td></td>
<td></td>
<td>0.739</td>
</tr>
<tr>
<td>Excellent</td>
<td>7 (20.0)</td>
<td>4 (22.2)</td>
<td>3 (17.6)</td>
<td></td>
</tr>
<tr>
<td>Very good</td>
<td>20 (57.1)</td>
<td>10 (55.6)</td>
<td>10 (58.8)</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>7 (20.0)</td>
<td>3 (16.7)</td>
<td>4 (23.5)</td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>1 (2.9)</td>
<td>1 (5.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental Health’, n (%)</td>
<td></td>
<td></td>
<td></td>
<td>0.658</td>
</tr>
<tr>
<td>Excellent</td>
<td>13 (37.1)’</td>
<td>6 (33.3)</td>
<td>7 (41.2)</td>
<td></td>
</tr>
<tr>
<td>Very good</td>
<td>18 (51.4)</td>
<td>10 (55.6)</td>
<td>8 (47.0)</td>
<td></td>
</tr>
</tbody>
</table>
Table 1 Continued

<table>
<thead>
<tr>
<th>Good</th>
<th>3 (8.6)</th>
<th>2 (11.1)</th>
<th>1 (5.9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fair</td>
<td>1 (2.9)</td>
<td>1 (5.9)</td>
<td></td>
</tr>
<tr>
<td>Difficulties in ADLs, % No</td>
<td>100</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Falls Within last 12 Months, Number</td>
<td>.29 (.52)</td>
<td>.33 (.59)</td>
<td>.24 (.43)</td>
</tr>
</tbody>
</table>

**Behavior**

<table>
<thead>
<tr>
<th>Physical Activity, min/week</th>
<th>644.57 (678.6)</th>
<th>429.96 (104.3)</th>
<th>861.64 (203.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting time, min/day</td>
<td>372.00 (.397.4)</td>
<td>448.24 (551.56)</td>
<td>300.0 (134.9)</td>
</tr>
<tr>
<td>Godin, score</td>
<td>51.94 (25.6)</td>
<td>63.00 (26.3)</td>
<td>41.50 (20.5)</td>
</tr>
<tr>
<td>Smoking, % Yes</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Note:** Data are mean and standard deviation unless otherwise noted. Cm = centimeters, kg = kilograms BMI= body mass index, MNA= mini nutritional assessment, m²= meters squared, OTC= over the counter, * data from one participant is missing.

### 4.2 Physiological Data

#### 4.2.1 Heart Rate (HR)

Average HR response was assessed at different time periods and exercise velocities/intensities and is presented in detail in Table 2. It is possible to observe a linear increase on HR values as the intensity of the exercise increased for the sled-push group. However, for the walking group values were similar throughout the different velocities/intensities. In addition, the average maximum age-predicted HR (pMHR) for the sled-push group was 160.3±3.1 bpm and for the walking group was 158.8±3.4 bpm. At the velocity of 75% participants in the sled-push were working at an average intensity of 67.2% of the pMHR, while participants in the walking group worked at an intensity of 55.9% of the pMHR. For the velocities of 125% the sled-push group was working at an intensity of 83.5% of the pMHR, while the walking control group worked at 58.1%.
Table 2. Average heart rate response during the progressive exercise session overall and separated by exercise modality.

<table>
<thead>
<tr>
<th></th>
<th>Overall (n = 36)</th>
<th>Sled-Push (n = 18)</th>
<th>%pMHR*</th>
<th>Walking (n = 18)</th>
<th>%pMHR*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting</td>
<td>73.2 (10.5)</td>
<td>74.7 (8.5)</td>
<td>46.6</td>
<td>71.6 (12.2)</td>
<td>45.1</td>
</tr>
<tr>
<td>Warm-Up</td>
<td>92.0 (13.7)</td>
<td>93.6 (13.9)</td>
<td>58.4</td>
<td>90.4 (13.6)</td>
<td>56.9</td>
</tr>
<tr>
<td>75%</td>
<td>98.2 (14.5)</td>
<td>107.7 (14.5)</td>
<td>67.2</td>
<td>88.7 (12.9)</td>
<td>55.9</td>
</tr>
<tr>
<td>85%</td>
<td>101.0 (19.7)</td>
<td>114.2 (16.9)</td>
<td>71.2</td>
<td>87.9 (12.2)</td>
<td>55.4</td>
</tr>
<tr>
<td>100% (T1)</td>
<td>103.5 (23.2)</td>
<td>121.3 (17.6)</td>
<td>75.7</td>
<td>86.6 (12.8)</td>
<td>54.5</td>
</tr>
<tr>
<td>100% (T2)</td>
<td>105.7 (24.7)</td>
<td>124.3 (18.7)</td>
<td>77.5</td>
<td>87.0 (13.1)</td>
<td>54.8</td>
</tr>
<tr>
<td>125% (T1)</td>
<td>111.9 (26.4)</td>
<td>131.7 (19.7)</td>
<td>82.2</td>
<td>92.0 (14.6)</td>
<td>57.9</td>
</tr>
<tr>
<td>125% (T2)</td>
<td>113.0 (27.5)</td>
<td>133.8 (21.0)</td>
<td>83.5</td>
<td>92.2 (14.1)</td>
<td>58.1</td>
</tr>
<tr>
<td>Post-exercise</td>
<td>77.5 (13.4)</td>
<td>83.4 (11.4)</td>
<td>52.0</td>
<td>71.6 (12.8)</td>
<td>45.1</td>
</tr>
</tbody>
</table>

Note: %pMHR: percent of maximum age-predicted heart rate; T1: trial 1; T2: trial 2
* Tanaka-HR max: equation = 208 - 0.7 x age

Figure 5 below displays detailed information of our further analysis. For purpose of our study, velocity conditions were grouped to form three defined categories: 1) subnormal (75 and 85%), normal (100% trials 1 and 2), and supranormal (125% trials 1 and 2). Mixed-factor ANOVA revealed a significant group x velocity interaction for HR $F(2, 66) = 25.924, p<.001$, $\eta^2 = .44$ and a main effect for group $F(1,33) = 40.582, p<.001$, $\eta^2 = .55$ and velocity for HR $F(2,66) = 48.712, p<.001$, $\eta^2 = .60$.

Follow-up independent $t$-test analysis revealed that HR responses to the acute progressive exercise session were significantly higher for the sled-push group compared to the walking group for all three defined velocities: subnormal $t(34) = -4.873, p<.001$, $d = 1.62$; normal $t(34) = -6.803, p<.001$, $d = 2.28$; and supranormal $t(34) = -6.953, p<.001$, $d = 2.31$. 
In addition, follow-up repeated measures ANOVA revealed a significant difference on HR response within the sled group among all three velocities $F(2,32) = 52.266, p<.001, \eta_p^2 = .77$. For the walking group, although the repeated measures ANOVA reported a within subjects effect $F(2,34) = 6.299, p=.010, \eta_p^2 = .27$, a significant difference on HR ($p<.001$) was only observed between the normal and supranormal velocity.

Figure 5. Mean and standard deviation values of heart rate according to different exercise modalities and velocities.
Velocity: subnormal (75 and 85% of normal walking speed); normal (100% of normal walking speed); supranormal (125% of normal walking speed).
* Significant difference between group ($p<.05$)
ab Significant difference within group ($p<.05$)

4.2.2 Blood Pressure (BP)

Average systolic and diastolic BP were assessed at different time periods and exercise velocities/intensities is presented in detail in Table 3. It is possible to observe a linear increase on systolic BP values as the intensity of the exercise increased for the sled-push group. However, for the walking group values were similar throughout the different velocities/intensities. At 75% the sled-push group systolic BP was at $139.4 \pm 8.4$ mmHg, while the walking control group
systolic BP was 79.8 ±4.4 mmHg. At the velocity of 125% the sled-push groups systolic BP was 166.6 ±8.3 mmHg, while the walking control groups systolic BP was 147.6 ±12.7 mmHg.

Table 3. Systolic and diastolic blood pressure response measured in millimeters of mercury (mmHg) overall and separated by exercise modality.

<table>
<thead>
<tr>
<th></th>
<th>Overall (n = 36)</th>
<th>Sled-push (n = 18)</th>
<th>Walking (n = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Systolic</td>
<td>Diastolic</td>
<td>Systolic</td>
</tr>
<tr>
<td>Resting</td>
<td>123.8 (8.2)</td>
<td>78.3 (3.1)</td>
<td>124.7 (9.2)</td>
</tr>
<tr>
<td>Warm-Up</td>
<td>131.2 (8.3)</td>
<td>79.0 (2.9)</td>
<td>131.3 (6.2)</td>
</tr>
<tr>
<td>75%</td>
<td>134.9 (10.4)</td>
<td>80.5 (4.0)</td>
<td>139.4 (8.4)</td>
</tr>
<tr>
<td>85%</td>
<td>139.9 (12.4)</td>
<td>80.4 (3.8)</td>
<td>146.7 (8.2)</td>
</tr>
<tr>
<td>100% (T1)</td>
<td>144.2 (13.1)</td>
<td>81.9 (4.6)</td>
<td>150.7 (8.0)</td>
</tr>
<tr>
<td>100% (T2)</td>
<td>148.4 (12.9)</td>
<td>82.6 (4.7)</td>
<td>155.4 (9.9)</td>
</tr>
<tr>
<td>125% (T1)</td>
<td>154.1 (13.6)</td>
<td>83.0 (4.9)</td>
<td>162.8 (8.3)</td>
</tr>
<tr>
<td>125% (T2)</td>
<td>157.0 (14.2)</td>
<td>82.7 (4.4)</td>
<td>166.5 (8.3)</td>
</tr>
<tr>
<td>Post-exercise</td>
<td>126.0 (9.8)</td>
<td>79.6 (3.8)</td>
<td>128.6 (10.0)</td>
</tr>
</tbody>
</table>

**Note:** Values are mean and standard deviation. T1: trial 1; T2: trial 2

Mixed-factor ANOVA looking at categorized velocities (subnormal, normal and supranormal) and groups revealed a significant group x velocity interaction for systolic BP $F(2, 68) = 8.815, p=.001, \eta^2_p = .21$ and a main effect for group $F(1,34) = 19.297, p<.001, \eta^2_p = .36$ and velocity for systolic BP $F(2,68) = 228.354, p<.001, \eta^2_p = .87$. For diastolic BP, no significant group x velocity interaction $F(2, 68) = .814, p=.421, \eta^2_p = .02$ and no main effect for group for diastolic BP $F(1,34) = .164, p=.688, \eta^2_p = .01$ was observed. However, a main effect for velocity was revealed $F(2,68) = 17.364, p<.001, \eta^2_p = .34$. 
Follow-up independent $t$-test analysis revealed that systolic BP responses to the acute progressive exercise session were significantly higher for the sled-push group compared to the walking group for all three calculated velocities: subnormal $t(34) = -3.548, p = .001, d = 1.18$; normal $t(34) = -3.804, p = .001, d = 1.26$; and supranormal $t(34) = -5.224, p < .001, d = 1.74$. In addition, follow-up repeated measures ANOVA revealed a significant difference on systolic BP response within the sled group among all three velocities $F(2,34) = 168.482, p < .001, \eta^2_p = .91$. Similar findings were observed for the walking group $F(2,34) = 71.970, p < .001, \eta^2_p = .81$.

**Figure 6** displays in detail these findings.

**Figure 6.** Mean and standard deviation values of systolic (left) and diastolic (right) blood pressure separated by exercise modalities and velocities.  
Velocity: subnormal (75 and 85% of normal walking speed); normal (100% of normal walking speed); supranormal (125% of normal walking speed).  
* Significant difference between group ($p < .05$)  
$^a$$^b$ Significant difference within group ($p < .05$)
4.2.3 Lactate

Average Lactate (LAC) response assessed at different time periods and exercise velocities/intensities is presented in detail in Table 4. It is possible to observe a linear increase on LAC values as the intensity of the exercise increased for the sled-push group. However, for the walking group values were similar throughout the different velocities/intensities. The sled-push groups LAC at 75% was 2.6 ±1.1 mmol/L, while the walking control groups LAC was at 1.7 ±0.5 mmol/L. The sled-push groups LAC at 125% was 5.7 ±2.9 mmol/L, while the walking control groups LAC was 1.5 ±0.7 mmol.

Table 4. Mean and standard deviation values of blood lactate (mmol/L) overall and separated by exercise modality.

<table>
<thead>
<tr>
<th></th>
<th>Overall (n = 36)</th>
<th>Sled-Push (n = 18)</th>
<th>Walking (n = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting</td>
<td>1.6 (0.6)</td>
<td>1.4 (0.5)</td>
<td>1.7 (0.7)</td>
</tr>
<tr>
<td>Warm-Up</td>
<td>1.9 (0.7)</td>
<td>1.9 (0.7)</td>
<td>1.8 (0.8)</td>
</tr>
<tr>
<td>75%</td>
<td>2.1 (1.0)</td>
<td>2.6 (1.1)</td>
<td>1.7 (0.5)</td>
</tr>
<tr>
<td>85%</td>
<td>1.9 (1.0)</td>
<td>2.6 (0.9)</td>
<td>1.4 (0.4)</td>
</tr>
<tr>
<td>100% (T1)</td>
<td>2.2 (1.3)</td>
<td>3.1 (1.3)</td>
<td>1.4 (0.6)</td>
</tr>
<tr>
<td>100% (T2)</td>
<td>2.6 (1.8)</td>
<td>3.7 (1.8)</td>
<td>1.4 (0.6)</td>
</tr>
<tr>
<td>125% (T1)</td>
<td>3.1 (2.2)</td>
<td>4.5 (2.1)</td>
<td>1.6 (0.7)</td>
</tr>
<tr>
<td>125% (T2)</td>
<td>3.6 (2.9)</td>
<td>5.7 (2.9)</td>
<td>1.5 (0.7)</td>
</tr>
<tr>
<td>Post-exercise</td>
<td>3.4 (3.0)</td>
<td>5.1 (3.3)</td>
<td>1.6 (0.9)</td>
</tr>
</tbody>
</table>

Note: Data is mean and standard deviation. T1: trial 1; T2: trial 2

Follow-up analysis examining groups of velocities (subnormal, normal, and supranormal) showed that there was a significant group x velocity interaction for blood lactate $F(2, 68) =$
19.613, \( p < .001 \), \( \eta_p^2 = .37 \) and a main effect for group \( F(1,34) = 36.209, \ p < .001, \ \eta_p^2 = .52 \) and velocity for blood lactate \( F(2,68) = 22.123, \ p < .001, \ \eta_p^2 = .39 \).

Figure 7 below displays in detail results of follow analysis. Subsequent independent \( t \)-test analysis revealed that blood lactate responses to the acute progressive exercise session were significantly higher for the sled-push group compared to the walking group for all three calculated velocities: subnormal \( t(34) = -4.818, \ p < .001, \ d = 1.60 \); normal \( t(34) = -5.124, \ p < .001, \ d = 1.71 \); and supranormal \( t(34) = -5.893, \ p < .001, \ d = 1.96 \).

In addition, follow-up repeated measures ANOVA revealed a significant difference on blood lactate response within the sled group \( F(2,34) = 23.305, \ p < .001, \ \eta_p^2 = .58 \) as a function of velocity. Significant differences were observed between subnormal and supranormal \( (p < .001) \) velocities and normal and supranormal \( (p < .001) \) velocities. For the walking group, repeated measures ANOVA reported no significant difference on blood lactate response within this group as a function of velocity \( F(2,34) = .680, \ p = .496, \ \eta_p^2 = .04 \).

### 4.2.4 Rate of Perceived Exertion

Average rating of perceived exertion (RPE) response assessed at different time periods and exercise velocities/intensities is presented in detail in Table 5. It is possible to observe a linear increase in RPE values as the intensity of the exercise increased for the sled-push group. The walking group values also increased in relatively linear manner throughout the different velocities/intensities, though not to the same degree as the sled-push group. The sled-push groups RPE at 75% 2.6 ±1.1, while the walking control groups RPE was 1.7 ±0.5. While at
Figure 7. Mean and standard deviation values of blood lactate as a function of different exercise modalities and velocities. Velocity: subnormal (75 and 85% of normal walking speed); normal (100% of normal walking speed); supranormal (125% of normal walking speed).

* Significant difference between group ($p<.05$)

a Significant difference within group ($p<.05$)
125% the sled-push groups RPE was 6.5 ±2.5, while the walking control groups RPE was 3.6 ±1.9.

Table 5. Mean and standard deviation values for rate of perceived exertion measured using the OMNI Perceived Exertion Scale overall and separated by exercise modality.

<table>
<thead>
<tr>
<th></th>
<th>Overall (n = 36)</th>
<th>Sled-Push (n = 18)</th>
<th>Walking (n = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting</td>
<td>0.3 (0.7)</td>
<td>0.5 (0.9)</td>
<td>0.2 (0.5)</td>
</tr>
<tr>
<td>Warm-Up</td>
<td>2.8 (2.0)</td>
<td>2.7 (1.7)</td>
<td>2.2 (1.2)</td>
</tr>
<tr>
<td>75%</td>
<td>2.1 (1.0)</td>
<td>2.6 (1.1)</td>
<td>1.7 (0.5)</td>
</tr>
<tr>
<td>85%</td>
<td>3.3 (2.0)</td>
<td>4.7 (1.7)</td>
<td>1.9 (1.0)</td>
</tr>
<tr>
<td>100% (T1)</td>
<td>4.0 (2.1)</td>
<td>5.6 (1.7)</td>
<td>2.4 (1.1)</td>
</tr>
<tr>
<td>100% (T2)</td>
<td>3.9 (2.4)</td>
<td>5.6 (2.0)</td>
<td>2.3 (1.3)</td>
</tr>
<tr>
<td>125% (T1)</td>
<td>4.7 (2.6)</td>
<td>6.4 (2.3)</td>
<td>3.1 (1.6)</td>
</tr>
<tr>
<td>125% (T2)</td>
<td>5.0 (2.6)</td>
<td>6.5 (2.5)</td>
<td>3.6 (1.9)</td>
</tr>
<tr>
<td>Post Exercise</td>
<td>0.9 (1.2)</td>
<td>0.9 (1.5)</td>
<td>0.8 (0.8)</td>
</tr>
</tbody>
</table>

Note: T1: trial 1; T2: trial 2

Mixed-factor ANOVA looking at groups of different velocities (subnormal, normal, and supranormal) revealed no significant group x velocity interaction for rate of perceived exertion $F(2, 68) = 2.384, p=.120, \eta_p^2 = .01$. However, analysis revealed a significant main effect for group $F(1,34) = 32.922, p<.001, \eta_p^2 = .49$ and velocity for RPE $F(2,68) = 48.270, p<.001, \eta_p^2 = .59$.

Subsequent repeated measures ANOVA revealed a significant difference on RPE within the sled-push group $F(1.3, 22.1) = 29.680, p<.001, \eta_p^2 = .64$ as a function of velocity. Figure 8 below displays in detail significant differences were observed between subnormal and normal ($p<.001$), normal and supranormal ($p=.005$), and subnormal and supranormal ($p<.001$) velocities.
Similar findings were observed for the walking group $F(1.4, 24.3) = 19.441, p<.001, \eta^2_p = .53$ with significant differences observed among all velocities ($p<.05$).

**Figure 8.** Mean and standard deviation values of rate of perceived exertion as a function of different exercise modalities and velocities. Velocity: subnormal (75 and 85% of normal walking speed); normal (100% of normal walking speed); supranormal (125% of normal walking speed).

$^{a,b}$ Significant difference within group ($p<.05$)

### 4.2.5 Body Discomfort

Body discomfort was minimal, and it was only reported by participants in the sled-push group. No participants in the walking control group experienced discomfort/pain from the exercise protocol. Out of 18 participants, 6 (33.3%) experienced some level of discomfort from the sled-push exercise protocol. Participants reported scores ranging from 1-3 (minimal discomfort/pain) out of a 10-point scale (0 “no discomfort/pain” to 10 “worst imaginable
discomfort/pain”). Reports of discomfort/pain were registered at low back, mid back, abdominals, and shoulders (Figure 9).

Figure 9. Illustration of the body diagram displaying the areas (yellow) where participants reported discomfort immediately after, 24 or 48 hours post exercise session.
4.3 Psychological Data

4.3.1 Enjoyment: During the Exercise Session

Average enjoyment response was assessed at different time periods and exercise velocities/intensities is presented in detail in Table 6. Enjoyment decreased slightly in value as the intensity of the exercise increased for the sled-push group. The walking groups enjoyment values also remained similar throughout the different velocities/intensities. The sled-push groups enjoyment at 75% 6.9 ±2.0, while the walking control groups enjoyment was 8.1 ±2.2. The sled-push groups enjoyment at 125% 6.6 ±2.3, while the walking control groups enjoyment was 8.5 ±1.7.

Table 6. Average enjoyment responses measured using a visual analogic scale reported by participants during the exercise session overall and separated by exercise modality.

<table>
<thead>
<tr>
<th></th>
<th>Overall (n = 36)</th>
<th>Sled-Push (n = 18)</th>
<th>Walking (n = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting</td>
<td>7.5 (2.8)</td>
<td>6.8 (3.1)</td>
<td>8.3 (2.2)</td>
</tr>
<tr>
<td>Warm-Up</td>
<td>7.6 (1.9)</td>
<td>7.3 (2.1)</td>
<td>4.1 (1.2)</td>
</tr>
<tr>
<td>75%</td>
<td>7.5 (2.2)</td>
<td>6.9 (2.0)</td>
<td>8.1 (2.2)</td>
</tr>
<tr>
<td>85%</td>
<td>7.8 (1.9)</td>
<td>7.1 (1.7)</td>
<td>8.4 (1.8)</td>
</tr>
<tr>
<td>100% (T1)</td>
<td>7.6 (1.9)</td>
<td>6.7 (1.6)</td>
<td>8.6 (1.7)</td>
</tr>
<tr>
<td>100% (T2)</td>
<td>7.7 (1.9)</td>
<td>6.8 (1.7)</td>
<td>8.6 (1.6)</td>
</tr>
<tr>
<td>125% (T1)</td>
<td>7.6 (2.1)</td>
<td>6.6 (2.1)</td>
<td>8.6 (1.6)</td>
</tr>
<tr>
<td>125% (T2)</td>
<td>7.6 (2.2)</td>
<td>6.6 (2.3)</td>
<td>8.5 (1.7)</td>
</tr>
<tr>
<td>Post-exercise</td>
<td>8.4 (2.3)</td>
<td>7.8 (2.7)</td>
<td>8.9 (1.8)</td>
</tr>
</tbody>
</table>

Note: T1: trial 1; T2: trial 2
When velocities were combined into three defined categories (i.e., subnormal, normal, and supranormal), mixed-factor ANOVA showed no significant group x velocity interaction $F(2, 68) = 1.808, p=.184, \eta_p^2 = .05$ and no main effect for velocity for enjoyment measured during the exercise session $F(2,68) = .114, p=.815, \eta_p^2 = .01$. However, analysis revealed a main effect for group on enjoyment assessed within the session $F(1, 34) = 9.122, p=.005, \eta_p^2 = .21$. Figure 10 displays the results in detail.

**Figure 10.** Mean and standard deviation values of rate of perceived exertion as a function of different exercise modalities and velocities. Velocity: subnormal (75 and 85% of normal walking speed); normal (100% of normal walking speed); supranormal (125% of normal walking speed).

4.3.2
Enjoyment was further assessed immediately after the last bout of exercise using the PACES. Independent $t$ test showed no significant difference on levels of enjoyment measured immediately after the exercise session between the walking and the sled-push group $t(34) = .373$, $p=7.12$, $d = .12$. Figure 11 below displays average values of enjoyment observed for participants.

![Figure 11](image)

**Figure 11.** Mean and standard deviation values for enjoyment measured immediately after the exercise session using the Physical Activity Enjoyment Scale (PACES).

### 4.3.3 Feeling

Average feeling response was assessed at different time periods and exercise velocities/intensities is presented in detail in Table 7. The sled-push groups feeling remained
similar throughout the different velocities/intensities. Similarly, the walking control groups feeling remained similar throughout the different velocities/intensities. The sled-push groups feeling at 75% 3.3 ±1.3, while the walking control groups feeling was 4.4 ±0.8. The sled-push groups feeling at 125% 3.1 ±1.7, while the walking control groups feeling 4.2 ±1.2.

Table 7. Average feeling scores measured using a visual analogic scale reported by the participants overall and separated by exercise modality.

<table>
<thead>
<tr>
<th></th>
<th>Overall (n = 36)</th>
<th>Sled-Push (n = 18)</th>
<th>Walking (n = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting</td>
<td>4.4 (1.2)</td>
<td>3.9 (1.5)</td>
<td>4.8 (0.5)</td>
</tr>
<tr>
<td>Warm-Up</td>
<td>3.9 (1.2)</td>
<td>3.8 (1.3)</td>
<td>4.1 (1.2)</td>
</tr>
<tr>
<td>75%</td>
<td>3.9 (1.2)</td>
<td>3.3 (1.3)</td>
<td>4.4 (0.8)</td>
</tr>
<tr>
<td>85%</td>
<td>3.8 (1.3)</td>
<td>3.2 (1.5)</td>
<td>4.4 (0.8)</td>
</tr>
<tr>
<td>100% (T1)</td>
<td>3.8 (1.2)</td>
<td>3.2 (1.3)</td>
<td>4.3 (0.8)</td>
</tr>
<tr>
<td>100% (T2)</td>
<td>3.9 (1.4)</td>
<td>3.2 (1.5)</td>
<td>4.4 (0.9)</td>
</tr>
<tr>
<td>125% (T1)</td>
<td>3.7 (1.4)</td>
<td>3.1 (1.5)</td>
<td>4.2 (1.0)</td>
</tr>
<tr>
<td>125% (T2)</td>
<td>3.7 (1.5)</td>
<td>3.1 (1.7)</td>
<td>4.2 (1.2)</td>
</tr>
<tr>
<td>Post-exercise</td>
<td>4.5 (0.9)</td>
<td>4.2 (1.2)</td>
<td>4.7 (0.5)</td>
</tr>
</tbody>
</table>

Note: T1: trial 1; T2: trial 2

When velocities were combined into three different categories (subnormal, normal, and supranormal), mixed-factor ANOVA revealed no significant group x velocity interaction for feeling $F(2, 64) = .020, p=.931, \eta^2_p = .01$ and no main effect for velocity for feeling $F(2,64) = 1.1583, p=.219, \eta^2_p = .05$. However, analysis revealed a main effect for group for feeling $F(1, 34) = 9.430, p=.004, \eta^2_p = .23$. Figure 12 below displays average values of feeling scores reported by participants during the exercise session.
Figure 12. Mean and standard deviation for feeling as a function of different exercise modalities and velocities.
Velocity: subnormal (75 and 85% of normal walking speed); normal (100% of normal walking speed); supranormal (125% of normal walking speed).
Chapter 5
DISCUSSION

5.1 Discussion

The present study investigated physiological and psychological responses resulting from an acute progressive session of sled-pushing exercise among older adults and compared that to a walking exercise session. Specifically, this study examined HR, BP, LAC, RPE, perceived level of enjoyment, feeling and body discomfort. The main findings were: a) HR, systolic BP, blood LAC, and RPE increased as a function of the exercise intensity in both group, with significantly higher values observed for the SLP for all intensities compared to the WKC; b) body discomfort was found to be minimal (intensity: 1-3 out of 10-point scale) and only reported in about 1/3 of the participants in the SLP group; c) enjoyment level assessed during the exercise session was found to be absolutely higher in participants of the WKC compared to the SLP; however, with no statistical significance between the groups. Enjoyment assessed after the exercise session revealed that the groups were similar; d) on average, participants in the WKC reported levels of feeling between good and very good (+4), while in the SLP group participants stayed in the good range (+3). These findings corroborate our hypothesis that a single bout of progressive sled-push exercise would produce physiological changes that were superior to the walking session, and that when done chronically could produce cardiovascular adaptations in the older adult population based on the assessment of selected physiological markers. The results further corroborate our hypothesis that levels of enjoyment would decrease as the intensity of the exercise session
increases and that participants in the sled-push exercise would report low levels of body discomfort immediately after, and 24 and 48h post-exercise session.

Participants in the SLP group worked at higher percentages of pMHR at all velocities compared to the WKC group. The difference was particularly highlighted during the supranormal bouts of exercise (125%) where the SLP group achieve an intensity of approximately 84% of the pMHR compared to 58% of the WKC group. From a training and improvement standing point, the literature describes that individuals working at a relative intensity of 60-70 % of MHR to be ideal to improve cardiovascular endurance. For older adults, Mazzeo et al., (1999) suggest that training at an pMHR between 55-70% has shown to be beneficial for older adults and that HR range is moderate intensity, which should be done for at least 30 minutes a day. However, it is known that training at higher intensities such as between the pMHR intensities of 70-80% of their maximum HR improves their cardiovascular and respiratory fitness, and it increases strength of the myocardial tissue. McFarland et al., (2021) noted that for moderate intensities HR should be between 50-70% and for vigorous intensities HR should be between 70-85% pMHR.

Recently, researchers have focused their attention to High Intensity Interval Training (HIIT) for different populations including older adults Marriott et al., (2021). According to Gibala and colleagues (2018) HR intensities for HIIT needs to be ≥85% of MHR. However, Jacob et al., (2022) concluded in their study that HR of ≥80% of MHR or peak HR being an effective HIIT HR intensity. Nevertheless, the HR achieved by the participants in our study in the last velocities of the exercise session is between what has been described in the literature Gibala et al., (2018) & Jacob et al., (2022) For instance, using the novel motorized sled-push
exercise requiring multiple large muscle movements in rhythmic fashion, combined with a progress resistance, participants achieved 83.5% of the pMHR. Similar to our study, De Matos et al., (2021) performed at a twice weekly HIIT session for older adults, and used HR to track the intensity of the HIIT training during their study. During the training sessions the participant goal was to achieve between 85-92% HR$_{\text{max}}$ which engendered positive CRF in peoples with metabolic syndrome. Collective, the findings of the present study coupled with results from previous studies suggest that if the sled-push modality and exercise protocol were done chronically, there would be improve cardiorespiratory fitness (CRF) of older adults, increasing their capacity to produce and sustain work. This is important, as the American College of Sports Medicine (ACSM) position stand on physical activity and exercise for older adult’s states that CRF is a critical component of overall healthy aging. This is because CRF has been associated with prevention or delayed onset of a wide range of chronic disease and conditions common to the older adult population, increased physical and cognitive function, and increased quality of life Chodzko-Zajko et al., (2009).

The expected physiological BP response to dynamic upright exercise is an increase in systolic BP, and no change or a slight drop in diastolic BP (Pescatello 2014; Schultz & Sharman 2014). Both systolic and diastolic BP of the participants in the SLP group responded as expected and at safe levels. The results of our study are in line with BP measures in literature from Sharman & Lagerche (2015), that describe the potential upper limits for safe systolic and diastolic BP, with the mean values for our population being between 182-196 mmHg. This was seen in the BP values of systolic, where numbers increased significantly more during all velocities in the SLP group (166 mmHg), while the walking exercise group was 146mmHg. The
diastolic BP values were similar between the SLP (83mmHg) and WKC (82mmHg). This does not come as a surprise as no changes or slight drop is expected for diastolic BP (Pescatello 2014; Schultz & Sharman 2014). This corroborates the findings observed by Ross et al., (2016) where they compared HIIT to moderate continuous training (MCT). In this study, the authors observed an increase with left ventricular ejection with an association of lower end-diastolic volume. Though our results showed a slightly elevated diastolic number for the sled-push group compared to the walking control, however, both performed an interval training type of exercise. This is important as a significant number of older adults present with multiple chronic health issues that can be benefited by regular exercise and physical activity. In fact, exercise has been highly recommended as an effective way to prevent, treat and manage high BP (i.e., hypertension), including among older adults Kazeminia et al., (2020).

The physiological benefits of physical activity, particularly, exercise training have been widely established for the prevention and management of chronic diseases and conditions affecting human beings Booth et al., (2012); Pedersen & Saltin, (2006). It is known that exercise routines elicit a dose-dependent response in terms of intensity, frequency, and duration, with variable exercise intensities inducing distinctive metabolic profiles (Sesso et al., 2002; Blair et al., 1989). In terms of intensity, blood LAC level is generally used as measure to assess metabolic profile at a specific exercise intensity Machado et al., (2019) and Lønbro et al., (2019). Blood LAC increased linearly in participants of the SLP group as a function of velocity (reaching ~5 mmol/L in supranormal velocities) while stayed at the same level in WKC group (~1.5 mmol/L). The increase in blood LAC in part can be considered to be from the engagement of the type II muscle fibers which produce and release more LAC when stimulated as compared to
type I muscle fibers, which take up more LAC Vermeulen et al., (2017). It is possible to see a correlation between our results and the study by Maddigan and colleagues (2014). Using electromyography, the authors observed that a weight sled-push was able to activate similar muscular response in quadriceps and hamstrings as squat. The weight was design to elicit muscular strength adaptations in both groups of this study, thus we can see the correlation between the resistance applied in our study to the production of greater blood LAC repsonse with type II muscle fibers being potentially more activated in the SLP exercise group. This is important as the ability to maintain (or lose) muscular mass and strength is associated with sarcopenia in older adult (Morrison & Newell, 2012). Gibala and colleagues (2014) also suggest that there is a hybrid modality of HIIT that can be used which encompasses both aerobic and anaerobic HIIT, due in part because anaerobic HIIT can still produce cardiorespiratory fitness (CRF). This study is in line with ours, as we observed a large main effect for both group and velocity specific response in the increase in blood LAC. This can partially be explained by the higher activation of large muscle groups in a repetitive, rhythmic manner while pushing against greater resistance as velocity increased. There was not similar response in blood LAC with the walking exercise group. Of note, a meta-analysis by Jacob and colleagues, shows that exercise induced blood LAC response even from a single dose session has beneficial effects in cognitive functioning. According to the authors, LAC when entering the brain can signal brain-derived neurotrophic factor (BDNF). BDNF is known to support many aspects of cognitive functioning (i.e., neurogenesis, neuronal survival, synaptic plasticity, and dendritic spine growth), and has shown have a key role in memory and learning.
In sports, health or particularly exercise testing, RPE is a highly used measure of exercise intensity level. Although no group x velocity interaction was observed for RPE, a main effect for group and velocity was observed. The ACSM and the American Heart Association (AHA) exercise recommendations state that RPE on a 0-10 scale should be between 5 to 6 for moderate intensity and 7-8 for vigorous intensity Chodzko-Zajko et al., (2009) to produce a wide range of health benefits. This shows that participants in the SLP group in this study were exercising at a moderate intensity when pushing the sled at a normal velocity (RPE = 5.4/10 – somewhat hard) and were very close to the lower range of vigorous when pushing the equipment in the supranormal speed (RPE = 6.4/10 somewhat hard). The WKC group exercise at intensities classified as somewhat easy. Lagally (2008) suggest that RPE has shown to be an accurate measure of exercise intensity and if a constant RPE intensity is maintained through the course of chronic exercise it will produce improvements in either anaerobic and aerobic exercise training.

Body discomfort was assessed immediately post-exercise, 24, and 48 hours post exercise session for both groups. The walking exercise group reported no pain/body discomfort, while the sled-push exercise group reported minimal (1-3 out of 10-point scale) pain/body discomfort at various times of immediately post-exercise, 24 and 48 hours post exercise session. However, the 6 participants that reported pain/discomfort had also been active either before or after participation and said that they could not distinguish between whether the pain/body discomfort was from the sled-push exercise or from the chronic pain they experience daily. The areas of the body that experienced pain/discomfort in the sled-push exercise group were various regions of the body (i.e., low back, mid back, abdominals, shoulders, and knees). The findings that we observed comes with surprise from having small numbers reporting discomfort. Given the
intensity of the exercise observed and reported by the participants. This is because delayed on set muscle soreness (DOMS) are a common response to exercise be it aerobic or anerobic in nature. According to Hotfiel et al., (2018) especially when it is exercise that has not been performed on a routine basis or from eccentric exercises and is considered to be a myopathy (i.e., muscular damage, denigration of tissues). This study is in line with our study where this is a novel exercise modality for older adults. While DOMS have been associated with myopathy, a smaller level of DOMS is in fact good and shows a correct response to the body that is working to adapt to a higher level.

This study further investigate enjoyment during and after the exercise session. Analysis of enjoyment during the exercise session revealed that there was no significant difference between group and velocity as well as no main effect for velocity on enjoyment. However, there was a large main effect for group on enjoyment. The SLP group average enjoyment was lower than the WKC group at all velocities (i.e., subnormal, normal, & supranormal). This was expected as the literature shows that enjoyment level is negatively associated with exercise intensity, meaning that the higher the intensity of the exercise the lower the level of enjoyment will be. Despite the lower absolute values in enjoyment for the SLP group, enjoyment level during the exercise session was found to be 6 out of 10 during the supranormal velocities compared to 8.5 in the WKC group. This shows that sled-pushing exercise in the form implemented in the present study is at least as enjoyable as walking. These findings are reinforced by the assessment of enjoyment at the end of the exercise session, where no significant differences between SLP and WKC groups were observed for overall enjoyment level. This is important as enjoyment level has been correlated with exercise participation among
older adults. This is in line with Mazzeo et al., (1999) where they spoke about how to best perform exercise prescription for safety and adherence. For example, researchers have observed that enjoyment of walking is predictive of continuity Salmon et al. (2003). Other examples of this are studies that point towards the Hedonic theory that indicate that people are attracted to do activities that they enjoy and will not engage in activities they perceived as not enjoyable. Taken together, it is possible that the sled-push exercise may lead to similar adherence levels of that of people using walking as exercise modality.

Similar to enjoyment, feeling has also been used by research as a way to understand potential psychological changes occurring during the exercise session that may help researchers explain why some people drop out exercise programs. A main effect for group was observed for feeling. Our results indicate that while the SLP group had lower feeling score through all velocities (i.e., subnormal, normal, & supranormal), they did not statistically differ from the WKC. Thus, our findings show that during the exercise session the SLP group had similar feeling as the walking control group (i.e., overall feeling of good). This analysis lends to the possibility that the sled-push exercise modality can be found as producing a good feeling while performing the exercise. Feeling good during exercise is another positive influence for greater adherence for utilization of this modality to help produce health benefits for the older adult population. Our results are in line with previous studies investigating the use of the feeling scale to control exercise intensity, which found the feeling scale to be an important subject method to control intensity as well as play a key role in future exercise participation (Bok et al., 2022).
5.2 Implications for Practice

Exercise has long been recommended for older adults as a key component to achieve optimal health. However, levels and rates of exercise participation among older adults are concernedly low. This study provides another exercise modality that can be safely performed by older adults and helping increasing the array of exercise possibilities this population. The findings of the present study provide initial information for a potential exercise prescription of the motorized sled-push modality for older adults. Although this study reports the findings of an acute progressive session of the motorized sled-push exercise, it is possible to argue that if performed chronically positive adaptations to the cardiorespiratory and neuromuscular system may occur. This is because the motorized sled-push can be used as a hybrid to improve both strength and aerobic conditioning. This is particularly important because significant declines in those two systems are strongly associated with a wide range of chronic diseases and conditions in the older adult population, particularly, sarcopenia and frailty. Health professionals, particularly exercise and fitness specialists, now have a new exercise modality that may be used to help increase exercise participation in this population, and to facilitate mitigation of functional ability and various chronic conditions that are common to older adults. The results of this study sheds light on the paucity of evidence that exists for novel motorized sled-push exercises for older adults, as well as bolsters the menu of exercises that can be prescribed for the older adult population. It is also the research’s hope that health professionals will utilize this information to help impact the health and well-being, and, as well as provide a framework for further investigation into this exercise modality for older adults. Exercise practitioners can utilize this
information in a variety of settings from the gym to long-term care facilities as means to enhance cardiorespiratory fitness and lower body muscular strength of older adults.

5.3 Strengths and Limitations

There are strengths to this study. To the best of the researcher’s knowledge this is the first study to systematically investigate physiological and psychological responses to the motorized sled-push exercise among older adults. A previous study conducted by Rosario, (2020) used the same sled equipment but in a sample of young adults to investigate neuromuscular activation in healthy young adults. In addition, the uniformity and conciseness of operations while collecting data along with the use of valid and reliable tools and instruments can also be viewed as a strength of this study.

The results of the present study should be interpreted with caution due to some limitations. This study presents the findings of one acute progressive session of sled-push exercise in apparently healthy older individuals. Although inferences can be made, the effects of chronic utilization of the sled equipment on physiological and psychological outcomes remains to be systematically tested. In addition, this study enrolled an unequal number of females and males with 100% of the sample being Whites. The lack of balance in sex-related biological characteristics, limits the generalizability of the study to differences of sex. The lack of familiarity time for the SLP exercise group to become acquainted using the sled and ensure proper pushing technique can also be views as limitation. However, participants were properly instructed on how to utilize the referred equipment. Despite the limitations, this study provides valuable preliminary information about the potential physiological and psychological effects of
the motorized sled-push exercise to elucidate positive cardiovascular adaptations among older adults.

5.4 Suggestions for Future Studies

Future research should attempt to address the limitations of the current study as presented in the previous section. For example, future studies should attempt to investigate the chronic effects of the motorized sled-push exercise in the older adult population. Additionally, future research should investigate the use of the sled-push exercise in the older adult population presenting with reduced mobility (e.g., individuals using assisted walking devices) or that have neurological diseases affecting balance and ambulation (e.g., multiple sclerosis, Parkinson’s disease, stroke, partial spinal cord injury). Future research should also utilize force measurement and EMG, as this will allow greater depth of understanding about muscle engagement, as well as attempt to examine the potential of this exercise modality to positively affect gait parameters/adaptations.

5.5 Conclusions

The purpose of the present study was to quantify physiological and psychological changes during an acute session of motorized sled-push exercise among older adults and compare that to a walking exercise session. Our findings suggest that an acute session of progressive sled-push exercise may be able to elucidate positive physiological adaptations that are superior to the walking session, specifically in HR, BP, LAC, RPE. In addition, this study observed that perceived level of enjoyment and feeling were similar between the SLP and WKC
group, although the WKC group reported higher values compared to the SLP group. Body discomfort for participants in the sled-push exercise reported low levels of body discomfort immediately after, and 24 and 48h post-exercise session.

This study is a first step in the research of a novel exercise modality for the older adult population. Studies of this nature are necessary for continued elucidation for exercise professionals on exercise modalities that can be safe, enjoyable, and engender positive health benefits for this population, and more important, help older adults maintain a physically active lifestyle. The importance of maintaining health as one ages should be a top priority for all.
References


APPENDIX A

RECRUITMENT MATERIALS
DEPARTMENT OF KINESIOLOGY AND PHYSICAL EDUCATION

Northern Illinois University

You are invited to participate in the Sled-Push Exercise Project

The Sled-Push Exercise is a study aiming to verify the potential health benefits of a sled-push exercise for older adults

Project Sled-Push Exercise is for
- People aged 65 and over
- People with no uncontrolled chronic or acute disease or illness
- Do not use major assistive device to walk such as walker or wheelchair

Participation involves:
- One time visit at the Motor Behavior Laboratory at the KNPE department at NIU for about 90 minutes
- Being randomly allocated to either the sled-push or the walking control

PARTICIPANTS WILL BE CASH COMPENSATED

For information please call 815-760-0586 or 815-753-3656 or send us an email at mbaumann1@niu.edu or esebastiao@niu.edu
Greetings from the Health and Exercise Research Group at NIU!

The Health and Exercise Research Group and the Motor Behavior Laboratory at NIU is looking for volunteers to participate in a PAID research study. The study is investigating the health benefits of the sled-push exercise in people aged 60 years and over.

Participation involves a single visit to the Motor Behavior Laboratory that will last for 75 minutes. During this time, participants will push a sled for a short distance six times with breaks in between.

During each break, trained research staff will collect information on heart rate, blood pressure, perceived effort, level of enjoyment and few others.

Upon completion, participants will be compensated $25 dollars cash for their time.

INTERESTED? Please contact:

- Principal Investigator: Dr. Emerson Sebastian at e.sebastian@niu.edu or call (815)-753-3656
- Graduate student: Michal Baumann at m.baumann1@niu.edu

Please visit us at https://www.niu.edu/herg/index.shtml to know more about our work.

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esebastian@niu.edu
APPENDIX B

IRB APPROVAL FORM
27-Jul-2021
Emerson Sebastiao (01839181)
Kinesiology and Physical Education

RE: Protocol # HS21-0481 “SLED-PUSH EXERCISE IN OLDER ADULTS: PHYSIOLOGICAL AND PSYCHOLOGICAL QUANTIFICATION”

Dear Emerson Sebastiao,

In a preliminary review, the Initial Submission of the above named research protocol was determined to meet the definition of human subjects research according to the federal regulations. The submission was then reviewed and approved by the Institutional Review Board through a Full Board Review on 14-Jul-2021. Please note the following information about your approved research protocol:

Protocol Approval period: 14-Jul-2021 - 13-Jul-2022

It is important for you to note that as an investigator conducting research that involves human participants, you are responsible for ensuring that the project has current IRB approval at all times. In addition, you are required to promptly report to the IRB any injuries or unanticipated problems involving risks to the subjects or others.

Please note that the IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Informed Consent:

Unless you have been approved for a waiver of the written signature of informed consent, this notice includes a date-stamped copy of the approved consent form for your use. NIU policy requires that informed consent documents given to subjects participating in non-exempt research bear the approval stamp of the NIU IRB. The stamped document is the only consent form that may be photocopied for distribution to study participants.

If consent for the study is being given by proxy (guardian, etc.), it is your responsibility to document the authority of that person to consent for the subject. Also, the committee recommends that you include an acknowledgment by the subject, or the subject's representative, that he or she has received a copy of the consent form.
You are responsible for retaining the signed consent forms obtained from your subjects for a minimum of three years after the study is concluded.

**Continuation and Amendments:**

Continuing review of the project, conducted at least annually, will be necessary until data collection is complete and you no longer retain any identifiers that could link the subjects to the data collected. Please remember to use your **protocol number** (HS21-0481) on any documents or correspondence with the IRB concerning your research protocol.

If you intend to make modifications to the study, you will need additional approval prior to incorporating the changes into the project and should contact the Office of Research Compliance, Integrity, and Safety for assistance [815-753-8588 or pwallace@niu.edu].

**Closing the Study:**

Please note that a **final report submission** should be created in the record in lieu of an annual continuation form if data collection has ended and the data are free of identifiers. The final report is a separate submission form in the list of options in the InfoEd record, and it may be submitted prior to the annual review deadline.

With all of this said, the IRB extends best wishes for success in your research endeavors!

Please see the RIPS website for guidance on the impact of COVID-19 on research(including face-to-face data collection) [https://www.niu.edu/divresearch/covid/index.shtml](https://www.niu.edu/divresearch/covid/index.shtml)
APPENDIX C

MEDICAL RELEASE FORM
Northern Illinois University

Department of Kinesiology and Physical Education
College of Education
Anderson Hall
220 Garden Road
DeKalb, IL 60115
Telephone 815-753-3556

*** Please Complete & Return this Document ***

MEDICAL RELEASE

To the attending physician of ____________________________ D.O.B. ________________

Your patient has expressed interest in participating in a research study examining common physiological (e.g., heart rate, blood pressure, rate of perceived exertion) and psychological (e.g., enjoyment and feeling) response of an exercise session for older adults. The exercise stimulus incorporates endurance and resistance training modes of exercise delivered across a single exercise session in the Department of Kinesiology and Physical Education at Northern Illinois University (Anderson Hall). The exercise protocol itself was developed by Assistant Professor Emerson Sebastião and will be delivered in a progressive manner using appropriate training guidelines. The exercise regimen involves 6 work bouts of approximately 10-15 seconds (pushing a wheeled motorized sled over a 30 meters (100 feet) course at different velocities. The velocities will be based on participants’ comfortable walking pace. As an initial preventive measure, we are carefully screening each applicant.

We ask for your assistance in the screening as your patient will not be allowed to participate without first presenting evidence of his or her physician’s approval. Please complete the approval form if, in your medical judgment, this individual shows no contraindications to participation in the exercise program. Thank you for your help.

I believe my patient to be capable of safely participating in the exercise program. ___YES___NO

Print ____________________________

Sign ____________________________ Date ____________________________
Thank you for taking time to read this summary and evaluate your patient’s status for participation in this study.

In order to expedite our scheduling process, please send a picture of this form to the email listed below or fax it to the listed number.

Permission to release patient information to The University of Illinois Department of Kinesiology can be found at the bottom of the page.

1. Email a picture of the completed form to:
   Emerson Sebastião, PhD
   esebastiao@niu.edu

2. Fax to:
   Emerson Sebastião, PhD
   815-753-1413

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By signing this document, I give permission to have my physician email or fax a Medical Release to Emerson Sebastião in the Department of Kinesiology and Physical Education at Northern Illinois University.

Print: __________________________________

Sign: ____________________________________  Today’s Date ______________
Participant Screening Questionnaire

[Checkbox options for Eligible or Not eligible]

Participant ID: __________________
Date: __________________________
Preference: □ Walking □ Sled-Push

Explain to potential participants first that some questions may sound awkward but are essential for participant safety and data integrity. Whether the participant is eligible or not, copy the next available ID from the ID-Link Form to this form. Do NOT record participant’s name and contact on the ID-Link Form until s/he is determined eligible for this study. Instead, mark “not eligible” on the ID-Link Form at the line of ID. This helps to track the recruiting process and efforts.

Screening process ends immediately when an exclusion condition is encountered.

1. Do you understand English? □ Yes □ No, exclude
2. Can you provide consent on your own will? □ Yes □ No, exclude
3. Are you a resident of California? □ No □ Yes, exclude
4. Are you a resident of European Union? □ No □ Yes, exclude

COVID-19 related screening

5. Have you received a diagnosis of COVID-19 in the past 14 days? □ No □ Yes, exclude
6. Have you had close contact with someone with a lab confirmed COVID-19 diagnosis in the past 14 days? □ No □ Yes, exclude

7. Do you exhibit any of the following COVID-19 symptoms? □ No □ Yes, exclude
   • cough
   • shortness of breath or difficulty breathing
   • chills
   • repeated shaking with chills
   • muscle pain
   • headache
   • sore throat
   • loss of taste or smell
   • diarrhea
   • fever (temperature of 100 or greater)

Below contains data to be used in the study

8. Are you female or male? (circle one)
9. What is your age? ________ □ between 00 and above □ not 00 and above, exclude
10. What is your height? __________
<table>
<thead>
<tr>
<th>Eligible</th>
<th>Not eligible</th>
</tr>
</thead>
</table>

**Participant ID:** __________

**Date:** __________ |

**Preference:** x Walking  ○ Sled-Push

---

**Participant Screening Questionnaire**

11. What is your body weight? ________  ○ lower than 125 lbs.  ○ higher than 240 lbs.

12. Are you currently in good health?  ○ Yes  ○ No, exclude

13. Did you have any major injury or surgery done on your lower body including foot, leg, pelvis, or lower back in the past?  ○ No  ○ Yes, exclude

14. Do you currently experience any pain in your lower body including foot, leg, pelvis or lower back?  ○ No  ○ Yes, exclude

15. Did you have any major cardiovascular diseases or conditions in the past?  ○ No  ○ Yes, exclude

16. Do you currently experience any cardiovascular diseases or conditions?  ○ No  ○ Yes, exclude

17. Do you have or had infectious diseases (such as flu, pneumonia, cold sore) or symptoms (such as fever, persistent coughing) within the last 30 days?  ○ No  ○ Yes, exclude

18. One major study measurement requires you to walk on your own without the use of any assisted walking device (i.e., cane, walker). Are you able to do ambulate without the use of any assisted device?  ○ Yes  ○ No, exclude

19. Do you have asthma or other respiratory conditions. for example in order to take inhaled medications?  ○ No  ○ Yes, exclude

20. Can you bring your own preferred exercise shoes to the testing site and the shoes you are bring in are in good condition without visible wear and tear?  ○ Yes  ○ No, exclude

**Conditional exclusion:**

21. Which part of the study are you interested in...walking, Sled-Push, or both? (circle one)

22. Can you do brisk walking for at least 30 minutes?  ○ Yes  ○ No
Participant Screening Questionnaire

If a participant is eligible for either or both tests, obtain more information from subject.

What is your name: Please use the ID-link Form.

How do you describe your race or ethnicity? (read table)
- White

What is the best contact method to reach you? (circle one)
- Phone: Please use the ID-link Form.
- Email: Please use the ID-link Form.

Below are a few questions regarding your exercise habit and fitness level

Over the past 30 days, how many days do you exercise a week? __________

How many hours or minutes per each workout day? __________

What is your preferred exercise type? __________

What is the average exercise intensity? __________

How often do you use treadmill in your exercise routine? __________
Northern Illinois University

Department of Kinesiology and Physical Education
College of Education
Anderson Hall
Dekalb, IL 60115

INFORMED CONSENT

SLED-PUSH EXERCISE IN OLDER ADULTS: PHYSIOLOGICAL AND PSYCHOLOGICAL QUANTIFICATION

You are invited to participate in our research study testing the benefits of a sled-push exercise among older adults. The study is being conducted by Dr. Emerson Sebastião, graduate student Micheal Baumann, and undergraduate student Evan Mackey of the Department of Kinesiology and Physical Education at the Northern Illinois University. The following statements inform you of what will be required if you decide to participate. Please read it carefully and let us know if you have any questions.

Key Points
- You are being asked to participate in a single session of a progressive exercise session that last about 90 minutes;
- Heart rate, blood pressure, blood lactate, rate of perceived exertion, and enjoyment will be assessed throughout the exercise session;
- Blood lactate will be collected via finger prick and it will be gathered 7 times;
- Immediately after the exercise session, and at 24h and 48h post-exercise session you will be asked to report on the intensity of your body discomfort using a simple visual diagram.

Before you can participate in this study, you will be asked to sign this informed consent and a copy will be provided to you. You are being asked to volunteer and participate in this study that aims to understand the effect of a single bout of a progressive sled-push exercise in older adults (aged 60 and over). This study will be conducted in a single session of either the sled-push exercise protocol or the walking exercise protocol. You will be randomly placed into one of the two groups. Only the researchers and you will know what group you are in during and after the data collection.

Before either the sled-push or walking control starts, you will be asked to complete a demographic and health questionnaire at the Dr. Joan Popp Motor Behavior Laboratory. We anticipate that time to complete your visit in the lab, which includes warm-up, and either sled-push or walking protocol, will take approximately 90 minutes. Tests will include measures of heart rate via electronic heart rate monitor, blood pressure via manual method, blood lactate via finger prick/ portable device, rate of perceived exertion, enjoyment, and body discomfort via simple question or visual diagram. In addition to those measures, we will also measure your height and weight.

telephone 815-753-4588 or visit http://www.niu.edu/ods/research/About/Contact.shtml
You are responsible for retaining the signed consent forms obtained from your subjects for a minimum of three years after the study is concluded.

Continuation and Amendments:

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Closing the Study:

Please note that a final report submission should be created in the record in lieu of an annual continuation form if data collection has ended and the data are free of identifiers. The final report is a separate submission form in the list of options in the InfoEd record, and it may be submitted prior to the annual review deadline.

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NORTHERN ILLINOIS UNIVERSITY

I have read and understand the informed consent provided by Dr. Sebastião. I voluntarily agree to the procedures outlined above and willingly consent to be a participant in this study.

Name (please print)    Signature    Date

Recherche Name    Signature    Date

If you have questions about your rights as a research subject, please contact the Institutional Review Board at 301 Lowden Hall - Office of Research Compliance, Integrity and Safety - Northern Illinois University, DeKalb, IL 60115, Phone: 815-753-8588, E-mail: researchcompliance@niu.edu.

Northern Illinois University
7/14/2021
Approved by NIU IRB
Void one year from above date
Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 to 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly.

Check YES or NO.

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?</td>
<td></td>
</tr>
<tr>
<td>2. Do you feel pain in your chest when you do physical activity?</td>
<td></td>
</tr>
<tr>
<td>3. In the past month, have you had chest pain when you are not doing physical activity?</td>
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</tr>
<tr>
<td>4. Do you lose your balance because of dizziness or do you ever lose consciousness?</td>
<td></td>
</tr>
<tr>
<td>5. Do you have a bone or joint problem (for example, back, neck, knee, or hip) that could be made worse by a change in your physical activity?</td>
<td></td>
</tr>
<tr>
<td>6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?</td>
<td></td>
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<tr>
<td>7. Do you know any other reason why you should not do physical activity?</td>
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</tr>
</tbody>
</table>

**YES to one or more questions:**

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES:

- You may be able to do any activity you want—so long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful to you.

**NO to all questions:**

If you answered NO honestly to all PAR-Q questions, you can be reassured that you can:

- Start becoming much more physically active—begin slowly and build up gradually. This is the safest and easiest way to go.
- Take part in a fitness appraisal—this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 140/94, talk with your doctor before you start becoming much more physically active.

**DELAY BECOMING MUCH MORE ACTIVE:**

- If you are not feeling well because of a temporary illness such as a cold or a fever—wait until you feel better; or
- If you are or may be pregnant—talk to your doctor before you start becoming more active.

**PLEASE NOTE:** If you have any health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

---

Informed use of the PAR-Q. The Canadian Society for Exercise Physiologists, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completion of this questionnaire, consult your doctor prior to physical activity.

**NOTE:** If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes:

“If I have read, understood and completed this questionnaire. Any questions I have were answered to my full satisfaction.”

ZID #

SIGNATURE: DATE:

SIGNATURE OF PARENT: WITNESS:

**NOTE:** This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.
APPENDIX E

DATA COLLECTION MATERIALS
## SLED-PUSH PROJECT

**SUBJECT'S ID:**

**Date:** __/__/____

**ASSESSOR:**

### INFORM CONSENT

### WALKING PROTOCOL

<table>
<thead>
<tr>
<th>ANTROPOMETRY</th>
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</thead>
<tbody>
<tr>
<td><strong>Height (ft.):</strong></td>
<td><strong>Weight (lb.):</strong></td>
<td><strong>Sitting height (ft.):</strong></td>
</tr>
</tbody>
</table>

### AVG VELOCITY (mph):

<table>
<thead>
<tr>
<th></th>
<th>75%</th>
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<tr>
<td></td>
<td>mph</td>
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<td>85%</td>
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<td>mph</td>
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<td></td>
<td>mph</td>
<td>bpm</td>
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### 30-METER COURSE

### RESTING (10 MINUTES)

<table>
<thead>
<tr>
<th>Room Temperature:</th>
<th>F</th>
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<tbody>
<tr>
<td>Hallway Temperature:</td>
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### WARM UP (5 MINUTES)

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<td>HR</td>
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<td>BP</td>
<td>BP</td>
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<tr>
<td>RPE</td>
<td>RPE</td>
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<tr>
<td>LACTATE</td>
<td>LACTATE</td>
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<tr>
<td>ENJOYMENT</td>
<td>ENJOYMENT</td>
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#### 2 MIN REST BETWEEN TRIALS

### T1 – 75% TIME:

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<td>LACTATE</td>
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<td>ENJOYMENT</td>
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### T2 – 75% TIME:

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<td>RPE</td>
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<td>LACTATE</td>
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<td>ENJOYMENT</td>
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### T3 – 100% TIME:

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<td>RPE</td>
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<td>LACTATE</td>
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<td>ENJOYMENT</td>
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### T4 – 100% TIME:

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<td>ENJOYMENT</td>
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### T5 – 125% TIME:

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<td>ENJOYMENT</td>
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### T6 – 125% TIME:

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<tr>
<td>RPE</td>
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<tr>
<td>LACTATE</td>
<td></td>
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<tr>
<td>ENJOYMENT</td>
<td></td>
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</tbody>
</table>

### POST EXERCISE (5 MINUTES)

| Note: Tanaka's equation: \( HR_{max} = 208 - 0.7 \times AGE \) |
|---|---|
| HR |   |
| BP |   |
| RPE|   |
| LACTATE |   |

### ENJOYMENT
**SLED-PUSH PROJECT**

**ANTROPOMETRY**

<table>
<thead>
<tr>
<th>Height (ft.)</th>
<th>Weight (lb.)</th>
<th>Sitting height (ft.)</th>
</tr>
</thead>
</table>

**AVG VELOCITY (mph):**

<table>
<thead>
<tr>
<th>75%</th>
<th>mph</th>
<th>bpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>85%</td>
<td>mph</td>
<td>bpm</td>
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<tr>
<td>100%</td>
<td>mph</td>
<td>bpm</td>
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<td>100%</td>
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<td>bpm</td>
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<tr>
<td>125%</td>
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<tr>
<td>125%</td>
<td>mph</td>
<td>bpm</td>
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</table>

**30-METER COURSE**

**WARM UP (5 MINUTES)**

<table>
<thead>
<tr>
<th>HR</th>
<th>BP</th>
<th>RPE</th>
<th>LACTATE</th>
<th>ENJOYMENT</th>
</tr>
</thead>
</table>

**RESTING (10 MINUTES)**

<table>
<thead>
<tr>
<th>HR</th>
<th>BP</th>
<th>RPE</th>
<th>LACTATE</th>
<th>ENJOYMENT</th>
</tr>
</thead>
</table>

**ROOM TEMPERATURE:**

**HALLWAY TEMPERATURE:**

**2-MIN REST BETWEEN TRIALS**

**POST EXERCISE (5 MINUTES)**

**Note:** Tanaka's equation: 
\[ HR_{max} = 208 - 0.7 \times AGE \]

<table>
<thead>
<tr>
<th>HR</th>
<th>BP</th>
<th>RPE</th>
<th>LACTATE</th>
<th>ENJOYMENT</th>
</tr>
</thead>
</table>
Northern Illinois University
Department of Kinesiology and Physical Education
Health and Exercise Research Group
PROJECT SLED-PUSH
Supervisor: Dr. Emerson Sebastião
Graduate Student: Micheal Baumann

DEMOGRAPHIC AND HEALTH QUESTIONNAIRE

| Subject's ID: | Date: ___ / ___ / ___ |

Please complete the following information about yourself.

PART I: DEMOGRAPHIC

1. Data of birth: ___ / ___ / ______
2. Age in years: ______

3. Sex  ( ) Female  ( ) Male

4. Race/Ethnicity  
   ( ) White  
   ( ) African American/Black  
   ( ) Asian  
   ( ) Native Indian/Pacific Islander

5. Education attainment  
   ( ) < high school  
   ( ) High school  
   ( ) Some college  
   ( ) College degree  
   ( ) Master's  
   ( ) PhD

6. Marital Status  
   ( ) Married  
   ( ) Single  
   ( ) Divorced/Separated  
   ( ) Widow/Widower
PART II: HEALTH & HEALTH BEHAVIOR

7. Would you say that in general your health is-
   ( ) Excellent
   ( ) Very Good
   ( ) Good
   ( ) Fair, or
   ( ) Very bad

8. Would you say that in general your physical health is-
   ( ) Excellent
   ( ) Very Good
   ( ) Good
   ( ) Fair, or
   ( ) Very bad

9. Would you say that in general your mental health is-
   ( ) Excellent
   ( ) Very Good
   ( ) Good
   ( ) Fair, or
   ( ) Very bad

10. Has a doctor, nurse, or other health professional EVER told you that you had any of the following? (Mark an “X” on the side of those you were told you have it)

<table>
<thead>
<tr>
<th>Physical</th>
<th>Physical</th>
<th>Psychological/Emotional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthritis/Rheumatoid</td>
<td>Stroke</td>
<td>Stress</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>Cancer</td>
<td>Anxiety</td>
</tr>
<tr>
<td>Type 2 Diabetes</td>
<td>Asthma/COPD</td>
<td>Depression</td>
</tr>
<tr>
<td>High Blood Pressure</td>
<td>Chronic Pain</td>
<td></td>
</tr>
<tr>
<td>Heart Disease</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
11. Do you need assistance with any of the following household chores or personal cares? (Mark an “X” on the side)

<table>
<thead>
<tr>
<th>Activities of Daily Living</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathing</td>
</tr>
<tr>
<td>Walking</td>
</tr>
<tr>
<td>Cleaning</td>
</tr>
<tr>
<td>Climbing stairs</td>
</tr>
<tr>
<td>Dressing</td>
</tr>
<tr>
<td>Toileting</td>
</tr>
<tr>
<td>Transporting</td>
</tr>
<tr>
<td>Meal Preparation</td>
</tr>
<tr>
<td>Shopping</td>
</tr>
<tr>
<td>Laundry</td>
</tr>
</tbody>
</table>

12. Do you smoke? ( ) Yes ( ) No

13. How many times did you fall in the last year (12 months)?

_______ times

14. Are you afraid of falling?

( ) Yes ( ) No

15. Do you avoid activities due to risk of falling?

( ) Yes ( ) No

16. Do you take multi-vitamin supplementation?

( ) Yes ( ) No

16. How many prescribed and over the counter medication are you currently taking?

_______ prescribed

_______ over the counter
17. Do you participate in any exercise program regularly? [Yoga, dance, aerobic class, etc.]

( ) Yes If yes, how many times per week? _____ days
Time duration per session: ________ minutes/hours

18. A) Has food intake declined over the past three months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
   0= severe loss of appetite
   1= moderate loss of appetite
   2= no loss of appetite

B) Weight loss during last month?
   0= weight loss greater than 3 kg
   1= do not know
   2= weight loss between 1 and 3 kg
   3= no weight loss

C) Mobility
   0= bed or chair bound
   1= able to get out of bed/chair but does not go out
   2= goes out

D) Has suffered psychological stress of acute disease in the past 3 months?
   0= yes
   2= no

E) Neuropsychological problems
   0= severe dementia, or depression
   1= mild dementia
   2= no psychological problem

F) Body mass index (BMI) (weight in kg)/(height in m)
   0= BMI less than 19
1= BMI 19 to less than 21
2= BMI 21 to less than 23
3= BMI 23 or greater

_________ total [TO BE COMPLETED BY THE ASSESSOR]

<table>
<thead>
<tr>
<th>Screening score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-14:</td>
<td>Normal nutritional status</td>
</tr>
<tr>
<td>8-11:</td>
<td>At risk of malnutrition</td>
</tr>
<tr>
<td>0-7:</td>
<td>Malnourished</td>
</tr>
</tbody>
</table>
**PHYSICAL ACTIVITY ENJOYMENT SCALE (PACES)**

**IF YOU ARE CURRENTLY PHYSICALLY ACTIVE:**
Please rate how you feel at the moment about the physical activity you have just been doing by circling the appropriate number along the scale (select only one number).

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I find it unpleasurable</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>It's no fun at all</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>It's very unpleasant</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>It's not at all invigorating</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>It's not at all gratifying</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>It's not at all exhilarating</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>It's very stimulating</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>It's not at all refreshing</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

**Scoring system**

\[
\text{Enjoyment} = \left( \frac{\text{Item 1} + \text{Item 2} + \text{Item 3} + \text{Item 4} + \text{Item 5} + \text{Item 6} + \text{Item 7} + \text{Item 8}}{8} \right)
\]
SHORT LAST 7 DAYS SELF-ADMINISTERED FORMAT

FOR USE WITH YOUNG AND MIDDLE-AGED ADULTS (15-69 years)

The International Physical Activity Questionnaires (IPAQ) comprises a set of 4 questionnaires. Long (5 activity domains asked independently) and short (4 generic items) versions for use by either telephone or self-administered methods are available. The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health-related physical activity.

Background on IPAQ
The development of an international measure for physical activity commenced in Geneva in 1998 and was followed by extensive reliability and validity testing undertaken across 12 countries (14 sites) during 2000. The final results suggest that these measures have acceptable measurement properties for use in many settings and in different languages, and are suitable for national population-based prevalence studies of participation in physical activity.

Using IPAQ
Use of the IPAQ instruments for monitoring and research purposes is encouraged. It is recommended that no changes be made to the order or wording of the questions as this will affect the psychometric properties of the instruments.

Translation from English and Cultural Adaptation
Translation from English is supported to facilitate worldwide use of IPAQ. Information on the availability of IPAQ in different languages can be obtained at www.ipaq.ki.se. If a new translation is undertaken we highly recommend using the prescribed back translation methods available on the IPAQ website. If possible please consider making your translated version of IPAQ available to others by contributing it to the IPAQ website. Further details on translation and cultural adaptation can be downloaded from the website.

Further Developments of IPAQ
International collaboration on IPAQ is on-going and an International Physical Activity Prevalence Study is in progress. For further information see the IPAQ website.

More Information
INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?
   ___ days per week
   □ No vigorous physical activities ➔ Skip to question 3

2. How much time did you usually spend doing vigorous physical activities on one of those days?
   ___ hours per day
   ___ minutes per day
   □ Don't know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.
   ___ days per week
   □ No moderate physical activities ➔ Skip to question 5
4. How much time did you usually spend doing **moderate** physical activities on one of those days?
   
   ___ hours per day
   ___ minutes per day
   
   [ ] Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?
   
   ___ days per week
   
   [ ] No walking  ➞  **Skip to question 7**

6. How much time did you usually spend **walking** on one of those days?
   
   ___ hours per day
   ___ minutes per day
   
   [ ] Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?
   
   ___ hours per day
   ___ minutes per day
   
   [ ] Don't know/Not sure

This is the end of the questionnaire, thank you for participating.