ADAPTATION OF A PAN-CANADIAN CHRONIC DISEASE PREVENTION INTERVENTION TO PROMOTE HEALTH BEHAVIOUR CHANGE IN BRAZILIAN ADULTS

by

Juliano Schwartz

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The following individuals certify that they have read, and recommend to the Faculty of Graduate and Postdoctoral Studies for acceptance, the dissertation entitled:

Adaptation of a pan-Canadian chronic disease prevention intervention to promote health behaviour change in Brazilian adults

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in Experimental Medicine

Examining Committee:

Dr. Darren Warburton, Professor, Experimental Medicine/Kinesiology, UBC

Supervisor

Dr. Paul Oh, Medical Director, Cardiovascular Prevention and Rehabilitation Program, University Health Network

Supervisory Committee Member

Dr. Ryan Rhodes, Professor, School of Exercise Science, Physical and Health Education, University of Victoria

Supervisory Committee Member

Dr. Alex Scott, Professor, Physical Therapy, UBC

University Examiner

Dr. Neil Eves, Professor, School of Health and Exercise Sciences, UBC

University Examiner

Additional Supervisory Committee Member:

Dr. Shannon Bredin, Professor, Kinesiology, UBC

Supervisory Committee Member

Abstract

Background: Due to the high prevalence of preventable unhealthy behaviours, chronic diseases are the major health problem worldwide. These diseases and common risk factors such as physical inactivity, unhealthy diet, and smoking impose a high burden on both individuals and governments. Considering this scenario, the World Health Organization has recently established as a research priority preventive interventions in low- and middle-income countries, such as Brazil.

Objective: The main purpose of this research was to examine the effectiveness of a comprehensive pan-Canadian lifestyle program adapted to Brazilians and to verify the reproducibility of the Brazilian Portuguese version of the Physical Activity Questionnaire for Everyone (PAR-Q+).

Methods: A 12-week program called ACCELERATION, focused on health behaviour change, was translated and culturally adapted to Brazilians. A quasi-randomized controlled trial was designed, consisting of weekly emails and educational videos addressing physical activity, healthy eating and smoking cessation. The main outcomes of the study were changes in the proportion of individuals participating in ≥ 150 min of moderate-to-vigorous physical activity (MVPA) per week, eating ≥ five daily servings of fruits/vegetables, and quitting smoking. The translation and cultural adaptation of the PAR-Q+ followed the guidelines of the PAR-Q+ Collaboration.

Results: The Brazilian experimental group had an increase of 68.3% in the number of participants engaging in physical activity and of 48.8% in the total of participants adopting a healthy diet. Also, the only smoker quit smoking. Additionally, this group had increments of

185.2% in the total of weekly minutes spent in MVPA (medium to large effect size) and of 108.7% in the number of fruits/vegetables consumed daily (large effect size). These results were equivalent to that of Canadian participants with similar demographics in the original program. Regarding the Brazilian version of the PAR-Q+, the translated questionnaire had an almost perfect agreement in 93.8% of the questions, and a substantial agreement in the other items.

Conclusion: The Brazilian version of the ACCELERATION program was as effective as the Canadian intervention, and the PAR-Q+ in Brazilian Portuguese had a strong reproducibility. Both initiatives have the potential to contribute to the fight against chronic diseases in Brazil.

Lay Summary

Chronic diseases such as cancer, type 2 diabetes, cardiovascular and respiratory diseases are the leading health problem worldwide. Recently, high-income countries have seen a deacceleration in the rates of these diseases and in their common risk factors such as physical inactivity, unhealthy diet, and smoking. Conversely, the opposite has been observed in low- and middle-income nations. This is the case of the middle-income country of Brazil, where more than 75% of deaths are due to chronic medical conditions. Accordingly, a pan-Canadian program, aimed at chronic disease prevention through health behaviour change, was translated and adapted to the Brazilian population. The Brazilian version of the intervention promoted significant positive health behaviour changes in the participants, with equivalent results to the original program. Therefore, the adapted version of the intervention can be regarded as similarly effective to the Canadian program and may contribute to the prevention of chronic diseases for Brazilians.

Preface

This dissertation consists of original work done by me, Juliano Schwartz. With support from my supervisory committee, I was responsible for writing each chapter of the dissertation and for delivering all components of the investigation. The design of the research was conceptualized under the leadership of Drs. Darren E. R. Warburton, Paul Oh, Ryan E. Rhodes, and Shannon S. D. Bredin. I wrote the ethics application and with support from colleagues, I conducted the data collection, delivery of the intervention, and statistical analyses. Dr. Warburton provided the structure for the data collection and delivery of the intervention, Dr. Oh suggested adapting the ACCELERATION program to the Brazilian population and contributed with practical support for the conduction of the research, Dr. Rhodes guided the inclusion of specific components of the project as well as part of the statistical analysis, and Dr. Bredin assisted with drafting publications resulting from this research.

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attested the accuracy of the back-translated version and reviewed all the steps involved in the writing of the manuscript. All authors approved the final version of the manuscript.

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The research projects outlined in chapters 5 and 6 were approved by the Clinical Research Ethics Board of the University of British Columbia (H17-03564). All participants provided written informed consent prior to research participation.

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List of Abbreviations

6MWT –	six-minute walk test
BC –	Brazilian control group
BE –	Brazilian experimental group
BMI –	body mass index
bpm –	beats per minute
CE –	Canadian experimental group
CI –	confidence interval
cm –	centimetre
COM-B –	capability, opportunity, motivation – behaviour
COVID-19 –	coronavirus disease 2019
DBP –	diastolic blood pressure
cpm –	counts per minute
HR –	heart rate
ICC –	intraclass correlation coefficient
kg –	kilogram
LMICs –	low- and middle-income countries
mmHg –	millimetre of mercury
m –	metre
min –	minute
MVPA –	moderate-to-vigorous physical activity
ml –	millilitre

PAL – Physical Activity Line

PAR-Q – Physical Activity Readiness Questionnaire

PAR-Q+ – Physical Activity Readiness Questionnaire for Everyone

SBP – systolic blood pressure

VO_2max – maximal oxygen consumption

WC – waist circumference

WHO – World Health Organization

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Dedication

To my daughters Alice and Beatriz, I love you! I am sorry for not being able to be more present recently; one day, you will understand this better. The two of you were an essential part of my inspiration, and being your dad helped me move forward during difficult moments.

Alice, thank you for being such a sweet, caring, and brave girl. Beatriz, thank you for being such a loving, companion, and courageous girl. I am extremely proud of you both.

You were born in a thriving and healthy Brazil, in which hunger had ceased to be a widespread problem. I hope you can grow up to live in a world without hunger and contribute to making this a reality.

Chapter 1: Introduction

1.1 General Overview

Between the end of the 20th and the beginning of the 21st century, chronic diseases, also known as noncommunicable diseases, have replaced infectious diseases as the leading cause of morbidity and mortality across the globe (Teo & Rafiq, 2021; WHO, 2021c). The ongoing coronavirus disease 2019 (COVID-19) pandemic has brought additional challenges to health care systems worldwide, and the disease is currently responsible for deaths close to the number of lives claimed by chronic medical conditions (Ahmad et al., 2021). Importantly, chronic disease patients are among the most susceptible individuals to COVID-19 and suffer more severe consequences than individuals without chronic medical conditions (Singh Thakur et al., 2021). As with previous infectious pandemics, evidence indicates that the maintenance of protective measures such as frequent handwashing and increased vaccination rates will significantly improve the situation surrounding COVID-19 over the next few years (GBD 2019 Risk Factors Collaborators, 2020; Mahmud et al., 2022). In fact, overall, an increase in basic hygiene and health care, along with medical advances over the years, has led to a substantial reduction of infections and subsequent deaths, resulting in a rise in the longevity of the global population (Boschiero et al., 2021; Egger & Dixon, 2014).

In addition to the worldwide aging phenomenon, simultaneous factors such as globalization, industrialization, and urbanization have had a significant impact across societies, altering individuals' lifestyles and increasing behavioural risk factors (Ndubuisi, 2021). Collectively, these aspects have resulted in a continuous increase in the morbidity and mortality related to chronic diseases (Egger & Dixon, 2014). Smoking, excessive alcohol intake, unhealthy diet, and physical inactivity are among the main contributors to the development of chronic

diseases (Singh Thakur et al., 2021). These illnesses, which are slow in their progression and long in their duration, affect mostly adults (Booth et al., 2012; Booth et al., 2017). The main chronic diseases, given their direct impact on the number of convalescences and deaths globally, are type 2 diabetes, cardiovascular disease, respiratory disease, and cancer (Egger & Dixon, 2014; WHO, 2021c).

Overall, international comparison studies in the health domain follow a classification from the World Bank in which countries are grouped into low-income, middle-income, and high-income (Mielke et al., 2018; Vandevijvere et al., 2019; Yusuf et al., 2014). Such allocation is based on the gross national income of each country. Whereas chronic medical conditions used to be a problem mainly in high-income countries, these diseases now affect low- and middle-income countries (LMICs) in a much higher proportion, with the majority of deaths due to these diseases occurring in lower-income nations (Ranasinghe et al., 2021).

According to recent global reports, low-income countries still face a high number of deaths caused by infectious diseases (WHO, 2020d, 2020e). However, according to the same sources, these nations have seen a continuous decrease in mortality due to communicable diseases and a simultaneous increase in the number of lives claimed by chronic diseases. These reports also show a steady increase in the number of deaths due to chronic medical conditions in middle- and high-income countries.

While aging is not modifiable, behavioural risk factors for chronic diseases are preventable and therefore have been receiving the attention of governments and other organizations across the globe (Manafò et al., 2011; Scatigna et al., 2019; Souza et al., 2021). As a consequence, there has been an improvement in health behaviours, such as a decrease in the prevalence of smoking and an overall stagnation of excessive alcohol intake (although emerging

evidence suggests possible increases in alcohol consumption has occurred in the initial stages of the COVID-19 pandemic) (WHO, 2020f, 2021b). However, healthy behaviours such as physical activity and healthy eating have decreased globally, which has resulted in increasing rates of obesity, contributing to the continuous increase of chronic diseases (Arena et al., 2017; WHO, 2018, 2021d). Recent research also suggests that rates of physical activity and healthy eating have also been negatively impacted by the COVID-19 pandemic (McDonough et al., 2021; Smaira et al., 2021).

Therefore, preventive initiatives centred on behavioural risk factors for chronic diseases, mainly physical inactivity and unhealthy eating are of critical, contemporary importance (Turner-Moss et al., 2021); however, such initiatives should also consider other behaviours, which despite some progress, still present global prevalence above desirable levels, particularly in terms of tobacco use (Douglas & Ahmed, 2021; WHO, 2020f). In fact, different initiatives to tackle smoking have been taken in lower-income locations and some approaches presented substantial effectiveness (Levy et al., 2012; Malta et al., 2015c; Reitsma et al., 2021). However, most of the evidence on how to successfully promote and facilitate physical activity and healthy eating comes from research conducted in high-income countries (Fanzo & Davis, 2019; Turner-Moss et al., 2021).

Although chronic diseases remain the leading cause of death in rich nations, a variety of interventions have shown a reduction in the prevalence of such diseases in these countries (Teo & Rafiq, 2021; Yusuf et al., 2014). Similarly, and more urgently given the impact caused by these diseases in LMICs, poorer nations require initiatives that consider their specific contexts, in order to tackle the burden caused by these chronic medical conditions (Bull et al., 2020; Turner-Moss et al., 2021). Accordingly, there is a call for action for interventions in LMICs, addressing

the behavioural risk factors for chronic diseases (Liu et al., 2019a; Sallis et al., 2016a; WHO, 2020b).

With more than 200 million people, Brazil is a middle-income nation in which chronic diseases are the primary cause of mortality (Brasil, 2020; WHO, 2020f). Although the country has made substantial progress in the areas of health and science, as well as in income distribution in the recent past, with some leading initiatives in health promotion and welfare, significant socioeconomic inequity still remains; indeed, the country is one of the most unequal nations in the world (Arrais et al., 2021; Crochemore-Silva et al., 2020). In fact, after a period of substantial growth and prosperity, poverty and inequality are on the rise in Brazil (Doniec et al., 2018; Szwarcwald et al., 2021). Underprivileged groups in the country experience worse working conditions, inferior wages, and more restricted access to health services, all of which favour the adoption of unhealthy behaviours (Silva et al., 2019). Additionally, Brazil has one of the world's fastest aging populations, with an estimated ratio of 153 seniors to 100 young individuals by 2040 – four times as many as 2010 (Lima-Costa, 2018; Miranda et al., 2016).

Another country with a rapidly aging population, Canada is a high-income nation where chronic diseases such as cancer, cardiovascular disease, respiratory disease, and diabetes are also pressing health problems (Chireh & D'Arcy, 2020; Varin et al., 2019). While the challenges to overcome the burden caused by chronic diseases in Canada are significant, including the high cost of health care associated with unhealthy behaviours, the country has consistently invested in a wide range of preventive actions (Politis et al., 2014; Politis et al., 2017). This includes the work developed by several provincial and national agencies and organizations, focusing on health promotion (Masuda et al., 2012; Maximova et al., 2019). Such initiatives have contributed to a slowdown in the incidence of chronic diseases in Canada, including the development of

policies and programs that serve as models for other jurisdictions (Dummer et al., 2018; Politis et al., 2017)

As part of these initiatives, the Canadian Partnership Against Cancer developed the project Coalitions Linking Action and Science for Prevention, aimed at improving the health of Canadians (Manafò et al., 2011). Such a project also counted on the financial support of Health Canada, the governmental department in charge of national health policy, a division which is also responsible for the Public Health Agency of Canada (CPAP, 2017). Considering the burden caused by the risk factors for chronic diseases, and the fact that most deaths caused by these diseases could be prevented, this Canadian Partnership Against Cancer's initiative fostered alliances across provinces, connecting research, practice, and policy sectors. As a result, several pan-Canadian coalitions were formed, broadening the reach and deepening the impact of chronic disease prevention efforts in the country (Politis et al., 2017).

The ACCELERATION program, an intervention to encourage health behaviour change to prevent chronic diseases, was one of the coalitions funded by the project and was also sponsored by the Heart and Stroke Foundation of Canada (CPAP, 2017; Oh & Nooyen, 2018). This program involved hospitals, universities, sport clubs, companies, and government bodies in different provinces, from coast to coast of the country (University Health Network, 2015), and is now being internationalized.

Although Brazil and Canada have significant differences, particularly in terms of socioeconomic factors, these countries share considerable similarities in terms of risk factors for chronic diseases (Souza Neto et al., 2021; WHO, 2020f). Based on initiatives tackling excessive alcohol consumption and mainly smoking in both countries, current evidence suggests that Brazilians and Canadians usually prioritize not engaging in (or quitting) harmful behaviours,

rather than adopting healthy behaviours such as physical activity and healthy eating (Dionato et al., 2021; Varin et al., 2019). Therefore, there has been a movement in Brazil and Canada calling for initiatives addressing these behaviours (Bédard et al., 2020; Macridis et al., 2020; Souza Neto et al., 2021). Considering the similarities in the health domain, both countries can mutually benefit from an exchange of knowledge. For instance, the newest version of Canada's dietary guidelines, published in 2019, has incorporated several aspects presented in the pioneering evidence-based dietary guidelines for the Brazilian population, launched in 2014 (Monteiro & Jaime, 2020). Similarly, Brazil can greatly benefit if the country follows the Canadian lead in prioritizing investments in physical activity interventions as well as chronic disease prevention initiatives in general, such as the ACCELERATION program.

1.2 Purposes and Hypotheses

The purpose of this dissertation is to address knowledge gaps related to interventions aimed at chronic disease prevention. Specifically, this dissertation aims to present the implementation and outcomes of two empirical studies focused on initiatives to promote health behaviour change in Brazilian adults.

1.2.1 Physical Activity Readiness Questionnaire for Everyone (PAR-Q+): The Brazilian Portuguese Version

This study aimed to translate, culturally adapt, and verify the reproducibility of the evidence-based PAR-Q+ to the Brazilian Portuguese language. It was hypothesized that the translated version would present high reproducibility and be a valid instrument to facilitate a safe engagement in physical activity for Brazilians.

1.2.2 Adaptation of a Pan-Canadian Program to Change Health Behaviours in Brazilian Adults

This study addressed the following research question: what is the effectiveness of a translated and culturally adapted version of a Canadian program aimed at changing health behaviours, known as risk factors for chronic diseases, in the Brazilian population? It was hypothesized that the Brazilian version would be as effective as the original project and that the experimental group would present better results than the control group.

1.3 Dissertation Outline

In light of the contexts presented in the general overview section, a research plan was designed, consisting of four projects, which are presented in chapters 3 to 6. The second chapter of this dissertation provides a background regarding the current scenario of chronic diseases worldwide. Specifically, this chapter discusses how the fight against chronic diseases and associated factors have been handled in Brazil.

Considering the importance of behavioural approaches to increase physical activity and healthy eating, chapter 3 of this dissertation presents a review of components commonly used in interventions addressing healthy lifestyles. This includes traditional and more recent behaviour change theories as well as behaviour change techniques, along with other strategies to successfully elicit the adoption of these healthy behaviours.

Given the scientific contributions provided by Canadian researchers and policy-makers in the field of physical activity throughout the years, as well as the scientific contributions provided by Brazilian researchers and policy-makers mainly in the last decade, particularly regarding healthy eating, a critical review was designed to discuss these matters. The discussion also considered the new concept of physical activity security, given its direct relationship to these topics. This review is presented in chapter 4, interpreting findings from studies in both countries

and how the aspects related to physical activity security, as well as the progress presented by each country in terms of physical activity and healthy eating can contribute to the prevention of chronic diseases in a more comprehensive and inclusive way.

To address physical inactivity in Brazil, an original research study was designed, to translate and culturally adapt the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+), aimed at providing Brazilians of all ages and different health conditions with an evidence-based tool to allow safe participation in physical activity and fitness assessments. The specific methods involved in this project and the results of this study are presented in chapter 5.

Finally, the pan-Canadian program ACCELERATION was translated and culturally adapted for Brazilian adults. After material preparation, the intervention was delivered in a quasi-randomized controlled trial, to Brazilians living in Canada. Details about both the Canadian and the Brazilian programs, including the results of the Brazilian intervention and the comparison with the Canadian data are presented in Chapter 6.

To close the dissertation, chapter 7 presents general conclusions based on the topics discussed in the previous chapters. This concluding chapter also presents the contributions from this research and proposes future directions.

Chapter 2: Background

2.1 Chronic Diseases

Due to significant improvements in the management of health conditions, the 20th century witnessed an increase in life expectancy for most populations across the world (Olshansky, 2018; Teo & Rafiq, 2021). As global medical advances have contributed to a decrease in premature mortality related to infectious diseases, there has also been a rise of a number of chronic diseases and an increase in consequent morbidity and mortality associated with these conditions (Ng et al., 2020; WHO, 2020f).

This shift, called epidemiological transition or health transition (GBD 2013 Mortality and Causes of Death Collaborators, 2015), has been associated with unhealthy behaviours across populations around the world, and chronic medical conditions are evident as one of the primary consequences of poor lifestyles (Arena et al., 2017; WHO, 2020f). These diseases are the main reason for global deaths, killing around 41 million people each year (Singh Thakur et al., 2021). The main chronic diseases are type 2 diabetes, responsible for 1.5 million yearly deaths; respiratory diseases (such as chronic obstructive pulmonary disease and asthma), which cause 4.1 million deaths/year; cancer, which is the reason for 9.3 million annual deaths; and cardiovascular diseases (such as heart attack and stroke), responsible for 17.9 million deaths a year (WHO, 2021c). These diseases are further defined and addressed below.

Diabetes is characterized by chronic high levels of blood glucose (hyperglycemia), due to inadequate insulin secretion and insulin resistance, i.e., an impairment in the mechanism whereby glucose is absorbed into the cells (American Diabetes Association, 2021). Additionally, this metabolic disease is related to excessive weight and/or a high body fat percentage (Riddell & Burr, 2011). Although more frequently observed in adults and older adults, type 2 diabetes has

been increasingly found in younger individuals (American Diabetes Association, 2021). According to a recent report, 462 million people live with type 2 diabetes, which corresponds to about 6.3% of the global population (Khan et al., 2020b).

A partially reversible airflow obstruction is the main characteristic of chronic obstructive pulmonary disease, whereas asthma is a chronic inflammatory condition associated with breathlessness, coughing, and chest tightness (Eves & Davidson, 2011). These are the two most common respiratory diseases; asthma is usually observed in younger adults whereas chronic obstructive pulmonary disease affects mainly older individuals (Xie et al., 2020). The primary cause of chronic obstructive pulmonary disease is smoking, while asthma is triggered by indoor and outdoor allergens, such as mites and pollen, respectively, as well as tobacco smoke (Eves & Davidson, 2011). A global burden of disease study estimated that, in 2015, 358.2 million people were living with asthma and 174.5 million with chronic obstructive pulmonary disease (GBD 2015 Chronic Respiratory Disease Collaborators, 2017).

Cancer is generally described as a malignant tumour – an abnormal growth of tissue that might have an unlimited expansion – which may be localized or systemic (Booth et al., 2012). There are several types of cancer, with breast, lung, colon/colorectal, and prostate being the most common in adults (WHO, 2021a). Causes of cancer include environmental, genetic, and behavioural factors, such as air pollution, family history, and unhealthy weight (Silva et al., 2021). In 2020, the number of new cases of cancer were as follows: breast – 2.26 million; lung – 2.21 million; colon/colorectal – 1.93 million; and prostate – 1.41 million (WHO, 2021a).

Cardiovascular disease is a group of conditions that affect the heart and blood vessels, among which ischemic heart disease (including myocardial infarction, also known as heart attack) and stroke are the most common worldwide (GBD 2013 Mortality and Causes of Death

Collaborators, 2015; Osler et al., 2020). The main cause of these diseases is atherosclerosis, a chronic inflammatory condition consisting of a blockage in the arteries that supply these organs, which may be induced by factors such as high blood pressure and altered lipid profile (Milutinović et al., 2020). The global prevalence of ischemic heart disease and stroke were recently estimated as 126 million and 101 million, respectively (GBD 2019 Stroke Collaborators, 2021; Khan et al., 2020a).

All these diseases are linked to societies' progressive industrialization and extensive automation of manual tasks (Archer & Blair, 2011; Boutayeb & Boutayeb, 2005). Overall, there has been a marked reduction in the requirement for human movement in daily activities, along with widespread availability and active promotion of inexpensive and low-quality food around the world (Teo & Rafiq, 2021). Consequently, since around the 1970s, initially high-income countries and subsequently LMICs have seen their populations engaging in unhealthy lifestyle behaviours, which represent the major cause of chronic diseases and early death (Teo & Rafiq, 2021; WHO, 2020f).

When the World Health Organization (WHO) launched its global action plan for the prevention and control of chronic diseases in 2013, such conditions were responsible for around 63% of worldwide deaths (WHO, 2013). According to the newest report, the last decade has not seen an improvement, indeed this rate is now about 10% greater (WHO, 2020a). Part of this situation is due to the lack of success in tackling the behavioural risk factors that are common to these diseases (Teo & Rafiq, 2021).

2.2 Behavioural Risk Factors

Two cessation behaviours, in relation to tobacco use and excessive alcohol consumption, as well as two adoption behaviours, in relation to physical activity and healthy eating, are some

of the main factors that affect chronic diseases (Ndubuisi, 2021; Precoma et al., 2019; Teo & Rafiq, 2021). Physical inactivity is usually identified when one does not engage in 150 minutes (min) of moderate-to-vigorous physical activity (MVPA) per week; unhealthy diet is often characterized when one eats less than five servings of fruits and vegetables per day; smoking is considered the use of tobacco in any dose or route; and harmful alcohol intake is commonly observed in irregular or chronic heavy drinking (Dietz et al., 2016; Rehm & Roerecke, 2017; Teo & Rafiq, 2021).

Mechanistically, smoking is responsible for various physiological changes such as insulin resistance, inflammation, and oxidative stress, which are directly related to the development of diabetes, cardiovascular disease, cancer (mainly lung), and chronic respiratory disease (Douglas & Ahmed, 2021). Harmful alcohol use is related to obesity, cardiovascular disease, cancer (mainly liver), and diabetes, through pathological mechanisms such as increases in body weight, blood pressure, triglycerides, and oxidative stress (Ratna & Mandrekar, 2017; Shield et al., 2014). Combined, unhealthy diet and physical inactivity lead to a decrease in insulin sensitivity and fat oxidation, an imbalance between free radicals and antioxidants, and an increase in inflammatory markers (Booth et al., 2012; Kopp, 2020). As a result, there is an increase in blood pressure, oxidative stress, glycemia, inflammation, and body weight, as well as an imbalance in lipid profile, which are contributors to the development of cardiovascular disease, cancer (mainly colon and breast), diabetes, and chronic respiratory disease (Booth et al., 2017; Caprara, 2021; Romagnolo & Selmin, 2017).

Tobacco use is the risk factor that has received the most attention among governments and researchers globally, owing to the overwhelming evidence supporting its role in premature mortality and the development of chronic medical conditions (WHO, 2020f). Although smoking

prevalence around the world remains higher than desired, several health and policy actions have resulted in significant advancements in addressing the prevalence of this unhealthy behaviour (Douglas & Ahmed, 2021; Hill et al., 2014). Addressing global alcohol intake has also made some progress and its overall prevalence has not raised in recent years, despite a recent indication of increases in some populations, mainly during the early stages of the COVID-19 pandemic (Asrani et al., 2021; WHO, 2020f, 2021b).

Alternatively, since the end of the 20th century, the worldwide prevalence of obesity has increased 50% in adults, and now there are more deaths related to being overweight and obese than to being underweight (Rosengren, 2021; WHO, 2020f, 2021d). At the beginning of humankind, food was not readily available, and significant effort was required to procure food in this "hunter-gatherer" phase of evolution, when eating happened only sporadically (Booth et al., 2017). Accordingly, in an effort to obtain adequate caloric intake, physical activity was mandatory, although this pursuit was not always successful (King, 2013). Through major societal developments of widespread agriculture and then industrialization, human beings transitioned from a very physically active lifestyle, with scarce availability of food, to times of greater accessibility to food and less need for movement (Arena et al., 2017).

Along with the rise in the amount of food consumed regularly, there was a critical change in the quality of food as it became increasingly processed, with high contents of sodium, sugar and many other refined ingredients (Vandevijvere et al., 2019). Concurrently, the required energy expenditure necessary for numerous daily life activities, such as commuting, leisure, and working decreased significantly (Booth et al., 2017). Consequently, in many countries, the current number of adults not engaging in regular physical activity and not following a healthy diet is worrisome (GBD 2017 Diet Collaborators, 2019; Hallal & Pratt, 2020).

While global smoking prevalence has been declining, and the harmful use of alcohol has overall stagnated worldwide, the other two main risk factors have gained increasing attention internationally since physical inactivity and suboptimal food intake have paralleled the epidemiological shift related to chronic diseases (Dietz et al., 2016; Turner-Moss et al., 2021; WHO, 2020f). As an attempt to reduce the harm caused by these risk factors and prevent the development of chronic diseases, some quality interventions focusing on the adoption of healthy behaviours have been put into practice around the globe, with consistently proven effectiveness of the benefits of physical activity and a healthy diet (Buja et al., 2020; McTiernan et al., 2019; Ramôa Castro et al., 2017; Rees et al., 2020). The main mechanisms through which physical activity and healthy eating protect against chronic diseases are shown in Figure 2.1.

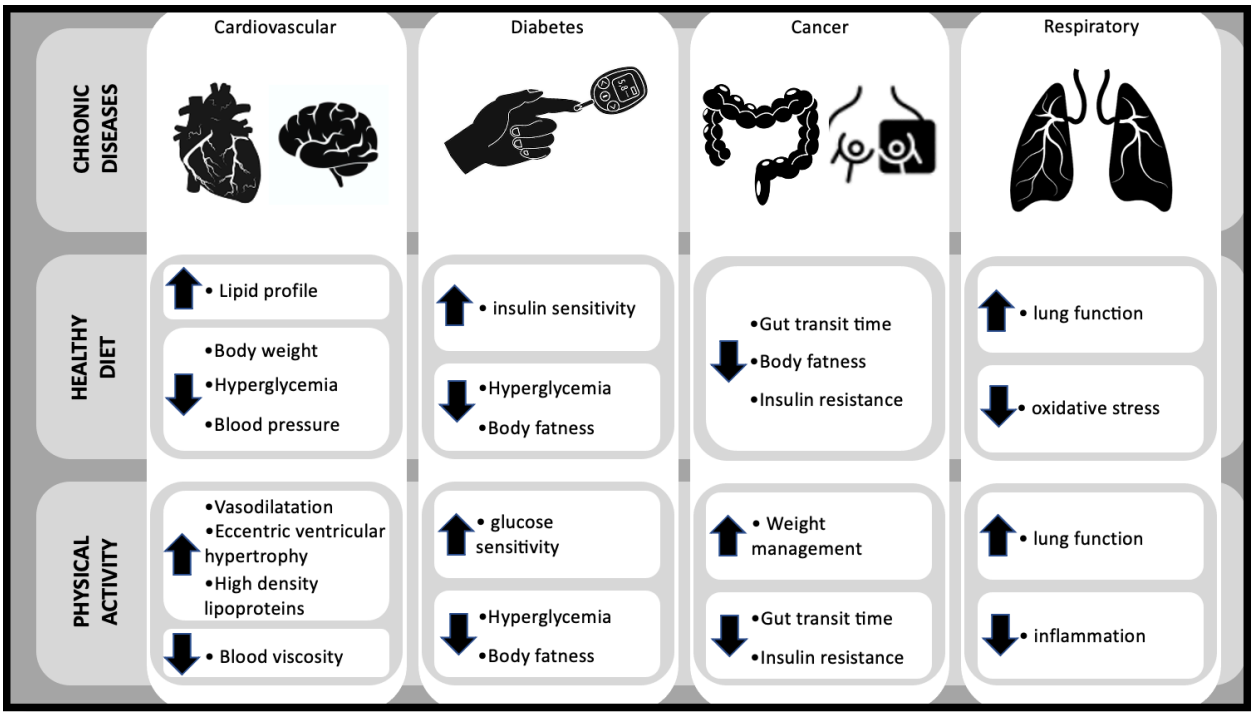

Figure 2.1 Main effects of a healthy diet and physical activity on the prevention of chronic diseases.
↑ = improvement; ↓ = decrease; (Booth et al., 2017; Caprara, 2021; Kantorowski et al., 2018; Romagnolo & Selmin, 2017; Scoditti et al., 2019)

2.3 World's Response to Chronic Diseases

Lifestyle behaviours are the factors that cause the main impact on health; however, preventive measures focusing on these modifiable risk factors usually receive little attention in many health care systems (Bauer et al., 2018; Bully et al., 2015; Owolabi et al., 2022). Despite the effectiveness of behavioural interventions on health, including better results than the use of medication to remedy the consequences of chronic diseases, treatment initiatives have been the main priority in most health service frameworks (Knowler et al., 2002; Pryor & Volpp, 2018). In fact, not only managerial personnel but also end-users in general prefer to invest in treatment rather than prevention (Rosewarne et al., 2021; Thavorncharoensap et al., 2013; Wolff et al., 2020). This culture is highly influenced by the power of big corporations, such as those in the pharmaceutical and food industries, in which highly profitable companies often make use of practices aimed at their own benefit, regardless of the consequences on people's lives (Jelinek & Neate, 2009; Katz et al., 2018; Tempels et al., 2020). Examples include persuading physicians to prescribe drugs, even when it is not in the best interest of individuals (Brody, 2005; Hailu et al., 2021); heavy advertisement of medications sometimes not completely tested to be considered safe as well as food products known for being harmful to health (Carters-White et al., 2021; King et al., 2021; Starr, 2015); and undermining initiatives that lead to less dependence on medication and a decrease in the consumption of unhealthy food products (Katz et al., 2018; Monteiro & Jaime, 2020; Spurgeon & Sweet, 2004).

Part of the success of initiatives tackling smoking (and alcohol to some extent) is a result of reducing the influence of these industries in research and media advertisement (Hawkins et al., 2021; US Department of Health and Human Service, 2014; Yoon & Lam, 2013). Such endeavours, although not simple, allow preventive campaigns to reach a higher impact in

changing behaviours (Charoenca et al., 2012; Gilmore et al., 2015). Preventive interventions have been shown to have a better cost-benefit relationship and to be more effective for both individuals' health and governments' financial situations (Bertram et al., 2018; Owolabi et al., 2022; Ramirez et al., 2021). Therefore, considering that most deaths worldwide are caused by preventable risk factors, a complete shift in the priority of health care, moving from a focus on treatment to emphasizing prevention, is of utmost importance (Boccia, 2021; Katz et al., 2018; Zhong et al., 2015).

This idea has been supported by different global documents, calling for actions to reduce premature death and improve health and well-being of current and future generations (UN, 2015; WHO, 2013, 2017). Some commendable initiatives have shown the effectiveness of interventions to prevent chronic disease (da Silva et al., 2013; Katz et al., 2018; Pryor & Volpp, 2018). However, many interventions have focused on only one risk factor, and some studies addressing multiple behaviours have presented less positive results than those centred on a single health behaviour (Craike et al., 2018; Meader et al., 2017; Oftedal et al., 2021). This is in accordance with findings that multiple health behaviour change approaches still need more scientific support and that individuals possibly do not value enough the benefits of such approaches (Aguiar et al., 2014; Nigg & Long, 2012; Prochaska & Prochaska, 2011).

In general, better results in studies addressing only one behaviour were observed in interventions focused on physical inactivity (Craike et al., 2018; Rhodes et al., 2017). Regarding other behaviours, the literature is less conclusive (Maisano et al., 2020; Meader et al., 2017; Minian et al., 2018). However, physical inactivity is just one of the unhealthy behaviours responsible for the development of chronic medical conditions, and physical activity alone is not enough to prevent obesity, which is another risk factor for chronic diseases (Vallis et al., 2020).

Therefore, since chronic medical conditions are affected by multiple risk factors, which are frequently interconnected, there is a clear need for more research addressing comprehensive lifestyle programs (Aznar-Lou et al., 2021; Geller et al., 2017; Ndubuisi, 2021).

One reason for the high prevalence of unhealthy behaviours is the complexity involved in face-to-face health behaviour change programs, which require a commitment of several in-person sessions that is unfeasible for most people (Goldberg & Kiernan, 2005; Thomas Craig et al., 2020). Moreover, offering such initiatives are costly and complicated, which often times precludes health professional and researchers from providing high-quality options (Aznar-Lou et al., 2021; Rhodes et al., 2017). Therefore, there has been an increase in the number of interventions that are offered via less conventional methods, which usually include deliveries over the phone and/or the internet (Smith et al., 2020; Wyse et al., 2021). However, to date, interventions based on technological tools have presented modest effectiveness, particularly in lower-income locations (Tang et al., 2020; Western et al., 2021). Given the importance of reaching the maximum possible number of individuals, new evidence is required to address such a context (Smith et al., 2020; Wyse et al., 2021).

In fact, another aspect that requires more research in the fight against chronic diseases is the realities faced by LMICs. While most of the available evidence comes from high-income countries, the largest proportion of the world's population lives in LMICs, where the majority of the deaths due to chronic diseases occur (Fanzo & Davis, 2019; Liu et al., 2019a; Turner-Moss et al., 2021). Increased knowledge and modification of behavioural risk factors, more effective implementation of preventive practices, and proper infrastructure of health systems have led to a reduction in chronic diseases in high-income nations (Teo & Rafiq, 2021; Yusuf et al., 2014). Although such diseases used to be a problem almost exclusively in high-income countries, the

rapid urbanization of lower-income countries has led to similar scenarios (Boutayeb & Boutayeb, 2005). Globalization and societal changes have had an enormous impact on the health and lifestyle of individuals in these locations, which requires urgent initiatives that consider local socioeconomic and cultural aspects to properly tackle chronic diseases and their risk factors in these countries (Bull et al., 2020; Turner-Moss et al., 2021).

Such a call has been made by different authors and was recently emphasized by the World Health Organization, which considers interventions in LMICs as a research priority, given the limited evidence from these jurisdictions (Liu et al., 2019a; Sallis et al., 2016a; Turner-Moss et al., 2021; WHO, 2020b). These WHO guidelines highlight the importance of comparing such interventions with those conducted in high-income countries with a goal of reducing health disparities and increasing the effectiveness of public health recommendations in lower-income regions.

Despite significant progress, chronic medical conditions are still a leading health problem in high-income countries (Varin et al., 2019; WHO, 2020f). However, these chronic conditions affect LMICs much more severely, with more than 75% of worldwide deaths from such diseases occurring in these nations (Ranasinghe et al., 2021). This is the case of Brazil, a country with more than 30% of the population being poor or extremely poor, where chronic diseases are also the leading cause of mortality (Arrais et al., 2021; Brasil, 2020; WHO, 2020f). While important measures were taken to tackle chronic diseases and respective risk factors in the country, the rates of chronic diseases continue to increase (Szwarcwald et al., 2021), as presented in the next section.

2.4 Brazilian Scenario

According to Brazil's latest National Health Survey (IBGE, 2020), in 2019, 7.7% of

Brazilians were living with diabetes, which is equivalent to 12.3 million people. In the previous survey, in 2013, this prevalence was 6.2% (Malta et al., 2015b). The same documents indicate that 11.5 million (7.3% of the adult population) had a cardiovascular disease (including stroke) in 2019, while in 2013 this rate was 5.7%. Still according to the same reports, in 2019, 2.6% of adults had cancer (4.1 million individuals), whereas in 2013 this prevalence was 1.8%. Regarding respiratory diseases, only asthma was reported, affecting 5.3% (8.4 million) of Brazilian adults in 2019, and 4.4% in 2013. A recent independent study reported a national prevalence of 17.0% of chronic obstructive pulmonary disease in adults aged ≥ 40 years in 2018 (Cruz & Pereira, 2020), and another independent study, focused on Sao Paulo, the most populous city in Brazil, found a prevalence of 14.9% of individuals of the same age in 2005 (Menezes et al., 2005). The Brazilian data regarding chronic obstructive pulmonary disease should be seen with caution though since it focused on the age group where the disease is most prevalent, and the metropolitan area of Sao Paulo is the most polluted region in the country (Leão et al., 2021).

2.4.1 Public Health Policies

Although the prevalence of chronic diseases has increased, this scenario could be worse, since the country has a rapidly aging population, and most households currently face significant financial challenges, both factors with direct implications on the health sector (Arrais et al., 2021; Lima-Costa, 2018). Starting in 2003, the establishment of several social policies allowed a large number of families to afford vital items to live within minimal standards of health for the first time in their lives (Ivo de Carvalho et al., 2007; Machado et al., 2010). During the following few years, more than 40 million people were lifted out of poverty and the country was removed from the World Food Programme's global hunger map (Doniec et al., 2018; Tepperman, 2016). These initiatives were accompanied by the development of health policies within a National

Health Plan aimed at an increase in the quality and the reach of public services, through actions developed in collaboration among different sectors and qualification of personnel (Guimarães & Ribeiro, 2009). A next step was the implementation of the National Health Promotion Policy, which was aligned with global tendencies and involved international cooperation, in an innovative and very effective approach within the Ministry of Health (Ferreira Neto et al., 2013).

This policy aimed at meeting the commitment made in the 1st International Conference on Health Promotion (WHO, 1986), such as tackling health inequalities and promoting opportunities for individuals to make healthy choices (Malta et al., 2018). According to these authors, although the principles of health promotion were established in the country in 1988, the policy was actually implemented only in 2006. Besides considering important aspects related to other risk factors for chronic diseases, the inclusion of essential components of the policy was based on the WHO's strategy on diet, physical activity and health (Waxman, 2004). Not only were several nutrition security actions taken, but physical activity was officially added in the policy and a national surveillance system was created to monitor chronic disease risk factors in the population (Moura et al., 2008).

Aligned with the progress promoted by the aforementioned initiatives, up until early 2016 several other measures taken by the government increased the quantity and quality of services provided by key sectors, such as education, health, and science, putting the country in a prominent international position (Guimarães et al., 2006; Malta et al., 2018; Tepperman, 2016). Examples include new federal universities, health units in the most distant locations, and scientific programs in partnership with cutting-edge institutions across the globe (Rezende, 2010; Rosa et al., 2021; Santos et al., 2017). In fact, such initiatives were necessary since in 2013 about 50 million Brazilians were still poor or extremely poor (IBGE, 2016). However, while Brazilians

still reap the extremely positive consequences from those actions, political changes in the country since 2016 have undermined such benefits (Arrais et al., 2021). Investments in health and education were declared frozen for years, scientific sponsorships were cut, and hunger has once again become a reality in the country, with around 60 million individuals living in poverty in 2019 (IBGE, 2020; Wendt et al., 2021).

This substantial backtracking can be well illustrated by the smoking legislation. Between 2003 and 2016, more than 20 national laws, decrees, ordinances, and resolutions were established to control the use of tobacco in Brazil, including the ban of smoking in public spaces as well as changes in cigarette taxation and the institution of a minimum price policy (Malta et al., 2015c; National Cancer Institute, 2021). As a consequence, the national consumption of tobacco declined substantially, becoming one of the lowest worldwide, and the country was considered a primary reference by WHO and other institutions (Levy et al., 2012; Malta et al., 2018). Another consequence was the reduction in socioeconomic inequities given the impact of buying tobacco products on families' budgets (Hill et al., 2014; Silva et al., 2019a). For instance, smokers in Brazil spent more on cigarettes than on beans and rice, the main staple foods in the country (IBGE, 2004). However, since 2017 smoking is not controlled as before, allowing actions such as the publication of an official ruling, in 2019, to reduce the tax in national tobacco products (Wendt et al., 2021). Such a ruling is based on the alleged intention of reducing the consumption of foreign cigarettes and resulting health risks, given the supposed low-quality of these items. However, not only is there no evidence that such a cut in taxes can bring any benefit for public health or even the public coffers, but the consequences can actually be an increase in health expenses and encouragement to smoke, mainly among the poor, resulting in even higher levels of illness and poverty (Silva et al., 2019a).

Such a situation is a reflection of the posture adopted in the country since 2016, which became worse from 2019 onwards. This is exacerbated by the handling of the COVID-19 pandemic in Brazil, based on denial, with several civil servants being fired for doing a proper job, and others being prevented from doing so (Boschiero et al., 2021). Despite this unfavourable reality, the country has fostered outstanding health professionals and high-end researchers who have been resisting and fighting against attempts to harm the Brazilian population in the name of vested interests (Hallal, 2021; Onocko-Campos & Tanaka, 2021; Parra et al., 2013). Throughout the years, Brazilian culture has been shaped based on the need of overcoming adversities, and although the current moment presents considerable challenges, there is hope that evidence-based policies will prevail, and the country will be back on track to becoming a healthy and prosperous nation (Arrais et al., 2021; Malta et al., 2018; Rosa et al., 2021).

2.5 Summary

Adverse scenarios are those in which new interventions are needed the most (Oliveira & Morais, 2018; Rosa et al., 2021). As stated by the World Health Organization, socially disadvantaged individuals develop chronic diseases and die sooner, given their higher exposure to harmful behaviours, and the fact that they have limited opportunities to care for their own health (WHO, 2021c). Therefore, innovative and accessible initiatives to tackle the behavioural risk factors for chronic diseases are much needed in Brazil and can contribute to reversing the current negative trends of chronic diseases in the country.

Chapter 3: Strategies to Increase Healthy Behaviours in Adults at Risk of Chronic Disease

3.1 Introduction

Given the health benefits of adopting healthy behaviours namely physical activity, such as accumulating 150 or more min of moderate-to-vigorous intensity per week, and healthy eating, such as consuming five or more servings of fruits/vegetables per day, there has been an increase in public health messaging about the relevance of both behaviours (Salvo et al., 2021; Wyse et al., 2021). Despite these efforts, the number of individuals following these guidelines remains low (GBD 2019 Risk Factors Collaborators, 2020; Hall et al., 2020; Teo & Rafiq, 2021).

Physical activity and healthy eating are complex behaviours, different from others in the domain of health: e.g., they are acquisition behaviours, whereas smoking and drug use are extinction behaviours; and they require more time and dedication than behaviours such as oral care (flossing and tooth brushing) (Burkholder & Nigg, 2002; Conner & Norman, 2017; Rhodes & Nigg, 2011). According to the literature, initiatives targeting individuals at risk of chronic diseases are often based on theoretical approaches to increase healthy lifestyle behaviours (Michie et al., 2009; O'Connor et al., 2020; Thomas Craig et al., 2020). In the field of health promotion and disease prevention, a theory represents different statements that explain health-related behaviours or gives a systematic way to guide practice targeting health improvement (DiClemente et al., 2009).

3.2 Behaviour Change Theories

Theories provide explanations for phenomena and generate predictions about why a behaviour is elicited or not, and what sources of influence should be addressed to change the behaviour (Lee & Owen, 1985; Michie et al., 2014). In some situations, a theory may not lead to

the comprehension of a particular problem. In that case, an understanding of such an issue may be provided by models, which are based on conceptualizations drawn from more than one theory (Glanz et al., 2008). Models and theories are theoretical frameworks that lead to an understanding of health behaviours in order to provide an improvement in health status (Hayden, 2009).

Each of these theoretical approaches was developed based on key concepts known as constructs (DiClemente et al., 2009; Rimer & Glanz, 2005). Different behaviour change theories and models, as well as their respective constructs, have been studied since the last century, to understand which aspects can contribute to an increase in physical activity and healthy eating patterns (Biddle & Nigg, 2000; Bully et al., 2015; Courneya et al., 2000; Dijksterhuis et al., 2021; Marcus et al., 1996; Rhodes et al., 2019c). According to different authors, these theories often present similar constructs, sometimes differing only by their names (Dijksterhuis et al., 2021; Glanz et al., 2008; Rhodes & Plotnikoff, 2005). The following sections present theoretical frameworks applied in interventions targeting physical activity and healthy eating, organized by historical tradition.

3.2.1 Social Cognitive Approaches

Some of the most common theory-based approaches used in interventions aiming to change health behaviours stem from the social cognition tradition (de Ridder et al., 2017; Hausenblas & Rhodes, 2017; Marcus et al., 1996; Williams & Rhodes, 2016). Three of the main frameworks used in studies addressing physical activity and healthy eating are social cognitive theory, transtheoretical model, and theory of planned behaviour (Biddle & Nigg, 2000; Dijksterhuis et al., 2021; Johnson et al., 2013; Marcus et al., 1992; Rhodes & Nigg, 2011).

The social cognitive theory (Bandura, 1986) addresses the factors that impact and dictate behaviour. It proposes that human behaviours are learned and modified by means of a principle called reciprocal determinism, which is an interplay between environmental (e.g., physical space), behavioural (e.g., effort) and personal (e.g., values) influences (Bandura, 1998; Crocker, 2016). Constructs from this theory include outcome expectation (beliefs regarding the consequences of engaging in a specific behaviour), socio-structural factors (the elements considered impediments and facilitators to a given behaviour, such as tiredness and pleasant weather, respectively), goals (having a goal makes one behave towards achieving such a goal), and self-efficacy (the achievement of a determined goal depends on beliefs in one's competency, i.e., a belief that one can do a specific task) (Bandura, 2004; Hausenblas & Rhodes, 2017). Although some critiques have been recently made to the theory, such as those concerning the measure of self-efficacy, which will be discussed further in this chapter, the framework has been shown to be useful to explain physical activity and healthy eating behaviours (Beauchamp et al., 2019; Stacey et al., 2015; Young et al., 2014).

According to the theory of planned behaviour, behaviour is determined by intention, which is one's motivational readiness to perform a behaviour (Ajzen, 1985). This approach is influenced by attitude (the positive or negative assessment of taking part in a behaviour, which is based on behavioural beliefs), subjective norms (the perceived social pressures to engage or not in a behaviour), and perceived behavioural control (to what extent one does not engage in a specific activity due to personal and environmental barriers) (McEachan et al., 2011; Rhodes et al., 2006). According to the meta-analysis by McEachan et al. (2011) on health-related behaviours, the theory of planned behaviour predicted different behaviours, particularly physical activity and dietary patterns. A more comprehensive version of this theory, the reasoned action

approach (Fishbein & Ajzen, 2011), includes all components of its predecessor while adding skills, abilities, and environmental aspects involved in enacting behaviour (Hagger et al., 2018). Another meta-analysis conducted by McEachan et al. (2016) has shown that the model can also be used to predict and understand health behaviours such as physical activity and healthy eating.

The transtheoretical model is based on dynamic stages of change and incorporates elements from various theoretical approaches. The model is a function of decisional balance (assessment of advantages and disadvantages of change), processes of change (how change happens), and self-efficacy (Prochaska & Velicer, 1997). The stages of the model are pre-contemplation (one does not intend to engage in the behaviour in the next six months), contemplation (one intends to engage in the behaviour in the next six months), preparation (one has taken some steps in order to engage in the behaviour in the next 30 days), action (one has been engaged in the behaviour for less than six months), and maintenance (one has been engaged in the behaviour for more than six months) (Nigg et al., 2019). Systematic reviews and meta-analyses testing the model have shown its efficacy in increasing physical activity and healthy eating behaviours, however these findings are not consistent across all studies (Carvalho de Menezes et al., 2016; Hutchison et al., 2009; Jiménez-Zazo et al., 2020; Kleis et al., 2020; Marshall & Biddle, 2001; Romain et al., 2018).

3.2.2 Humanistic Needs Approaches

With an emphasis on personal choices and the sense of belonging, humanistic approaches emphasize personal meanings, based on the fulfillment of individual needs (Dickinson et al., 2019; Maslow, 1943). The most common framework based on humanistic approaches that have been used to understanding physical activity and healthy eating is the self-determination theory (Deci & Ryan, 1985; Hartmann et al., 2015; Ryan et al., 2009). The theory comprises five mini-

theories that incorporate the fundamental concepts of motivation. These are: cognitive evaluation theory (effect of external factors in one's motivation), organismic integration theory (behaviour as the representation of self), causality orientations theory (individual differences in motivation orientations), basic needs theory (fundamental needs required for growth, integrity, and wellness), and goal content theory (effects of different goals on well-being and performance) (Deci & Ryan, 2012; Vansteenkiste et al., 2010).

According to the self-determination theory, three psychological needs must be satisfied for an activity to be chosen and maintained: autonomy (when one perceives oneself as having options and in control of one's behaviour), relatedness (when one feels one has meaningful connections related to a behaviour), and competence (related to feeling capable of engaging in a behaviour) (Hausenblas & Rhodes, 2017; Ryan & Deci, 2000). This theory approaches motivation to engage in behaviour as a continuum, from amotivation (complete lack of motivation) to different phases of extrinsic motivation (when one engages in a behaviour due to external factors) until motivation becomes intrinsic (when one engages in a behaviour voluntarily, for enjoyment, without any imposition by others) (Crocker, 2016). According to different systematic reviews and meta-analyses, the theory provides an appropriate framework to the understanding of physical activity and healthy eating behaviours (Maillet & Grouzet, 2021; Ng et al., 2012; Ntoumanis et al., 2021; Sheeran et al., 2020; Teixeira et al., 2012).

In order to increase intrinsic motivation, lifestyle counselling programs have been incorporating motivational interviewing (Campbell et al., 2009; Gilliland et al., 2015; Lai et al., 2019; Teixeira et al., 2015). To elicit self-motivation, this client-centred method, which is commonly used in interventions using the transtheoretical model, actively engages individuals in the process of decision making, in an open and non-judgemental environment (Hardcastle et al.,

2013; Miller & Rollnick, 2013; Yacoub & Karmally, 2015). Through the adoption of strategies such as the use of open-ended questions and reflective listening, studies applying motivational interviewing, aiming at increasing physical activity and healthy eating behaviours, have shown positive outcomes (Armstrong et al., 2011; Emmons et al., 2005; Jackson et al., 2007; Samdal et al., 2017; Soderlund et al., 2019).

These theoretical frameworks have provided valuable information on constructs related to physical activity and healthy eating behaviours and have been widely used. At the same time, it is important to note that these theories, models, and methods were conceived to be used with other behaviours and not necessarily considered aspects specifically related to patterns of physical activity and diet (Dijksterhuis et al., 2021; Rhodes & Nigg, 2011; Rhodes & Yao, 2015). Current evidence suggests that successful initiatives targeting individuals at risk of chronic diseases require an understanding of the factors preventing the engagement in healthy lifestyle behaviours in order to achieve sustainable behaviour change (Fiedler et al., 2020; Vallis et al., 2020). Additionally, it has been proposed that approaches that integrate components from the theories mentioned above, in conjunction with other aspects such as the environment and nonconscious processes, as presented further in this chapter, likely serve the science of healthy behaviours in a better way (de Ridder et al., 2017; Lucassen et al., 2021; Rhodes et al., 2019c). Accordingly, the next section presents advances that have been made recently, concerning this situation.

3.3 Evolving Understanding of the Adoption of Healthy Behaviours

3.3.1 Healthy Behaviour Determinants

Different determinants may lead individuals to be physically active (Rhodes et al., 2017). Early studies focused on motivation, showing that some adults do not engage in regular physical

activity owing to a relative lack of encouragement (Hagger & Chatzisarantis, 2007; Kavussanu & Roberts, 1998; Knittle et al., 2018). Later, attention was given to environmental factors (e.g., built environment), which showed that addressing factors related only to individuals might not be enough to lead a person to be more active (Sallis et al., 2016b; Sallis et al., 2012). Recently, literature has shed light on the relevance of automatic and reflective processes, in relation, for example, to pleasantness and perceived opportunities to change physical activity behaviour, as explored further in this chapter (Rebar & Rhodes, 2020; Rebar et al., 2016b; Rhodes, 2017).

While physical inactivity poses serious health hazards, this risk factor is different from sedentary behaviour, which is also linked to several chronic medical conditions (Ekelund, 2018). As such, a clear separation of sedentary behaviour and physical inactivity definitions is required. The terms "sedentary" and "physically inactive" are often used interchangeably and without the full appreciation for how these are distinct concepts, each carrying its own independent risks (WHO, 2020b). Sedentary behaviour is classically defined as time spent in activities that require very low levels of energy expenditure in prolonged sitting, reclining or lying postures, such as watching TV, using the computer, and playing conventional video games (Owen et al., 2010a; Warburton & Bredin, 2016; WHO, 2020b). In contrast, physical activity refers to all leisure and non-leisure time body movements leading to an increased energy expenditure from rest (excluding low-energy expenditure activities done while sitting, reclining, or lying down) (Bouchard & Shephard, 1994; Caspersen et al., 1985). Physical activity behaviour has four broad domains: occupational (work-related), domestic (housework, yard work, child care, chores), transportation (bicycling or walking), and leisure-time (discretionary or recreational time for physical activity, sports, exercise, and hobbies) (Warburton, 2010). In turn, physical inactivity is often operationally defined as not meeting physical activity international recommendations, such

as 150 min per week of MVPA (Huang et al., 2011; Lachman et al., 2015). However, recent authors have argued against the potential perils of this threshold-based messaging and indicate that the health benefits could still be acquired for much lower durations and/or intensities (Del Pozo Cruz et al., 2021; Warburton & Bredin, 2018).

When considering sedentary behaviours, most people (except those bedridden or dependent on others) will engage in some form of physical activity throughout the day (Tudor-Locke & Myers, 2001; Warburton, 2010). It is also important to acknowledge that a physically active person can also be highly sedentary (Owen et al., 2010b). Although adults who usually spend too much time in sedentary behaviours are often not physically active, other individuals engage in some MVPA throughout the week but spend long periods in sedentary activities during the rest of their time (Grace & Dunstan, 2018; Hadgraft et al., 2018).

The health risks of routinely engaging in sedentary behaviours have been increasingly examined. Links to an increased risk for medical conditions such as weight gain, diabetes, heart diseases, cancer, and premature mortality are well established (Katzmarzyk et al., 2009; Omura et al., 2021; Van der Ploeg et al., 2012). Public health messaging related to physical activity promotion has thus been modified to include more inclusive statements such as “move more and sit less” (Warburton & Bredin, 2016). However, it has been argued that the increased attention to sedentary behaviours has taken away from some of the attention paid to the importance of regular physical activity participation (Das & Horton, 2016). Although it is clear that routine physical activity has its own benefits in reducing chronic disease, importantly, it can also reduce the increased risks associated with sedentary behaviours and possibly eliminate the elevated risk of mortality related to prolonged sitting times (Chastin et al., 2021; Ekelund et al., 2016). In fact, according to Ekelund (2018), one hour of moderate physical activity a day is suggested to

eliminate the increased risk of mortality imposed by eight hours of daily sitting time. This physical activity effect is particularly valuable when it is unavoidable to be sitting daily for extended periods.

Different determinants also lead a person to adopt a healthy eating behaviour (Orji et al., 2012). Determinants leading to the adoption of a healthy diet include individual factors, such as perceptions, beliefs, and knowledge about nutrition and healthy eating, as well as environmental factors, such as social and economic aspects, including culture, income, access to food, and food marketing (de Ridder et al., 2017; McAmmond, 2001; Smaira et al., 2021). Regarding individual factors, motivation plays a key role, specifically in terms of attitude, which is closely related to outcome expectations, particularly short-term ones (Brug, 2008). Also, the relevance of individual preferences has been pointed out (de Ridder et al., 2017). In fact, a crucial factor for deciding what to eat or not is liking or disliking the food (Renner et al., 2012; Smaira et al., 2021). Therefore, it is not surprising that the food industry applies several strategies, from the elaboration of different dietary products to marketing and sales, to have a captive consumer base (Gómez, 2021).

In the last few decades, food or food products that are hyper-palatable, ready to consume, and sold at low cost, have displaced traditional dietary practices that are based on freshly prepared meals (Gramza-Michałowska, 2020; Monteiro et al., 2016). In face of this scenario, a new system of classification of food and food products was proposed, based on processing levels (Monteiro et al., 2010). This new classification did not take into account specific nutrients but rather grouped items into four categories: unprocessed/minimally processed foods, processed culinary ingredients, processed foods, and ultra-processed foods (Monteiro et al., 2011). The first group includes natural (unprocessed) foods, such as edible parts of animals and plants, like meat

and seeds, respectively, as well as water. This group also includes foods that are minimally processed, for example, by refrigeration, roasting, and boiling, without adding any substance to the original food, such as salt, oils, and sugar. These three processed ingredients are part of the second group, consisting also of margarine and butter, among other items. The addition of these ingredients to natural and minimally processed foods makes the processed foods, the third group in the classification, which usually consist of two or three ingredients, such as fruits in syrup and salted nuts. The final group consists of highly processed foods, which are industrial formulations, typically with at least five but usually many more ingredients, including flavour enhancers and colour stabilizers, to create products that are highly convenient, highly attractive, highly profitable, and highly appealing as compared to unprocessed and minimally processed foods (Monteiro et al., 2016).

This context has led to the domination of the food market by ultra-processed food products, such as pre-prepared pasta and pizza, sausages, soft drinks, and packaged snacks, among many other items in which natural foods are just a small proportion or are totally absent from the final products (Monteiro et al., 2016; Wyse et al., 2021). Whereas the regular intake of natural and minimally processed foods promote protection against several chronic medical conditions, the global rise in the consumption of highly processed food has corresponded to a rapid increase in the rates of being overweight and obese, leading to a high incidence and prevalence of chronic diseases and early mortality (Mozaffarian, 2020; Vandevijvere et al., 2019). This has led several high-income as well as low- and middle-income countries and international organizations to apply this new food classification in research and policy, including dietary guidelines, to prevent and control chronic medical conditions (Monteiro et al., 2016; Srour & Touvier, 2021).

In addition to the possibility for a person to be physically active and still sedentary, it is not uncommon that good dietary patterns be accompanied by the regular intake of ultra-processed food (Grace & Dunstan, 2018; Jayedi et al., 2020). Similar to the fact that engaging in certain levels of physical activity has been shown to attenuate the burden caused by sedentary behaviour, the intake of unprocessed foods such as fruits and vegetables may mitigate the risks associated with the consumption of highly processed foods (Ekelund et al., 2016; Harrison & Taren, 2018; Jardim et al., 2021; Juul et al., 2021). Based on the health consequences of each food group of this new classification, researchers involved in its development recommend diets based on natural and minimally processed foods, using small amounts of processed culinary ingredients for seasoning and cooking, limiting the consumption of processed foods, and avoiding highly processed food products (Monteiro et al., 2016). These recommendations are summarized in the following golden rule message: Always give preference to unprocessed or minimally processed foods as well as freshly made meals to highly processed food products.

3.3.2 Dual Process Frameworks

It has been shown that simply weighing the cognitive expectations of behaviour and its consequences is not enough to elicit behaviour (Deutsch & Strack, 2020; Jeffery, 2004). Dual process models posit that behaviours are determined by two interacting systems: deliberative processes, dependent on effort, also known as reflective processes, and spontaneous, more difficult to control processes, known as non-conscious or automatic (Evans & Frankish, 2009; Hagger, 2016; Strack & Deutsch, 2004). Whereas previous theories are based predominantly on reflective processes, recent evidence has demonstrated the influence of less conscious approaches to understand and promote health behaviour change (Biddle et al., 2021; Hagger, 2016).

Based on this evidence, the automatic responses to environmental cues have been a significant aspect of research addressing both physical activity and healthy eating (Haynes et al., 2015; Kremers et al., 2006; Rhodes et al., 2019c). In different situations, the impulsive, automatic component has presented a prominent role, which demonstrates how it should not be neglected in interventions aimed at chronic disease prevention (Hagger et al., 2017; Pfeffer & Strobach, 2020). Given the importance of non-conscious processes in physical activity and healthy eating behaviours, this topic is discussed in further detail later in this chapter.

3.3.3 Action Control Theories

Traditionally, self-efficacy and intention are considered two main constructs to explain physical activity and have also been relevant in terms of healthy eating behaviour (de Ridder et al., 2017; Marcus et al., 1992; Williams & French, 2011). Intention is considered one's motivational readiness to perform a behaviour, and self-efficacy relates to the confidence in the ability to engage in a behaviour (Ajzen, 1985; Bandura, 1997; Marcus et al., 1996). Whereas the positive association between self-efficacy and physical activity as well as healthy eating is well consolidated, it is not clear whether capability to engage in these behaviours can be measured by self-efficacy since when individuals are asked if they can do determined task/activity, this might actually reflect motivation instead of perceived capability (Williams & Rhodes, 2016). These authors suggest that, when questioning individuals about their perception regarding engaging in a given behaviour, including a phrase such as "if you wanted to" decreases the association between the rate of self-efficacy and motivation, leading to a more accurate measure of perceived capability. Additionally, there has been evidence in the last few years demonstrating a gap in the relation between intention and behaviour, in that intention explains just a small part of the engagement in physical activity and healthy eating (de Ridder et al., 2017; Rhodes & de Bruijn,

2013). Indeed, despite having positive intentions to adopt healthy behaviours, many individuals do not increase their physical activity participation and healthy eating practices, which indicates that new approaches are required to tackle this situation (Maher et al., 2017; Rhodes et al., 2021b; Walker et al., 2019).

Some models have been proposed to bridge this intention-behaviour gap (Faries & Dudgeon, 2019). One approach involves the concept of implementation intention (Gollwitzer, 1999). This concept comprises self-regulatory processes such as action and coping planning. The former is related to thorough plans to achieve a specific goal, including details on how to implement such a goal (i.e., what to do, when, where, and with whom), and the latter refers to anticipating how to overcome possible future barriers to meet a specific goal (Sniehotta et al., 2005).

Such an approach has been shown to be effective in enhancing goal attainment in different contexts (Keller et al., 2019). Specifically, these strategies have been effective to translate intentions to eat healthily into practice (Adriaanse et al., 2011) as well as to promote physical activity (Bélanger-Gravel et al., 2013).

Another model is the health action process approach, which is a framework based on self-regulation to move individuals forward to improve health behaviours (Schwarzer, 2008). According to the framework, once individuals are motivated to get healthier, they initially intend to act but without really taking action (intention stage); afterwards, individuals plan on how to elicit the behaviour (plan stage); and finally, if the plan is translated into action, individuals have moved to engage in the behaviour (behaviour/action stage) (Schwarzer & Hamilton, 2020).

Perceived self-efficacy is key for goal pursuit in the health action process approach, since it leads to formation of intention and implementation of behaviour (Lippke et al., 2005;

Schwarzer, 1992). The model also integrates implementation intention strategies, such as action and coping planning (Schwarzer & Hamilton, 2020). The efficacy of the framework has been tested in a recent meta-analysis, showing positive results in the prediction of physical activity and healthy eating behaviours (Zhang et al., 2019).

Research has also highlighted the importance of affective judgments to engage in healthy behaviours, i.e., how pleasure and enjoyment influence people's choices regarding a given behaviour, as well as the relevance of perceived opportunity – how the social and physical environment, such as social support and resources, enable behaviour (de Ridder et al., 2017; Rhodes & de Bruijn, 2013; Rhodes & Yao, 2015). His findings in this field led Rhodes (2017) to present a new model to explain physical activity behaviour change, the multi-process action control (M-PAC) framework, which accounts for factors that characterize the gap between intention and adoption of the behaviour, such as motivational, regulatory, reflective, and reflexive aspects, therefore blending aspects from the social cognitive and dual process model traditions.

The M-PAC schematic addresses the discrepancy between affective (e.g., pleasant-unpleasant) and instrumental (e.g., useful-useless) judgements; distinctions between perceived opportunity and perceived capability; processes incorporating intentions, judgements, and decisions about a specific stimulus to influence behaviour; regulation processes to maintain an intention amidst competing behaviours; and finally reflexive processes (e.g., identity), which are formed across time (Rhodes, 2017). According to this framework, initially, reflective processes such as perceived capability (self-efficacy) and instrumental attitude in relation to a behaviour lead to the formation of intention. Subsequently, affective judgements, such as expectation of enjoyment, and perceived opportunity, such as expectations of availability of time and access to

engage in a behaviour, translate intention into execution of the behaviour. Then, once the behaviour is being performed, the action control adoption phase starts, in which the performance of the behaviour depends on regulatory processes. This phase involves tactics related to planning, seeking support, self-monitoring, and the regulation of emotions to avoid temptations and stimuli that can prevent individuals from keeping on track with their initial intention. Lastly, after engaging in a behaviour on a regular basis, individuals enter the action control maintenance stage, which encompasses the formation of habit and identity concerning the behaviour.

This novel approach has demonstrated great relevance in the adoption of healthy behaviours (Hathaway & Gregg, 2021; Liu et al., 2019b; Walker et al., 2019). In fact, although the model has been just recently presented, its efficacy has been demonstrated in different studies, addressing not only physical activity but also healthy eating behaviour change (Perdew et al., 2021; Rhodes et al., 2021a; Rhodes et al., 2019a; Rhodes & Lim, 2016; Vallerand et al., 2017).

While theories and models explain the mechanisms to achieve a change of behaviour, they require specific techniques to grant change (Michie et al., 2013; Rhodes et al., 2017). Although the health benefits of physical activity and good-quality diets are increasingly evident, not all approaches to elicit these behaviours have yielded the expected results (de Ridder et al., 2017; Lucassen et al., 2021; Samdal et al., 2017). Accordingly, the following section outlines different strategies used to effectively increase engagement in physical activity and healthy eating.

3.4 Building on Strategies and Behaviour Change Techniques to Increase Physical Activity and Healthy Eating

As introduced earlier, although traditional behavioural approaches have provided some theories to explain change in behaviours such as physical activity and healthy eating, there is limited evidence showing effective associations between these theoretical frameworks and an increase in healthy behaviours (Willmott et al., 2021). In their review on theories of physical activity behaviour change, Rhodes et al. (2019c) suggest that improvements in this scenario can be likely provided by approaches that consider both basic and applied sectors involved in promoting healthy behaviours. According to these authors, an example of such an approach is the behaviour change wheel, a method designed to elicit behaviour change, contemplating not only basic science but also and mainly interventions conducted by health promoters (Michie et al., 2011). Recent studies targeting physical activity and healthy eating to prevent chronic medical conditions have focused on the core components of this method and have presented promising results (Cowdell & Dyson, 2019; Crowley et al., 2020; Willmott et al., 2021). These central components are capability, opportunity, and motivation to behaviour, which collectively are a meta-model known as the COM-B system (Michie et al., 2011).

According to this model, engagement in the behaviour depends on a person being physically and psychologically capable, with the social and physical environment offering opportunities, besides personal motivation based on automatic and reflective processes (Michie et al., 2011). These constructs correspond to techniques that were compiled by Michie et al. (2013) in an international agreement leading to a taxonomy of validated behaviour change techniques. More recently, mechanisms of action linked to the effect caused by these techniques were identified by researchers and collaborators from the same group, aiming to provide a

resource for more effective interventions (Carey et al., 2018; Johnston et al., 2020). Examples of techniques and respective mechanisms of action used to depict each component of the COM-B model are presented in Table 3.1.

Table 3.1 Examples of behaviour change techniques and mechanisms of action related to the components of the COM-B model.

COM-B component	Behaviour change technique	Mechanism of action
Capability	Information about health consequences	Knowledge; beliefs about consequences
	Instruction on how to perform a behaviour	Knowledge; skills
	Prompts and cues	Memory, attention, and decision processes
Opportunity	Social support	Social influences; environmental context/resources
	Restructuring the social environment	Environmental context/resources
	Restructuring the physical environment	Behavioural cueing; environmental context/resources
Motivation	Focus on past success	Beliefs about capabilities
	Problem solving	Beliefs about capabilities
	Relapse prevention	Beliefs about capabilities

(Kinnear et al., 2020; McEvoy et al., 2018; Rhodes, 2017)

Besides behaviour change techniques, successful interventions to increase healthy lifestyle behaviours in adulthood have adopted numerous strategies to increase physical activity and healthy eating. Examples include programs that incorporate different amounts of physical activity and healthy foods (Adhikari & Gollub, 2021; Ku et al., 2020; Sparling et al., 2015; Yu et al., 2018), less conventional modes of delivery and less traditional physical activity modalities

for public health purposes (Schwartz et al., 2021c; Valdés-Badilla et al., 2021), as well as the use of technology (Milne-Ives et al., 2020; Schoeppe et al., 2016).

3.4.1 Focus on Small Changes

International guidelines recommend a threshold of a minimum of 150 min of MVPA per week to achieve numerous health benefits (Ekelund et al., 2019; Pedersen & Saltin, 2015; WHO, 2020b). This message, however, may impose an avoidable and unnecessary barrier to healthy living for those who could benefit from simply becoming more active at lower levels since research has shown that such a threshold does not seem to exist (Knox et al., 2014; Segar et al., 2020; Warburton & Bredin, 2016). Even small quantities of physical activity are linked with reduced premature mortality as well as the primary and secondary prevention of cardiovascular disease, diabetes, and cancer, among various other chronic conditions (Warburton & Bredin, 2017; Wen et al., 2011). In fact, Hupin et al. (2015) revealed that the first 15 min of physical activity lead to the greatest benefits to the health of older adults. Furthermore, the clear message around the importance of simply becoming more physically active is of crucial importance for vulnerable groups, such as minorities, women, and those with low socioeconomic status (Egan, 2017; Warburton & Bredin, 2017). Additionally, although more research is needed, recent studies have started to demonstrate the health benefits of light-intensity physical activity, including metabolic and cognitive gains (Chastin et al., 2021; Erlenbach et al., 2021; Füzéki et al., 2018).

Regarding healthy diet, the most common recommendation in international guidelines is the daily intake of at least five servings of fruits/vegetables (Brasil, 2020; Varin et al., 2019; Wyse et al., 2021). However, according to these authors, most individuals do not follow such a recommendation, which is equivalent to 400 grams of fruits/vegetables per day (WHO, 2013).

Instead, diets are usually high in sodium, fat, and sugar (Fanzo & Davis, 2019). Thus, simply recommending the intake of a minimum of servings of fruits/vegetables per day has not been compelling enough (Wyse et al., 2021). Therefore, different approaches have been suggested to increase the chances of meeting these dietary recommendations (Hills et al., 2013). This includes small dietary changes, such as adding one daily serving of fruit or vegetable, for example, as an alternative for a snack, instead of a candy bar or potato chips (Yu et al., 2018). Interventions using such an approach presented meaningful health outcomes, which emphasizes the relevance of this strategy (Adhikari & Gollub, 2021).

Moreover, besides the health benefits related to the inclusion of small quantities of physical activity and healthy foods in one's lifestyle, these little modifications can lead to gradual behaviour change, which relates to a technique called graded tasks (Feldman et al., 2018; Michie et al., 2013; Yu et al., 2018). In fact, gradual changes as well as setting short-term goals have been reported as effective strategies to support the adoption of healthy behaviours (Mattei & Alfonso, 2020; Peng et al., 2021; Sporrel et al., 2021; Stewart et al., 2017).

3.4.2 Increasing Self-Regulation

Approaches involving self-management (e.g., learning strategies to engaging in positive health behaviours) have demonstrated positive results in terms of behaviour change (Michie et al., 2009). In fact, short- and long-term physical activity behaviour increases when self-regulatory techniques are implemented (Murray et al., 2017; Olander et al., 2013). Also, strong beliefs in the bad taste and inconvenience of healthy foods were associated with less self-regulation, while increased self-regulatory behaviours had positive effects on the intake of fruits and vegetables (Munt et al., 2017). Among the techniques of self-regulation – a process focused on achievement and maintenance of one's goal – self-monitoring (record keeping about a

specific behaviour) is strongly suggested to increase physical activity levels and has been shown to also increase healthy eating (Michie et al., 2009; Murray et al., 2017; Pentikäinen et al., 2019; Prestwich et al., 2014).

An example of how self-monitoring can boost physical activity participation and healthy eating practices is through the use of technology, such as wearable devices, which have been used to track both physical activity patterns and food intake (Dong & Biswas, 2013; Oliveira et al., 2021). This equipment allows a more accurate detection of each behaviour, reducing the subjectivity associated with self-reported methods (Samuel-Hodge et al., 2004). In terms of physical activity, different models of pedometers and accelerometers can monitor movements such as step counts as well as the time spent in different intensities (Lobelo et al., 2018). The use of these devices was shown to develop autonomous motivation for engagement, not only during physical activity investigations but also outside research contexts (Donnachie et al., 2017). Although this technology has brought significant advances to physical activity surveillance and has been widely used, it has some limitations. This includes the fact that individuals may change their patterns of physical activity when using the devices during evaluation periods, and that measures from these devices do not provide the context of the activity recorded, besides the complexity in analyzing their data (Baumann et al., 2018; Omura et al., 2021).

While devices to track physical activity have been used for a long time, including old and modern models, instrumented diet monitoring is more recent and has been less disseminated (Bassett, 2012; Bell et al., 2020; Dong, 2014). Wearable sensors to monitor food intake include microphones to detect chewing and electromyography to sense muscular contraction during the act of swallowing (Vu et al., 2017). Other systems have been recently developed, and although there is an expectation for opportunities leading to a more accessible use of this technology,

currently there are significant challenges, such as high cost and complex operationalization (Bahador et al., 2021; Skinner et al., 2020).

According to Michie et al. (2009), self-monitoring, when used together with at least one more behaviour change technique related to self-regulation, such as goal setting (defining specific goals to be achieved) and behaviour feedback (comparing one's performance with similar others, as well as comparing the current performance with previous ones) form a cluster considered strongly associated with increases in both physical activity and healthy eating. With the addition of action planning (elaboration of a meticulous plan about the action to be taken, including details such as context, frequency, and duration), the use of these regulatory behaviour change techniques has been supported in numerous publications (Borek et al., 2019; Caperon et al., 2018; Hathaway & Gregg, 2021; Hendrie et al., 2020; Prestwich et al., 2014; Rhodes et al., 2017; Samdal et al., 2017; Williams & French, 2011).

3.4.3 Nonconscious Processes

As mentioned previously, conscious regulatory processes to participate in physical activity, such as intention (plans) and self-efficacy (beliefs), have been shown to explain just a small proportion of physical activity behaviour, and this is also true in terms of eating a healthy diet (de Ridder et al., 2017; Rebar et al., 2016a). At the same time, an increasing number of publications highlight the importance of unconscious processes (unaware mental operations) to increase physical activity and healthy eating (Gardner et al., 2011; Kaushal et al., 2018; Phipps et al., 2020; Rebar et al., 2016a). Among other nonconscious processes, such as automatic associations, more research attention has been given to habits (de Ridder et al., 2017; Kaushal et al., 2017; Rhodes & Rebar, 2018).

Habitual behaviours are considered to be an automatic sequence of actions, elicited by environmental cues rather than by conscious assessments of possible outcomes (Rhodes, 2017; Verplanken, 2018). Regarding diet, this has been investigated for decades, and evidence also shows that habit has a substantial influence on eating behaviours (Brug et al., 2006; Gardner et al., 2011; Shepherd & Sparks, 1994). Although more research is warranted to clarify the amount of time needed for the development of a habit, initial studies in physical activity showed that around 42 days might be a reasonable period (Hagger, 2018; Kaushal & Rhodes, 2015). A study investigating healthy eating, among other health behaviours, reported that an average of 66 days is necessary to lead to habit formation (Lally et al., 2010).

Key to this process of consistent engagement in physical activity and healthy eating is the fact that these practices must be enjoyable (de Ridder et al., 2017; Kaushal & Rhodes, 2015; Kaushal et al., 2018). As stated before, a person will engage in these behaviours depending on automatic evaluations, which are the affective judgments related to one's decision when faced with specific events or stimuli (Rebar et al., 2016b; Rhodes et al., 2009). Indeed, studies conducted in the last years have demonstrated the importance of considering emotions in relation to the expectation of how enjoyable/pleasant a given occasion would be, in order to increase the efficacy of healthy behaviour interventions (de Ridder et al., 2017; Ekkekakis & Brand, 2019; Rhodes et al., 2021b). These nonconscious concepts are associated with behaviour change techniques such as prompts/cues, remove aversive stimulus, and habit formation (Michie et al., 2013; Rhodes, 2017).

3.4.4 Internet and Telephone

Conn et al. (2011) suggest that interventions mediated by the internet or telephone are

less effective than those delivered face-to-face. Although Rhodes et al. (2017) agree with these findings, they point out that practical issues limiting delivery should also be contemplated, especially when financial and human resources are not available to support in-person counselling. These are important considerations since the high global burden of chronic diseases in low resource settings demands low-cost interventions targeting as many people as possible (Reis et al., 2016; Wyse et al., 2021).

Accordingly, approaches using electronic health (eHealth) and mobile health (mHealth), such as mobile devices and smartphone applications (apps), are cost-effective in promoting engagement in physical activity and healthy eating (Thomas & Bond, 2014; Vandelanotte et al., 2016; Watanabe-Ito et al., 2020). Indeed, well-implemented telehealth and web-based tools to prevent chronic disease (including but not being limited to telephone lines and e-mail communications) have been shown to properly translate how the best scientific evidence can be utilized by end-users in an effective and dynamic manner (Bredin & Warburton, 2013; Goode et al., 2012; Monzani & Pizzoli, 2020; Thomas Craig et al., 2020).

3.5 Conclusions

Overall, recent findings indicate that no isolated strategy stands out more than others in terms of facilitating an increase in physical activity and healthy eating behaviours. Instead, it seems that a combination of behaviour change techniques that integrate different constructs along with recent technology can lead to better outcomes. In order to increase physical activity and healthy eating aiming at chronic disease prevention, interventions should be designed to be applied by health promoters, making use of a number of approaches that are grounded in relevant theories and scientific evidence, targeting the individual and their environment.

Chapter 4: Recent Approaches to Prevent Chronic Diseases in Brazil and Canada: from Wholistic Dietary Guidelines to Physical Activity Security

4.1 Introduction

According to the WHO's latest report, in 2016 there were around 1.9 billion adults who were overweight worldwide, out of which 650 million were obese (WHO, 2021d). This phenomenon is directly related to unhealthy diets and physical inactivity, which requires effective national and international public health measures to tackle (Brasil, 2020; Statistics Canada, 2021; WHO, 2020f). In this respect, new evidence-based documents which present cutting-edge advances, such as the current dietary guidelines of Brazil and Canada and the 2020 global guidelines on physical activity, will be discussed in the following sections along with the newly proposed concept of physical activity security.

While 39% of adults across the globe are overweight or suffer from obesity, in Brazil and Canada this combined prevalence of being overweight or obese is 55.4% and 59.8%, respectively (Brasil, 2020; Statistics Canada, 2021). As expected, according to official indicators, both countries also face high rates of physical inactivity and unhealthy dietary patterns.

In Canada, 83.6% of adults do not engage in at least 150 min of MVPA per week, whereas in Brazil this prevalence is 44.8% of the adult population (Brasil, 2020; Varin et al., 2019). This substantial difference is likely due to the lack of agreement between the methods of assessment used in each country. In Canada, physical activity was measured with accelerometers, which present better reliability and sensitivity, whereas Brazil used self-reports, which usually overestimate physical activity (Steene-Johannessen et al., 2016). To illustrate this difference, Colley et al. (2018) compared both methods, which were used in a Canadian survey in 2016, showing that almost half of the Canadian adults reported engaging in 150 or more min

of MVPA per week, whereas the accelerometer-measured data showed that this was the case for only 17% of these individuals. Regarding diet, 71.3% of Canadian adults and 87.1% of adults in Brazil do not eat five or more fruits and vegetables daily (Brasil, 2020; Varin et al., 2019).

Considering these realities, and in light of the new concept of physical activity security as well as innovative approaches introduced in the latest dietary guidelines of each country and in the latest WHO guidelines on physical activity, the current chapter aims to present and discuss current aspects regarding chronic disease prevention in adults. Specifically, preventive initiatives in terms of physical activity and diet carried out in Brazil and Canada were analyzed and synthesized, with a particular focus on physical activity.

4.2 Prevention Approaches in Brazil and Canada

Given the alarming prevalence of unhealthy diets and physical inactivity in Brazil and Canada, both countries have implemented population health programs and protocols to address these risk factors, including some novel initiatives (Dai et al., 2020; Ferrari, 2018; Oliveira & Santos, 2020; Truelove et al., 2020). An innovative action taken by both countries was the update of their dietary guidelines. Brazil led the way, with their revolutionary approach to inform healthy eating (Monteiro et al., 2015). Canada followed with the launch of its new Food Guide, which incorporated similar concepts (Vandevijvere et al., 2019). Both documents address the context of eating rather than the usual focus on nutrients and food groups, which was a turning point in the field of nutrition and public health (Bédard et al., 2020; Kirkpatrick et al., 2019). A common specific area of concern relates to the science regarding the negative impact on health from processed and ultra-processed food (Vandevijvere et al., 2019). With such evidence, the latest version of each guide addresses the importance of avoiding highly processed food and prioritizing minimally processed and unprocessed options (Brazilian Ministry of Health, 2014;

Health Canada, 2019). These recommendations are directly aligned with the focus on chronic disease prevention, a primary goal in both documents (Dai et al., 2020; Oliveira & Santos, 2020).

Without the food industry's participation in their development, both guidelines provide clear alternatives to processed and ultra-processed food, using simple and direct messaging (Brazilian Ministry of Health, 2014; Health Canada, 2019). Good examples are the recommendations to eat plenty of fruits and vegetables and to have water as the beverage of choice. Instead of the widely used nutrition-based guides, these food-based guidelines focus on healthy eating and, at the same time, make a direct ecological impact by encouraging a sustainable eating pattern (Dai et al., 2020; Monteiro et al., 2015).

Another aspect present in both guides is the emphasis on meal planning and the connection with others during the act of eating, which incorporates sociocultural values, and are also considered strategies to support a healthy diet (Bédard et al., 2020). With its emphasis on sustainability, this food- and meal-based wholistic approach put Brazil and Canada in the global leadership of dietary recommendations for optimal health of both human beings and the planet (Gardner, 2019).

As is the case with all population-based guidelines, there is incremental work to be done beyond their release (WHO, 2007). There is a need for accompanying implementation tools for the guide, policy development, and multiple layered initiatives and support to target health behaviour change (Health Canada, 2019). There are many barriers to be overcome, and it can be challenging to make healthy food choices (Monteiro et al., 2015). The Brazilian and Canadian dietary guidelines recognize the influence of social and physical environments, household income and the many determinants of health, educational and health programs, along with

government food policies for the successful implementation of these guidelines (Brazilian Ministry of Health, 2014; Health Canada, 2019; Malta et al., 2018).

While Brazil's latest dietary guidelines have been widely praised (Monteiro & Jaime, 2020), by the time of its publication the country took a surprisingly different approach to physical activity guidelines. The efforts and costs involved in creating national guidelines as a policy for health promotion were considered unjustified, and the country instead chose to adopt the general WHO physical activity recommendations (Sebastião et al., 2014). This was in opposition to the opinion of many Brazilian physical activity experts, who considered that a specific Brazilian guideline would be impactful and meaningful (P. C. Halal, E. Sebastião, and G. I. Mielke, personal communications, January-February 2018).

Conversely, investments in physical activity policies have been a priority in Canada (Craig, 2011; Public Health Agency of Canada, 2018). Such a context has led the country to be a leader in the promotion of the health benefits of physical activity and the development of evidence-informed physical activity recommendations for healthy individuals and persons living with chronic medical conditions (Bouchard & Shephard, 1994; Giacomantonio et al., 2013; Gledhill & Jamnik, 2011; Global Advocacy Council for Physical Activity International Society for Physical Activity and Health, 2010; Warburton & Bredin, 2019; Warburton et al., 2006). This includes leading international initiatives and conferences, such as the first and second "International Conference on Physical Activity, Fitness and Health" (held in 1988 and 1992), the "Dose-Response Symposium" (2000), the "Communicating Physical Activity and Health Messages Science into Practice" meeting (2001), the Toronto Charter for Physical Activity (2010), and the International Society for Physical Activity and Health Congress (2010 and 2021) (Ashamalla et al., 2021; Bouchard, 2001; Gledhill & Jamnik, 2011; Shephard, 2002). Also, the

Canadian government was one of the main supporters of the 2020 WHO physical activity guidelines, which was launched in light of substantial advances in the field after the release of the previous version (Bull et al., 2020).

Besides an emphasis on participation and inclusivity, aiming at a broader reach, the latest WHO guidelines on physical activity address the new science on activities' intensity and duration (WHO, 2020b). Specifically, the document highlights the importance of light-intensity physical activity and states that some activity is better than none. This echoes previous statements made by Canadian and international experts highlighting the importance of simply becoming more active (Geidl et al., 2020; Warburton & Bredin, 2016; Wen et al., 2011). Also, due to insufficient supporting findings, these guidelines have removed the requirement for physical activity to be performed in bouts of at least 10 min of moderate-to-vigorous intensity to obtain health benefits (WHO, 2020b). This new evidence is critical for less affluent settings since regular recreational physical activities are inaccessible for many in these locations, as is the case in some areas in Canada as well as LMICs in general, including Brazil (Basky, 2020; Manta et al., 2020; Segar et al., 2020). Indeed, discrepancies in physical activity participation have been widely observed, with socioeconomically advantaged individuals having more opportunities to be physically active (Chastin et al., 2020; Lehne & Bolte, 2017). The inclusive approach presented in the 2020 WHO physical activity guidelines therefore has the potential to impact health outcomes in both Canada and Brazil, since inequalities in physical activity, besides contributing to the pandemic of physical inactivity, were found, for example, to be predictive of obesity in middle- as well as in high-income countries (Althoff et al., 2017; Chastin et al., 2020). Further work is warranted, however, owing to the limited uptake of physical activity guidelines internationally and the deficits-based nature of physical activity messaging that focuses on the

health perils of too little physical activity (i.e., increased risk for cardiometabolic disease) rather than the diverse benefits of simply moving more (Knox et al., 2014; Warburton & Bredin, 2021).

Numerous disparities across the world require physical activity to be approached through the lens of equity. This view is presented in the new Brazilian and Canadian dietary guidelines (Brazilian Ministry of Health, 2014; Health Canada, 2019). Just as these documents should lead to the development of strategies to address inequity and food insecurity, physical activity policies should also lead to recommendations on equity. This concept was recently described as physical activity security – when everyone, everywhere, would have unrestricted access to physical activity, meeting all needs for an active and healthy life (Lambert et al., 2020).

In fact, there is a pressing demand for physical activity security worldwide, including certain areas of Canada and much of Brazil's territory (Battista & Manaugh, 2019; Sá et al., 2016). Importantly, although some of these regions present a high prevalence of physical activity, many times such engagement happens due to a lack of alternatives, rather than simply choice, including walking and cycling to and from work/school in unsafe traffic areas as well as in locations with a high perception of criminality (Crochemore-Silva et al., 2020; Lambert et al., 2020; Nykiforuk et al., 2018).

An important point corroborating this new approach is the evidence demonstrating significant health benefits with lower levels of physical activity than suggested in different guidelines (Segar et al., 2020). It has been demonstrated that such benefits can be attained even with half of the usual recommendation, particularly among previously inactive individuals (Warburton & Bredin, 2016). As mentioned in chapter 3, these findings show the lack of a minimum threshold in the amount of physical activity for health gains – a position which has just been endorsed by the WHO (Bull et al., 2020). This has a great impact in terms of public health,

since engaging in regular physical activity, regardless of the intensity and the duration, can promote change in other health behaviours, such as diet and smoking, thereby significantly contributing to the prevention of chronic diseases (Duan et al., 2017; Loprinzi & Walker, 2016; Nigg & Nigg, 2021; Oaten & Cheng, 2006).

Moreover, despite the well-known health benefits of regular physical activity (Warburton & Bredin, 2016), additional positive effects on the immune system, mental health, and quality of life have also been reported in the context of the COVID-19 pandemic, thus providing further support for physical activity to be made accessible to everyone (Dwyer et al., 2020). Therefore, the current moment is a window of opportunity to emphasize physical activity as a human right, calling for actions from local policy- and decision-makers (Lambert et al., 2020; Stamatakis & Bull, 2020). In light of this recent evidence, the following section addresses aspects of different dimensions that should be considered in contemporary initiatives in Brazil and Canada aimed at population physical activity promotion.

4.3 Macroscopic Dimensions of Physical Activity

Physical activity dimensions are commonly addressed only in terms of individual and physiological characteristics, such as energy expenditure, as well as activities' duration, frequency, and intensity, characterizing a strictly biomedical relationship (Sallis & Saelens, 2000; Thompson et al., 2015). At the same time, internal aspects such as motivation and self-regulation are frequently identified as significant barriers to physical activity in high-income nations (Basky, 2020; Moreno-Murcia et al., 2017). However, given the low rates of physically active individuals in countries like Canada (Clarke et al., 2019), it is unlikely that lack of motivation alone explains the level of physical inactivity in industrialized countries, and consequently, other characteristics of population subgroups should also be considered. In fact,

physical activity interventions focusing only on personal factors were excluding for many, particularly in disadvantaged areas, regardless of the geographic location (Basky, 2020; Crochemore-Silva et al., 2020). These findings suggest the need for a more socially contextualized approach to make physical activity an attainable and enjoyable purpose for everyone, including those in middle- and high-income countries (Chastin et al., 2020; Scatigna et al., 2019). In that regard, some of the aspects employed in the current Brazilian and Canadian dietary guidelines could be used as references, aiming at establishing a wholistic approach to physical activity guidance that would influence research and policy development for equitable interventions for physical activity promotion (Ball et al., 2015; Swinburn et al., 1999). The name of each of the following dimensions under which physical activity should be seen is not necessarily the only option since some have interchangeable characteristics for adults. The emphasis here is on the overall content presented rather than the specific label of each dimension.

4.3.1 Cultural

The interest in understanding the influence of culture on physical activity behaviour is not new, however, to date, still little is known about this topic (Cardinal et al., 2004; El Masri et al., 2019). Commonly, health promotion interventions, including those aiming to increase physical activity participation, are based on outcomes from studies conducted with certain ethnicities and are then generalized to all cultures. As a consequence, since not all these interventions are universally transferable, individuals with different traditions, such as those in specific ethnic groups, religious communities, immigrant clusters, and Indigenous peoples often present lower levels of physical activity (Mahmood et al., 2019; Tharmaratnam et al., 2018; Williamson et al., 2021). Even when resources are available and the built environment is

conducive to physical activity, the absence of cultural care can limit changes in this behaviour (Mikell et al., 2020; Perrin et al., 2016). Accordingly, an increasing number of studies report that initiatives aiming at raising physical activity levels should take cultural backgrounds into consideration (Guthold et al., 2018; Stamatakis & Bull, 2020; Williamson et al., 2021).

Despite Brazil's culture being a result of the integration of distinct nationalities and ethnic backgrounds, which implies a population full of diverse cultural roots (Chor et al., 2019; Pitanga et al., 2014), limited studies have investigated Brazilian initiatives that incorporated cultural contexts. These include an extensive intervention considering differences between cities in one specific state (Matsudo et al., 2003), and one community-based program addressing traditional components of specific physical activities (Paez et al., 2015). Given the large and very heterogeneous population of the country, there is a need for a broader emphasis on cultural aspects in physical activity interventions. This is supported by studies showing a high prevalence of overweight and obesity in Indigenous peoples, a higher risk of obesity among immigrants with higher levels of acculturation, and a high prevalence of physical inactivity in black individuals (Baldoni et al., 2019; Pitanga et al., 2014; Schwingel et al., 2007).

Conversely, in Canada, where only one third of the population reported being of Canadian origin (Statistics Canada, 2016), more studies have investigated physical activity interventions considering cultural backgrounds than in Brazil (Forde et al., 2015; Mead et al., 2013; Sharma, 2010; Teufel-Shone et al., 2009). However, there has been a growing movement calling for a more systematic approach in the country to implement culturally safe physical activity programs, similar to measures already in place in other health promotion initiatives (Giles & Darroch, 2014). Although such an approach has focused initially on Indigenous peoples, it could be extended to other ethnicities, as some individuals from different ethnicities

report not feeling culturally supported in physical activity initiatives (Mahmood et al., 2019; Mansfield et al., 2012). For instance, Culp (2013) highlighted the importance of addressing immigrants' and ethnic minorities' cultural norms in order to reduce physical activity barriers. Also, Brooks-Cleator and Giles (2016) showed that even physical activity programs aiming at being culturally relevant for Indigenous peoples include some aspects which do not meet this purpose. This demonstrates the overall importance of research and promotion of culturally sensitive physical activity interventions for all ethnicities (Williamson et al., 2021).

4.3.2 Economic

Following physical activity guidelines requires different investments that are not affordable for various individuals (Basky, 2020; Sanz-Remacha et al., 2019). Despite the direct expenditure of money required to participate in some activities (e.g., clothing and/or equipment purchases), allocating a certain number of minutes per day or week exclusively to engage in physical activity is an investment incompatible with the routine of many (Dwyer et al., 2020; Galvim et al., 2019; Hafner et al., 2020; Venn & Strazdins, 2017). Although different barriers to physical activity are found in specific regions (Peixoto et al., 2018; Sanz-Remacha et al., 2019), low income is associated with physical activity insecurity in high- as well as lower-income countries (Basky, 2020; Lima et al., 2019).

Whereas in some high-income nations the main obstacle for leisure-time physical activity is lack of time and possibly motivation – mainly for individuals of high socioeconomic status – in Brazil the main barrier is lack of money (Moreno-Llamas et al., 2020; Silva et al., 2016; Venn & Strazdins, 2017). Despite presenting some advances in economic welfare, Brazil is still one of the world's most unequal countries (Crochemore-Silva et al., 2020). This is reflected, for example, in higher levels of physical inactivity in low-income groups than in the economic elite,

which has more means to afford being physically active (Silva et al., 2016). To address this and other inequalities related to chronic disease prevention, important actions were taken, mainly between 2004 and 2013, such as the inclusion of physical activity in the national health promotion agenda (Malta et al., 2018).

Currently, economic aspects can be considered the main obstacle to overcome in order to reduce disparities in Brazil, as evidenced by the significant hardship faced by some sectors, such as health and science (Hallal, 2021). This is a result of changes that have been implemented in the national economy since 2016, with direct effects on physical inactivity and its consequences (Crochemore-Silva et al., 2020; Silva, 2020). In 2017, for example, after years of stability, there was an increase in hospitalizations due to affective disorders, coinciding with stagnant physical activity levels in the same year, after increasing between 2006 and 2016 (Werneck et al., 2020). Such economic changes deepened national discrepancies in physical activity, with less economically advantaged regions presenting a higher burden of mortality related to chronic disease due to low physical activity levels (Silva, 2020). Other findings demonstrate the complexity around the difficulties faced by financially disadvantaged Brazilians. For instance, according to Galvim et al. (2019), even when free physical activity programs are offered to economically vulnerable communities, adherence is low. They also report a significant number of dropouts, mainly due to participants finding new employment. Additionally, in contrast to high-income areas, solely building free-of-cost fitness facilities in low-income neighbourhoods appears to be insufficient to favour physical activity in these communities (Alberico et al., 2019). Therefore, more innovative initiatives are required, allowing for a broader and more effective participation (Crochemore-Silva et al., 2020; Precoma et al., 2019). In that regard, several investigations have shown how increases in physical activity levels can lead to considerable

savings in the country, thus justifying that investments in policies for the promotion of an active lifestyle must be a priority, even in this adverse context (Araujo et al., 2017; Bueno et al., 2017; Ranasinghe et al., 2021; Silva, 2020).

As a high-income country, economic factors may be regarded as less limiting for physical activity engagement in Canada. However, longitudinal data starting in the 20th century has shown that, through the decades, individuals with low incomes were engaging in consistently less leisure-time physical activity, and therefore this group should be prioritized in terms of efforts to increase population physical activity in the country (Barnett et al., 2008). This is corroborated by findings showing that natural and free options for engagement in physical activity during the winter in Canada, such as an urban trail on a frozen waterway, which could help minimize weight gain during this season, are usually not used by adults at low income, likely due to access limitations via public transit as well as lack of adequate clothing (McGavock et al., 2019). Additionally, it has been shown that even utilitarian physical activity, such as active transportation and its associated benefits – including decreases in body weight – is less accessible for low-income Canadians, highlighting the fact that some interventions to increase active travel may actually increase inequalities since many initiatives favour financially advantaged individuals in a higher proportion (Luan et al., 2019).

Overall, economic disparities in physical activity are present in different parts of Canada, such as those recently reported by physicians and policy experts who serve low-income communities (Basky, 2020). According to this author, given the difficulties in meeting national physical activity guidelines, such recommendations were not relevant for the 3.5 million Canadians living in poverty. Therefore, since there is a clear need for more actions to make physical activity accessible to members from low-income households in the country, such

initiatives could capitalize on the potential health care savings that are brought about by a more active population (Mondor et al., 2020). This is corroborated by the fact that in Canada, physical inactivity was found to be the primary unhealthy behaviour leading to costs in the health sector (Alberga et al., 2018).

4.3.3 Sociodemographic

Several studies have reported gender inequalities in physical activity programs, with a higher overall prevalence of inactivity in women than in men, thus signalling the need for gender-neutral interventions and actions that are inclusive of gender (Guthold et al., 2018; Lee & Park, 2021; Lehne & Bolte, 2017; Mielke et al., 2018). For instance, according to Althoff et al. (2017), obesity is more strongly predicted by gender disparities in physical activity than by physical inactivity alone. Similarly, using data from 142 countries, Mielke et al. (2018) showed that small decreases in physical inactivity in women would lead to an overall 10% reduction in this unhealthy behaviour, achieving a global target set by the WHO (Guthold et al., 2018), even without changing the prevalence in men.

Besides these disparities between men and women, education and marital status were other sociodemographic aspects investigated in different studies. Although most investigations found that more highly educated individuals demonstrated higher levels of physical activity (Brasil, 2020; Dai et al., 2014; Dohrn et al., 2020; Eime et al., 2018; Mäkinen et al., 2012), some investigations found opposite results (Fan et al., 2015; Lee & Park, 2021). The association between marital status and physical activity seems to be even more complex, with some studies showing that married individuals are more active (Lehne & Bolte, 2017; Peixoto et al., 2018; Sánchez Castillo et al., 2021), some research showing the opposite (Eime et al., 2018; Mäkinen

et al., 2012; Sánchez Castillo et al., 2020), and some studies indicating no significant difference (Dai et al., 2014; Lee & Park, 2021; Sánchez Castillo et al., 2019).

Some gender differences are present in physical activity engagement of the general Canadian population (Clarke et al., 2019), as well as of specific groups, such as Indigenous peoples (Akande et al., 2019) and immigrants (Tharmaratnam et al., 2018), with studies consistently reporting that men were more physically active than women. In regards to education, similar to most international findings, Canadians tend to be more physically active with increasing education levels (Dai et al., 2014; Mäkinen et al., 2012). With regards to marital status, two studies found that married Canadians are more physically active (Chad et al., 2005; Lipscombe et al., 2014) while two studies have shown the opposite (Aparicio-Ting et al., 2014; Dai et al., 2014).

In Brazil, sociodemographic inequalities in physical activity are considerable, particularly with regards to recreational activities. In terms of gender, men engage more in physical activity than women. This trend is observed not only in the general population (Brasil, 2020) but also in rural communities (Bicalho et al., 2010) and among black individuals (Pitanga et al., 2014). Brazilians are also more physically active the more years of schooling they have (Brasil, 2020), but the findings are mixed with regards to marital status. Whereas one study showed that married Brazilians were more active (Peixoto et al., 2018), evidence from two studies showed the contrary (Dumith et al., 2007; Marcellino et al., 2014), whilst three other studies did not find any significant difference between married and not married individuals (Bicalho et al., 2010; Boclin et al., 2014; Vagetti et al., 2013).

4.3.4 Biological

Many of the first population-based initiatives on physical activity targeting adults did not consider certain groups, such as the elderly, pregnant women, and individuals living with chronic diseases (Warburton et al., 2011a; WHO, 2010). However, with the inversion in the age pyramid, the older population has been receiving increasing attention, with several guidelines and other physical activity initiatives being tailored to older adults (Boulton et al., 2020; Son et al., 2020). The WHO guidelines on physical activity have a specific chapter for this population (WHO, 2020b). Besides recommending a minimum of 150 min of MVPA, the document mentions the importance of light-intensity activities and states that some physical activity is still of benefit for health in case the recommendations are not fully met by this group.

Additionally, for the first time, the 2020 WHO guidelines have addressed pregnancy and morbidities (Bull et al., 2020). The document provides specific recommendations for pregnant and postpartum women, and has dedicated sections for both chronic medical conditions and disabilities (WHO, 2020b). The first section addresses cancer, hypertension, type 2 diabetes, and HIV, which is also considered a chronic condition given its treatment's advances and availability. The other section focuses on multiple sclerosis, spinal cord injury, and cognitive function impairments, including Parkinson's disease, stroke, depression, schizophrenia, and intellectual disabilities.

Individuals in these groups need comprehensive and permanent initiatives, to allow a safe and continuous engagement in physical activity. In this regard, good examples of simple and effective strategies to reduce barriers for these individuals are the Canadian evidence-based pre-participation screening tools Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and the electronic Physical Activity Readiness Medical Examination (ePARmed-X+), which are

currently being translated and adapted to different languages (Schwartz et al., 2019a; Warburton et al., 2011b). For example, the Brazilian version of the PAR-Q+ has just been validated (see Chapter 5), and the Spanish version, which could be used by some Brazilians given cultural influence from neighbouring countries, was also recently validated (Cavalcanti & Maher, 2017; Schwartz et al., 2019a; Schwartz et al., 2021b).

4.3.5 Environmental

The effects of different human actions have posed severe risks to the planet, and the consequences can be disastrous (WHO, 2018). Therefore, measures to mitigate these effects and avoid further harm are urgently needed. Recent evidence has revealed the positive impact that interventions to increase physical activity levels can have on the natural environment (Nigg & Nigg, 2021). This is aligned with a global action plan on physical activity, highlighting the contributions of an increase in active recreation, sports, walking, and cycling to a sustainable and prosperous world (WHO, 2018). For instance, reductions in traffic volumes and speeds, along with improving infrastructure to provide safe and welcoming spaces for active transportation, have led to a decrease in traffic accidents and pollution (Oliveira et al., 2021). Other incentives to active commuting, such as bike-sharing programs, reduce automobile use and decrease fossil fuel consumption, thereby contributing to the mitigation of climate change (Scatigna et al., 2019).

Another influence of physical activity on planetary health is related to dietary patterns. Given the deleterious effects of packaged highly processed food on the environment, a reduction in its consumption is greatly warranted (Kirkpatrick et al., 2019). Replacing these options with unprocessed foods, such as fruits and vegetables, contributes to a healthier weight and preserves planetary resources (Willett et al., 2019). Besides the fact that eating these plant-based

alternatives in combination with physical activity leads to better weight management, physically active individuals usually eat more fruits and vegetables (Nigg & Nigg, 2021).

Additionally, aside from investigations addressing the built environment in the last decades, recent studies have analyzed the relationship between physical activity and the natural environment in Brazil and Canada. This topic is critical in both countries since they are among the top ten nations in producing greenhouse gas emissions (Bernard et al., 2021). A positive aspect is that Canadians cited their concern with the planet as one of the reasons to engage in physical activity (Galway et al., 2021). However, these authors also identified some issues that need to be addressed in the country, such as the underutilization of cycling as a mode of transportation and the barriers related to winter weather. In their review on cycling usage, including studies from Canada and Brazil, Jahanshahi et al. (2021) highlight some key considerations, such as the need for initiatives addressing inequalities in accessing bike-sharing systems. On the other hand, according to Benedini et al. (2020), bicycle infrastructure expansions have led underrepresented groups in Brazil to cycle more. As mentioned before, this is likely related to the fact that active transportation is the only commuting option for several individuals in low-income settings, which can be linked to the precarious transit system and spatial segregation in several regions of the country (Sá et al., 2016).

4.4 Discussion

Mirroring the remarkable progress regarding national dietary guidelines and related policy development in Brazil and Canada, emergent evidence indicates that similar approaches are necessary in terms of physical activity (Battista & Manaugh, 2019; Lambert et al., 2020; Precoma et al., 2019). Broader and more inclusive initiatives are needed to allow proper access to physical activity, addressing internal and external barriers, and mindful of cultural

background, education level, gender, age, socioeconomic conditions, and health status, while promoting sustainable development (Hämäläinen et al., 2020; WHO, 2018). Despite the challenges involved in implementing public policies that consider these aspects, especially in low-income settings, localized comprehensive interventions have been recently implemented in many countries, including Brazil and Canada, and must be scaled up (Lima et al., 2019; Nykiforuk et al., 2018; Oliveira et al., 2021; Sones et al., 2019).

Although disparities in physical activity are still present in Canada, different efforts have been made to tackle this situation, including the development and implementation of several provincial and national physical activity policies (Macridis et al., 2020; Public Health Agency of Canada, 2018). An example was the inclusion of accelerometer-measured physical activity in the Canadian Health Measure Survey (Clarke et al., 2019). Physical activity monitoring systems allow the identification of target groups, the assessment of the population impact of policies, and the detection of changes in physical activity related to policies, thereby guiding effective actions to increase physical activity levels (Craig et al., 2017). Other country-wide initiatives to increase physical activity levels include the ParticipAction program, a non-profit organization aimed at making daily physical activity a vital part of Canadians' lives (Macridis et al., 2020), and the federal initiative Let's Get Moving – A Common Vision for Increasing Physical Activity and Reducing Sedentary Living in Canada (Public Health Agency of Canada, 2018). Both initiatives promote education material and activities to increase physical activity participation, as well as campaigns and products for community mobilization and engagement, such as the case of a recent free mobile phone app (Cornish et al., 2020; Truelove et al., 2020). Another example is the Physical Activity Line (PAL), developed by researchers at the University of British Columbia to provide telehealth support (Bredin & Warburton, 2013). Residents from anywhere

in the province were able to receive free evidence-based physical activity guidance from a qualified exercise professional via telephone or internet. The service led to a major advancement in the promotion of health benefits of physical activity and served as a role model in the area of telehealth across Canada. The PAL was incorporated into HealthLink BC where it is now a part of the Government of British Columbia's menu of telehealth services (Clark et al., 2021). Other initiatives include the National Health & Fitness Day (Warburton & Bredin, 2020), as well as the National Indigenous Physical Activity Awareness Week, organized by the Indigenous Physical Activity and Cultural Circle, with a specific focus on this population (Miles et al., 2019).

Unlike in Canada, inequalities in Brazil are much more widespread and have lately been increasing (Crochemore-Silva et al., 2020). However, with several cutting-edge researchers on physical activity promotion, some initiatives in the country have received worldwide recognition (Fioravanti, 2012; Lane, 2016). Examples include the World Physical Activity Day, adopted in the five continents, and the Agita São Paulo program (Ferrari, 2018; Matsudo & Lambert, 2017). The latter is a permanent physical activity intervention focused on chronic disease prevention, known for its campaigns targeting physical inactivity, and for the participation of numerous and diverse communities, which led the WHO to consider it a model for other LMICs (Fioravanti, 2012). Other programs focused on physical activity promotion include the Health Gym Program, a national health promotion initiative that makes use of public spaces to offer physical activity in different communities (Florindo et al., 2016), and the Family Health Strategy, which provides multidisciplinary teams to promote counselling for physical activity among other aspects of healthfulness (Souza Neto et al., 2021). Although these initiatives have contributed to increases in physical activity levels, significant challenges have been reported, including the lack of proper

infrastructure, human resources, support from superiors, and standardized evaluations (Paiva et al., 2019; Tristão & Gomes, 2020).

An initial version of the present chapter was submitted for publication recommending the establishment of physical activity guidelines specifically tailored for the Brazilian population, highlighting that based on the aforementioned experiences, Brazilian researchers had the required expertise for the development and implementation of effective national guidelines. Exactly five days after this submission, my co-authors and I learned that the physical activity guidelines for the Brazilian population had just been launched (Brasil, 2021). We were pleased to see that these guidelines bring significant messages, such as the emphasis on keeping in mind that engaging in any physical activity, whenever and wherever possible is better than nothing and can lead to health benefits. Additionally, the document makes clear that engaging in physical activity does not depend solely on one's decision, and that several aspects may act as barriers or facilitators, such as personal, environmental, cultural, financial, and political factors. Aiming at the successful uptake of the guidelines, the document recommends Brazilians to have conversations about these topics and to approach municipal, state, and federal politicians from different sectors, to enquire about how their communities can be more propitious to physical activity engagement (Brasil, 2021).

This approach is in agreement with the WHO document Global Action Plan on Physical Activity 2018-2030: More Active People for a Healthier World, which states that not recognizing and investing in physical activity as a priority is a serious mistake, leading to harmful consequences for the health system, economic development, and the environment, as well as quality of life and community well-being (WHO, 2018). Indeed, despite the importance of the initiatives previously mentioned, considering Brazil's large population and the current context of

significant inequalities, developing national physical activity guidelines and providing the support of appropriate public policies for its implementation is crucial to prevent setbacks and to enable massive participation (Crochemore-Silva et al., 2020; Ferrari, 2018).

Additionally, since the new evidence shows that policies to prevent chronic diseases should not be limited to improving individual's health behaviours but also focusing on reducing several inequalities, there is a need for the training of different professionals to put such policies into action (Lambert et al., 2020). According to these authors, this includes transport engineers and urban planners, as well as physical activity providers in the health sector, such as qualified exercise professionals, who should be well prepared to deliver socially contextualized physical activity interventions. However, health agents in charge of promoting physical activity in the Brazilian Unified Health System reported a lack of knowledge and protocols to properly do so (Becker et al., 2016), which emphasizes the importance of the newly released physical activity guidelines in the country.

4.5 Conclusion

As discussed in the introduction of this chapter, Canada followed the pioneering work of Brazil, in launching innovative dietary guidelines. Besides targeting chronic disease prevention, both documents also apply a wholistic approach, addressing economic, biological, sociodemographic, environmental, and cultural dimensions. As well, Brazil and Canada are developing and implementing policies to help support the uptake of their respective dietary guides. Similarly, broader and more inclusive initiatives are needed to allow proper physical activity access in both countries. Although some physical activity disparities still persist in Canada, the newest evidence shows that Brazil's population would greatly benefit if the country could follow the Canadian lead in prioritizing investments in physical activity policies. The

launch of the brand-new physical activity guidelines for the Brazilian population is a significant step in this respect. In addition to individuals in both countries having a clear guidance to help them to decide what to eat and how, they should also have appropriate guidance to support their entitlement to be physically active and thereby enjoy the numerous advantages linked to this human right.

Chapter 5: Brazilian Version of the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+)

5.1 Introduction

A concerning number of adults worldwide do not engage in the recommended levels of physical activity or exercise for optimal health (Hall et al., 2020). Owing to the numerous benefits of physical activity as stated in earlier chapters, governments and health organizations around the world are investing in essential initiatives for the promotion of regular physical activity, including changes in the physical environment and public policies (Salvo et al., 2021). However, there are other factors significantly associated with physical inactivity, such as biological and psychological aspects (Bauman et al., 2012; Rhodes et al., 2017). In this respect, the fear of injury, getting sick, and even dying are reported, among others, as common barriers to physical activity (Burton et al., 2017; Herazo-Beltrán et al., 2017; Schutzer & Graves, 2004). These concerns are shared by health professionals who prescribe supervised as well as unsupervised physical activity and exercise to prevent and manage chronic diseases (Granger et al., 2017; Herazo-Beltrán et al., 2017; Mazzuca et al., 2017). Such apprehension is justifiable since literature has shown evidence of transient adverse events workout-related, mainly in persons not used to physical activity (Franklin & Billecke, 2012). At the same time, there is indisputable evidence that these transient risks are far surpassed by the health benefits of regular physical activity and exercise (Goodman et al., 2011; Riebe et al., 2015; Warburton et al., 2011a). This apparently contradictory scenario, in which physical activity is associated with both substantial benefits and significant health risks, was subject of concern of different international authorities, to safeguard individuals' health when involved in physical activity and fitness assessments (Thompson et al., 2013; Warburton et al., 2016).

To address this issue, the Physical Activity Readiness Questionnaire (PAR-Q) was created in Canada in the 1970s, as a pre-participation screening tool, based on experts' opinion, for people wanting to become more physically active and for people wanting to undergo physical fitness assessments (Chisholm et al., 1975; Warburton et al., 2011a). The PAR-Q contained seven health-related questions to be answered as Yes or No, and was used extensively globally for more than 30 years (Warburton et al., 2011c). The questionnaire underwent a series of changes over the years; however, various limitations to the survey were acknowledged (Jamnik et al., 2007; Shephard, 2015; Thomas et al., 1992).

For instance, a major limitation of the PAR-Q was that its use was restricted to people between 15 and 69 years of age (Shephard, 2000). Age restrictions on a front-line pre-participation screening tool is a contemporary issue for physical activity participation given worldwide population aging (Fu et al., 2021). Another significant limitation was the conservative nature of the PAR-Q, which led to many false positives and subsequent unnecessary medical referrals since when an individual answered Yes to one or more questions, they were advised to consult a physician for clearance to participate in physical activity (Bredin et al., 2013; Cardinal & Cardinal, 1995; Warburton et al., 2010). Obtaining physical activity clearance from a physician may not be feasible in several jurisdictions (Armstrong et al., 2018). On a global scale, access to medical professionals can involve very long waiting lists for public services, and access to private options are limited and unaffordable for many (Asch et al., 2006; Tulimiero et al., 2020). Additionally, despite the conservative nature of the PAR-Q, the questionnaire could clear higher-risk individuals to engage in physical activity and exercise (Gledhill et al., 2016). These authors explain that, for example, persons living with diabetes or cancer could answer No to all questions of the PAR-Q and therefore be allowed into physical activity programs. Given the

intermediate to high risk of complications such as cardiovascular events, musculoskeletal injuries, and sudden death, further probing may be required for many of these individuals (Jones, 2011; Riddell & Burr, 2011; Valenti et al., 2008).

Given such limitations, a series of systematic reviews together with an evidence-based consensus process were performed to establish best practices in risk stratification for physical activity participation (Charlesworth et al., 2011; Chilibeck et al., 2011; Eves & Davidson, 2011; Goodman et al., 2011; Jones, 2011; Rhodes et al., 2011; Riddell & Burr, 2011; Thomas et al., 2011; Warburton et al., 2011d; Zehr, 2011). This process was overseen by the PAR-Q+ Collaboration, including lead authors (e.g., Dr. Roy Shephard, Dr. Norman Gledhill, and Dr. Veronica Jamnik) who have been involved in the ongoing evaluation and revision of the PAR-Q over the years (Warburton et al., 2011e). From this process, a new, evidence-based pre-participation screening tool was created: The Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) (Warburton et al., 2010).

The current PAR-Q+ is a four-page document designed to identify possible restrictions or limitations to physical activity participation through a series of questions to be answered as Yes or No. While there is a total of 48 items on the document, completing the tool is straightforward and takes approximately five minutes to complete (Bredin et al., 2013). On page one there are seven evidence-based general health questions. If the respondent answers No to all seven questions, they are self-cleared for unrestricted physical activity participation (Warburton et al., 2011c). If the individual answers Yes to one or more of the questions, they are required to complete pages two and three of the PAR-Q+, which contain follow-up questions and sub questions on specific chronic health conditions (Warburton et al., 2011b). If the individual answers No to all follow-up items, they are cleared to become more physically active. If a

participant answers Yes to one or more of these supplementary questions, they are referred to the electronic Physical Activity Readiness Medical Examination (ePARmed-X+; www.eparmedx.com), or to consult with a health professional qualified to prescribe exercise, i.e., individuals with advanced university education, such as certified exercise physiologists and those licensed to prescribe exercise and diagnose physical activity constraints, which is the case of physiotherapists (Bredin et al., 2013; Ferretti et al., 2014; Jamnik et al., 2007). Through this screening process, the vast majority of participants are cleared for physical activity or exercise (Warburton et al., 2011d).

The PAR-Q+ was created based on evidence that shows that the risks of being physically inactive far outweigh the transient risks that may occur after acute exercise in both asymptomatic and symptomatic populations across the lifespan (Warburton et al., 2011b). Further, there was no evidence base to support the age restrictions of the PAR-Q (Bredin et al., 2013). Therefore, the PAR-Q+ is a pre-participation screening tool that is suitable not only for people of all ages but also for people at risk as well as those already living with chronic health conditions (Warburton et al., 2011a). Additionally, this new questionnaire was recently published in a digital format, thus providing the advantage of online completion (Warburton et al., 2018). The versatility of the document and its evidence-informed nature makes the PAR-Q+ an international standard screening tool (Gledhill et al., 2016; Goodman et al., 2016; Liguori et al., 2022; Norton & Norton, 2019).

Insufficient levels of physical activity (< 150 min of MVPA/week, as per international guidelines) are a preeminent risk factor for chronic diseases and early mortality, and is one of the most prevalent risk factors for these noncommunicable illnesses in Brazilian adults (Ekelund et al., 2016; Silva et al., 2019b; WHO, 2020b). According to studies about perceived barriers to

physical activity in Brazil, having a disease and being afraid of getting injured are also among the main reasons preventing minors, adults, and the elderly from becoming more physically active (Cruz et al., 2018; Rech et al., 2018; Sousa et al., 2020). The country has one of the world's fastest aging populations, and over 70% of Brazilian seniors are considered insufficiently active (Lima-Costa, 2018; Souza et al., 2015). This prevalence is 61% for adults (Brasil, 2020) and over 80% for children and adolescents in the country (Mendes et al., 2018).

Brazil is a multilingual country with more than one hundred Indigenous languages, several communities with immigrant languages, such as German, Italian, and Japanese, and a great number of speakers of Spanish especially in the area bordering Paraguay, Argentina, and Uruguay (Cavalcanti & Maher, 2017). However, Brazilian Portuguese and Brazilian Sign Language (Libras) are the official languages of the country and the ones that reach the vast majority of the population (de Quadros & Rossi, 2019). Therefore, since health issues are among the main barriers to physical activity in Brazilians, an instrument like the PAR-Q+, translated and properly adapted to Brazilian Portuguese, could be crucial to allow numerous individuals to safely start or increase physical activity participation. Accordingly, the purpose of this study was to translate, culturally adapt, and verify the reproducibility of the questionnaire to the Brazilian context.

5.2 Methods

This study was designed in two phases. Initially, the questionnaire was translated and culturally adapted to the targeted language. Subsequently, a test re-test procedure was adopted with different groups of individuals, to verify reproducibility.

5.2.1 Phase One – Translation and Adaptation

Permission to develop the Brazilian Portuguese version of the document was granted from the organization in charge of the questionnaire (i.e., the PAR-Q+ Collaboration). The screening tool was first translated into Brazilian Portuguese by two independent translators, who speak Brazilian Portuguese as their native language. A group of Brazilian experts in health and physical activity then came together to produce a combined initial version. Overall, the experts involved in the validation of the PAR-Q+ in Brazilian Portuguese agreed with the versions developed by the translators. Only a couple of minor phrasing adjustments were necessary to culturally adapt the PAR-Q+ to the Brazilian context. The next step was for two native English speakers, fluent in Brazilian Portuguese and accustomed to the Brazilian culture, with no previous exposure to the original PAR-Q+, to back-translate the questionnaire into English. When assessing these back-translations, the PAR-Q+ Collaboration noted a few terms slightly different from the original document. These were considered to have occurred due to the choice of terms in Brazilian Portuguese to allow a better understanding of the questionnaire by the Brazilian population, and these adaptations do not modify the original meaning. After having its accuracy ensured, a final version was approved (Appendix A).

5.2.2 Phase Two – Field-Testing

To assess the reproducibility of the translated version, Brazilians living in Brazil and abroad responded to the questionnaire on two separate occasions, one to two weeks apart. A total of 567 individuals attending health and fitness facilities as well as members from the general public, from both sexes and all age groups, were invited to take part in this project. There were no exclusion criteria. However, 74 individuals did not complete the questionnaire for the second time, mainly due to schedule incompatibility. Therefore, the final sample was composed of 493

participants (59% female), between 5 and 93 years old (39.9 ± 25.4 yr). A total of 114 were children and adolescents, 252 were adults, and 127 were older adults. The questionnaire was administered in person to 84 individuals in a lifestyle management program focusing on chronic disease prevention, 11 clients at a physiotherapy clinic, 24 participants of a fitness project, 14 members of a CrossFit gym, and 43 patients from a rehabilitation centre. The remaining 317 questionnaires were completed online. Respondents represented a variety of health status cohorts such as clinical populations, healthy individuals, athletes, non-competitive exercisers, and physically inactive persons. As per the guidelines of the PAR-Q+, those under the legal age had the questionnaire completed by their parents/guardians. In all settings and forms of application, the participants were welcomed to provide comments, if any, about their understanding of the document. Participants also reported the time taken to answer the questionnaire for the first time.

5.2.3 Statistical Analysis

Data were analyzed with SPSS v.27 for Windows. Using a 95% confidence interval, Kappa was calculated to evaluate the reproducibility of each question between the two applications (Mackinnon, 2000). Additionally, the intraclass correlation coefficient (ICC) and its 95% confidence interval (CI) were calculated to verify the total reproducibility (reliability) (Koo & Li, 2016). The sum of all positive questions was compared between the first and the second times the questionnaire was administered. The criteria for agreement was as follows: 0.0-0.20 (poor), 0.21-0.40 (fair), 0.41-0.6 (moderate), 0.61-0.8 (substantial), and 0.81-1.0 (almost perfect) (Landis & Koch, 1977). Internal consistency was calculated with Cronbach's alpha, using all initial and follow-up questions of the translated version. Significance level was set at 5% for all tests.

5.3 Results

The Brazilian Portuguese version of the PAR-Q+ had excellent internal consistency with a Cronbach's alpha of 0.993. In terms of reproducibility, out of the 48 items of the questionnaire, 45 (93.8%) had an almost perfect agreement between the first and second applications, and three (6.2%) had a substantial agreement (follow-up questions 2a, 5e, and 8b). The translated version of the questionnaire had an excellent general reproducibility (ICC = 0.901, 95% CI: 0.887–0.914). Specifically, as shown in Table 5.1, every one of the seven general health questions of the questionnaire had an almost perfect agreement.

Table 5.1 Kappa value for each general health question between two applications of the Brazilian version of the PAR-Q+ for all participants.

General health question	Agreement between applications
1	0.949
2	0.915
3	0.927
4	0.950
5	0.976
6	0.882
7	0.904

The maximum number of questions answered positively was 20. A total of 405 (82.2%) participants provided the same answer to every question they answered both times they completed the questionnaire. Out of those, 229 answered negatively to all questions. For those individuals who did not have the same answer for all questions in both applications, 62 had one different answer, 16 responded to two questions with different answers, and 10 had three answers that did not match. The comparison of the sum of questions answered positively between the first and the second administrations of the questionnaire is shown in Figure 5.1.

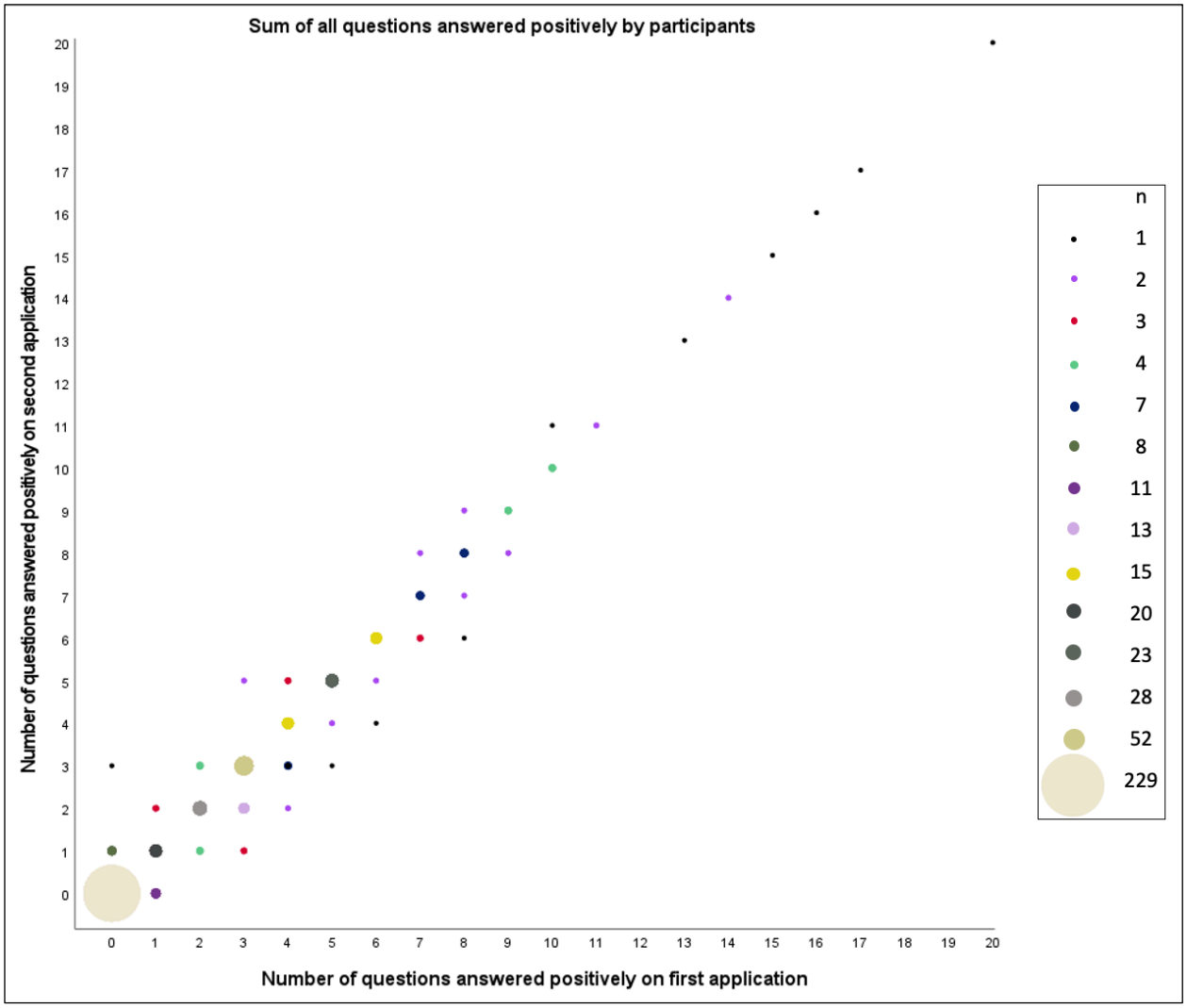

Figure 5.1 Number of questions answered positively by participants (n = 493) in the first and second applications of the Brazilian Portuguese version of the PAR-Q+.

The time reported to answer the PAR-Q+ in Brazilian Portuguese was 4.4 ± 2.3 min. After answering the questionnaire, a few participants provided their opinion about their comprehension of the questionnaire. Two individuals taking medication reported uncertainty about how to answer the following question: Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments). Since their health conditions were under control, these

individuals received clarification from the researcher, explaining they should answer negatively. No other concern was raised by any participant.

Specifically, the subsample of children and adolescents had 46 questions (95.8%) presenting an almost perfect agreement and two questions (4.2%) presenting a substantial agreement: follow-up items 1 and 5e. The group of adults also had 46 items (95.8%) with an almost perfect agreement, and two items (4.2%) with a substantial agreement, namely follow-up questions 7c and 8b. In the subsample of older adults, 45 questions (93.8%) had an almost perfect agreement, and three questions (6.2%) had a substantial agreement: follow-up items 4a, 5a, and 6.

Similar to the whole sample, as shown in Table 5.2, every one of the seven general health questions of the questionnaire had an almost perfect agreement for all three age groups.

Table 5.2 Kappa value for each general health question between two applications of the Brazilian version of the PAR-Q+ for each age group.

General health question	Agreement between applications		
	Children and adolescents	Adults	Older adults
1	0.853	0.934	0.966
2	1.000	0.887	0.919
3	0.853	0.863	1.000
4	0.963	0.935	0.949
5	1.000	0.956	0.984
6	0.848	0.832	0.937
7	0.873	0.846	0.955

All age groups had excellent internal consistency. The group of children and adolescents and the subsample of older adults had a good general reproducibility, while the group of adults had an excellent total reproducibility. The time reported to answer the questionnaire, the internal

consistency, as well as the general reproducibility for each one of the age groups are presented in Table 5.3.

Table 5.3 Time to complete the questionnaire, internal consistency, and total reproducibility according to each age group of individuals to validate the Brazilian Portuguese version of the PAR-Q+.

	Children and adolescents	Adults	Older adults
Time to complete (mean ± standard deviation)	4.0 ± 2.2 min	4.1 ± 2.6 min	5.0 ± 1.8 min
Internal consistency (Cronbach's alpha)	0.980	0.993	0.997
Total reproducibility (ICC; 95% CI)	0.819 (0.766–0.866)	0.905 (0.888–0.921)	0.885 (0.843–0.920)

5.4 Discussion

The Brazilian version of the PAR-Q+ showed strong reproducibility, with all items demonstrating an agreement between substantial and almost perfect in the whole sample, as well as in each age group. This strong reproducibility is similar to the one presented by the sample of Spanish speakers, which also had all questions in these categories of agreement (Schwartz et al., 2019a).

The PAR-Q+ was initially developed in two languages, English and French, since it was created in Canada, which is a bilingual country (Warburton et al., 2011f; Warburton et al., 2011h). To date, the questionnaire has been officially translated into Spanish, and multiple other translation processes are in progress (Schwartz et al., 2019a). The study about the Spanish version analyzed the participants as a single group, which had 47 items presenting an almost

perfect agreement and only one presenting a substantial agreement. In the whole sample of the Brazilian study this proportion was slightly different, with 45 items presenting an almost perfect agreement and three presenting substantial agreement. There are a number of potential explanations for this variation. The Brazilian Portuguese document was validated with almost triple the sample size than the Spanish version (177 participants), and with some individuals much younger and others much older than the participants in that study (13 to 85 years old). Also, most individuals in the Brazilian version answered the questionnaire online. All of these factors could be considered strengths of the current validation, given that the larger sample as well as the larger age range increase the representativeness of the population, while the online application allows for a more widespread application. It is also possible, however, that these aspects led to a couple of answers being less consistent, which could explain the slightly higher number of questions below an almost perfect agreement. However, when providing feedback about their understanding of the questionnaire, other than two individuals requiring further clarification about one question, no additional concerns were raised.

For the whole sample and for each age group, all of the seven initial questions of the Brazilian version had an almost perfect agreement. However, it is possible that some participants did not pay full attention to all follow-up questions when answering the questionnaire for the second time. This may be a factor for those who answered the PAR-Q+ online by themselves, without the presence of a health/fitness professional. According to Kung et al. (2018), a low rate of inattentive answers is expected in any research based on survey responses, and this rate can be higher if there is little or no incentive for respondents to complete a survey. Although all participants voluntarily accepted to participate in the study and received a sound and thorough explanation about the research's importance and how to proceed, they were not financially

compensated. Additionally, according to Schneider et al. (2018), who examined self-administered and internet-based questions on quality of life, some individuals may provide careless responses when there is a lack of personal, face-to-face interaction. This is supported by Meade and Craig (2012), who pointed out that the distance from the respondent to the professional in charge of the questionnaire can lead to less accountability when completing the survey. An additional possible cause of some level of inattention is the need to repeatedly answer the same questionnaire in a short period of time (Conijn et al., 2019; Wardell et al., 2014). This could have been a factor in the present study, since the validation process required participants to answer the same questionnaire twice, seven to 14 days apart. However, in real-life situations, this repetitive process will not be necessary to start or increase participation in physical activity, as per the questionnaire guidelines individuals will only have to respond once within any 12-month period, unless there is a change in their health conditions. Furthermore, in their validation study of the International Physical Activity Questionnaire in 12 countries, Craig et al. (2003) noted that longer questionnaires can be seen as boring and repetitive. Although the PAR-Q+ has many more questions than the previous PAR-Q, this innovative format, with the initial and the follow-up evidenced-based questions, is what makes this new screening tool unique, in providing physical activity clearance to 99% of its respondents without needing to be referred to a physician (Joy & Pescatello, 2016). Nevertheless, the present study showed that the Brazilian Portuguese version of the PAR-Q+, like the original document, takes approximately only five minutes to complete (Bredin et al., 2013).

This questionnaire does not require that every individual who answers positively to one or more of the health general questions obtains clearance from a physician, making it a convenient screening tool in high- as well as in low- and middle-income nations. In

industrialized countries, where the offer of medical services is usually sufficient for most of the population, providing clearance for physical activity is often considered a time-consuming and cumbersome process by physicians (Warburton et al., 2011g). Removing unnecessary consultations with this health professional before participating in physical activity or in a fitness appraisal is especially important in lower-income countries like Brazil since due to social inequities in health, a large number of individuals have limited access to medical professionals (Boccolini & de Souza Junior, 2016). In fact, there is a need for low-cost and accurate self-assessment tools related to physical activity that can be utilized around the world in different cultures and ethnic groups (Sebastiao et al., 2012). Specifically, effective screening provides a significant contribution to maximize physical activity engagement at the population level (Shephard, 2015). Accordingly, having the PAR-Q+ properly translated and culturally validated to the Brazilian Portuguese language can contribute to greater numbers of individuals to safely start or increase physical activity participation.

5.4.1 Limitations

While the present study has a considerable sample size, with individuals living in different locations, this cohort is not necessarily representative of the entire Brazilian population. To address this issue, participants were recruited in the most populous city in the country (São Paulo), which contains individuals from all Brazilian states (Alencar et al., 2012). Participants were also recruited in two other major cities: Campinas and Vancouver (Canada). Another limitation was the fact that the cognitive debrief happened during the data collection instead of at a specific pre-test moment. The intention was to allow every participant to provide feedback about their understanding of the questionnaire.

5.5 Conclusion

Based on the findings of this study, it can be concluded that, overall, Brazilians of different ages and sexes, healthy or living with chronic medical conditions, had no difficulty in understanding the translated and adapted version of the questionnaire. The results also indicate that participants were able to similarly complete the Brazilian Portuguese version of the PAR-Q+ on two independent occasions, showing the strong reproducibility of the questionnaire. Altogether, these outcomes demonstrate that the PAR-Q+ in Brazilian Portuguese is a valid and reliable screening tool. It is expected that nationwide implementation of the questionnaire could allow a substantial number of Brazilians to safely engage in more physical activity participation, as well as in fitness assessments, providing ways to enhance wellness and to contribute toward the prevention and management of chronic diseases in this population.

Chapter 6: Effectiveness of a Pan-Canadian Program to Change Health Behaviours in Brazilian Adults

6.1 Introduction

Chronic diseases, including type 2 diabetes, cancer, and cardiovascular and respiratory diseases, are the leading cause of mortality worldwide (WHO, 2020f). These diseases share common behavioural risk factors, such as physical inactivity, low-quality diets, smoking, and excessive alcohol intake (Ng et al., 2020). These behavioural risks are increasingly prevalent in contemporary societies due to social, political, and economical changes that have all contributed to unhealthy lifestyles (Teo & Rafiq, 2021).

These risk factors are also responsible for several metabolic and mental health disorders, such as obesity, hypertension, anxiety, and depression (Egger & Dixon, 2014). Although these morbidities affect broad populations in both high- and lower-income countries, due to many socioeconomic disparities, those living in low-income settings suffer the consequences of these chronic medical conditions in a much higher proportion (Ranasinghe et al., 2021). As pointed examples, most of the residents in these areas cannot afford memberships to join health clubs or community centres, and/or frequently face daily challenges to follow a healthy diet (WHO, 2021c). Also, public services provided by health care professionals are scarce in these regions, and private health care has prohibitive costs (Armstrong et al., 2018). Therefore, there is a need for innovative preventative health interventions to be delivered through alternative channels, i.e., interventions should be developed taking into account this adverse context, in order to reach individuals in these situations (Misra et al., 2019). Additionally, most research aimed at providing solutions to tackle the problems related to chronic medical conditions and their risk factors has been conducted in high-income countries (Liu et al., 2019a). Given the considerable

socioeconomic differences between high and LMICs, the intervention designs and outcomes from studies in high-income jurisdictions are not appropriate to guide actions to be taken in lower-income countries (Heller et al., 2019; Oni et al., 2020; Turner-Moss et al., 2021).

With the substantial advances in telecommunications in recent years, access to information has increased exponentially (Tsetsi & Rains, 2017). These advances have led to the development of more affordable electronic devices – such as computers, tablets, and smartphones – which have allowed the majority of households to have at least one device connected to the internet, even in economically disadvantaged communities (Correa et al., 2020). This has contributed to swift sharing of information, and therefore it is safe to assume that most people are aware of the numerous benefits of healthy and active lifestyles. Still, the majority of the population does not engage in positive health behaviours. Two possible reasons for this situation are that initiatives to tackle health behaviours might not be sufficiently appealing to some individuals, for example, for not considering personal preferences, and the fact that some individuals simply do not have access to opportunities aimed at health behaviour change, mainly in LMICs (Bassett-Gunter et al., 2015; Miranda et al., 2019; Rhodes & Yao, 2015; Schwartz et al., 2021a).

To bridge these gaps, a 12-week pan-Canadian intervention aimed at chronic disease prevention through health behaviour change was adapted to be delivered to Brazilians in 2019. Besides cultural adaptions, other modifications (particularly considering the appropriate socioeconomic context) were made and will be presented further in this chapter. They are related to the mode of delivery and the incorporation of some behaviour change strategies that were presented in studies published after the delivery of the original program. Otherwise, the adapted version was very similar to the Canadian protocol. The planning and delivery of the original

intervention took place between 2013 and 2016, and the project was named ACCELERATION (ACtivity, smoking Cessation, healthy Eating and aLcohol Education, inteRvention, and motivATION) program, which targeted individuals at risk of developing chronic diseases in four provinces, aimed at changing the risk factors known to impact these diseases (University Health Network, 2015). The original project was delivered in different locations in each province and supervised by senior researchers from the following institutions: Cardiovascular Prevention and Rehabilitation Program, Toronto Rehabilitation Institute - University Health Network in Ontario; Montreal Behavioural Medicine Centre - L'Hôpital du Sacré-Cœur de Montréal in Quebec; Cardiovascular Physiology and Rehabilitation Laboratory - University of British Columbia in British Columbia; and Community Cardiovascular Hearts in Motion in Nova Scotia (Oh & Nooyen, 2018). These centres have many years of experience in primary and secondary prevention of chronic diseases and were well structured to provide in-person education and exercise sessions in every week of the original project.

All materials and components of the program were translated and culturally adapted into Brazilian Portuguese by a certified translator and a Brazilian Portuguese-speaking physiotherapist, who has advanced clinical exercise physiology training and is familiar with chronic disease prevention programs delivered in Brazil and Canada. The Brazilian version of the program was entirely delivered by this physiotherapist in Vancouver, British Columbia. He coordinated a team of Brazilian health professionals (physician, dietitian, psychologist, physiotherapist, and kinesiologist) who practiced their professions in Canada, and collaborated with the project by providing their input to the Brazilian version of the intervention and answering specific questions of the participants during the program. One of these professionals also assisted during the assessments, which will be presented in the Assessment Measures

section of this chapter. As it will be also presented further in this chapter, the program was based on different behaviour change strategies used in chronic disease prevention and physical activity promotion centres in the Canadian provinces where the original program was delivered (Bacon, 2020; Jones et al., 2003; Nolan et al., 2014; Rhodes, 2017; Rhodes et al., 2017).

The objective of this project was to examine the effectiveness of the Brazilian version of the ACCELERATION program, in order to make this intervention also available for the Brazilian population. Specifically, this translated and culturally adapted program had the following main goals for each health behaviour:

- An increase of at least 35% in the number of participants accumulating ≥ 150 min of MVPA per week
- An increase of at least 10% in the number of participants consuming ≥ five servings of fruits/vegetables per day
- A reduction of at least 50% in the number of smokers

The primary hypothesis of the study was that the Brazilian intervention would lead to positive changes in health behaviours according to the targets set for each specific goal (physical activity, food intake, and smoking). Such an outcome would show that the Brazilian version of the ACCELERATION project had a similar effectiveness to the original Canadian project. Additionally, it was hypothesized that the Brazilian experimental group would present better behaviour change outcomes than the control group.

6.2 Methods

6.2.1 Study Design

An open-label quasi-randomized controlled trial was used, with the initial participants being assigned to the experimental group and the other participants being assigned to a waitlist

control group. At baseline, both groups underwent all health and fitness assessments and behavioural questionnaires completion, which will be presented in the Measures Assessment section of this chapter. Right after these initial evaluations, the intervention was delivered to the experimental group, and participants in the control group were asked to keep their current lifestyles without any change during that period. After the 12 weeks of intervention in the experimental group, both groups were assessed again, and subsequently, the control group received the same intervention initially delivered to the experimental group.

The intervention's primary outcome was change in physical activity, particularly in the proportion of participants engaging in ≥ 150 min MVPA/week. The secondary outcomes included changes in the other behaviours: healthy diet (particularly the proportion of participants eating ≥ 5 servings of fruits/vegetables per day) and smoking (proportion of smokers). The remaining variables were considered tertiary outcomes.

The results of the Brazilian experimental group (BE) were compared to the results of the Brazilian control group (BC) and the Canadian experimental group (CE). There was no control group in the Canadian intervention, which was designed as a pre- vs. post-intervention within-subject evaluation rather than a randomized controlled trial. The primary goal of the original project was to demonstrate feasibility of the health behaviour change intervention in broad populations from different provinces and settings across Canada. All assessments and pre-participation activities – completion of the PAR-Q+ and motivational interviewing, to be presented further in this chapter – were carried out at the Cardiovascular Physiology and Rehabilitation Laboratory of the Physical Activity Promotion and Chronic Disease Prevention Unit at the University of British Columbia.

6.2.1.1 Inclusion Criteria

To be included in the program, participants had to be Brazilians over 18 years old, who spoke Brazilian Portuguese fluently, and presented at least one of the following criteria:

- physical inactivity (<150 min of MVPA per week)
- unhealthy diet (consumption of fewer than five fruits/vegetables per day)
- smoking (any amount of personal tobacco use by self-report)

In addition, participants could have stable medical co-morbidities, such as chronic diseases. Moreover, all participants needed to have consistent internet access in order to be able to watch educational videos and to communicate over email with the researchers, as explained in the Behaviour Change Intervention section.

6.2.1.2 Exclusion Criteria

Any of the following criteria were considered a reason not to be included in the study:

- any unstable clinical condition
- inability to participate fully in the program due to mental or physical limitations
- concurrently participation in other studies of intensive health behaviour modification

6.2.1.3 Participant Recruitment

In partnership with the Brazilian consulate in Vancouver, men and women were invited to participate in the program through different mechanisms. These included emails and social media postings via official channels. The program was also promoted in activities targeting Brazilians living in Vancouver and neighbouring cities, such as lectures about an active lifestyle, as well as distributing information leaflets in community events.

According to the last Canadian population census (Statistics Canada, 2017), in 2016, Brazilians made up 0.1% of the 2,264,823 people living in the Greater Vancouver area. To

overcome the challenge of obtaining the required sample size, which will be presented in the Statistical Analysis section, and to maximize the project's reach, the program was tailored to allow participation during the 12 weeks without the need to travel. Apart from the assessments before and after the intervention, participants were able to follow the program wherever and whenever was suitable for them. Considering that many of these individuals did not live in the city of Vancouver but rather in other municipalities of the greater metropolitan area and taking into account the different routines of potential participants, the 12-week intervention was delivered online.

6.2.2 Behaviour Change Intervention – Risk Factor Management

After the initial health and fitness assessments, a baseline interview, structured following a motivational communication framework, was conducted before the beginning of the intervention, to get a broader perspective of each participant's motivation and confidence to change health behaviours (Anstiss, 2009). This approach aimed at strengthening these two aspects in the participants, as well as participants' commitment to their goals, by eliciting and exploring their reasons for change, through acceptance and compassion (Rubak et al., 2005).

This collaborative communication, centred on the participant, supported these individuals to engage in the program in a goal-oriented style. By prioritizing the participant's needs, without approving or disapproving of their behaviour, a partnership was established with each individual to evoke the skills and strengths they already had (Anstiss, 2009). Together with the researcher, each participant made decisions on goals and how to achieve them. Open-ended questions to encourage elaboration, with affirmations to acknowledge the participant's experiences and reflective listening to demonstrate empathy and interest, were followed by summary statements to confirm the understanding of the information shared by the participant (Miller & Rollnick,

2013). Focusing on the positive aspects involved in engaging in healthier lifestyles, rather than underscoring the perils of poor health behaviours, each individual was encouraged to consider their perceptions about the advantages and disadvantages involved in adopting positive health behaviours (Patrick et al., 2014).

The final part of the motivational interviewing was dedicated to action planning and goal setting, based on the results of the baseline assessments. Considering what was relevant for them, each participant received assistance to develop a specific, attainable, and detailed plan for short- and long-term moderately challenging goals, to be measured throughout and at the end of the program. Participants were oriented to include the following in their plans for each goal: what, how, where, when/how often, and how much (Glanz et al., 2008). These individual goals and plans/strategies were revised in different phases of the program. Although participants were encouraged to set both short- and long-term goals, the emphasis was on the former, to promote a perception of control over the situation, and to build self-efficacy towards achieving long-term goals (Rhodes & Kowalski, 2014). These approaches preceding the beginning of the 12 weeks consisted of some of the techniques from the taxonomy of behaviour change techniques presented in chapter 3, namely goal setting (behaviour) and action planning (Michie et al., 2013).

The online sessions consisted of a structured education intervention as well as different behaviour change techniques emphasizing self-management and motivation. Since in-person exercise sessions were not possible in this version of the program, the participants received an individualized three-page physical activity plan and one-page dietary recommendations, based on the results of the initial assessments, and a booklet focusing on health behaviours. Each participant also received an elastic resistance band (TheraBand, Akron, OH, USA) appropriate to their strength level and was oriented on how to recognize whether another band would be

necessary (based on an increase in musculoskeletal fitness and/or damage to the equipment), and on how to proceed about that. Additionally, participants were instructed to monitor their daily steps during the 12 weeks using a free mobile phone app (Pacer). Along with the kit provided to participants before the intervention, they were also given a diary in which they were oriented to keep track of their physical activities (mainly daily minutes of MVPA) and dietary patterns (mainly daily servings of fruits and vegetables) to self-monitor their behaviours. Those who smoked were also encouraged to keep track of reductions in their smoking patterns, such as smoking fewer cigarettes, inhaling them less often and less deeply, as well as smoking them halfway down.

Based on the participants' initial health and fitness assessments, the physical activity plan included a 12-week program consisting of progressive aerobic and strength activities (Figures 6.1-6.3). In addition to the guidance to increase the intake of vegetables and fruits, the diet recommendations focused on specific advice on reducing rather than eliminating foods rich in sugar, fat, and salt while increasing those rich in fibre (Figure 6.4). The approach adopted in both the physical activity plan and the diet recommendations, supported by the strategies applied during the intervention (to be presented further in this section), were aimed at rewarding experiences. To encourage autonomy, participants were advised to follow the physical activity program where convenient, including parks, gyms, and their own homes. They were also encouraged to be active throughout the day and to reduce sedentary time. The more concise and broad diet recommendations were complemented by one exclusive dietary educational session every other week, which covered practical skills and a variety of topics (as presented in the continuation of this section), except for the last week of the program, which addressed all

behaviours. Additionally, more personalized guidance was provided during individual interactions throughout the program, as explained in more detail further in this section.

PHYSICAL ACTIVITY

This physical activity plan consists of two progressive components: aerobic (cardiorespiratory) and resistance (musculoskeletal). You will find recommendations on how to safely engage in different activities.

Personal Exercise Levels
These values have been created individually based on your age and resting heart rate, using a measure called Heart Rate Reserve (HRR). This method uses a percentage of the difference between resting and maximum heart rate to calculate your intensity. Your resting heart rate is 64 beats per minute (bpm).

Low Intensity (20-39% of your HRR): When your heart rate during or immediately after exercise is between 87 & 108 bpm, the exercise would likely be classified as low intensity. This includes activities such as: light walking, bowling, stretching, or light gardening.

Moderate Intensity (40-59% of your HRR): When your heart rate during or immediately after exercise is between 109 & 131 bpm, the exercise would likely be classified as moderate intensity. This includes activities such as: cycling, brisk walking, or cleaning the house.

Vigorous Intensity (60-84% of your HRR): When your heart rate during or immediately after exercise is between 132 & 159 bpm, the exercise is most likely vigorous intensity. This includes activities such as: running, cycling fast, playing soccer, practicing martial arts, or carrying heavy groceries.

Aerobic Progression:

Every one to two weeks, try to increase the intensity of your aerobic physical activity. This could include increasing the duration, the intensity, or the weekly frequency.

To increase intensity, try increasing the speed at which you are going. You can also get creative, try taking a route with a steep incline or fit in an extra walk into your day during a lunch break.

Intensity can be determined by different means, such as the Heart Rate and the attached **Rating of Perceived Exertion (RPE)** scale.

If you've been at the same level of activity for a while (>2 weeks) consider aiming for a greater heart rate, or a higher value of RPE.

Number Rating	Verbal Rating	Example
6		No effort at all. Sitting and doing nothing.
7	Very, very light	Your effort is just noticeable.
8		
9	Very light	Walking slowly at your own pace.
10		Light effort.
11	Fairly light	Still feels like you have enough energy to continue exercising.
12		
13	Somewhat hard	
14		Strong effort needed.
15	Hard	
16		Very strong effort needed.
17	Very hard	You can still go on, but you really have to push yourself. It feels very heavy and you're very tired.
18		
19	Very, very hard	For most people, this is the most strenuous exercise they have ever done. Almost maximal effort.
20		Absolute maximal effort (highest possible). Exhaustion.

Figure 6.1 Example of the physical activity plan, page 1/3.

This aerobic prescription has been crafted specifically for you based on your fitness test results. In addition to heart rate zones, we have included ways to measure the intensity levels at which you are exercising by using perceived exertion, breathing rate, or body temperature.

Your **personalized** program is broken into 3 stages: Initial, Improvement, and Maintenance. During the Initial phase, you will build up an aerobic and musculoskeletal fitness base. Once you have built the base, and become accustomed to your methods of exercise, you may progress to the Improvement Stage. In the Improvement Stage, your physical activity intensity levels will increase along with your fitness levels. The goal in the maintenance phase is to keep exercising at the level to which you have achieved.

Our main recommendation is for you to accumulate 150 or more minutes of Moderate-Vigorous Physical Activity per week!

Stage	Weeks	Frequency per week	Duration (Minutes)	Intensity	Effort (RPE 6-20 Scale)	Breathing rate	Body Temp	Heart rate Range (BPM)
Initial Stage	1	3	30	Moderate	11-13	Noticeably Increased	Warmer	109-120
Initial Stage	2	3	30	Moderate	11-13	Noticeably Increased	Warmer	109-120
Initial Stage	3	3	30	Moderate	12-14	Noticeably Increased	Quite Warm	115-126
Initial Stage	4	3-5	30	Moderate	12-14	Noticeably Increased	Quite Warm	115-126
Improvement	5 - 7	3-5	30-45	Moderate	12-14	Noticeably Increased	Quite Warm	120-132
Improvement	8 - 10	3-5	30-45	Moderate	12-14	Noticeably Increased	Quite Warm	120-132
Improvement	11 - 12	3-5	30-45	Moderate-Vigorous	13-15	Some Difficulty Talking While Exercising	Very Warm	126-137
Maintenance	> 12	3-5	30-45	Moderate-Vigorous	13-15	Some Difficulty Talking While Exercising	Very Warm	126-137

Please note that both aerobic and musculoskeletal fitness plans are just individualized guidelines; if you have any concern, or feel discomfort, delay becoming more active and contact Juliano Schwartz.

Figure 6.2 Example of the physical activity plan, page 2/3.

Musculoskeletal Fitness

The following prescription cannot list the loads you should be using for resistance. While exercising, you should be just able to complete the amount of reps listed below. If you can do more than the prescribed reps, increase the resistance. If you struggle to complete the prescribed reps, decrease the resistance.

Musculoskeletal Progression:

One of the main ideas of fitness is the principle of Overload. This means that in order to increase muscle function, it must be subjected to force greater than it is accustomed to. To achieve this, you can increase the number of sets, the number of repetitions (reps), or the resistance. When increasing the load of your workout, be sure to increase only one of these variables while keeping the others constant.

For this program, you will engage in 1-2 days per week of musculoskeletal training. The training program will involve three stages: 1) Familiarization, 2) Goal Specific, and 3) and Maintenance. During the familiarization phase (lasting 4 weeks), you will become accustomed to working with a variety of upper and lower body exercises. During weeks 5-12, you will progressively increase the volume and/or intensity of exercises that you complete. At the end of the program, the exercise prescription is designed to maintain the fitness gains that you have achieved.

Repetition refers to the completion of a single exercise. Set refers to a number of repetitions performed consecutively until reaching fatigue. Fatigue refers to when the participant is unable to complete the exercise in a correct manner. For each set of exercise, the range of repetitions (e.g., 10-15) refers to the participant being able to complete this number of repetitions before reaching fatigue. The resistance will need to be adjusted accordingly if a participant is able to lift more than recommended repetitions. Participants should complete each repetition in the full range of motion (without pain) with a moderate speed of movement (approximately 2-5 seconds per repetition).

Program Stage	Week	Frequency (days/week)	Intensity (reps)	Sets	Muscle Groups
Familiarization	1	1	15-20	1	8-10 Muscle Groups
Familiarization	2	1	15-20	1	At least one exercise
Familiarization	3	1-2	15-20	1	per muscle group.
Familiarization	4	1-2	15-20	1	Exercise large muscle groups first.
Goal Specific	5 to 7	2	10-15	1-2	Alternate between upper and lower
Goal Specific	8 to 10	2	10-15	1-2	body exercises to facilitate recovery.
Goal Specific	11 to 12	2	10-15	1-2	Allow approximately 2-3 min for
Maintenance	> 12	2	10-15	2	recovery between exercises.

Warburton DER. Health-related Exercise Prescription for the Qualified Exercise Professional. 6th ed. Vancouver: Health & Fitness Society of BC; 2016.

Figure 6.3 Example of the physical activity plan, page 3/3.

DIET

- **FRUITS/VEGETABLES** (recommendation: ≥ 5 servings/day). Your average daily consumption: 2 serving(s)
- **Fibre** (recommendation ≥ 25g/day). Your average daily consumption: 10 g
- **Fat** (recommendation: ≤ 1 point). Your score: 4 point(s)
- **Sugar** (recommendation: ≤ 5 items/week). Your average weekly consumption: 8 item(s)
- **Sodium** (recommendation: ≤ 5 points). Your score: 9 point(s)

EAT WELL

Harmoniously!

Make natural or minimally processed foods the basis of your diet	Shop in places that offer a variety of natural or minimally processed foods
Use oils, fats, salt, and sugar in small amounts	Develop, exercise and share cooking skills
Limit the consumption of processed foods	Plan your time to make eating something important in your life
Avoid the consumption of ultra-processed foods	When eating out of home, prefer places that serve freshly made meals
Eat regularly and carefully in appropriate environments and, whenever possible, in company	Be wary of food advertising and marketing

Brazilian Ministry of Health. Dietary guidelines for the Brazilian population (2nd edition). 2014

Figure 6.4 Example of the diet recommendations.

The education sessions consisted of videos focusing on health behaviours, delivered via weekly emails, as shown in Table 6.1. Most of the physical activity aspects of the program were based on the work of the Canadian Association of Cardiovascular Prevention and Rehabilitation (formerly known as Canadian Association of Cardiac Rehabilitation) (CACR, 2009; Tobe et al., 2014), as well as on the global recommendations on physical activity for health (WHO, 2010), with minor adaptations to accommodate Brazilian culture. Given that the participants of the Brazilian groups were living in Canada, there was no need for major modifications in terms of physical activity since the available options and factors affecting the practice of different modalities, such as weather, were the same for the participants of the original program. As an example of a modification for the Brazilian version, the practice of martial arts for quality of life and health purposes, rather than competition, is very popular among Brazilians and was used as one of the suggestions in terms of more attractive/enjoyable forms of physical activity (Lindquist et al., 2014; Schwartz et al., 2021c; Schwartz et al., 2015). Diet, on the other hand, required more cultural adjustments, since despite how long people have been living abroad, they are usually very attached to their original dietary patterns (Brown et al., 2010; Greaves et al., 2011). Therefore, this component of the program was based mainly on the latest Brazilian dietary guidelines (Brazilian Ministry of Health, 2014) and nutrition targets for chronic disease prevention established by the World Health Organization (WHO, 2020c). A Brazilian nutritionist, who is a registered dietitian in Canada, provided extensive support to this segment of the intervention.

Smoking was not a concern for the vast majority of the participants. Therefore, most counselling and support related to this unhealthy behaviour was provided over individual interactions with the physiotherapist in charge of the intervention, rather than in educational

sessions delivered to all participants. This component of the project was mostly based on the Certificate Program in Intensive Tobacco Cessation Counselling, offered by the University of Toronto. Such program is part of the Training Enhancement in Applied Counselling and Health (TEACH) project, which is coordinated by the Centre for Addiction and Mental Health, a Pan American Health Organization/World Health Organization collaborating centre (Herie et al., 2012). The training in the TEACH Project involved a pre-requisite course (Tobacco and Public Health: From Theory to Practice), a core course (An Interprofessional Comprehensive Course on Treating Tobacco Use Disorder), a specialty course (Integrated Chronic Disease Management and Prevention), and educational rounds to work with multiple behaviour change goals (Smoking, Physical Inactivity, and Poor Nutrition) (Ebn Ahmady et al., 2017).

Table 6.1 Topic, content, behaviour change techniques and respective mechanisms of action of educational videos.

Week/Session title	Key Messaging	Behaviour change technique (mechanism of action)
One: Physical activity – the basics	How to exercise in a safe and effective manner (FITT principle: frequency, intensity, time/duration, and type of activity)	-Information about health consequences (knowledge; beliefs about consequences) -Instruction on how to perform a behaviour (knowledge; skills)
Two: Introduction to healthy eating	Principles established by the World Health Organization for a healthy diet	-Information about health consequences (knowledge; beliefs about consequences)
Three: Physical activity safety	Physical activity – what to avoid Exercising when sick Cold/Hot weather	-Information about health consequences (knowledge; beliefs about consequences) -Instruction on how to perform a behaviour (knowledge; skills)

Week/Session title	Key Messaging	Behaviour change technique (mechanism of action)
Four: Golden rule of healthy eating	Food processing (prioritize unprocessed or minimally processed foods, limit processed foods, and avoid ultra-processed ones)	-Information about health consequences (knowledge; beliefs about consequences) -Restructuring the physical environment (behavioural cueing; environmental context/resources)
Five: Resistance training and aspects of general physical conditioning	Importance of resistance training and further explanation on how to do it, as well as the main concepts of fitness	-Instruction on how to perform a behaviour (knowledge; skills) -Demonstration of the behaviour (social learning/imitation)
Six: Fruits and Vegetables	Importance of fruits and vegetables, and how to increase their consumption	-Instruction on how to perform a behaviour (knowledge; skills)
Seven: Stress and Coping	Chronic and Persistent Stress as a Risk Factor Coping – exercise, meditation, deep breathing	-Information about health consequences (knowledge; beliefs about consequences) -Instruction on how to perform a behaviour (knowledge; skills) -Demonstration of the behaviour (social learning/imitation)
Eight: Mindfulness eating	How to eat consciously	-Instruction on how to perform a behaviour (knowledge; skills)
Nine: Progression and Barriers	How to progress and how to overcome barriers	-Graded tasks (beliefs about capabilities) -Problem solving/coping planning (beliefs about capabilities) -Prompts/cues (memory, attention, and decision processes) -Remove aversive stimulus (environmental context/resources)

Week/Session title	Key Messaging	Behaviour change technique (mechanism of action)
Ten: Reading food labels	How to make healthy choices	-Instruction on how to perform a behaviour (knowledge; skills)
Eleven: Dealing with setbacks	Relapsing is normal Coping strategies	-Relapse prevention (beliefs about capabilities) -Problem solving/coping planning (beliefs about capabilities)
Twelve: Wrapping up - Graduation	Long term positive health behaviours	-Habit formation (behavioural cueing) -Feedback on behaviour (motivation) -Goal setting (behaviour)

The videos had an average duration of seven minutes. At the end of each video, there was a question that the participants were asked to answer by email. This served to check the participant's understanding of the topic. When necessary, additional support and/or clarification was provided.

Although the structure of the Brazilian project was based on the original program, previous data analyses and participants' feedback to the latter suggested that some adjustments would improve the practicality of the translated and adapted program. The senior researchers who contributed to the development of the Brazilian program (supervisory committee members of the present study) came to an agreement to reduce the number of questionnaires to be applied in the initial and follow-up assessments, in order to encourage the total completion of these documents. They also advised that two questions be added to the questionnaire of each health behaviour, one related to affective judgment and the other contemplating perception of opportunity. Although the inclusion of these items required more time to answer the questionnaires, these questions caused no disruption to the original material, and in the end the number of pages to complete was reduced from 15 to eight.

There was also an agreement to remove excessive alcohol intake as an inclusion criterion, as established by Canada's low-risk alcohol drinking guidelines (Canadian Centre on Substance Abuse, 2011), given the low number of participants presenting such behaviour in the original intervention. As such, the Brazilian version of the program was known as ACCELERATION (ACtivity, smoking CEssation, heaLthy eating Education, inteRvention, and motivATION).

During the whole intervention, besides the general emails with the educational videos, participants also received a short, individualized email every week to increase self-efficacy and motivation. These addressed not only health-related long-term benefits but also immediate/short-term ones, focusing on positive emotions and overall well-being (Hall et al., 2018; Ruissen et al., 2018). Different behaviour change techniques and mechanisms of action, as presented in chapter 3, were used during these interactions, aiming at positive health behaviour change. As well, these emails provided additional resources to facilitate the adoption of healthy behaviours and also served to address any concerns that could have arisen throughout the program. The theme addressed each week varied according to each participant's specific needs, and therefore several contents were addressed more than once. Still, overall they followed the main topics presented in Table 6.2. This communication served as a complement to the individualized report and recommendations as well as the educational booklet received after the initial assessments, and provided further specific guidance to reassess individual goals, particularly those in terms of reaching ≥ 150 min of MVPA per week, eating ≥ five servings of fruits/vegetables per day, and reducing/quitting smoking.

Table 6.2 Main topic and overall content, as well as behaviour change techniques and respective mechanisms of action used in each individualized email.

Week/Email main topic	Content	Behaviour change technique (mechanism of action)
One: Motivation	-Fostering autonomy, with empathy and reminders of realistic goals -Listing positive expected outcomes and inquiring about benefits from the specific plan	-Information about health consequences (knowledge; beliefs about consequences) -Focus on past success (beliefs about capabilities) -Review behaviour goals (goals)
Two: Small changes - big outcomes	-Strategies to progress safely and successfully -Benefits of small volumes of physical activity, small improvements in fruits/vegetables consumption and other dietary patterns, and small decreases in smoking	-Graded tasks (beliefs about capabilities) -Restructuring the social environment (environmental context/resources) -Restructuring the physical environment (behavioural cueing; environmental context/resources)
Three: Habit formation	-Cues and prompts to elicit behaviour change -Consistency of practices -Eating well on a budget -Provision of positive feedback and encouragement	-Prompts/cues (memory, attention, and decision processes) -Remove aversive stimulus (environmental context/resources) -Habit formation (behavioural cueing) -Feedback on behaviour (motivation)
Four: Avoiding relapse	-Identifying and planning to overcome potential challenges to translate intentions into actions -Revising goals and plans / Assistance on problem-solving	-Relapse prevention (beliefs about capabilities) -Review behaviour goals (goals) -Problem solving/coping planning (beliefs about capabilities)

Week/Email main topic	Content	Behaviour change technique (mechanism of action)
Five: Enjoyable physical activity	-Guidance on accessing and engaging in fun physical activity -Traditional and less conventional formats and environments	-Instruction on how to perform a behaviour (knowledge; skills) -Information about emotional consequences (beliefs about consequences) -Restructuring the social environment (environmental context/resources) -Restructuring the physical environment (behavioural cueing; environmental context/resources)
Six: Halfway assessment	-Guidance on how to do a simple and effective health and fitness assessment -Provision of positive feedback and encouragement	-Review behaviour goals (goals) -Feedback on behaviour (motivation)
Seven: Easy healthy and happy eating	-Tasty, practical, and inexpensive meal and recipe suggestions -Seasonal food availability	-Instruction on how to perform a behaviour (knowledge; skills) -Information about emotional consequences (beliefs about consequences)
Eight: Self-regulation	-Self-monitoring – reinforcement on record keeping of daily steps/MVPA, fruits/vegetables intake, reduction in smoking -Revising goals and plans / Assistance on problem-solving	-Self-monitoring of behaviour (behavioural regulation) -Review behaviour goals (goals) -Problem solving/coping planning (beliefs about capabilities)
Nine: Time management	-Adjusting priorities -Overcoming barriers to eat more produce -Provision of positive feedback and encouragement	-Action planning (behavioural cueing; behavioural regulation) -Feedback on behaviour (motivation)

Week/Email main topic	Content	Behaviour change technique (mechanism of action)
Ten: Social support beyond the program	-Guidance on proactivity to identifying and establishing a social net of support, and increasing confidence	-Social support (social influences; environmental context/resources) -Restructuring the social environment (environmental context/resources)
Eleven: Sit less and move more	-Explaining why couches can be bad for health -How to turn sedentary activities into light physical activities	-Information about health consequences (knowledge; beliefs about consequences) -Salience of consequences (beliefs about consequences) -Restructuring the physical environment (behavioural cueing; environmental context/resources)
Twelve: Onward and upward	-Reviewing key aspects of the program	-Review behaviour goals (goals) -Feedback on behaviour (motivation) -Problem solving/coping planning (beliefs about capabilities)

The strategies adopted in the educational videos and counselling sessions of the current intervention followed the overall structure of the original project with some adaptions, aiming at offering the best evidence-based program tailored to the targeted population. Such adjustments were based on preliminary consultations with members of the targeted population as well as consultations with the senior researchers involved in the planning of the current intervention. These adaptations included more educational sessions about healthy diet and behaviour change approaches contemplating affective judgement (enjoyment related to the adoption of a behaviour), perceived opportunity (time and access to adopt a behaviour) and nonconscious processes (exposure to the same stimuli over time – habit development) (Liu et al., 2019b; Rhodes, 2017).

6.2.3 Assessment Measures

Before the beginning of the assessments, all participants answered the Brazilian version of the PAR-Q+, to screen for health issues (also see Chapter 5; Schwartz et al., 2021b). All measures were collected before and after the intervention, except for demographics as well as program satisfaction and adherence. Demographic characteristics were collected only at baseline, whereas information about adherence and satisfaction with the program was obtained only at the end of the intervention. During assessments at baseline and post-intervention, participants stated whether or not they were engaging in at least 150 min of MVPA per week, eating five or more servings of fruits/vegetables per day, and smoking (tobacco use in any amount). Subsequently, they started the remaining of the assessments.

6.2.3.1 Demographics

At the beginning of the baseline assessments, the following characteristics were collected: age, sex, diagnosed chronic diseases, income, employment, marital status, time to travel to the assessments, and mode of transportation to travel to the assessments.

6.2.3.2 Self-Reported Physical Activity Patterns

A modified version of the Godin-Shephard Leisure-Time Exercise Questionnaire was used to assess the average self-reported amount of time spent in light, moderate, and vigorous physical activity per week (DuBose et al., 2006; Godin & Shephard, 1985) (Figure 6.5). After answering the number of times engaging in each intensity, the participants specified the average duration of each activity. The amount of time spent in each intensity was obtained by multiplying the weekly frequency by the average of minutes engaging in light, moderate, and vigorous activities. MVPA was determined by adding moderate and vigorous intensities together. Participants were then classified as meeting or not the minimum of 150 min of MVPA per week.

Physical Activity

We would like you to recall your average weekly exercise over the past month. How many times per week on average did you do the following kinds of exercise over the past month?

When answering these questions please:

- Only count exercise that was done during free time (i.e., not occupation or housework).
- Note that the main difference between the three categories is the intensity of the exercise.
- Please include the average frequency (times per week) and the average duration for each respective category (i.e., Strenuous, Moderate, and Mild Exercise).

STRENUOUS EXERCISE (HEART BEATS RAPIDLY, SWEATING)
(e.g., running, jogging, hockey, soccer, squash, cross country skiing, vigorous swimming, vigorous long-distance bicycling, vigorous aerobic dance classes, heavy weight training)

Times Per Week	Average Duration (min)	

MODERATE EXERCISE (NOT EXHAUSTING, LIGHT PERSPIRATION)
(e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)

Times Per Week	Average Duration (min)	

MILD EXERCISE (MINIMAL EFFORT, NO PERSPIRATION)
(e.g., easy walking, yoga, bowling)

Times Per Week	Average Duration (min)	

Figure 6.5 Physical activity questionnaire.

Sedentary behaviour was self-reported through the Sedentary Behavior Questionnaire, which assessed time spent in different activities during a typical weekday and a typical weekend day (Rosenberg et al., 2010) (Figure 6.6). The answers from the week were multiplied by five, and the answers from the weekend were multiplied by two, then the total was divided by seven, thereby calculating the average of sedentary time spent in hours per day.

Sedentary Behaviour

On a typical weekday, how much time do you spend (from when you wake up until you go to bed) doing the following?

Behaviour	≤15 min	30 min	1 hr	2 hr	3 hr	4 hr	5 hr	6 hr
Watching television								
Playing computer/video games								
Sitting while listening to music								
Sitting and talking on the phone								
Doing paperwork or office work								
Sitting and reading								
Playing a musical instrument								
Doing arts and crafts								
Sitting and driving/riding in a car, bus, or train								

On a typical weekend day, how much time do you spend (from when you wake up until you go to bed) doing the following?

Behaviour	≤15 min	30 min	1 hr	2 hr	3 hr	4 hr	5 hr	6 hr
Watching television								
Playing computer/video games								
Sitting while listening to music								
Sitting and talking on the phone								
Doing paperwork or office work								
Sitting and reading								
Playing a musical instrument								
Doing arts and crafts								
Sitting and driving/riding in a car, bus, or train								

Figure 6.6 Sedentary behaviour questionnaire.

6.2.3.3 Accelerometry

Before and after the 12 weeks, participants were asked to wear an accelerometer (Actigraph wGT3X-BT, Pensacola, FL, USA) on an adjustable elastic belt, snugly positioned over the hip bone on the right side. Participants were instructed to wear the device during seven consecutive days, for at least 12 hours a day, without modifying their usual activity routine. They were oriented to put on the device right after waking up and removing it only when sleeping and in situations that could damage the device, such as those involving intense body contact as well as water since the device is not waterproof. The participants received a log to take note of the starting and ending use time of each day, as well as when they removed the accelerometer for specific reasons. This was the case for bathing and physical activities such as swimming and martial arts. When the reason to remove the device was engaging in physical activity, participants were asked to report the duration, as well as the type and intensity of the activity. The same was applicable for biking since the accelerometer does not capture movements during this activity. Along with the log, all participants received a handout reinforcing the instructions on the proper use of the device. The participants were asked to return the accelerometer and the log to the laboratory after the seven-day period.

Each device was initialized to collect data at a sample rate of 100 Hz. After being downloaded in its raw form in the Actilife software, data were downsampled to 30 Hz as per recent evidence showing that the conversion from raw data to activity counts can be affected by different sampling rates (Brønd & Arvidsson, 2016). This downsampling process consisted of initially using a Java software (Oracle Corp., Redwood Shores, CA, USA) to convert the original raw (.gt3x) files to .wav files. Subsequently, MATLAB (MathWorks Inc., Natwick, MA, USA) was used to downsample (resample function) to 30 Hz (Lyons, 2013) and the data was stored in

new files using the original raw (.gt3x) format. These files were then analyzed using the Actilife software using a 60-second epoch.

To be considered valid, data had to have been collected for a minimum of 10 hours a day, during four days, including one weekend day. Participants with wearing time below this threshold were removed from the analysis (Migueles et al., 2017). Intervals longer than 60 minutes of zero counts per minute (cpm), with a maximum allowance of two minutes of movement up to 100 cpm, were determined as non-wear time (Troiano et al., 2008). The accelerometer was used to record the number of steps, as well as sedentary time and different intensities of physical activity according to the following cut-points: sedentary (0 – 149 cpm), light (150 – 2689 cpm), moderate (2690 – 6166 cpm), vigorous (≥ 6167 cpm), and MVPA (≥ 2690 cpm) (Kozey-Keadle et al., 2011; Sasaki et al., 2011).

6.2.3.4 Dietary Patterns

A series of questionnaires were presented to the participants, addressing their dietary patterns (Firth et al., 2015; Firth et al., 2017) (Figure 6.7-6.9). The diet survey asked about behaviours related to the intake of fibre (including fruits and vegetables), fat, sugar, and sodium.

Diet

Fibre Intake		***Score***
How many servings of fruits do you eat daily? _____ **X 2 =** *(1 serving=1/2 cup* ***- give yourself 2 grams for each serving)***	**Fibre grams =_____**	
How many servings of vegetables do you eat daily? _____ **X 2 =** *(1 serving=1/2 cup* ***- give yourself 2 grams for each serving)***	**Fibre grams =_____**	
Do you eat a high fibre breakfast cereal at least 4 days per week? *(i.e.: "Fibre 1", "All Bran", "Bran Buds")*. OR… If you don't eat high fibre cereal, do you add fibre to your diet? *(ie: psyllium, flax).* ***If yes…give yourself 8 grams***	**Fibre grams =_____**	***Fibre Grams***
Do you add beans or lentils to your diet at least 2 times a week? ***If yes…give yourself 8 grams***	**Fibre grams =_____**	=_____
Do you eat whole grain bread or bread products *(i.e.: slice of bread, small tortilla, English muffin, ½ bagel, roll) # of servings daily.* _____ **X 2 =** ***If yes…give yourself 2 grams per serving***	**Fibre grams =_____**	

Figure 6.7 Diet questionnaires, page 1/3.

Fat Intake	☑ Please check your answer	
Do you eat any of the following: regular cheese, high fat milk products (cream, 2%, or homogenized)?	____Yes ____ No	***Fat Score*** =_____
Do you put butter or margarine on bread, rolls or muffins?	____Yes ____ No	
Do you usually leave the skin on chicken ***and/or*** do you eat red meat 2 or more times a week?	____Yes ____ No	
Do you often use full fat salad dressing or mayonnaise?	____Yes ____No	
On a weekly basis, do you eat high fat treats like chips, pastries, donuts, ice cream, cookies etc.?	____Yes ____No	

Sugar Intake – select the items consumed on a weekly basis	**Weekly**	**Never**
Drink fruit juice or other sweetened beverage (**i.e.: fruit punch, regular pop, sports or energy drinks)**		
Use sweeteners like: sugar, honey, maple and corn syrup, or agave **(if you are adding any of the above to your coffee/tea include it here)**		
Use jellies, jams or sweetened sauces		
Drink sweetened specialty flavoured coffees, hot beverages or drinks **(if you drink coffee and tea with sugar do not include here)**		
Eat candy including: jellybeans, jube jubes, licorice, mints **and/or** chocolate; including bars, or squares of chocolate		
Eat pastries, pies, cakes, or squares		
Eat cookies, granola bars, muffins, loaves, or donuts		
Eat frozen yogurt, ice cream, sorbet or other frozen ice treats		
Add up the total number of check marks you have in each column **TOTAL #**		

Figure 6.8 Diet questionnaires, page 2/3.

Sodium Intake	How to score: No = **0** Yes = **2** *0 x/week=* ***0*** *1 x/week* = **1** *2-3x/week=* **2** *>3x/week=* **3** Score		
Do you use salt at the table?	Yes / No		
How many servings of processed, canned, and deli meat do you eat per week? *Serving size: deli meats (2 slices), bacon (3 slices), hot dogs& sausage (1), ham, jerky, canned or frozen meats/patty (1), chicken nuggets (4)*	___/wk		
How many *tablespoons* of condiments do you use per week? (i.e.: ketchup, mustard, soy sauce, dill pickles, mayo, sweet pickles, bottled salad dressing, olives)	___/wk		***Sodium Score*** =_____
How often do you use canned soups, broths, bottled/canned sauces, canned vegetables, packaged/frozen meals, tomato juice, pizza per week?	___/wk		
How many servings (*approx. 1 cup*) of chips, pretzels and other salty snacks do you eat per week?	___/wk		
How many servings of cheese do you eat per week? (1.5oz = the size 4 dice)	___/wk		
How often do you eat out? (i.e.: cafeteria, fast food, coffee shop, restaurant)	____/wk		

Figure 6.9 Diet questionnaires, page 3/3.

These answers were used to determine the number of fruits/vegetables eaten per day, the total of dietary fibre consumed per day, and specific scores for the consumption of fat, sodium, and sugar. Participants were then classified as meeting or not the following guidelines: intake of ≥ 25 g/day of fibre, no more than one point in the fat score, five or fewer sugary items per week, and no more than four points in the sodium score.

6.2.3.5 Smoking

A modified version of the smoking questionnaire from the Canadian Health Measures Survey was used to assess smoking behaviour (Statistics Canada, 2011) (Figure 6.10). Participants were asked whether they smoked or not, and those who smoked were asked to answer additional questions.

Smoking

1. Do you smoke cigarettes?
   - Yes
   - No (if no, skip to question 5)

2. If yes, how many do you smoke on average?
   - Number of cigarettes per day: _____

3. If yes, how soon after waking do you have your first cigarette?
   - Number of minutes: _____

4. Throughout your life, how many cigarettes have you smoked, on average, per day?
   - Number of cigarettes per day: _____

If you are currently still a smoker, please skip to question 9

5. If you currently do not smoke, have you ever smoked cigarettes regularly in the past?
   - Yes (please go through the next questions)
   - No (if no, this is the end of the questionnaire)

6. If you have smoked in the past, how many cigarettes did you smoke, on average, per day?
   - Number of cigarettes per day: _____

7. At what age did you quit smoking?
   - _____Years

8. How many years did you smoke?
   - _____ Years

9. At what age did you begin to smoke?
   - _____Years

10. Have you tried to quit smoking in the past?
    - Yes
    - No
    - If yes: a) How many times : _____
      b) Longest time smoke free: _____ days/month/years (please circle)
      c) When was your last quit attempt: _____ year

Figure 6.10 Smoking questionnaire.

6.2.3.6 Psychological Measures

The next items addressed psychological aspects regarding each behaviour, on a 0 to 10 scale. The first question assessed attitude and the second question assessed self-efficacy (Mason et al., 2010; Miller & Rollnick, 2013) (Figure 6.12-6.14). The next item assessed affective judgment and the final item assessed perceived opportunity (Rhodes, 2017; Rhodes et al., 2006). As previously mentioned, the last two items were presented only to the Brazilian groups.

Psychological Measures

1. **Physical Activity:**

1a. On a scale of 0-10, where 0 is not at all and 10 is extremely, how important is it for you to become or stay active for at least 150 minutes per week? Please circle the number that best applies to your situation.

Not at all — Extremely

0	1	2	3	4	5	6	7	8	9	10

1b. On a scale of 0-10, where 0 is not at all and 10 is extremely, how confident are you to become or stay active for at least 150 minutes per week if you really wanted to?

Not at all — Extremely

0	1	2	3	4	5	6	7	8	9	10

1c. On a scale of 0-10, where 0 is strongly disagree and 10 is strongly agree, circle the number that best applies to your situation: becoming or staying active for at least 150 minutes per week would be pleasant.

Strongly disagree — Strongly agree

0	1	2	3	4	5	6	7	8	9	10

1d. On a scale of 0-10, where 0 is strongly disagree and 10 is strongly agree, circle the number that best applies to your situation: If I really wanted to, I would have the opportunity to become or stay active for at least 150 minutes per week?

Strongly disagree — Strongly agree

0	1	2	3	4	5	6	7	8	9	10

Figure 6.11 Psychological measures, page 1/3.

2. **Diet**

2a. On a scale of 0-10, where 0 is not at all and 10 is extremely, how important is it for you to start or continue to eat 5 or more fruits/vegetables per day? Please circle the number that best applies to your situation.

Not at all — Extremely

0	1	2	3	4	5	6	7	8	9	10

2b. On a scale of 0-10, where 0 is not at all and 10 is extremely, how confident are you to start or continue to eat 5 or more fruits/vegetables per day if you really wanted to?

Not at all — Extremely

0	1	2	3	4	5	6	7	8	9	10

2c. On a scale of 0-10, where 0 is strongly disagree and 10 is strongly agree, circle the number that best applies to your situation: starting or continuing to eat 5 or more fruits/vegetables per day would be pleasant.

Strongly disagree — Strongly agree

0	1	2	3	4	5	6	7	8	9	10

2d. On a scale of 0-10, where 0 is strongly disagree and 10 is strongly agree, circle the number that best applies to your situation: If I really wanted to, I would have the opportunity to start or continue to eat 5 or more fruits/vegetables per day?

Strongly disagree — Strongly agree

0	1	2	3	4	5	6	7	8	9	10

Figure 6.12 Psychological measures, page 2/3.

3. **Smoking**

3a. On a scale of 0-10, where 0 is not at all and 10 is extremely, how important is it for you to become or stay smoke-free? Please circle the number that best applies to your situation.

Not at all — Extremely

0	1	2	3	4	5	6	7	8	9	10

3b. On a scale of 0-10, where 0 is not at all and 10 is extremely, how confident are you in your ability to become or stay smoke-free if you really wanted to. Please circle the number that best applies to your situation.

Not at all — Extremely

0	1	2	3	4	5	6	7	8	9	10

3c. On a scale of 0-10, where 0 is strongly disagree and 10 is strongly agree, circle the number that best applies to your situation: becoming or staying smoke-free would be pleasant.

Strongly disagree — Strongly agree

0	1	2	3	4	5	6	7	8	9	10

3d. On a scale of 0-10, where 0 is strongly disagree and 10 is strongly agree, circle the number that best applies to your situation: If I really wanted to, I would have the opportunity to become or stay smoke-free?

Strongly disagree — Strongly agree

0	1	2	3	4	5	6	7	8	9	10

Figure 6.13 Psychological measures, page 3/3.

6.2.3.7 Stages of Change

In addition to the specific questionnaires pertaining to physical activity, diet, and smoking, participants reported their readiness to change each behaviour through different items (Figure 6.11). To determine the stage of change, the participants read a different introduction for each behaviour, then answered a question choosing one out of five possible options, which were the same for all behaviours (Marcus et al., 1992).

Stages of Change

1. **Physical Activity:**

Regular Exercise is any planned physical activity (e.g., brisk walking, aerobics, jogging, bicycling, swimming, rowing, etc.) performed to increase physical fitness. Such activity should be performed 3 to 5 times per week for 20-60 minutes per session. Exercise does not have to be painful to be effective but should be done at a level that increases your breathing rate and causes you to break a sweat.

Do you exercise regularly according to that definition? Please select the statement that best applies to your situation.

- o Yes, I have been for MORE than 6 months
- o Yes, I have been for LESS than 6 months
- o No, but I intend to in the next 30 days
- o No, but I intend to in the next 6 months
- o No, and I do NOT intend to in the next 6 months

2. **Diet**

Think about your intake of fruits and vegetables. Please select the statement that best applies to your situation.

Do you eat at least 5 servings of fruits/vegetables per day?

- o Yes, I have been eating 5 servings of fruits/vegetables per day for MORE than 6 months
- o Yes, I have been eating 5 servings of fruits/vegetables per day for LESS than 6 months
- o No, I do not eat 5 servings of fruits/vegetables per day, but I intend to in the next 30 days
- o No, I do not eat 5 servings of fruits/vegetables per day, but I intend to in the next 6 months
- o No, I do not eat 5 servings of fruits/vegetables per day, and I do NOT intend to in the next 6 months

3. **Smoking**

Smoke-free is defined as not smoking (not a single puff).

Are you smoke-free according to that definition? Please select the statement that best applies to your smoking status.

- o Yes, I have been for MORE than 6 months.
- o Yes, I have been for LESS than 6 months.
- o No, but I intend to be in the next 30 days.
- o No, but I intend to be in the next 6 months.
- o No, and I do NOT intend to be in the next 6 months.

Figure 6.14 Stages of change questionnaire.

6.2.3.8 Health and Fitness Measures

Body composition, cardiovascular measures, strength, and aerobic fitness were assessed before and after the intervention. For the body composition assessments, the participants were instructed to wear light clothes, and remove shoes, socks, and any object they could be carrying, such as keys and wallets. Height was measured with a stadiometer (Seca 213, Hamburg, Germany) to the nearest 0.1centimeter (cm); weight and body fat were recorded using a bioimpedance scale (Tanita TBF-300, Arlington Heights, IL, USA), to the nearest 0.1 kilogram (kg) and 0.1%, respectively; and waist circumference (WC) was measured immediately above the lateral border of the iliac crest, with a standard anthropometric tape, to the nearest 0.1 cm. The following formula was used to determine the body mass index (BMI): weight in kg divided by height in metres squared (Liguori, 2018).

After five minutes of rest in the seated position, heart rate in beats per minute (bpm), as well as systolic blood pressure and diastolic blood pressure in millimetres of mercury (mmHg) were recorded three times at one-minute intervals, using an automated measurement system (BP-Tru, Coquitlam, BC, Canada). The average of the two last measures for each variable was adopted (Leung et al., 2016; Whelton et al., 2018). Handgrip strength was measured in kg, twice in each hand, with a one-minute interval between the assessments, using an analog dynamometer (Almedic, Montreal, QC, Canada). The sum of the highest measure of each hand was adopted (CSEP-PATH, 2013). A submaximal six-minute walk test (6MWT) was used to determine aerobic fitness. Participants were asked to walk back and forth, as fast as possible, in a 20-metre (m) corridor. The walked distance was recorded and the maximal oxygen consumption (VO_2max) in ml/kg/min was estimated with the following formula: 70.161 + (0.023 × walked

distance [m]) – (0.276 × weight [kg]) – (6.79 × sex, where male = 0, female = 1) – (0.193 × resting heart rate [bpm]) − 2 (0.191 × age [years]) (Burr et al., 2011).

6.2.3.9 Program Satisfaction and Adherence

At the end of the intervention, program satisfaction was assessed along with the final survey. Participants were asked the following three questions:

-On a scale of 0-10, how helpful was the program for you?

-On a scale of 0-10, how easy was the program for you?

-On a scale of 0-10, how likely are you to recommend this program to others?

Adherence to the program was assessed in terms of retention rate. This was calculated based on the number of participants present at the baseline who attended the assessments after the intervention.

6.2.4 Program Timeline

The activity planned for each moment of the program is presented in Table 6.3.

Table 6.3 Program timeline.

Measure	Baseline	1	2	3	4	5	6	7	8	9	10	11	12	End of program
Demographics	✓													
Health Screen (PAR-Q+)	✓													
Motivational interviewing	✓													

Measure	Baseline	1	2	3	4	5	6	7	8	9	10	11	12	End of program
Questionnaires - physical activity - diet - smoking - stages of change - psychological	✓													✓
Body composition	✓													✓
Strength and Aerobic fitness - grip strength - six-minute walk test	✓													✓
Cardiovascular measures - blood pressure - heart rate	✓													✓
Accelerometry	✓													✓
Education and counselling sessions		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Program satisfaction														✓

6.2.5 Statistical Analysis

The primary outcome measure for statistical planning purposes was change in physical activity. The original protocol aimed to double the proportion of individuals engaging in ≥ 150

min of MVPA per week. At the time of the planning of the Canadian intervention, Statistics Canada estimated that 15% of the adult population was meeting the international guidelines of ≥ 150 min of MVPA per week (Statistics Canada, 2009). The original protocol projected to double this proportion to 30%. Using a 1-sided t-test to compare binomial proportions with an alpha of 0.05 and power of 0.80, the required sample size would be a minimum of 95 individuals. According to the Brazilian database Vigitel, an equivalent of Statistics Canada, 35% of the Brazilian population were meeting these guidelines when the Brazilian version of the program was being planned (Malta et al., 2015a). Using the same method, the required sample size for each Brazilian group was 23 participants.

Preliminarily, data were examined for accuracy and detection of missing values. Data were analyzed only when collected at baseline. For data missing due to loss to follow-up, Little's test was used to determine whether data were missing completely at random throughout the dataset rather than revealing a systematic pattern. The Little's test confirmed that data were missing completely at random, which supported expectation maximization imputation. Variables with missing data had no more than 5% of missing values, which were handled using the expectation-maximization algorithm (Nakai & Ke, 2011; Nelwamondo et al., 2007).

Subsequently, data were analyzed for participants with complete pre- and post-assessments and carried out for each variable. Interval and ratio variables were analyzed depending on the following conditions. When data met both the normal distribution (based on skewness and kurtosis, presented in Appendix C) and homogeneity of variances (Levene’s test), a two-way repeated measures ANOVA with group by time (3x2) design and Bonferroni adjustments for post hoc tests were used. When the normal distribution but not homogeneity of variances was observed, Welch’s correction for group comparisons and Games-Howell as post

hoc test were included. When data showed no normal distribution, Kruskal-Wallis H test for comparison among groups with Dunn's test as post hoc were used.

For comparisons between two groups (i.e., Canadian group versus the Brazilian experimental group, or the Brazilian experimental group versus the Brazilian control group), the t-test for independent samples was carried out when normal distribution and homogeneity of variances were observed. When normal distribution but not homogeneity of variances was observed, Welch's correction was used. When normality was not observed, the Mann-Whitney U-test was used.

The comparison of categorical data among groups was performed using the chi-squared test of independence (X^2) with multiple Z-tests for proportions with Bonferroni adjustments as post hoc analysis. The pre-post analysis of these variables was carried out with the McNemar test.

Effect sizes for group comparisons of continuous variables were calculated with omega squared (ω^2) for ANOVA, eta squared (η^2) for Kruskal-Wallis H-test, Cohen's d for t-test, and R^2 for Mann-Whitney U-test, whereas pre – post comparison effect sizes were calculated with Cohen's d. In categorical variables, phi statistic (φ) and Cramer's V were calculated as effect size statistics. The reference cut points to categorize the effect sizes as small, medium, or large were: 0.01, 0.06, 0.14 for ω^2, η^2, and R^2; 0.2, 0.5, 0.8 for Cohen's d; and 0.1, 0.3, 0.5 for φ and Cramer's V, respectively (Sullivan & Feinn, 2012; Volker, 2006). Any effect size below the cut point for a small effect was considered trivial.

Continuous data were expressed as mean ± standard deviation if normal distribution was observed, or median (25th – 75th percentiles) for not normally distributed data, whereas post – pre

differences were reported as mean (95% CI). Categorical variables were expressed as frequency counts (percentage).

Considering the low prevalence of smoking in the participants of the present study and the fact that nearly all assessed items related to this behaviour were constant rather than variable, the results pertaining to smoking were presented descriptively.

A result was deemed significant for a p-value < 0.05. All analyses were carried out in SPSS v.27, and graphs were drawn in GraphPad Prism v.7.04 for Windows.

6.3 Results

All Brazilian participants were recruited at the same time. A total of 125 adults meeting the inclusion criteria were recruited. Out of those, two individuals changed their mind about their availability to take part in the program and decided not to be included. Thirty-nine individuals who confirmed interest in the project were not able to participate because they were unable to visit the laboratory for all the assessments. Since it was not possible to anticipate the number of individuals who would meet all the inclusion criteria and be able to make all the required visits to the laboratory, the first 46 participants were allocated to the Brazilian experimental group, and 38 who enrolled after the establishment of the experimental group were enrolled in the Brazilian control group.

At different stages after the beginning of the assessments and the delivery of the program, five individuals from the Brazilian experimental group and two individuals from the Brazilian control group withdrew due to changes in work/school workload and schedule. Another participant from the control group became pregnant and decided not to continue with the program. Nevertheless, these participants continued to be supported by the program whenever they reached out for guidance surrounding healthy lifestyle behaviours. A total of 41 participants

in the BE group, aged 34.9 ± 6.4 yr, and 35 participants in the BC group, aged 36.2 ± 6.9 yr, completed the study. The study flow of Brazilian participants through the trial is shown in Figure 6.15.

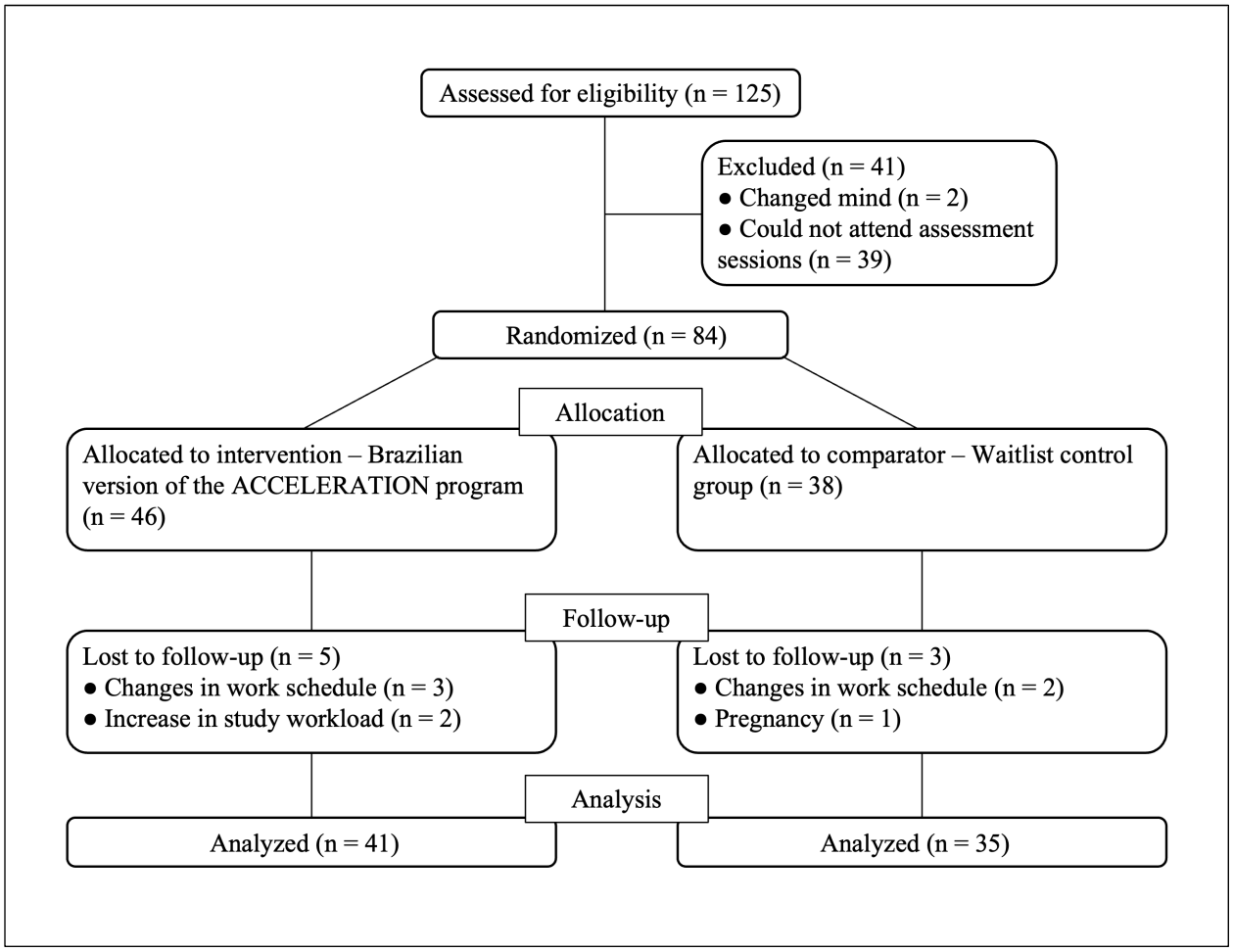

Figure 6.15 Flow of Brazilian participants through the trial.

All individuals but one in each group were cleared to become more physically active, according to the PAR-Q+. These two individuals were directed to obtain clearance from their family physicians. The participant in the control group presented the physician clearance form, highlighting specific precautions, which were followed during the delivery of the program to this

individual. However, the participant from the experimental group did not present such a form. Therefore, this individual agreed to proceed with dietary changes only, and although this participant received special attention during the whole program, no intervention nor any physical activity material was provided to them.

Although the original intervention was mainly focused on primary prevention populations across Canada, some participants from the Canadian group were recruited in health care centres. As a consequence, this sample had several older adults and individuals with diagnosed chronic diseases, whereas the Brazilian groups had no older adults and no participants with diagnosed chronic diseases. Also, since the Canadian group had excessive alcohol intake as an additional possible inclusion criterion, which was not the case for the Brazilian groups, participants from the original project with the characteristics above were not included in the analyses of the present study, aiming at more homogeneous groups for comparisons.

A total of 230 Canadian adults, who were younger than 65 years old, with no diagnosed chronic diseases, and reporting not to drink alcohol beyond the limits established by Canada's low-risk alcohol drinking guidelines (Canadian Centre on Substance Abuse, 2011), attended the baseline assessments of the original project. Of those, 194 participants, aged 47.5 ± 9.3 yr, completed the original project.

For personal reasons, some participants in each group did not answer all the items of the questionnaires and/or did not perform all tests, at baseline and/or after the 12 weeks. Therefore, the sample sizes of each group differ among variables.

Regarding the statistical analysis, a few variables were not normally distributed: the distance from the six-minute walk test, accelerometer-measured vigorous physical activity, and the four intensities of self-reported physical activity. Outliers were detected through the

examination of Z-scores, and values < -3.29 or > 3.29 (less than 5% of the sample) were fixed to the next highest value in the distribution (Barbeau et al., 2019; Tabachnick & Fidell, 2001). This procedure normalized half of the variables. Since transformation of the data did not normalize the other three variables (accelerometer-measured vigorous physical activity, self-reported light physical activity, and self-reported vigorous physical activity), they were analyzed with non-parametric tests.

6.3.1 Demographic Characteristics

At the beginning of the baseline assessments, participants reported their sex, marital and employment status, income, as well as details about the access to the assessment's facility, namely mode of transport and commute time. The socioeconomic characteristics of each group are presented in Table 6.4.

Table 6.4 Demographic data compared among groups. Data expressed as frequency counts (percentage).

	n[1]	CE	BE	BC	p-value[2]	Effect size
Sex	194/41/35				0.001	0.230[3]
Female		168 (86.6)†	26 (63.4)	25 (71.4)		
Male		26 (13.4)†	15 (36.6)	10 (28.6)		
Marital status	189/41/35				0.012	0.182[3]
Married		140 (74.1)†	39 (95.1)	28 (80.0)		
Not married		49 (25.9)†	2 (4.9)	7 (20.0)		
Income	176/40/34				0.001	0.209[4]
< $50,000/year		32 (18.2)†‡	15 (37.5)	16 (47.1)		
$50,000 to $74,999/year		36 (20.4)	10 (25.0)	7 (20.6)		
$75,000 to $99,999/year		39 (22.2)	7 (17.5)	7 (20.6)		
> $100,000/year		69 (39.2)‡	8 (20.0)	4 (11.8)		

	n[1]	CE	BE	BC	p-value[2]	Effect size
Employment	128/41/35				<0.001	0.253[4]
Full-time		103 (80.5)†‡	23 (56.1)	14 (40.0)		
Part-time		10 (7.8)‡	5 (12.2)	9 (25.7)		
Unemployed		15 (11.7)†‡	13 (31.7)	12 (34.3)		
Transport time	128/41/35				<0.001	0.459[4]
<30 min		86 (58.1)†‡	3 (7.3)	4 (11.4)		
30 to 60 min		55 (37.2)	12 (29.3)	12 (34.3)		
>60 min		7 (4.7)†‡	26 (63.4)	19 (54.3)		
Transport mode	131/39/34				<0.001	0.334[4]
I drove		97 (74.0)‡	22 (56.4)	11 (32.4)		
By public transit		17 (13.0)†‡	17 (43.6)	20 (58.8)		
By taxi		0 (0.0)	0 (0)	1 (2.9)		
Someone drove me		17 (13.0)	0 (0)	2 (5.9)		

[1]Sample sizes for CE/BE/BC, respectively, for each variable; [2]p-value calculated with X^2 test of independence; [3]effect size calculated as phi (φ); [4]effect size calculated as Cramer's V. †Denotes a significant difference from BE within categories ($p < 0.05$); ‡denotes a significant difference from BC within categories ($p < 0.05$). BC: Brazilian control group; BE: Brazilian experimental group; CE: Canadian experimental group.

All variables showed significant differences between the Canadian and the Brazilian groups. The Canadian group showed the highest female proportion, which was higher than the Brazilian experimental group but not the Brazilian control group, with a small to medium effect size. CE showed the lowest proportion of married participants, with a significant difference from BE but not BC, having a small to medium effect size. For income, group differences showed a small to medium effect size; particularly, participants in CE showed a significantly higher proportion of participants earning > $100,000 per year than BC but not BE. Conversely, both BE and BC showed a higher proportion of participants earning < $50,000 per year than the CE group. Regarding employment, group comparisons showed a small to medium effect size; full-time employment was more prevalent in CE than in BE and BC, and unemployment was less common in CE than BE and BC. Transport time to the facility in charge of the intervention showed a medium to large effect size; there were more participants in CE that spent < 30 min to

travel than BE and BC, and a lower proportion of participants in CE spending > 60 min in transport than BE and BC. For transport mode, group comparisons showed a medium to large effect size; there was a higher proportion of participants in CE driving by themselves than BC but not BE. However, there was a lower proportion of participants in CE using public transit than BE and BC.

6.3.2 Primary Outcome

6.3.2.1 Self-Reported Physical Activity Patterns

The proportions of participants not engaged in at least 150 min of MVPA/week before and after the intervention are shown in Figure 6.16. The amount of time spent in different intensities of self-reported physical activity as well as in sedentary behaviour at both baseline and post-assessments are presented in table 6.5. The differences in these variables over time are presented in Figure 6.17.

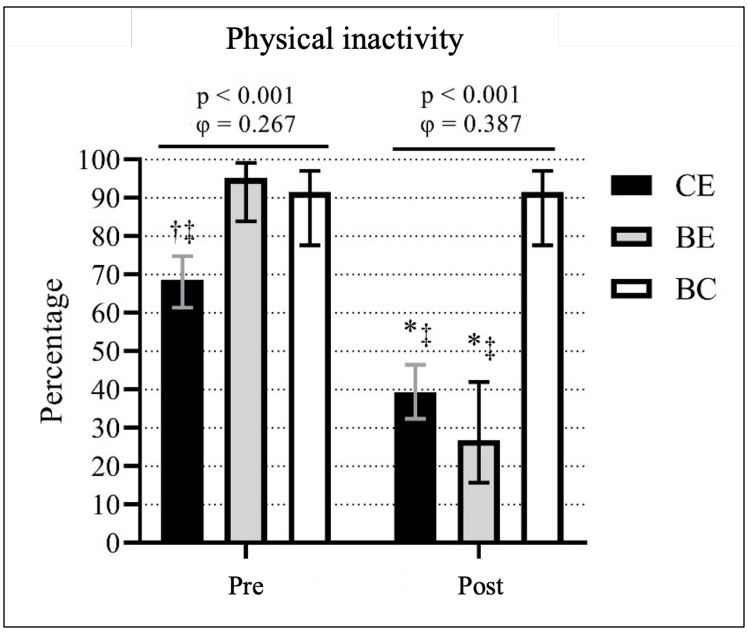

Figure 6.16 Participants engaging in less than 150 minutes of MVPA/week compared among groups over time.
Bars represent the percentage of participants per category; whiskers denote 95% confidence intervals; p-values and φ statistic are for comparisons among groups within the same time point. ‡Denotes a significant difference versus BC ($p < 0.05$) within the same time point; †denotes a significant difference versus BE ($p < 0.05$) within the same time point; *denotes a significant difference versus pre ($p < 0.05$). BC: Brazilian control group; BE: Brazilian experimental group; CE: Canadian experimental group.

At baseline, the Canadian group showed a significantly lower proportion of participants engaging in less than 150 min of MVPA/week (68.5%) in comparison with the Brazilian experimental group (95.1%) and the Brazilian control group (91.4%) (small to medium effect size). After the intervention, CE and BE showed a significant decrease in the proportion of participants not engaging in ≥ 150 min of MVPA/week (both $p < 0.001$), whereas no significant change was observed in BC ($p = 1.000$). This decrease in CE (39.2%) and BE (26.8%) led to significant differences versus BC (91.4%) after the intervention (medium to large effect size).

Table 6.5 Self-reported physical activity time spent at different intensities and sedentary behaviour compared among groups over time. Data expressed as mean ± SD or median (25th – 75th percentile).

Variable	Time point	CE (n = 194)	BE (n = 41)	BC (n = 35)	p-value
Light (min/week)[§]	Pre	50.0 (0.0 – 101.2)[†‡] 71.2 ± 81.7	20.0 (0.0 – 67.5) 41.2 ± 62.2	0.0 (0.0 – 60.0) 41.9 ± 76.2	0.002[1]
	Post	25.0 (0.0 – 80.0)[†] 60.2 ± 87.9	75 (30.0 – 150.0)[‡] 101.0 ± 108.6	15.0 (0.0 – 52.5) 32.7 ± 56.5	0.001[1]
Moderate (min/week)	Pre	58.0 ± 81.7[†]	30.5 ± 54.9	35.1 ± 59.2	0.017[2]
	Post	94.0 ± 73.6[‡]	89.8 ± 95.8[‡]	43.8 ± 74.1	0.002[3]
Vigorous (min/week)[§]	Pre	0.0 (0.0 – 60.0) 40.1 ± 68.7	0.0 (0.0 – 35.0) 18.8 ± 31.7	0.0 (0.0 – 25.0) 22.4 ± 53.3	0.314[1]
	Post	0.0 (0.0 – 60.0)[‡] 36.8 ± 55.6	30.0 (0.0 – 95.0)[‡] 50.7 ± 60.1	0.0 (0.0 – 0.0) 13.6 ± 36.8	0.001[1]
MVPA (min/week)	Pre	98.1 ± 109.4[†]	49.3 ± 64.1	57.6 ± 90.4	0.001[2]
	Post	130.8 ± 92.1[‡]	140.6 ± 109.8[‡]	57.3 ± 85.4	<0.001[3]
Sedentary (h/day)	Pre	7.2 ± 4.5[‡]	8.9 ± 4.3	9.3 ± 4.0	0.009[3]
	Post	6.1 ± 4.6[†‡]	8.3 ± 3.9	9.7 ± 4.2	<0.001[2]

[1]p-value calculated with Kruskal-Wallis H test for comparisons among groups within the same time point; [2]p-value calculated with Welch's correction for comparisons among groups within the same time point; [3]p-value calculated with one-way ANOVA for comparisons among groups within the same time point. [†]Denotes a significant difference from BE within a time point ($p < 0.05$); [‡]denotes a significant difference from BC within a time point ($p < 0.05$); [§]mean ± SD are provided for information purposes only. BC: Brazilian control group; BE: Brazilian experimental group; CE: Canadian experimental group; MVPA: moderate-to-vigorous physical activity.

According to self-reports, at baseline, the time spent in light-intensity physical activity was significantly larger in CE than in the Brazilian groups, whereas after the intervention BE spent significantly more time in this intensity than the other two groups. Moderate intensity was significantly higher in CE than in BE at baseline, while at the post-assessment both CE and BE spent significantly more time than BC in this intensity. There was no difference among groups for vigorous physical activity before the intervention but after the 12 weeks both experimental groups had spent significantly more time in this intensity than BC. At baseline, the Canadian group spent significantly more time in MVPA than the other two groups, whereas after the intervention CE and BE presented significantly more minutes per week in moderate-to-vigorous

intensity than BC. In terms of sedentary time, at baseline, the Canadian group spent significantly less time in this behaviour than BC, and after the intervention, CE spent significantly less time than both Brazilian groups.

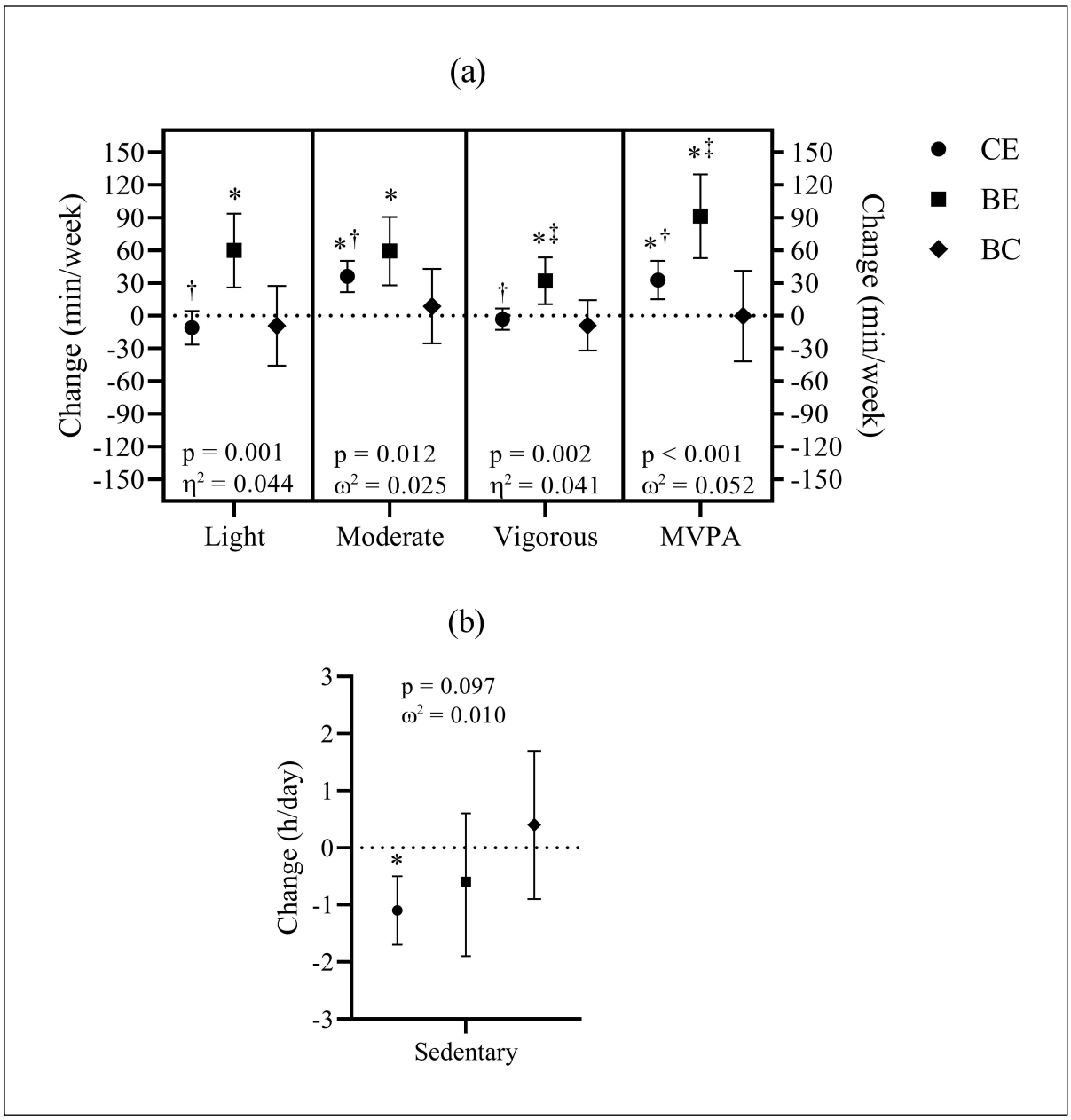

Figure 6.17 Changes over time in physical activity at different intensities (a) and sedentary behaviour (b). Data expressed as mean and 95% confidence intervals; p-values calculated with Kruskal-Wallis H-test (light and vigorous) and one-way ANOVA (moderate, MVPA, and sedentary) for group comparisons; omega squared (ω^2) and eta squared (η^2) as effect size. ‡Denotes a significant difference versus BC ($p < 0.05$); †denotes a significant difference versus BE ($p < 0.05$); *denotes a significant change over time ($p < 0.05$). BC: Brazilian control group (diamonds); BE: Brazilian experimental group (squares); CE: Canadian experimental group (circles); MVPA: Moderate-to-vigorous physical activity.

Participants in the BE group showed significant changes in all four intensities of self-reported physical activity: 59.8 min/week in light ($p = 0.001$, $d = 0.500$), 59.3 min/week in

moderate ($p < 0.001$, $d = 0.522$), 31.9 min/week in vigorous ($p = 0.003$, $d = 0.582$), and 91.3 min/week in MVPA ($p < 0.001$, $d = 0.691$), but not in sedentary behaviour (-0.6 h/day, $p = 0.289$, $d = -0.174$). CE had a significant change in moderate (36.0 min/week, $p < 0.001$, $d = 0.356$) and MVPA (32.8 min/week, $p < 0.001$, $d = 0.261$) intensities as well as in sedentary behaviour (-1.1 h/day, $p < 0.001$, $d = -0.288$) but not in light (-11 min/week, $p = 0.164$, $d = -0.097$) and vigorous (-3.2 min/week, $p = 0.518$, $d = -0.043$) intensities. BC showed no significant differences at all (light = -9.2 min/week, $p = 0.619$, $d = -0.131$; moderate = 8.7 min/week, $p = 0.622$, $d = 0.096$; vigorous = -8.8 min/week, $p = 0.451$, $d = -0.165$; MVPA = -0.2 min/week, $p = 0.991$, $d = -0.002$, and sedentary behaviour = 0.4 h/day, $p = 0.505$, $d = 0.096$). The groups' comparison showed that BE was significantly different than CE in all physical activity intensities, and for vigorous intensity and MVPA, BE was also significantly different than BC, all with small to medium effect sizes. No difference among groups was observed for sedentary behaviour.

6.3.2.2 Accelerometry

Technical problems with the accelerometry data from the Canadian group resulted in invalid results. The devices were worn on the wrist in this group, and the algorithms available to analyze this data provided unreliable values. Therefore, only the data from the Brazilian groups were included in the study.

The variables of each group collected with accelerometers, at baseline and after the intervention, are presented in Table 6.6. The differences in these variables over time are shown in Figures 6.18 and 6.19.

Table 6.6 Physical activity time spent at different intensities, sedentary behaviour, and step count assessed with accelerometry compared between groups over time. Data expressed as mean ± SD or median (25th – 75th percentile).

Variable	Time point	BE (n = 37)	BC (n = 31)	p-value
Light (min/week)	Pre	1668.3 ± 413.9	1495.5 ± 504.3	0.125[1]
	Post	1575.2 ± 456.9	1508.5 ± 468.9	0.555[1]
Moderate (min/week)	Pre	129.2 ±101.6	172.3 ± 128.7	0.128[1]
	Post	169.5 ± 103.4	140.5 ± 92.5	0.230[1]
Vigorous (min/week)[§]	Pre	0.0 (0.0 – 3.0) 3.8 ± 10.3	0.0 (0.0 – 5.0) 6.8 ± 15.4	0.426[2]
	Post	0.0 (0.0 – 2.0) 2.9 ± 7.3	0.0 (0.0 – 1.0) 4.0 ± 10.2	0.547[2]
MVPA (min/week)	Pre	133.4 ± 105.8	180.8 ± 137.8	0.114[1]
	Post	172.7 ± 106.4	145.1 ± 97.1	0.272[1]
Sedentary (h/day)	Pre	9.7 ± 1.0	9.4 ± 1.7	0.395[1]
	Post	8.4 ± 1.8	9.1 ± 1.6	0.093[1]
Step count (steps/day)	Pre	6404.7 ± 1900.0	7275.4 ± 3162.0	0.166[3]
	Post	8428.2 ± 2788.4	6885.2 ± 2553.5	0.021[1]

[1]p-value calculated with independent samples t-test for comparison between groups within the same time point; [2]p-value calculated with Mann-Whitney U-test for comparisons between groups within the same time point; [3]p-value calculated with Welch's correction for comparisons among groups within the same time point. [§]Mean ± SD are provided for information purposes only. BC: Brazilian control group; BE: Brazilian experimental group; MVPA: moderate-to-vigorous physical activity.

After the intervention, the Brazilian experimental group presented a higher number of steps per day than the Brazilian control group. No other difference between groups was observed for accelerometer-measured variables, in both baseline and post-assessments.

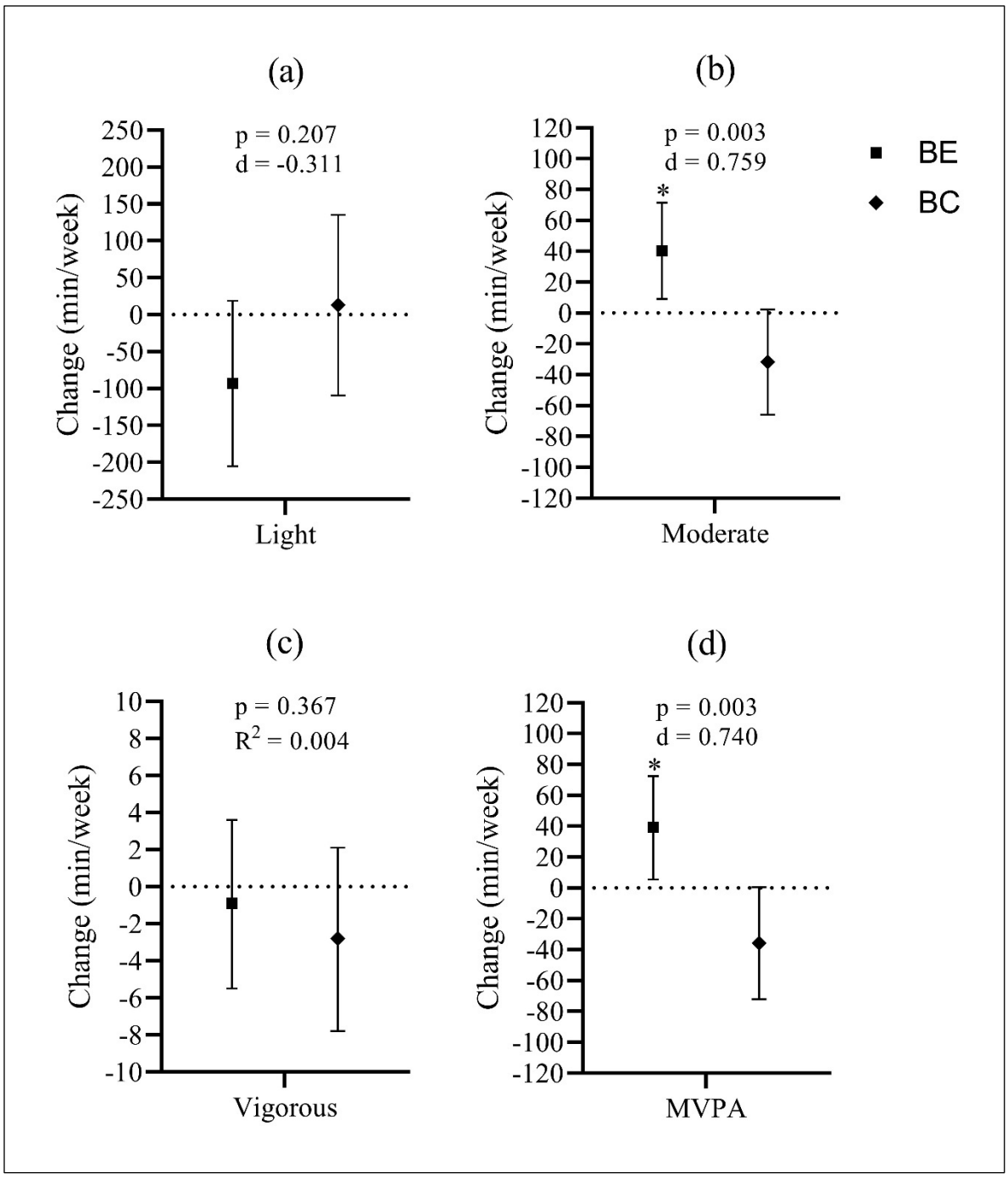

Figure 6.18 Changes over time in weekly light (a), moderate (b), and vigorous (c) intensities, as well as MVPA (d) assessed with accelerometry.
Data expressed as mean and 95% confidence intervals; p-values calculated with independent samples t-test, except for panel (c) which was calculated with Mann-Whitney U-test; Cohen's d (d) and R^2 as effect size. *Denotes a significant change over time ($p < 0.05$). BC: Brazilian control group (diamonds); BE: Brazilian experimental group (squares); MVPA: Moderate-to-vigorous physical activity.

The BE group showed significant increases over time in accelerometer-measured moderate physical activity (40.3 min/week, p = 0.012, d = 0.417) and MVPA (39.3 min/week, p = 0.021, d = 0.392), whereas there were no significant changes in light (-93.1 min/week, p = 0.102, d = -0.249) and vigorous physical activity (-0.9 min/week, p = 0.686, d = -0.085). No physical activity intensity in BC showed significant change over time: light (13 min/week, p = 0.834, d = 0.044), moderate (-31.8 min/week, p = 0.067, d = -0.342), and vigorous physical activity (-2.8 min/week, p = 0.258, d = -0.169), as well as MVPA (-35.7 min/week, p = 0.054, d = -0.348). The groups' comparison showed significant differences between groups in moderate physical activity and MVPA (both with medium to large effect sizes). There was no difference between groups in light and vigorous physical activity.

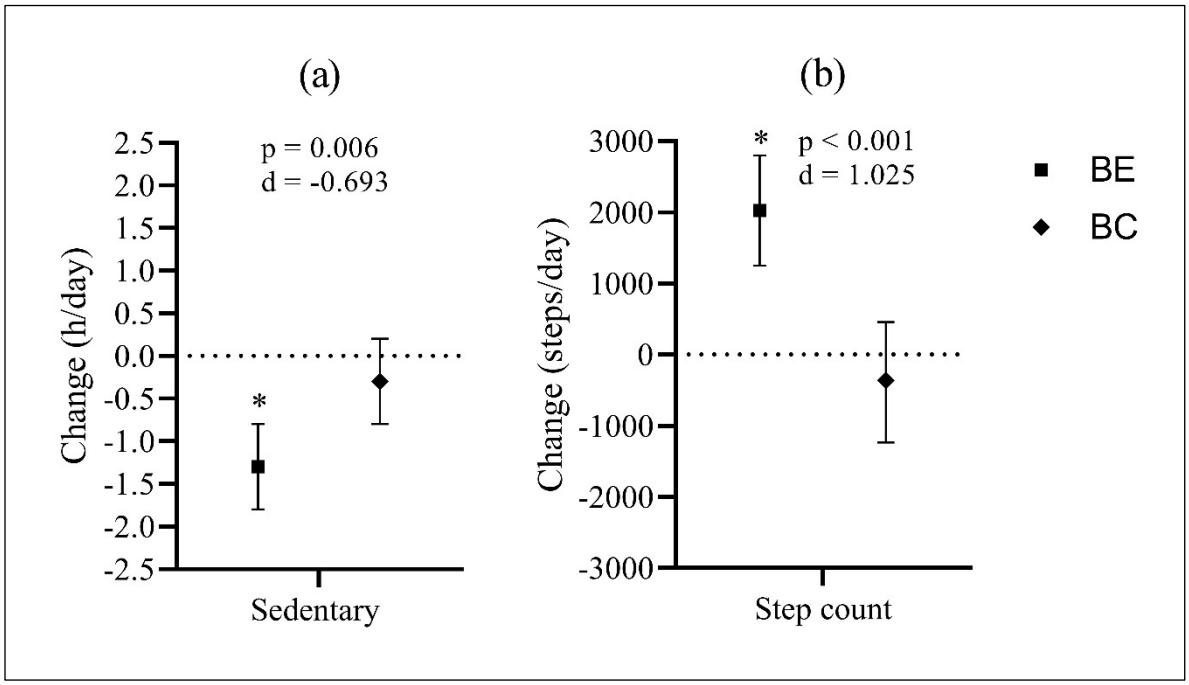

Figure 6.19 Changes over time in sedentary time (a) and step counts (b) assessed with accelerometry. Data expressed as mean and 95% confidence intervals; p-values calculated with independent samples t-test; Cohen's d (d) as effect size. *Denotes a significant change over time ($p < 0.05$). BC: Brazilian control group (diamonds); BE: Brazilian experimental group (squares).

Over time, BE showed a significant decrease in sedentary behaviour (1.3 h/day, $p < 0.001$, $d = -0.924$) and a significant increase in step count (2023.5 steps/day, $p < 0.001$, $d = 0.841$). BC showed no significant changes over time: sedentary behaviour (-0.3 h/day, $p = 0.262$, $d = -0.196$), and step count (-390 steps/day, $p = 0.360$, $d = -0.170$). The groups' comparison showed significant differences in both sedentary behaviour (medium to large effect size) and step count (large effect size).

6.3.3 Secondary Outcomes

6.3.3.1 Dietary Patterns

The proportions of participants reporting a poor diet (< five daily servings of fruits/vegetables) at pre- and post-assessments are shown in Figure 6.20. The number of fruits/vegetables consumed per day, as well as specific scores for the intake of fibre, fat, sodium, and sugar, before and after the intervention, are presented in table 6.7. The changes over time in these five variables are shown in Figures 6.21 and 6.22.

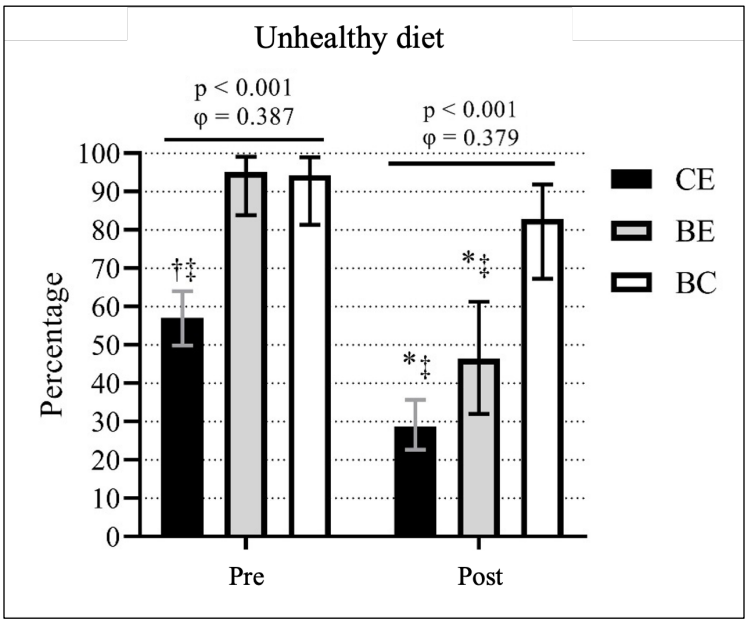

Figure 6.20 Participants eating < five servings/day of fruit/vegetables compared among groups over time. Bars represent the percentage of participants per category; whiskers denote 95% confidence intervals; p-values and φ statistic are for comparisons among groups within the same time point. ‡Denotes a significant difference versus BC ($p < 0.05$) within the same time point; †denotes a significant difference versus BE ($p < 0.05$) within the same time point; *denotes a significant difference versus pre ($p < 0.05$). BC: Brazilian control group; BE: Brazilian experimental group; CE: Canadian experimental group

At baseline, the Canadian group showed a significantly lower proportion of participants having a poor diet (< five servings of fruits/vegetables per day) (57.1%) in comparison with the Brazilian experimental group (95.1%) and the Brazilian control group (94.3%) (medium to large effect size). After the intervention, CE and BE showed a significant decrease in participants with a poor diet (both $p < 0.001$), whereas no significant change was observed in BC ($p = 0.125$). This decrease in CE (28.8%) and BE (46.3%) led to significant differences versus BC (82.9%) after the intervention (medium to large effect size).

Table 6.7 Nutritional variables compared among groups over time. Data expressed as mean ± SD.

Variable	n[1]	Time point	CE	BE	BC	p-value
Fruits/vegetables (servings/day)	114/41/35	Pre	8.8 ± 4.9†‡	2.3 ± 1.4	2.9 ± 1.7	<0.001[2]
		Post	11.4 ± 4.8†‡	4.8 ± 2.0‡	3.0 ± 2.0	<0.001[2]
Fibre (g/day)	114/41/35	Pre	18.5 ± 10.1†‡	28.2 ± 23.4	35.7 ± 27.8	<0.001[2]
		Post	24.3 ± 9.5†‡	40.5 ± 25.4	39.5 ± 26.0	<0.001[2]
Fat (a.u.)	113/41/35	Pre	2.0 ± 1.2†	1.3 ± 1.0	1.5 ± 1.0	0.001[3]
		Post	2.5 ± 1.3†‡	1.9 ± 1.4	1.6 ± 1.2	<0.001[3]
Sodium (a.u.)	114/41/34	Pre	9.4 ± 3.5	9.6 ± 3.4	10.0 ± 4.0	0.802[3]
		Post	8.0 ± 3.3‡	7.6 ± 3.2‡	10.0 ± 4.0	0.008[3]
Sugar (a.u.)	113/41/35	Pre	2.3 ± 1.5†‡	3.5 ± 2.0	3.3 ± 1.7	<0.001[2]
		Post	2.2 ± 1.6‡	2.7 ± 2.1	3.4 ± 1.7	0.002[2]

[1]Sample sizes for CE/BE/BC, respectively, for each variable; [2]p-value calculated with Welch's correction for comparisons among groups within the same time point; [3]p-value calculated with one-way ANOVA for comparisons among groups within the same time point. †Denotes a significant difference from BE within a time point ($p<0.05$); ‡denotes a significant difference from BC within a time point ($p<0.05$). BC: Brazilian control group; BE: Brazilian experimental group; CE: Canadian experimental group.

At baseline, CE presented a significantly higher consumption of fruits/vegetables per day than BE and BC. This pattern was kept after the intervention, but at that moment BE also presented higher values than BC. At both before and after the 12 weeks, CE had a significantly lower consumption of grams of fibre per day than the Brazilian groups. Regarding fat, CE presented a significantly higher consumption than BE before the intervention, and higher than both Brazilian groups after the intervention. Whereas at baseline there was no significant difference in sodium consumption among groups after the intervention both experimental groups presented a lower sodium score than BC. In terms of sugar, the Brazilian groups presented a significantly higher consumption than CE at baseline, whereas after the 12 weeks only BC had a significantly higher consumption than the Canadian group.

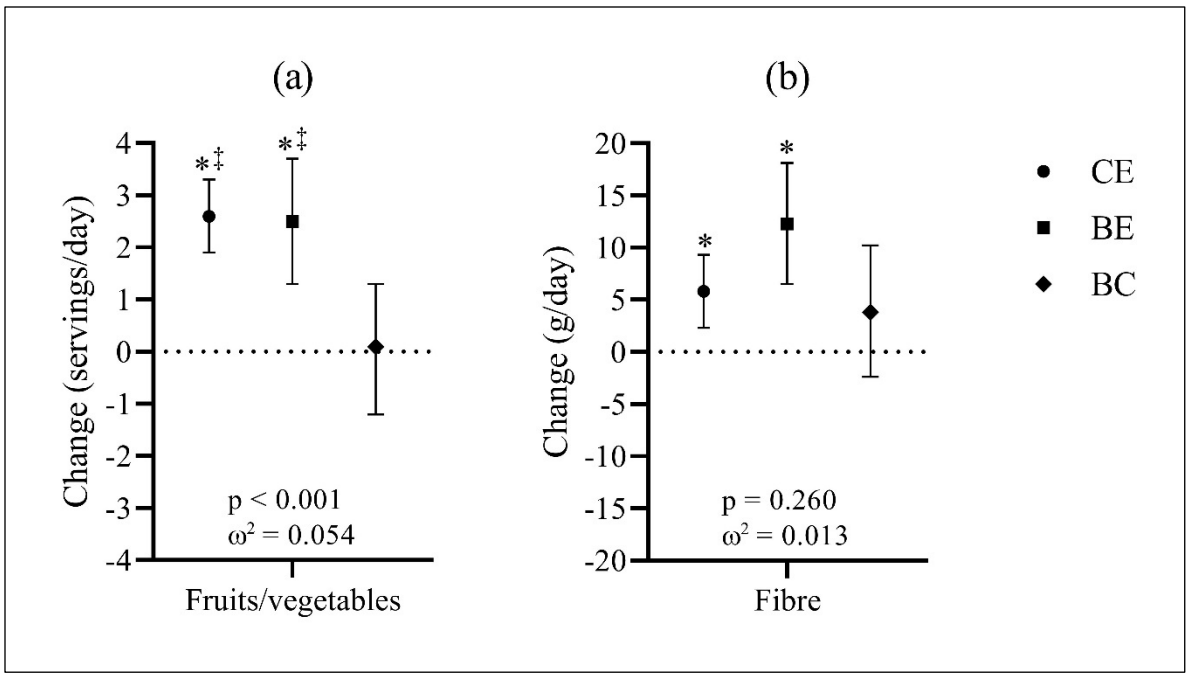

Figure 6.21 Changes over time in fruits/vegetables (a) and fibre intake (b).
Data expressed as mean and 95% confidence intervals; p-values calculated with Welch's correction for group comparisons; omega squared (ω^2) as effect size. ‡Denotes a significant difference versus BC ($p < 0.05$); *denotes a significant change over time ($p < 0.05$). BC: Brazilian control group (diamonds); BE: Brazilian experimental group (squares); CE: Canadian experimental group (circles).

Participants in the CE group showed significant increases over time in the intake of both fruits/vegetables (2.6 servings/day, $p < 0.001$, $d = 0.565$) and fibre (5.8 g/day, $p = 0.001$, $d = 0.597$). Participants in BE also showed significant increases over time in fruits/vegetables (2.5 servings/day, $p < 0.001$, $d = 1.255$) and fibre consumption (12.3 g/day, $p < 0.001$, $d = 0.491$). BC showed no significant change over time (fruits/vegetables = 0.1 servings/day, $p = 0.947$, $d = 0.022$; fibre = 3.8 g/day, $p = 0.226$, $d = 0.128$). The groups' comparison showed that CE and BE were significantly different than BC in fruits/vegetables consumption, with trivial effect size, whereas there was no significant difference among groups in the intake of fibre.

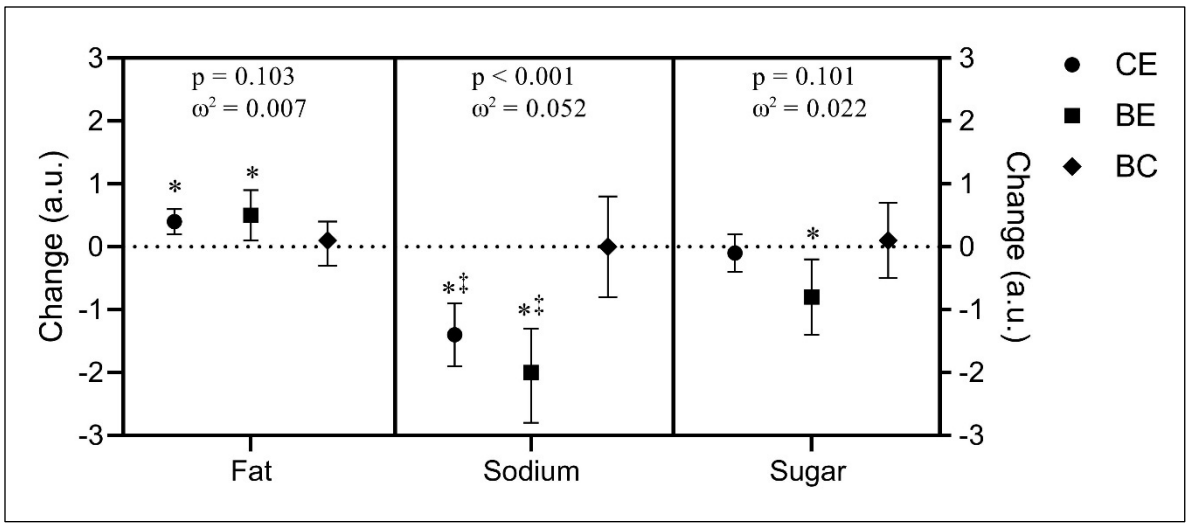

Figure 6.22 Changes over time in fat, sodium, and sugar intake.
Data expressed as mean and 95% confidence intervals; p-values calculated with Welch's correction for group comparisons; omega squared (ω^2) as effect size. ‡Denotes a significant difference versus BC ($p < 0.05$); *denotes a significant change over time ($p < 0.05$). BC: Brazilian control group (diamonds); BE: Brazilian experimental group (squares); CE: Canadian experimental group (circles).

BE showed a significant increase over time in the intake of fat (0.5, p = 0.004, d = 0.411), as well as significant decreases in sodium (2.0, p < 0.001, d = -0.787) and sugar (0.8, p = 0.005, d = -0.365). The Canadian group also showed a significant increase over time in fat (0.4, p < 0.001, d = 0.374), as well as a significant decrease in sodium (1.4, p < 0.001, d = -0.506), but there was no significant change in sugar (-0.1, p = 0.637, d = -0.047). Again, BC showed no significant change over time (fat = 0.1, p = 0.666, d = 0.097; sodium = 0.0, p = 1.000, d = 0.000, and sugar = 0.1, p = 0.707, d =0.072). The groups' comparison showed that CE and BE were significantly different than BC in sodium, with small to medium effect size, whereas there was no significant difference among groups in the other two variables.

The results regarding the change over time in reaching the program guidelines for the consumption of fibre, fat, sodium, and sugar are presented in Figure 6.23.

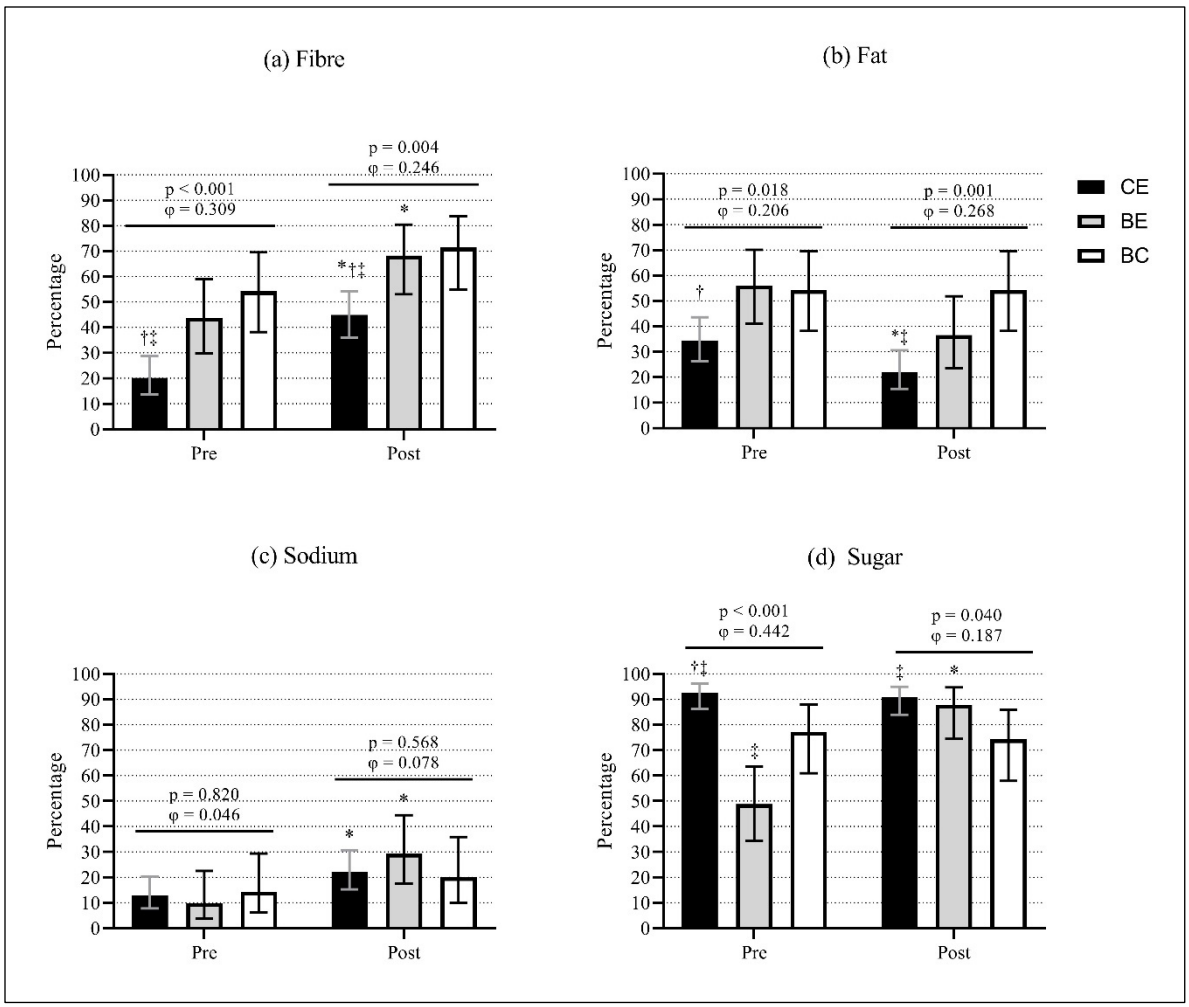

Figure 6.23 Participants reporting to reach the recommended intake for fibre (a), fat (b), sodium (c), and sugar (d), at baseline (pre) and after the intervention (post).
Bars represent the percentage of participants per category; whiskers denote 95% confidence intervals; p-values and φ statistic are for comparisons among groups within the same time point. ‡Denotes a significant difference versus BC ($p < 0.05$) within the same time point; †denotes a significant difference versus BE ($p < 0.05$) within the same time point; *denotes a significant difference versus pre ($p < 0.05$). BC: Brazilian control group; BE: Brazilian experimental group; CE: Canadian experimental group.

At baseline, the proportion of participants reaching the recommended intake for fibre in CE (20.2%) was significantly lower than BE (43.9%) and BC (54.3%) (medium to large effect size). The same pattern was observed after the 12 weeks, but with a small to medium effect size. Both experimental groups, CE (45.0%, $p < 0.001$) and BE (68.3%, $p = 0.006$), showed a significant increase over time, whereas BC (71.5%) did not show a significant change (p =

0.109). For fat intake, CE group showed a significantly lower proportion of participants reaching the recommendations at baseline (34.5%) in comparison with BE (56.1%) but not BC (54.3%) (small to medium effect size). After the intervention, the proportion of participants reaching the recommended intake in CE (22.1%) was significantly lower than and BC (54.3%) but not BE (36.6%), with a small to medium effect size. Over time, CE showed a significant decrease ($p = 0.007$), whereas BE ($p = 0.57$) and BC ($p = 1.000$) did not show a significant change. For sodium intake, there were no significant differences among groups at baseline (CE = 12.8%, BE = 9.8%, and BC = 14.3%) and after the intervention (CE = 22.0%, BE = 29.3%, and BC = 20.0%), both with a trivial effect size. However, CE ($p = 0.021$) and BE ($p = 0.008$) showed a significant increase over time whereas BC did not ($p = 0.727$). For sugar consumption, BE showed a significantly lower proportion of participants reaching the recommended intake (48.8%) than CE (92.7%) and BC (77.1%) at baseline (medium to large effect size). After the intervention, CE (90.8%) was significantly higher than BC (74.3%) but not BE (87.8%) (small to medium effect size). The only significant change over time was observed for the BE group ($p < 0.001$) (CE, $p = 0.774$; BC, $p = 1.000$).

6.3.3.2 Smoking

At baseline, the Canadian group (n = 183) reported 11 participants to be smoking (6.0%), whereas in the Brazilian experimental group (n = 41) only one participant reported to be smoking (2.4%) and no participant in the Brazilian control group (n = 35) reported to be smoking. After 12 weeks of intervention, the CE group reported five participants that had quit smoking (2.7%), but one (0.5%) that was initially not a smoker started to smoke, leading to six participants (3.8%) smoking after the intervention, whereas in BE the single smoker had quit smoking. No changes were observed in the BC group.

6.3.4 Tertiary Outcomes

6.3.4.1 Psychological Measures

The importance rated by participants (attitude) to engage in ≥ 150 min of MVPA/week and their confidence (self-efficacy) to do so, at baseline and after the intervention, are presented in Table 6.8. The importance rated by participants to eat five or more servings of fruits/vegetables per day and their confidence to do so, at baseline and after the intervention, are presented in Table 6.9. The differences over time in these variables for each group are presented in Figure 6.24.

Table 6.8 Attitude and self-efficacy to become or stay active for at least 150 minutes per week, compared among groups over time. Data expressed as mean ± SD.

Variable	Time point	CE (n = 158)	BE (n = 41)	BC (n = 35)	p-value
Attitude (a.u.)	Pre	8.9 ± 1.5	9.1 ± 1.5	8.6 ± 1.8	0.415[1]
	Post	8.9 ± 1.4	9.0 ± 1.5	9.0 ± 1.2	0.887[1]
Self-efficacy (a.u.)	Pre	7.6 ± 2.1	7.7 ± 1.6	7.6 ± 1.7	0.878[2]
	Post	7.6 ± 2.0	7.5 ± 1.9	7.7 ± 1.7	0.944[1]

[1]p-value calculated with one-way ANOVA for comparisons among groups within the same time point; [2]p-value calculated with Welch's correction for comparisons among groups within the same time point. BC: Brazilian control group; BE: Brazilian experimental group; CE: Canadian experimental group.

The answers of all groups for both variables, before and after the intervention, were close to the high end of the scale. There was no significant difference among groups at both time points.

Table 6.9 Attitude and self-efficacy to start or continue to eat five or more fruits/vegetables per day, compared among groups over time. Data expressed as mean ± SD.

Variable	Time point	CE (n = 156)	BE (n = 41)	BC (n = 35)	p-value
Attitude (a.u.)	Pre	8.9 ± 1.6	9.2 ± 1.2	9.2 ± 1.2	0.441[1]
	Post	9.0 ± 1.4	9.1 ± 1.3	9.3 ± 1.2	0.568[1]
Self-efficacy (a.u.)	Pre	8.1 ± 1.8	8.4 ± 1.4	8.1 ± 1.7	0.613[1]
	Post	8.3 ± 1.6	7.9 ± 2.2	8.1 ± 1.8	0.434[2]

[1]p-value calculated with one-way ANOVA for comparisons among groups within the same time point; [2]p-value calculated with Welch's correction for comparisons among groups within the same time point. †Denotes a significant difference from BE within a time point (p<0.05); ‡denotes a significant difference from BC within a time point (p<0.05). BC: Brazilian control group; BE: Brazilian experimental group; CE: Canadian experimental group.

Just like the variables regarding physical activity, the answers of all groups were close to the high end of the scale for both variables in relation to diet, before and after the intervention. Also, similarly to physical activity, there was no significant difference among groups at both time points.

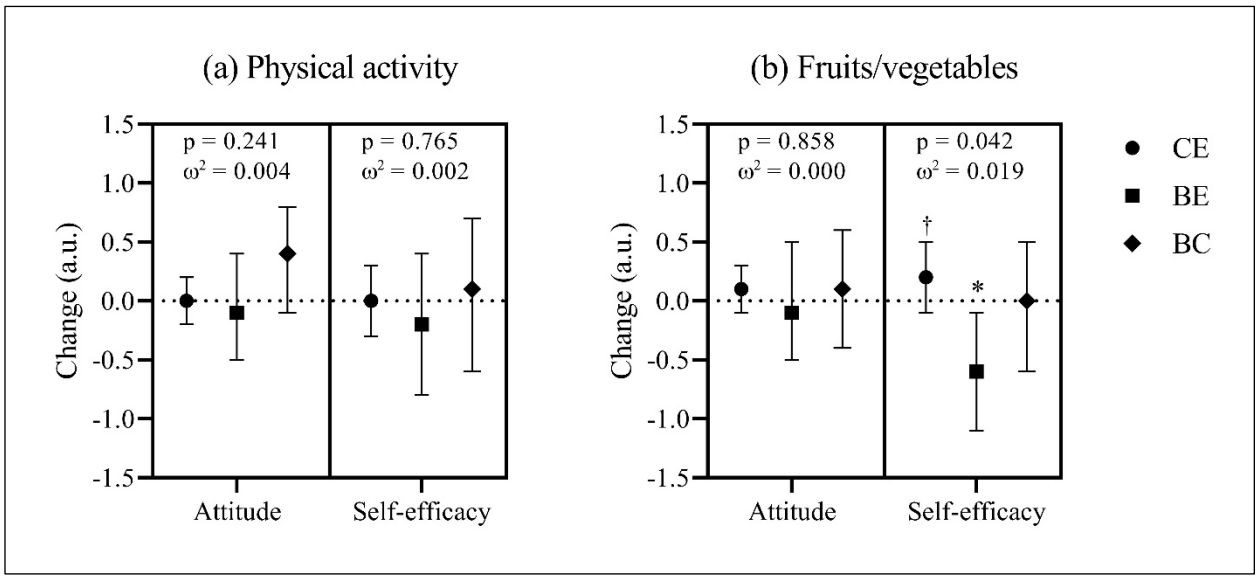

Figure 6.24 Changes over time in attitude and self-efficacy to become or stay active for at least 150 minutes per week (a), and to start or continue to eat five or more fruits/vegetables per day (b).
Data expressed as mean and 95% confidence intervals; p-values calculated with one-way ANOVA for group comparisons, except for self-efficacy in panel (a) which was calculated with Welch's correction; omega squared (ω^2) as effect size. †Denotes a significant difference versus BE ($p < 0.05$); *denotes a significant change over time ($p < 0.05$). BC: Brazilian control group (diamonds); BE: Brazilian experimental group (squares); CE: Canadian experimental group (circles).

There was no significant change over time in any group in attitude (CE = 0.0, p = 0.819, d = -0.018; BE = -0.1, p = 0.822, d = -0.035; BC = 0.4, p = 0.090, d = 0.286) and self-efficacy (CE = 0.0, p = 0.830, d = 0.017; BE = -0.2, p = 0.517, d = -0.086; BC = 0.1, p = 0.792, d = 0.082) to become or stay active for ≥ 150 min/week, and there was also no significant difference among groups in these two variables in relation to physical activity. Regarding diet, there was also no significant change over time in any group in attitude to start or continue to eat ≥ five daily servings of fruits/vegetables (CE = 0.1, p = 0.311, d = 0.077; BE = -0.1, p = 0.921, d = -0.020; BC = 0.1, p = 0.669, d = 0.072), whereas in self-efficacy BE showed a significant decrease of -0.5 over time (p = 0.035, d = -0.279). The other groups showed no change over time (CE = 0.2, p = 0.168, d = 0.119; and BC = 0.0, p = 0.842, d = -0.032). Whereas there was no significant difference among groups in attitude, the Canadian group was significantly different than the Brazilian experimental group in self-efficacy to start or continue to eat ≥ five servings of fruits/vegetables per day.

How pleasant (affective judgement) participants considered that it would be to engage in ≥ 150 min of MVPA/week and how they perceived their opportunity to do so, as well as how pleasant participants considered that it would be to eat ≥ five servings of fruits/vegetables per day and how they perceived their opportunity to do so, at baseline and after the intervention, are presented in tables 6.10 and 6.11, respectively. The differences over time in these variables for each group are presented in Figure 6.25.

Table 6.10 Affective judgement and perceived opportunity to engage in at least 150 minutes per week, compared between groups over time. Data expressed as mean ± SD.

Variable	Time point	BE (n = 41)	BC (n = 35)	p-value
Affective judgement (a.u.)	Pre	8.9 ± 1.6	8.4 ± 2.3	0.265[1]
	Post	9.1 ± 1.2	8.2 ± 2.4	0.028[2]
Perceived opportunity (a.u.)	Pre	8.0 ± 2.3	8.8 ± 1.5	0.067[1]
	Post	8.2 ± 1.8	8.7 ± 1.6	0.246[1]

[1]p-value calculated with independent samples t-test for comparison between groups within the same time point; [2]p-value calculated with Welch's correction for comparisons between groups within the same time point. BC: Brazilian control group; BE: Brazilian experimental group.

Similarly to attitude and self-efficacy, the answers related to affective judgement and perceived opportunity to become or stay active for ≥ 150 min/week in the Brazilian experimental group and the Brazilian control group were close to the high end of the scale. Whereas there was no difference between groups at baseline for both variables, after the intervention BE had significantly higher values than BC for affective judgement.

Table 6.11 Affective judgement and perceived opportunity to eat five or more fruits/vegetables per day, compared between groups over time. Data expressed as mean ± SD.

Variable	Time point	BE (n = 41)	BC (n = 35)	p-value
Affective judgement (a.u.)	Pre	8.5 ± 2.2	8.7 ± 1.6	0.656[1]
	Post	8.9 ± 1.7	8.5 ± 1.9	0.278[1]
Perceived opportunity (a.u.)	Pre	8.0 ± 2.7	8.8 ± 1.4	0.107[2]
	Post	8.9 ± 1.4	9.2 ± 1.2	0.428[1]

[1]p-value calculated with independent samples t-test for comparison between groups within the same time point; [2]p-value calculated with Welch's correction for comparisons between groups within the same time point. BC: Brazilian control group; BE: Brazilian experimental group.

Once more, the answers to both variables were close to the high end of the scale. However, there was no significant difference between groups in both variables related to start or continue to eat five or more fruits/vegetables per day, at both time points.

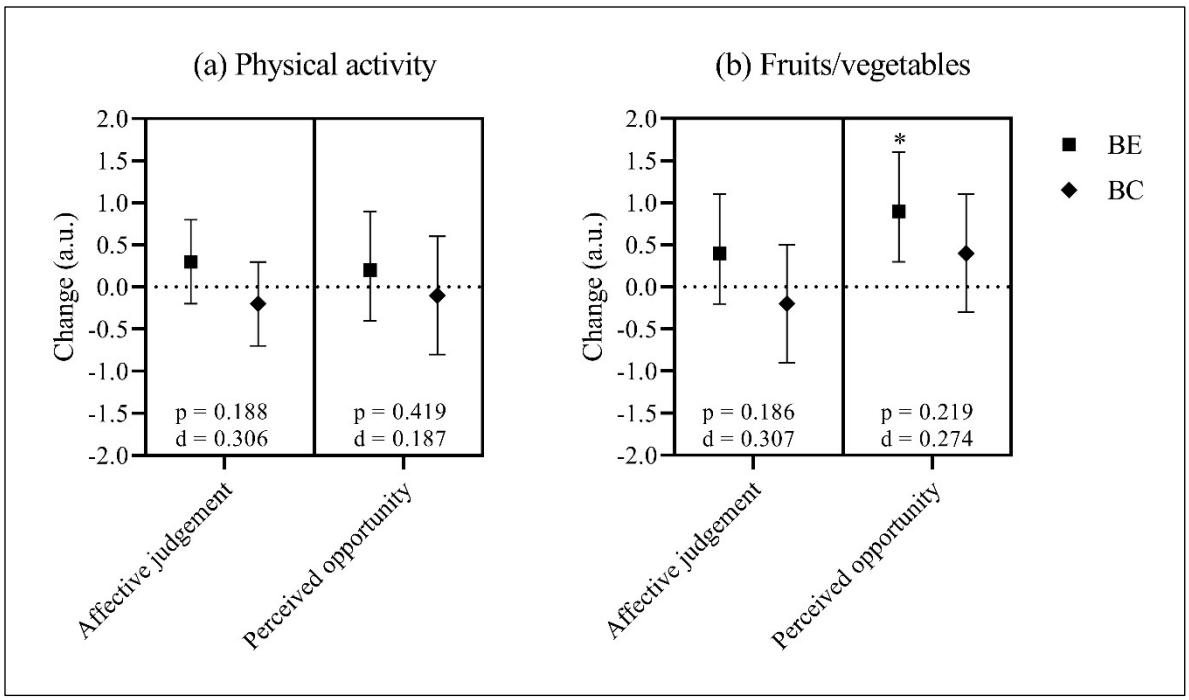

Figure 6.25 Changes over time in affective judgement and perceived opportunity to become or stay active for at least 150 minutes per week (a), and to start or continue to eat five or more fruits/vegetables per day (b). Data expressed as mean and 95% confidence intervals; p-values calculated with t-test for group comparisons, except for perceived opportunity in panel (b) which was calculated with Welch's correction; Cohen´s d (d) as effect size. *Denotes a significant change over time ($p < 0.05$). BC: Brazilian control group (diamonds); BE: Brazilian experimental group (squares).

There was no significant change over time in any group in affective judgement (BE = 0.3, p = 0.248, d = 0.201; BC = -0.2, p = 0.465, d = -0.112) and perceived opportunity to become or stay active for ≥ 150 min per week (BE = 0.2, p = 0.452, d = 0.110; BC = -0.1, p = 0.684, d = -0.077). As well, there was no significant difference between groups in these two variables in relation to physical activity. There was also no significant change over time in any group in affective judgement to start or continue to eat five or more fruits/vegetables per day (BE = 0.4, p = 0.209, d = 0.179; BC = -0.2, p = 0.520, d = -0.127), whereas in perceived opportunity BE showed a significant increase of 0.9 (p = 0.005, d = 0.376). Again, BC showed no significant change over time (0.4, p = 0.283, d = 0.275), and there was also no significant difference between groups in these two variables in relation to diet.

6.3.4.2 Stages of Change

Changes in stage of behaviour change, related to physical activity over time for each group, are presented in Figure 6.26. The results regarding the changes in stage of behaviour change in respect to healthy diet are presented in Figure 6.27.

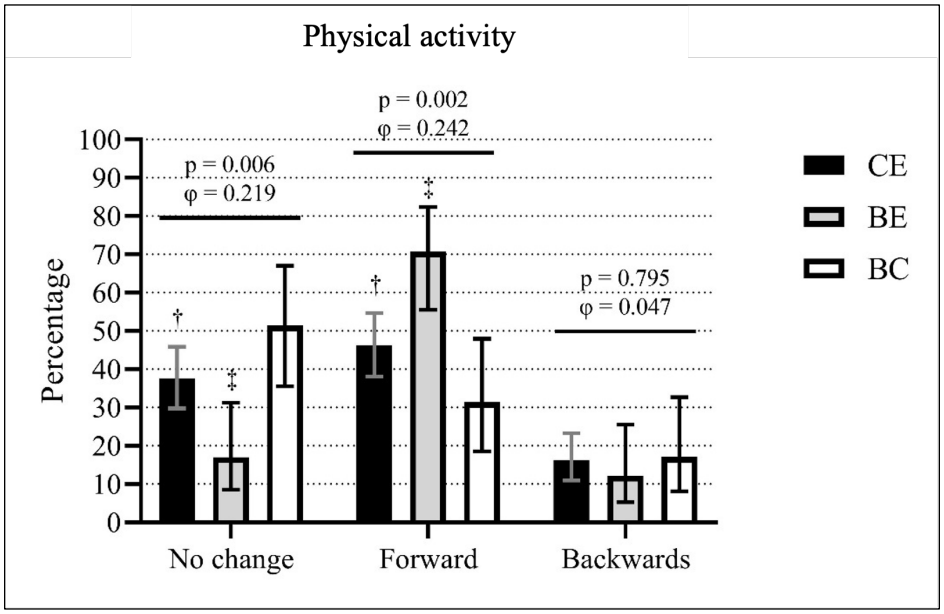

Figure 6.26 Comparison of physical activity stages of change at the end of the intervention.
Participants were grouped depending on whether they did not change their behaviour (No change), moved forward to a better stage (Forward) or moved backwards to a worse stage (Backwards). Bars represent the percentage of participants per category; whiskers denote 95% confidence intervals; p-values and φ statistic are for comparisons among groups within categories. ‡Denotes a significant difference versus BC ($p < 0.05$) within the same category; †denotes a significant difference versus BE ($p < 0.05$) within the same category. BC: Brazilian control group; BE: Brazilian experimental group; CE: Canadian experimental group.

The chi-squared test suggested a significant difference among groups ($p = 0.010$) with a small to medium effect size (Cramer's V = 0.177). The post hoc test showed that after 12 weeks of intervention, the BE group showed a significantly higher proportion of participants moving forward at least one stage of change (70.7%) in comparison with the CE (46.3%, $p = 0.020$) and BC (31.4%, $p = 0.003$) groups, with no differences between CE and BC ($p = 0.343$), reaching a small to medium effect size. In a similar manner, BE group showed the lowest proportion of

participants that did not change stages (17.1%) in comparison with CE (37.5%, p = 0.047) and BC (51.4%, p = 0.007) groups, with no differences between CE and BC (p = 0.410) (small to medium effect size). No significant differences among groups were observed for those participants moving backwards at least one stage (CE 16.2% versus BE 12.2% versus BC 17.1%; CE versus BE, p = 1.000; CE versus BC, p = 0.131; BE versus BC, p = 0.133; trivial effect size).

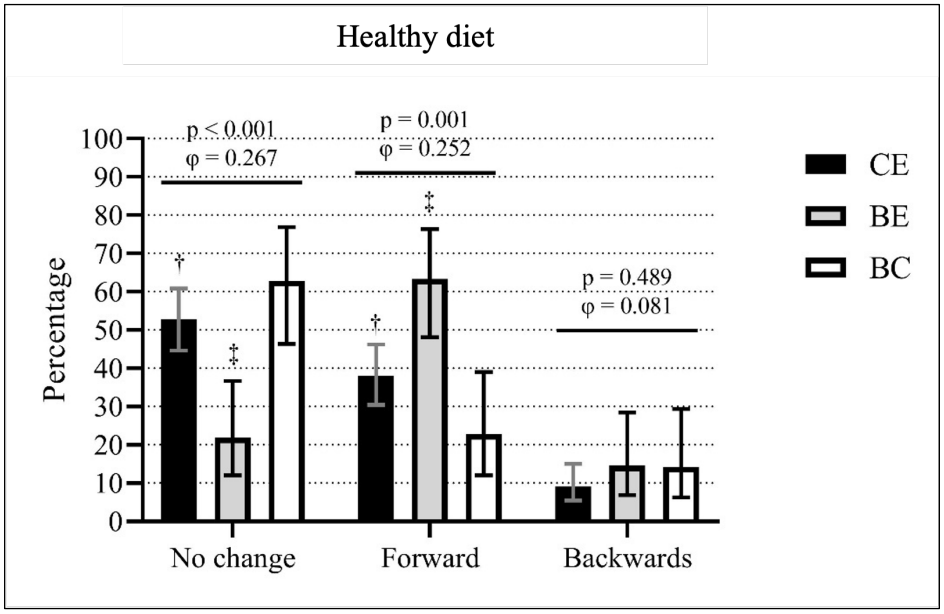

Figure 6.27 Comparison of healthy eating stages of change at the end of the intervention.
Participants were grouped depending on whether they did not change their behaviour (No change), moved forward to a better stage (Forward) or moved backwards to a worse stage (Backwards). Bars represent the percentage of participants per category; whiskers denote 95% confidence intervals; p-values and φ statistic are for comparisons among groups within categories. ‡Denotes a significant difference versus BC ($p < 0.05$) within the same category; †denotes a significant difference versus BE ($p < 0.05$) within the same category. BC: Brazilian control group; BE: Brazilian experimental group; CE: Canadian experimental group.

The chi-squared test suggested a significant difference among groups (p = 0.002) with a small to medium effect size (Cramer's V = 0.200). The post hoc analyses showed that after 12 weeks of intervention the BE group showed a significantly higher proportion of participants moving forward at least one stage of change (63.4%) in comparison with CE (38.0%, p = 0.013) and BC (22.8%, p = 0.002) groups, with no difference between CE and BC (p = 0.279) reaching

a small to medium effect size. In a similar manner, BE group showed the lowest proportion of participants that did not change stages (22.0%) in comparison with CE (52.8%, p = 0.002) and BC (62.9%, p = 0.002) groups, with no differences between CE and BC (p = 0.851) (small to medium effect size). No significant differences among groups were observed for those participants moving backwards at least one stage (CE 9.2% versus BE 14.6% versus BC 14.3%; CE versus BE, p = 0.960; CE versus BC, p = 1.000; BE versus BC, p = 1.000; trivial effect size).

Regarding the stages of change for smoking, in the CE group three participants (2.9%) moved forward at least one stage, two participants (1.9%) moved backwards at least one stage, and 99 participants (95.2%) did not change their stage. In BE, 40 participants (97.6%) remained in the same stage and one participant (2.4%) moved forward one stage. No changes were observed in the BC group.

6.3.4.3 Health and Fitness Measures

The height of each group (mean ± SD) was as follows: 164.8 ± 8.2 cm in the Canadian group, 167.1 ± 9.9 cm in the Brazilian experimental group, and 169.0 ± 11.0 in the Brazilian control group. There were no significant differences among groups (p = 0.057; $\omega^2 = 0.022$). The other body composition data of each group, at baseline and at the end of the intervention are presented in Table 6.12. The differences over time for each group are presented in Figure 6.28.

Table 6.12 Body composition variables compared among groups over time. Data expressed as mean ± SD.

Variable	n[1]	Time point	CE	BE	BC	p-value[2]
Weight (kg)	188/41/35	Pre	78.7 ± 19.2	83.2 ± 19.8	79.6 ± 23.3	0.418
		Post	78.0 ± 18.2	83.0 ± 20.5	80.6 ± 24.1	0.290
BMI (kg/m^2)	188/41/35	Pre	28.9 ± 6.4	29.7 ± 6.5	27.6 ± 6.2	0.344
		Post	28.7 ± 6.2	29.6 ± 6.6	27.9 ± 6.5	0.498

Variable	n[1]	Time point	CE	BE	BC	p-value[2]
Body fat (%)	188/41/35	Pre	36.1 ± 8.5‡	34.7 ± 7.6	31.8 ± 8.6	0.020
		Post	35.5 ± 8.2‡	33.6 ± 7.4	31.7 ± 8.5	0.030
WC (cm)	191/41/35	Pre	94.4 ± 16.0	98.3 ± 14.7	96.7 ± 14.2	0.296
		Post	93.4 ± 15.0	97.1 ± 15.4	96.6 ± 15.9	0.241

[1]Sample sizes for CE/BE/BC, respectively, for each variable; [2]p-value calculated with one-way ANOVA for comparisons among groups within the same time point. ‡Denotes a significant difference from BC within a time point (p<0.05). BC: Brazilian control group; BE: Brazilian experimental group; BMI: body mass index; CE: Canadian experimental group; WC: waist circumference.

Except for body fat, there was no significant difference among groups for any other body composition variable at any time point. The Canadian group presented significantly higher body fat percentage than BC at both baseline and post-assessments.

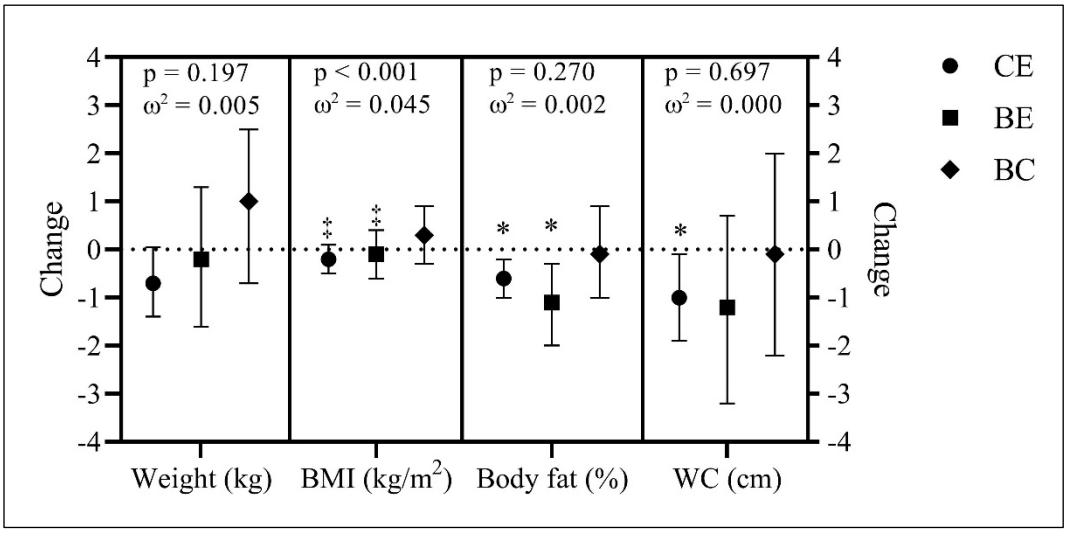

Figure 6.28 Changes over time in weight, BMI, body fat, and WC.
Data expressed as mean and 95% confidence intervals; p-values calculated with one-way ANOVA for group comparisons, except for BMI which was calculated with Welch's correction; omega squared (ω^2) as effect size. ‡Denotes a significant difference versus BC ($p < 0.05$); *denotes a significant change over time ($p < 0.05$). BC: Brazilian control (diamonds); BE: Brazilian experimental group (squares); BMI: Body mass index; CE: Canadian experimental group (circles); WC: Waist circumference.

Participants in CE showed significant decrease of 0.6 % in body fat (p = 0.003, d = -0.211), and 1.0 cm in WC (p = 0.030, d = -0.144), whereas weight (-0.7 kg, p = 0.064, d -0.118) and body mass index (-0.3 kg/m^2, p = 0.083, d = -0.111) did not have a significant change.

Participants in BE only showed a significant change in body fat (-1.1%, p = 0.012, d = -0.553), whereas there was no significant change in weight (-0.2 kg, p = 0.840, d = -0.061), BMI (-0.1 kg/m^2, p = 0.733, d = -0.102), and WC (-1.1 cm, p = 0.223, d = -0.258). BC showed no significant changes over time (weight = 1.0 kg, p = 0.256, d = 0.545; BMI = 0.3 kg/m^2, p = 0.263, d = 0.594; body fat = -0.1 %, p = 0.882, d = -0.026; and WC = -0.1 cm, p = 0.936, d = -0.022). The groups' comparison showed that CE and BE were significantly different than BC in body mass index (small to large effect size). No other significant difference among groups was observed.

The cardiovascular variables of each group, at baseline and after the intervention, are presented in Table 6.13. The differences in these variables over time are presented in Figure 6.29.

Table 6.13 Cardiovascular variables compared among groups over time. Data expressed as mean ± SD.

Variable	n[1]	Time point	CE	BE	BC	p-value
SBP (mmHg)	192/41/35	Pre	120.4 ± 17.8[‡†]	110.4 ± 11.9	109.5 ± 11.5	<0.001[2]
		Post	116.5 ± 15.7[‡†]	109.2 ± 8.4	106.6 ± 10.2	<0.001[2]
DBP (mmHg)	192/41/35	Pre	76.1 ± 9.8[‡†]	71.5 ± 7.0	71.7 ± 9.5	0.002[3]
		Post	73.9 ± 9.1[‡]	71.7 ± 6.0	69.8 ± 9.0	0.022[2]
HR (bpm)	191/41/35	Pre	72.7 ± 10.5	73.4 ± 8.8	73.3 ± 9.4	0.861[3]
		Post	69.9 ± 10.6[‡]	73.4 ± 8.9	75.3 ± 10.2	0.005[3]

[1]Sample sizes for CE/BE/BC, respectively, for each variable; [2]p-value calculated with Welch's correction for comparisons among groups within the same time point; [3]p-value calculated with one-way ANOVA for comparisons among groups within the same time point. [†]Denotes a significant difference from BE within a time point (p<0.05); [‡]denotes a significant difference from BC within a time point (p<0.05). BC: Brazilian control group; BE: Brazilian experimental group; CE: Canadian experimental group; DBP: diastolic blood pressure; HR: heart rate; SBP: systolic blood pressure.

Before and after the intervention, the Canadian group presented significantly higher systolic blood pressure than the Brazilian groups. This was also the case for diastolic blood

pressure at baseline, whereas at post-assessments CE was significantly higher than the Brazilian control group but not the Brazilian experimental group. While there was no significant difference among groups for heart rate at baseline, after the intervention CE had significantly lower values only than BC.

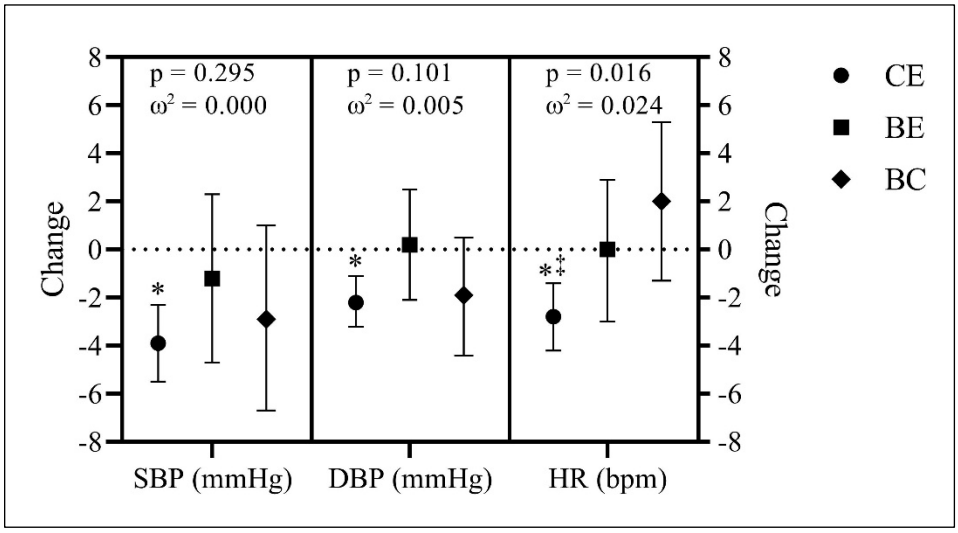

Figure 6.29 Changes over time in SBP, DBP, and HR.
Data expressed as mean and 95% confidence intervals; p-values calculated with Welch's correction for group comparisons, except for HR which was calculated with one-way ANOVA; omega squared (ω^2) as effect size. ‡Denotes a significant difference versus BC ($p < 0.05$); *denotes a significant change over time ($p < 0.05$). BC: Brazilian control group (diamonds); BE: Brazilian experimental group (squares); bpm: beats per minute; CE: Canadian experimental group (circles); DBP: Diastolic blood pressure; HR: Heart rate; SBP: Systolic blood pressure.

Participants in CE showed significant decreases of 3.9 mmHg in SBP ($p < 0.001$, d = -0.310), 2.2 mmHg in DBP ($p < 0.001$, d = -0.280), and 2.8 bpm in HR ($p < 0.001$, d = -0.288). There were no significant changes over time in BE (SBP = -1.2 mmHg, p = 0.500, d = -0.131; DBP = 0.2 mmHg, p = 0.890, d = 0.028; HR = 0 bpm, p = 0.964, d = -0.008) and BC (SBP = -2.9 mmHg, p = 0.141, d = -0.415; DBP = -1.9 mmHg, p = 0.125, d = -0.347; HR = 2.0 bpm, p = 0.227, d= 0.173). The groups' comparison showed that CE was significantly different than BC in HR (small to medium effect size). No other group comparison showed significant differences.

The aerobic and musculoskeletal fitness variables of each group, at baseline and post-assessments, are shown in Table 6.14. The differences in these variables over time are presented in Figure 6.30.

Table 6.14 Physical performance variables compared among groups over time. Data expressed as mean ± SD.

Variable	n[1]	Time point	CE	BE	BC	p-value
6MWT (m)	139/41/35	Pre	598.4 ± 90.7	616.6 ± 76.7	620.3 ± 69.2	0.259[2]
		Post	627.7 ± 68.7	653.2 ± 62.9	617.6 ± 71.4	0.051[2]
VO_2max (ml/kg/min)	135/41/35	Pre	32.5 ± 7.1[†‡]	36.2 ± 5.9	36.5 ± 7.8	0.001[2]
		Post	33.7 ± 6.7	36.5 ± 5.9	35.2 ± 7.9	0.051[2]
Handgrip strength (kg)	154/41/35	Pre	57.0 ± 17.7[†]	64.7 ± 17.8	65.4 ± 21.5	0.014[3]
		Post	59.6 ± 17.2[†]	69.4 ± 18.8	67.9 ± 23.9	0.006[3]

[1]Sample sizes for CE/BE/BC, respectively, for each variable; [2]p-value calculated with one-way ANOVA for comparisons among groups within the same time point; [3]p-value calculated with Welch's correction for comparisons among groups within the same time point. [†]Denotes a significant difference from BE within a time point ($p<0.05$); [‡]denotes a significant difference from BC within a time point ($p<0.05$). BC: Brazilian control group; BE: Brazilian experimental group; CE: Canadian experimental group; 6MWT: six-minute walk test; VO_2max: maximal oxygen uptake.

While there was no significant difference among groups in the distance of the 6MWT before and after the intervention, VO_2max was significantly higher in the Brazilian groups in comparison with CE at baseline. There was no significant difference among groups for this variable after the intervention. Regarding handgrip strength, CE had significantly lower values than BE at both time points.

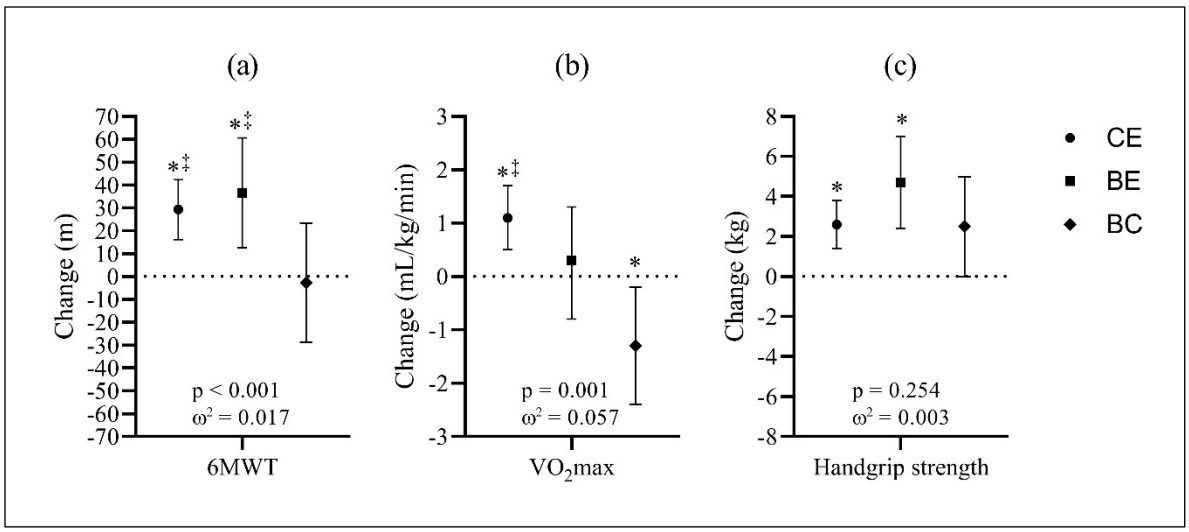

Figure 6.30 Changes over time in 6MWT (a), VO_2max (b), and handgrip strength (c).
Data expressed as mean and 95% confidence intervals; p-values calculated with one-way ANOVA for group comparisons, except for panel (a) which was calculated with Welch's correction; omega squared (ω^2) as effect size. ‡Denotes a significant difference versus BC ($p < 0.05$); *denotes a significant change over time ($p < 0.05$). 6MWT: Six-minute walk test; BC: Brazilian control group (diamonds); BE: Brazilian experimental group (squares); CE: Canadian experimental group (circles); VO_2max: Maximal oxygen uptake.

Over time, participants in CE showed significant increases of 29.3 m in the 6MWT ($p < 0.001$, $d = 0.327$), 1.2 ml/kg/min in VO_2max ($p = <0.001$, $d = 0.322$), and 2.5 kg in the handgrip strength ($p < 0.001$, $d = 0.325$). Participants in BE showed significant increases of 36.6 m in the 6MWT ($p = 0.001$, $d = 0.597$), and 4.7 kg in the handgrip strength ($p < 0.001$, $d = 0.721$), whereas VO_2max did not show a significant change over time (0.3 ml/kg/min, $p = 0.656$, $d = 0.075$). The BC group had a significant decrease of 1.2 ml/kg/min in VO_2max (p 0.025, d = -0.406), whereas the distance in the 6MWT (-2.7 m, $p = 0.885$, $d = -0.079$) and the handgrip strength (2.4 kg, $p < 0.001$, $d = 0.312$) did not have a significant change over time. The groups' comparison showed that both experimental groups were significantly different than BC in the distance covered in the 6MWT (trivial effect size), and only CE was significantly different than BC regarding VO_2max (trivial effect size). No significant differences among groups were observed for handgrip strength.

6.3.4.4 Program Satisfaction and Adherence

Rates ≥ 6 were used to determine the participants' satisfaction with the program. The proportion of participants who considered the intervention helpful, easy, and would recommend it is shown in Figure 6.31.

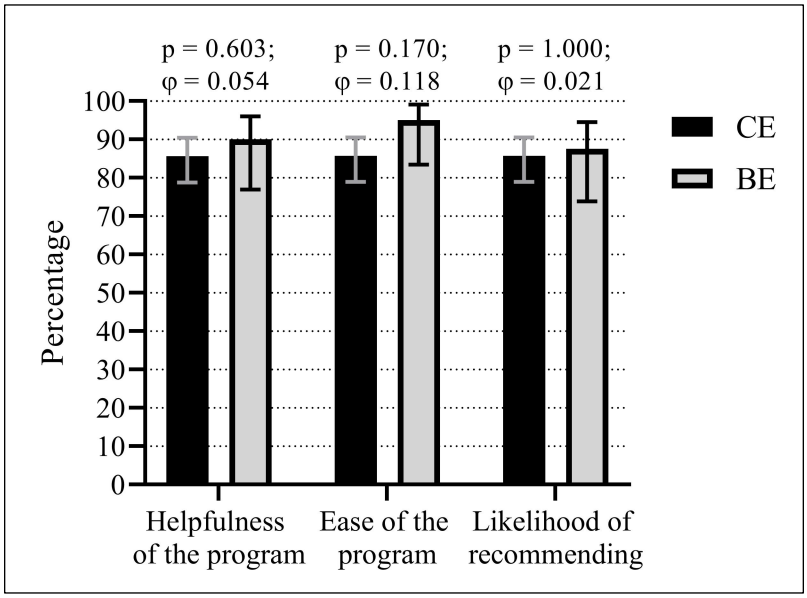

Figure 6.31 Proportion of participants who considered the program helpful, easy, and would recommend it. Bars represent the percentage of participants per category; whiskers denote 95% confidence intervals; p-values and φ statistic are for comparisons between groups within categories. BE: Brazilian experimental group; CE: Canadian experimental group.

There was no difference between groups in the proportion of participants who considered the program helpful (trivial effect size), easy (small to medium effect size), and would recommend it (trivial effect size).

After 12 weeks of intervention, 194/230 participants in the Canadian group (84.3%), 41/46 participants in the Brazilian experimental group (89.1%), and 35/38 participants in BC (92.1%) completed the study. No significant differences were observed among groups (p = 0.355), showing a trivial effect size (φ = 0.082).

6.4 Discussion

The overall purpose of this study was to examine the effectiveness of the ACCELERATION program adapted to the Brazilian population. Specifically, this intervention aimed to reach individual targets for each health behaviour, as follows:

- At least 35% more participants engaging in ≥ 150 min of MVPA per week
- At least 10% more participants consuming ≥ five servings of fruits/vegetables per day
- At least 50% more participants becoming smoke-free

The Brazilian version of the program reached all these targets and, overall, the Brazilian experimental group presented similar results to the Canadian group. These findings confirm the primary hypothesis of the study and show that this adapted program was as effective as the original intervention. Additionally, the Brazilian experimental group presented better behaviour change outcomes than the control group, which confirms the final hypothesis of the project.

Given the health disparities between populations across the globe, there has been a call for culturally appropriated interventions, mainly in LMICs (Perrin et al., 2016; Turner-Moss et al., 2021; Williamson et al., 2021). Accordingly, some studies were conducted to perform a cross-cultural adaptation of interventions focusing on health behaviours. However, most of them did not have a control group, making it difficult to ascertain the effectiveness of the cultural adaptations (Duarte et al., 2019; McCool et al., 2018; Neamah et al., 2016). Two studies with some similarities to the present research did have a control group though, and also found better results in individuals in the experimental group when compared to those in the control group. A chronic disease prevention intervention from Finland was culturally adapted to south Asians from India and Pakistan, in which participants had 15 sessions with a dietitian over a period of three years, addressing not only dietary aspects but also physical activity promotion (Bhopal et

al., 2014). The other study was a 12-month internet-based program from the United States, tailored for Hispanic populations in the country, with a web diary and instructional videos focusing on physical activity and diet (Phelan et al., 2017). These studies adopted some of the same strategies used in the present research, such as educational sessions and self-regulation, as well as targeting more than one health behaviour. On the other hand, both interventions had considerably longer durations, which suggests that 12 weeks may also be an appropriate period to yield effective results.

6.4.1 Primary Outcome

6.4.1.1 Self-Reported Physical Activity Patterns

The number of participants in the Brazilian experimental group engaging in ≥ 150 min of MVPA per week drastically increased after the intervention, from 4.9% to 73.2%, thereby meeting the goal of having at least 35% more participants meeting this guideline. The Canadian group also had a considerable increase in the number of participants engaging in at least 150 min of MVPA/week, from 31.5% to 60.8%. According to these results, both groups were effective to induce a decrease in physical inactivity rates and were superior to the Brazilian control group, with a medium to large effect size.

The effectiveness of both interventions can be confirmed by the increases in the minutes of weekly MVPA of 185.2% in BE (medium to large effect size) and 33.3% in CE (small to medium effect size), whereas BC remained the same (trivial effect size). With this substantial increase, BE was superior to the other two groups. The results observed in the Brazilian experimental group are equivalent or better to those found in studies with similar characteristics, targeting adults at risk of chronic diseases. A meta-analysis with six randomized controlled trials assessing self-reported MVPA reported overall medium effects (Direito et al., 2017). With an

average duration between 8 and 12 weeks, these interventions included the use of phone text messages, wearable devices, phone apps, and emails.

Three other studies, also with similar characteristics to the present research, were published after this meta-analysis' search period. A community-based lifestyle program, consisting of three face-to-face sessions and 16 text messages throughout 12 weeks showed a significant increase in the total amount of MVPA with a trivial effect size (Lai et al., 2020). A lifestyle program designed in three phases of six months duration did not observe changes in self-reported physical activity (Gill et al., 2019). According to the authors, the initial phase consisted of bi-monthly in-person sessions and access to technology support (an app, telephone coaching, and an online social network), in the second phase the technology support was kept but the in-person sessions were removed, and in the final phase only the access to the app was kept. Another lifestyle intervention with technology support, lasting three months, included website, wearable device, and social media network, as well as weekly face-to-face sessions and a resistance band to each participant (Ashton et al., 2017). The authors reported an increase in MVPA with a medium to large effect size.

BE also had an increase in the weekly minutes of light physical activity, of 145.1% (medium effect size), being superior to induce this change to CE (trivial effect size), which had no change, as was also the case of BC (trivial effect size). A likely explanation for this difference between the two experimental groups is the recent emphasis given to this intensity of physical activity (WHO, 2020b). The Brazilian intervention took place after the publication of guidelines and other studies highlighting the potential health benefits of light-intensity physical activity (2018 Physical Activity Guidelines Advisory Committee, 2018; Füzéki et al., 2017; LaMonte et al., 2017). Indeed, shortly after the end of this adapted version of the ACCELERATION

program, the World Health Organization released its new guidelines on physical activity, in which special attention is given to this type of intensity (WHO, 2020b). Therefore, the fact that light-intensity physical activity did not increase in CE must be related to the emphasis in the Canadian intervention being put almost exclusively in MVPA, including the information passed to the participants in the educational sessions as well as in the material given to each individual. In fact, usually studies and guidelines addressing physical activity and health up to 2013-2016, when the original ACCELERATION program was planned and delivered, did not even include light-intensity physical activity in the research design, which corroborates the focus of the researchers on MVPA rather than light physical activity (Strain et al., 2016; Warburton & Bredin, 2016; WHO, 2010).

In terms of sedentary behaviour, only the Canadian group had a significant change, a decrease of 15.2%, with a small to medium effect size. A possible reason for the absence of change in this behaviour in the Brazilian experimental group is the fact that many items in the questionnaire are not mutually exclusive, which can lead individuals to report many more hours than the real time spent being sedentary (Rosenberg et al., 2010). This is the case, for example, of the third item (sitting while listening to music) and the last item (sitting and driving/riding in a car, bus, or train). Although this could have also happened with CE, this was likely not an issue given the larger sample size of this group (Jia et al., 2019). The limited accuracy of the assessment instrument is acknowledged by the authors of the study on the reliability and validation of the Sedentary Behavior Questionnaire (Rosenberg et al., 2010). Nevertheless, according to a meta-analysis the tool had the best performance among questionnaires evaluating this behaviour, when compared against device-assessed sedentary time (Prince et al., 2020).

A systematic review assessing the effectiveness of interventions using wearable devices for healthy lifestyle outcomes performed a meta-analysis with two studies that assessed self-reported sedentary behaviour (Ringeval et al., 2020). One intervention had a three-month duration and the other lasted twice as long. As it was observed in BE, this analysis also reported a non-significant decrease in sedentary behaviour, with a trivial effect size.

6.4.1.2 Accelerometry

There is a growing awareness of the importance of direct measurements to assess physical activity patterns (Dempsey et al., 2020). Although accelerometer-measured physical activity provides a more objective assessment, such technology is not yet broadly accessible, particularly in lower-income regions (Ferrari et al., 2020). While researchers are increasingly looking for more affordable accelerometers, given the reliability of the research-graded devices, many contemporary studies regardless of geographic location, continue to use self-reports to assess physical activity patterns, particularly in the case of populational studies, including national and international guidelines (Barkley et al., 2019; Ramakrishnan et al., 2021).

Although self-reports are still widely used, they have been gradually replaced by accelerometer-measured physical activity, and as presented in chapter 4, both measures do not always coincide (Colley et al., 2018; Ferrari et al., 2020; Prince et al., 2008). In the present study, in terms of differences over time, this was the case with light and vigorous intensities of physical activity. Both witnessed a significant increase after the intervention in the Brazilian experimental group when self-reported (both with a medium to large effect size) but did not change when measured with the accelerometer (small to medium and trivial effect sizes, respectively). Conversely, while self-reported sedentary behaviour did not change in BE, it did improve 13.4% according to the direct measure (large effect size). This difference between

methods is similar to the one reported in a meta-analysis assessing sedentary behaviour in university students (Castro et al., 2020).

Whereas there was no difference between the Brazilian groups in light and vigorous accelerometer-measured physical activity, the experimental group was superior to the control group in reducing sedentary behaviour measured with the accelerometer. Similar studies assessing sedentary behaviour found different results. Six trials included in the systematic review from Ringeval et al. (2020) evaluated device-measured sedentary behaviour and were assessed in a meta-analytic approach. Similar to the findings from the meta-analysis with interventions using self-reported questionnaires in the same review, this part of the study reported no changes in sedentary behaviour over time. The duration of these trials varied from 10 weeks to six months, and besides an activity tracker, other research methods included phone calls, educational group sessions, financial incentive, virtual support group, and tailored physical activity advice. Another similar study, published after this meta-analysis, also did not observe change over time (McDonough et al., 2021). This 12-week video-delivered intervention, aiming at reducing sedentary behaviour, also focused on sleep quality, which did see a significant increase.

BE was also superior to BC in MVPA. The experimental group had an increase of 29.5% (small to medium effect size), whereas the control group did not change (small to medium effect size). The findings regarding MVPA in the Brazilian experimental were equivalent to those found in similar interventions. A meta-analysis containing five trials based on text messages, educational material, and wearable devices, with an average duration of 12 weeks, found an increase in MVPA, also with a small to medium effect size (Smith et al., 2020). According to the authors, studies with tailored content, more components, and interventions in clinical populations led to larger effect sizes.

Three studies also similar to the present research were published after the publication of this meta-analysis. In a three-month lifestyle intervention, in which participants received individual consultations and tailored exercise sessions, there was no change in MVPA after the program (Blom et al., 2020). A 12-week lifestyle study had two groups that received an intervention based on self-monitoring and an app for social comparison with other participants (Middelweerd et al., 2020). One group used an activity tracker and the app during the intervention, and the other group was provided with the same tools and also received tailored coaching messages. According to the authors, no change in MVPA was observed in either group. A web-based intervention however did find a significant change in MVPA, with a small to medium effect size (Grey et al., 2019). This study consisted of an in-person introductory session, followed by 12 weeks in which the participants used a pedometer and had access to a website with information targeting change in health behaviours such as physical activity.

Regarding the number of steps per day, once more BE was superior to BC. The Brazilian experimental group had an increase of 31.6%, with a large effect size, whereas there was no change in the control group (trivial effect size). Besides a meta-analysis for accelerometer measured MVPA, Smith et al. (2020) also conducted a meta-analysis for steps/day, in which they found a significant increase with a small to medium effect size. This analysis included 10 trials, with an average duration of 14.6 weeks. Positive changes with small to medium effect sizes were also found in another intervention with similarities to the present study, which was published after the search period of the meta-analysis of Smith et al. (2020): a four-month program, in which participants had dance lessons twice a week plus monthly educational sessions, focused on increasing physical activity levels (Aguiñaga & Marquez, 2019).

The findings from the present study were equivalent or better than those from similar trials. Although previous research suggested that longer interventions lead to better results (Goode et al., 2012; Villablanca et al., 2009), the data from the Brazilian version of the ACCELERATION program indicate that 12 weeks may be an appropriate duration to elicit increases in both self-reported and accelerometer-measured MVPA as well as to decrease sedentary behaviour assessed via accelerometer. Additionally, it seems that the use of a number of components instead of only one (such as an activity tracker or phone messages) to support participants during the intervention, as proposed by Smith et al. (2020), corroborated to the positive results of the present trial in terms of physical activity patterns. As well, the adoption of different behaviour change techniques, including those focusing on enjoyment, attainability, and nonconscious processes, likely contributed to these findings, which is in agreement with recent theories (Rhodes, 2017; Rhodes & Rebar, 2018). Moreover, encouraging individuals to perform as much physical activity as they considered possible, whenever and wherever suitable for them, without demanding a minimal threshold nor requiring practices in specific locations, as it has been increasingly suggested in the last years (Segar et al., 2020; Thomas Craig et al., 2020; Warburton & Bredin, 2017), probably also contributed to the results observed in this trial. Since not many interventions have applied the same behaviour change techniques as the present research, future studies with similar approaches and larger samples are warranted to provide a further understanding on the relationship between these strategies and the positive results observed in this trial.

6.4.2 Secondary Outcomes

6.4.2.1 Dietary Patterns

There was a substantial increase in the proportion of participants in the Brazilian

experimental group eating ≥ five servings of fruits/vegetables per day, from 4.9% at baseline to 53.7% after the intervention, surpassing the goal of having at least 10% more of participants following this recommendation. The Canadian group also had a considerable increase, from 42.9% to 71.2%. These results indicate that both experimental groups were effective in decreasing the prevalence of unhealthy diets and were superior to the Brazilian control group, with a medium to large effect size.

The increases in the number of daily servings of fruits/vegetables in the two experimental groups confirm the effectiveness of both interventions. BE had an increment of 108.7% (large effect size) and CE increased 29.5% (medium to large effect size), whereas BC remained the same (trivial effect size). This smaller raise in CE can be explained by the fact that this group already had a considerable higher consumption of fruits/vegetables at baseline, which was almost four times higher than BE. Nevertheless, as well as BE, CE was also superior to BC in inducing a change in this variable.

Studies similar to the present research, focusing on chronic disease prevention, reported less convincing results. A meta-analysis focused on technological tools, such as mobile phones and the internet, with 11 interventions aiming at increasing the consumption of fruits and vegetables, reported positive changes with a small to medium effect size (Rodriguez Rocha & Kim, 2019). These studies used different quantities of behaviour change techniques and had an average duration of 12.7 weeks. Another web-based intervention, apparently with the same inclusion criteria but not included in this meta-analysis, presented an increase in the intake of fruits/vegetables with a medium to large effect size (Duan et al., 2017). The study consisted of an eight-week program, also applying different behaviour change techniques.

Fibre intake, which also included items other than fruits and vegetables, such as whole grains and beans, increased in both experimental groups, 31.4% in CE, with a medium to large effect size, and 43.6% in BE, with a medium to large effect size. Sodium intake also improved in these groups, with a decrease of 14.9% in CE and 20.8% in BE, both with medium to large effect sizes, and both were superior to BC, which did not change (trivial effect size). Regarding the intake of sugar, only BE had an improvement over time, with a decrease of 22.9% (small to medium effect size), while there was no change in the other groups, both with a trivial effect size. It is possible that the sugar score in CE did not improve because the participants in this group already had low scores, which were significantly smaller than the ones of the participants in the Brazilian groups at baseline.

A systematic review and meta-analysis on the effectiveness of interventions for improving dietary intake grouped the studies into those where the intervention produced a significant change and those where this did not happen (Ashton et al., 2019). Although the studies had different purposes and applied diverse methodologies to collect data on different diet components, two of them were similar to the present research, focusing on health behaviour change and using some form of technology support. A six-week online intervention, aimed at preventing weight gain by providing educational sessions on a digital platform and feedback via email, observed no change in the fibre intake (Gow et al., 2010). And a three-month intervention, based on a smartphone app and counseling sessions with a health coach, assessed the consumption of sugar and sodium, and also did not observe changes over time (Stephens et al., 2017). Although no other meta-analytic study was found, an intervention with similar characteristics to the present study was published after the publication of the meta-analysis from Ashton et al. (2019). This intervention was a 12-week program, which used a research-made

website and a pedometer, and assessed fibre, sodium and sugar intake (Grey et al., 2019). As with the other studies, no changes were observed after the intervention.

Unlike the other dietary variables, both experimental groups in the present research had a worsening in the consumption of fat, with increases of 25% in CE (small to medium effect size) and 46.2% in BE (also small to medium effect size). A probable explanation for this situation is that a change in the dietary patterns of the participants in these groups, such as an increase in the consumption of fruits and vegetables, involved an adjustment/compensation in the eating behaviour with higher intake of fatty foods. Possible examples include snacks or desserts consisting of fruits with whipped cream as well as snacks or meals containing vegetables seasoned with full fat salad dressings. Eating more fat while adjusting to a healthier diet has been reported in other studies (Gleason & Suitor, 2003; Sikkes et al., 2009), and is corroborated by the fact that the Brazilian control group, which had no change in the fat intake, also did not change the consumption of fruits/vegetables nor the other dietary items of the research.

Two studies included in the meta-analysis of Ashton et al. (2019), which assessed other dietary items, also assessed fat intake and did not observe changes over time (Gow et al., 2010; Stephens et al., 2017). This was the same result reported by another study included in this meta-analysis, which however did not evaluate the consumption of fibre, sugar, or sodium. The intervention consisted of a three-month internet-based program, tailored to the specific needs of each participant (Franko et al., 2008). Even though no additional comparable meta-analysis was found, the study conducted by Grey et al. (2019), which reported no changes in the consumption of fibre, sodium, and sugar, did observe a change over time in fat intake: a decrease with a small to medium effect size.

The pattern of changes in the proportion of individuals in each group meeting the program's guidelines for fibre, fat, sodium, and sugar resembled the changes observed in the specific scores/measures of these dietary variables. Both experimental groups increased the number of participants eating ≥ 25 g of fibre per day (55.6% more in BE and 122.8% more in CE) and reporting ≤ four points in the sodium score (199.0% more in BE and 71.9% more in CE). There was also an increase of 52.3% in the number of participants in BE eating ≤ five sugary items per week, whereas CE had a decrease of 35.9% in the number of participants reporting one item in the fat score. Similar to the sugar score, probably the number of individuals in CE following the program's guideline on sugar intake did not increase because this proportion was already very high in this group at baseline, being significantly higher than the Brazilian groups.

No study was found with similar characteristics to the present trial, assessing changes over time in the proportion of participants meeting dietary recommendations for specific components. However, two preventive lifestyle interventions presented some related results. A 12-week program based on phone text messages, focusing on weight management, assessed the number of participants following specific dietary guidelines only at baseline and reported that while between 22%-33% of participants met the guidelines for fibre, sodium, and sugar, only 0.9% met the guidelines for fat (Nour et al., 2015). Another program using phone messages over five months, focusing on reducing cardiovascular risk, adopted a more general form of assessment. Instead of evaluating the number of participants meeting guidelines for specific diet components, it only assessed the proportion of individuals meeting a healthy diet, which should be high in fibre, and low in fat, sugar and sodium (Lu & Wu, 2021). According to the authors,

61.1% more of participants were following a healthy diet after the intervention, in comparison to baseline.

Overall, the dietary results of the present trial were equivalent or better to those from similar studies. Based on the findings of two recent meta-analyses focusing on healthy eating, there are two possible aspects that might help explain these findings: the duration and the number of behaviour change techniques used in this intervention. Ashton et al. (2019) reported that higher increases in the intake of fruits/vegetables are observed after three months of intervention when compared to interventions with longer durations. Also, according to Rodriguez Rocha and Kim (2019), larger effect sizes are presented in studies applying seven or more behaviour change techniques. The Brazilian version of the ACCELERATION program lasted three months and used a total of 20 behaviour change techniques, out of which 19 were applied in contexts related to diet. Specifically, regarding fat intake however, the program did not present the same positive results; indeed, this variable worsened after the intervention. Therefore, it is recommended that future studies and practical interventions addressing this variable consider alternative approaches. Moreover, complete randomized control trials are needed to confirm the positive dietary changes found in the present study.

6.4.2.2 Smoking

Out of the 183 individuals who answered the tobacco use questionnaire in the original project, only 11 reported being smokers at baseline. A similar observation was recorded with just one out of 41 participants in the Brazilian experimental group, while no participant was smoking in the Brazilian control group. Both experimental groups were effective in reducing the number of smokers. After the program, the number of smokers decreased to five in the Canadian group and the Brazilian experimental group had no more smokers. While BE met the goal of reducing

the proportion of smokers by at least 50%, these small numbers of participants who smoked before the program reflect the low prevalence of smokers in these communities, a trend also observed in other lifestyle interventions conducted in the 21st century (Blom et al., 2020; Kypri & McAnally, 2005; Woolf et al., 2006). As well as in the present study, two of these articles presented descriptive data about tobacco use: a three-month behaviour change program, delivered in health care centres, reported that only 3% of participants had tobacco cessation as the primary reason to take part in the intervention (Blom et al., 2020), and a tailored web-based study reported that 25% of smokers quit this behaviour after four months of intervention (Woolf et al., 2006). The other study did not provide any data regarding smoking since according to the authors, given the low number of smokers at baseline, the effect of the intervention on this behaviour could not be assessed (Kypri & McAnally, 2005).

6.4.3 Tertiary Outcomes

6.4.3.1 Psychological Measures

Just as was observed in similar interventions, the average findings regarding the psychological variables of the present study were close to the high end of the scale at the beginning of the program, not allowing much room for improvement (Caini et al., 2020; Carcaise-Edinboro et al., 2008). Indeed, no group observed any significant increase in attitude (perceived importance) or self-efficacy (confidence) regarding physical activity and diet. The only significant change was a decrease of 6.0% in the self-efficacy to start or continue to eat ≥ five fruits/vegetables per day in the Brazilian experimental group. This change had a small to medium effect size, making the Canadian group superior to BE in keeping self-efficacy the same after the program.

A meta-analysis of interventions based on smartphone apps to promote physical activity reported the same findings as the present study, i.e., an increase in physical activity and no change in self-efficacy (Silva et al., 2020). No meta-analysis addressing diet with a focus on interventions using technology support was found. However, a meta-analytic review with diverse populations and different delivery modes did include nine studies with similar characteristics to the present research (Prestwich et al., 2014). Equivalent results were found in three interventions: an internet-based study reported an increase in healthy eating with no change in self-efficacy (Turner-McGrievy et al., 2009), and the other two interventions, also delivered via internet, observed positive outcomes in healthy eating along with a decrease in self-efficacy (Lombard et al., 2009; Riebe et al., 2005). Three other internet-based studies however, observed an increase in both dietary patterns and self-efficacy (Block et al., 2008; Campbell et al., 1999; Irvine et al., 2004), and Irvine et al. (2004) also assessed attitude, observing the same results. On the other hand, although three other internet-based interventions also reported increases in healthy eating behaviour and self-efficacy, participants in these studies have reported low scores in self-efficacy at baseline, allowing more room for improvement (Cook et al., 2007; Luszczynska et al., 2007; Richards et al., 2006). Additionally, Cook et al. (2007) also measured attitude, which had the same pattern. Regarding attitude towards physical activity, only one study similar to the present research that measured this variable as well as physical activity behaviour was found (Looyestyn et al., 2018). Such an intervention consisted of a running program delivered online, with the support of a social media network. Similar to the present research, the authors observed an increase in physical activity but not in attitude towards this variable. Moreover, a two-year phone-based trial, which investigated determinants of motivation to engage in healthy behaviours and was issued after the publication of the meta-analyses from Silva et al. (2020) and Prestwich

et al. (2014), did not observe changes in attitude towards physical activity and healthy eating nor in self-efficacy regarding these two behaviours (Caini et al., 2020).

Regarding the other psychological measures, the Brazilian experimental group had an increase in affective judgement and perceived opportunity regarding both physical activity and diet. While the increase in perceived opportunity to start or continue to eat ≥ five daily servings of fruits/vegetables was significant and clinically meaningful (small to medium effect size), the other variables did not reach significance; however, the increase in affective judgement to become or stay active for ≥ 150 min/week was clinically meaningful (small to medium effect size). In the Brazilian control group, all variables had a non-significant decrease, except for perceived opportunity to start or continue to eat ≥ five daily servings of fruits/vegetables, which had a non-significant increase.

As mentioned in chapter 3, motivation theories have been evolving, targeting behaviours such as physical activity and healthy eating, which were not considered in the elaboration processes of traditional theories (de Ridder et al., 2017; Rebar & Rhodes, 2020; Rhodes, 2017). Thus, constructs of significant importance to explain and predict these healthy behaviours, such as affective judgment and particularly perceived opportunity, have just recently started to receive more attention; therefore, fewer lifestyle trials have investigated these variables in comparison to other psychological measures such as instrumental attitude and particularly self-efficacy (Gardner et al., 2011; Willmott et al., 2021). In a meta-analysis focusing on affective judgement and physical activity (Rhodes et al., 2019b), two studies were similar to the present research. A trial based on text messages reported increases in both physical activity and affective judgement (Kinnafick et al., 2016). On the other hand, a study comparing fitness lessons only versus fitness lessons plus access to a social media group with additional information such as videos and

articles about health and fitness reported that both groups increased physical activity without increasing affective judgement (Wang et al., 2015).

Regarding perceived opportunity, no similar study assessing changes in this variable over time was found. However, this construct has been an important part of recent interventions addressing both physical activity and healthy eating behaviours, such as a 10-week blended nutrition program with in-person and online sessions, focusing on healthy weight (Perdew, 2019), and an eight-week physical activity intervention, delivered through lessons using a smartphone, focusing on incentives for physical activity engagement (Willms, 2021).

The psychological variables' scores of the present study demonstrate that participants in all groups were highly motivated to engage in behaviour change at baseline and kept this motivation throughout the study. As such, it is not common for variables related to this construct, such as the psychological measures from this trial, to present significant changes over time (Caini et al., 2020; Mildestvedt et al., 2008; Young et al., 2016). The fact that both physical activity and healthy eating had overall positive changes while most of the psychological variables did not have significant improvements may be related to two aspects observed in this trial. One reason is similar to what happened in the study conducted by Caini et al. (2020): the frequent contact from the participants with the researcher during the emails exchange addressing different aspects throughout the Brazilian version of the ACCELERATION program, which happened after initial interactions during the recruitment period, health and fitness assessments, as well as the motivational interviewing. According to personal communications during and particularly after the program, participants felt cared for and constantly encouraged in their efforts. According to Young et al. (2016), another probable motive is the fact that some

participants reached their goals in terms of health behaviour change before the end of the intervention, which would likely limit increases in the constructs related to motivation.

At the same time, BE presented a decrease in self-efficacy and a simultaneous increase in perceived opportunity to start or continue to eat ≥ five servings of fruits/vegetables per day. Possibly, while the program increased the participants' perception that eating healthier would be attainable, these individuals also realized that such a change is more challenging than they were expecting (Galbo, 2011). This phenomenon, known as response shift, is commonly observed in circumstances involving behaviour change (Young et al., 2016).

The results of the present study indicate that tailored interactions with participants, considering their individual characteristics and preferences, with the use of behaviour change techniques emphasizing enjoyment and attainability, have the potential to elicit health behaviour change. This conjecture is corroborated by recent studies addressing these topics, such as the systematic review and meta-analysis from Smith et al. (2020), the state-of-the-art review from de Ridder et al. (2017), and studies about the intention-behaviour gap (Rhodes, 2017; Rhodes et al., 2021b; Rhodes & Yao, 2015).

6.4.3.2 Health and Fitness Measures

While there were no changes over time in weight in any group, and no group differed from any other in such a variable, a different pattern was observed with regards to BMI. Although no significant change was observed for any group in this variable, the Brazilian control group had an increase of 1.1%, which was clinically meaningful (medium to large effect size) although not statistically significant, which led this group to be significantly inferior to the experimental groups in avoiding an increase in BMI. In fact, the Brazilian experimental group and the Canadian group had significant decreases in body fat percentage, of 3.2% (medium to

large effect size) and 1.7% (small to medium effect size) respectively. Also, regarding WC, while BC had no change and CE had a decrease of 1.1% with a trivial effect size, BE had a clinically meaningful although not statistically significant decrease of 1.2%, with a small to medium effect size. It is possible that a greater decrease in BE than CE was not considered significant because of the smaller sample size of the Brazilian group (Jia et al., 2019). Indeed, no group was superior to any other in changing WC.

The body composition results observed in the Brazilian experimental group are equivalent or better than those found in a meta-analysis with online interventions focused on health behaviour change (Beleigoli et al., 2019). The same items were analyzed (weight, BMI, body fat percentage, and WC), and no variable presented different results from the control group.

In terms of cardiovascular measures, only CE had significant changes, all with small to medium effect sizes: decreases of 3.2% in SBP, 2.9% in DBP, and 3.9% in HR, being the change in HR superior to BC. It is possible that DBP and mainly SBP did not have significant decreases in BE because this group had normal values of blood pressure (Flack & Adekola, 2020). Also, CE had significantly higher values than BE in both SBP and DBP at baseline. This could be related to a higher number of female participants in BE, since usually women have lower blood pressure levels than men until the age of 64, exactly the upper limit age of the present study (Morbach et al., 2020). However, this was not the case, since BE had a significantly lower proportion of women than CE.

On the other hand, a meta-analysis with studies using technology support such as websites to deliver physical activity and healthy eating programs (McMahon et al., 2021) found contrasting results in comparison to BE. Most of the included studies lasted ≥ 6 months, and overall, there was an improvement over time in SBP, DBP, and HR. A probable explanation for

the difference between the findings from this review to those from the present research is that evidence shows that longer interventions promote better results in terms of physiological changes (Berk et al., 2012; Blom et al., 2020; Mouodi et al., 2019).

Regarding physical performance, both experimental groups were superior to the control group in the distance covered in the 6MWT, with increases of 5.9% (medium to large effect size) in BE and 4.9% (small to medium effect size) in CE. While VO_2max increased in CE (3.7%, small to medium effect size) but did not change in BE, the Brazilian experimental group was effective in preventing a decrease in this variable, which can be confirmed by the fact that the maximal consumption of oxygen had a significant decrease of 3.6% in BC. This decline, with a small to medium effect size, led the Brazilian control group to be inferior to CE in terms of improvements in VO_2max. And regarding handgrip strength, both experimental groups had significant and clinically meaningful increases: 7.3% (medium to large effect size) in BE and 4.6% (small to medium effect size) in CE, while BC did not change (small to medium effect size).

The results observed in the Brazilian experimental group are equivalent or better than those found in studies with similar characteristics, aiming at healthier lifestyles. The only study found with such characteristics and that assessed the distance covered in the 6MWT, although without estimating VO_2max, was a 12-week program, in which participants received an activity tracker and a tablet with an app to monitor their physical activity throughout the intervention, besides weekly counselling sessions over the phone (Lyons et al., 2017). No change in the 6MWT was observed. Regarding VO_2max, again only one intervention was found, with similar characteristics to the present study. A two-month motivational program for runners, delivered via social media, in which the maximal consumption of oxygen was also estimated based on the

results of a fitness test, reported that this variable did not change over time (Looyestyn et al., 2018). A systematic review on interventions focusing on chronic disease prevention through the use of technology support such as text messages and phone apps included one study that assessed handgrip strength in a 10-week program and did not observe changes after the intervention (Buss et al., 2020). This variable was also evaluated in another study similar to the present research, which was published after the systematic review from Buss et al. (2020). In a 12-month internet-delivered personalized exercise intervention, handgrip strength did not improve but actually declined (Sun et al., 2021). At least in part, a possible reason for this finding is that the sample of this study was comprised of both adults and older adults and decreases in muscular strength are associated with aging (Milanović et al., 2013).

Considering the significant decreases in body fat in both BE and CE, as well as the significant decrease in CE and the clinically meaningful although not statistically significant decrease in WC observed in BE, significant decreases in weight and BMI could be expected in both groups (de Ridder et al., 2017). A possible explanation for the absence of improvements in those variables is the significant increase in handgrip strength in both experimental groups, a fact that may be a consequence of an increased muscle mass, which weighs more than fat mass (Black et al., 2017; Mazzeo et al., 1998). While the findings of the present study indicate that the program had overall positive effects in the body composition and fitness variables, the intervention might be ineffective at improving cardiovascular measures, which is likely related to the program's duration.

6.4.3.3 Program Satisfaction and Adherence

More than 85% of participants in each experimental group considered the program

helpful, easy to follow, and would recommend it. The fact that there was no difference in the levels of satisfaction between the Brazilian experimental group and the Canadian group reinforces the hypothesis of the study that the Brazilian version was as effective as the Canadian program. The study's findings regarding satisfaction are equivalent or better than those from similar studies. In a six-month text-message based intervention, focusing on behaviour change strategies aiming at weight management, 70% of the participants considered the program useful and 75% reported being satisfied with it (Fjeldsoe et al., 2016). Two other studies did not present the proportion of participants satisfied with the interventions but did report the general level of the participants' satisfaction. To assess the effects of an app for monitoring physical activity, a 12-week intervention was conducted addressing behavioural aspects such as self-efficacy and goal setting (Middelweerd et al., 2020). The authors reported that, likely because of technical issues with the app, the participants provided lower rates of satisfaction than the control group, which used a commercial activity tracker only. And in an intervention using a website to provide tailored information to pursue healthy behaviours, participants also did not provide high rates of satisfaction (Woolf et al., 2006). According to the authors, this suggests that the participants found that the website was not especially helpful, and that tools with interactive features would be more beneficial.

As well as the levels of satisfaction with the program, the rates of adherence of the two experimental groups were similar, around 85% in CE and about 90% in BE, and were not different from BC, which was also close to 90%. These retention rates are equivalent to those from similar studies. A three-month program, based on individual consultations and personalized exercise sessions, conducted in health care facilities, retained 72% of the participants (Blom et al., 2020). A program based on in-person sessions and web support, including a social media

network and an activity tracker, had a retention rate of 94% after the three months of intervention (Ashton et al., 2017). And another three-month program, based on email and telephone support, focusing on improving diet and increasing physical activity, had 78% of retention rate (Watson et al., 2015).

The findings of the Brazilian version of the ACCELERATION program regarding the participants' satisfaction and levels of retention rate demonstrate that the structure of the intervention was appropriate to please the vast majority of those registered in the study. These results indicate that this program's design may be an effective alternative to promote health behaviour change in adults at risk of chronic diseases.

6.4.4 Demographic Characteristics

All differences observed in demographic characteristics among groups were both statistically significant and clinically meaningful. Although the Canadian group had more women than the Brazilian experimental group, female participants were the majority in all three groups, a proportion also found in other lifestyle management studies (Baxter et al., 2016; Haire-Joshu et al., 2021; Rynders et al., 2019). Regarding marital status, while again CE was different than BE, in the three groups the majority of participants were married. This is a trend also seen in other studies addressing health behaviours (Brown et al., 2014; Farmaki et al., 2019; Whittemore et al., 2002). Given the higher household income expenditure of families in comparison to those of single individuals, married individuals may not consider adopting healthy behaviours a priority (Alghafri et al., 2017). Therefore, the fact that the current program was offered for free possibly encouraged those who were married to participate in the intervention (Josyula & Lyle, 2013).

CE had more participants earning more than $100,000/year than BE, and both Brazilian groups had more individuals earning less the $50,000/year than the Canadian group which is likely related to the fact that CE had more full-time employed individuals and fewer unemployed participants than BE and BC. Although it could be assumed that the higher rate of unemployment and the lower rate of full-time employment were responsible for the Brazilian individuals to take part in the program, the data about transport shows the opposite. Both BE and BC had more participants than CE taking longer than 60 min to travel to the facility in charge of the program and more participants in CE than BE and BC took less than 30 min for these trips. Also, more participants in CE than in BC drove as a mode of transport, while more participants in the Brazilian groups travelled by transit, which shows the willingness and effort of the Brazilian individuals to participate in the intervention. In fact, many of these individuals did not live in the same city of the university where the assessments were done, and although there is an approved plan to build a rapid transit system to the university, currently the only transit access to it is by bus, which can be a long commute (Harlos, 2018).

6.4.5 Final Considerations

Regarding the overall results of this research, some of the tertiary variables were not observed to improve significantly in the Brazilian experimental group. However, particularly regarding the health and fitness ones, the intervention did support positive change in health behaviours that are known for improving these variables (Schoeppe et al., 2016). Also, it is probable that more improvements in these measures could be observed if the intervention had lasted longer (Blom et al., 2020; Villablanca et al., 2009).

Despite the fact that longer durations involve practical aspects that may limit the feasibility of interventions, as for example the time commitment required from participants

(Goldberg & Kiernan, 2005), the present program did achieve the main goals of the trial, namely increases in the proportion of participants engaging in ≥ 150 min of MVPA per week and eating ≥ five servings of fruits/vegetables per day, as well as a reduction in the number of smokers. Additionally, most findings of the present trial had medium to large effect sizes, which are overall superior to those from interventions focusing on physical activity and health behaviour change, which usually have small to medium effect sizes (Howlett et al., 2019; Meader et al., 2017).

These are promising results also because interventions addressing multiple risk factors for chronic diseases have in general presented worse results than those focusing on a single behaviour, which is particularly true in terms of physical activity (Craike et al., 2018; Prochaska & Prochaska, 2011; Rhodes et al., 2017). While the literature is limited regarding the comparison between individual and multiple approaches when behaviours other than physical activity are considered (Maisano et al., 2020), the examination of the effectiveness of collective approaches has been receiving increasing attention (Aznar-Lou et al., 2021; Chevance et al., 2020; Geller et al., 2017). This should not come as a surprise, considering that chronic diseases share common risk factors, which commonly appear simultaneously (Nigg et al., 2017). The growing interest in comprehensive interventions is in fact to be expected given the high prevalence and incidence of chronic diseases, including in younger individuals (Harris et al., 2021; Mszar et al., 2020).

As previously presented, among the risk factors examined in this investigation smoking has been the least prevalent, and this trend has been observed in the present trial as well as in recent studies with large samples of Brazilians (Dionato et al., 2021; Reitsma et al., 2021). In fact, based on the findings of a recent population-based study addressing risk factors for chronic diseases, Dionato et al. (2021) have suggested that Brazilians likely prefer to quit unhealthy

behaviours such as smoking and excessive alcohol intake rather than adopting healthy behaviours such as physical activity and healthy eating. Considering the increasing rates of overweight and obesity in Brazil and across the world (Brasil, 2020; WHO, 2020f), improving physical activity and healthy eating patterns are of utmost importance (WHO, 2021d). At the same time, due to political choices, the decrease in the prevalence of smoking in Brazil has decelerated in the last couple of years, as a consequence of a reduction in public health surveillance (Souza et al., 2021). Therefore, these reasons emphasize the need for interventions addressing multiple risks factors in Brazilians.

Regarding the positive results of the present program, a possible explanation for that is the high levels of motivation presented by the participants, which is related to the high rates throughout the program not only in attitude and self-efficacy but particularly in affective judgement and perceived opportunity (Caini et al., 2020; Rhodes et al., 2006). Actually, a positive attitude and high self-efficacy towards healthy behaviours do not necessarily enact such behaviours (Bassett-Gunter et al., 2015; Sniehotta et al., 2005). Common reasons for this situation might be poor action planning and not having the proper skills, limited access to engage in these behaviours, and lack of appealing options (Rhodes & Yao, 2015; Schwarzer & Hamilton, 2020). Accordingly, high values in affective judgements and perception of opportunities to adopt healthier lifestyles are essential to translate intentions into behaviours (Rhodes, 2017). Therefore, it is probable that a substantial reason for the encouraging results observed in this intervention lies in the maintenance and increase of the high levels of affective judgements and perceived opportunities, which are due to the choice of the different behaviour change techniques and the overall elaboration and implementation of the present trial.

Such decisions and structure aimed at reaching individuals that might not be able to attend an in-person intervention and people who do not necessarily feel encouraged to engage in more conventional lifestyle programs, which can be considered too strict and/or cumbersome (Brazilian Ministry of Health, 2014; Rhodes, 2017; Schwartz et al., 2021a; Schwartz et al., 2019b). This was done focusing on capability, opportunity, and motivation, through the provision of written and audiovisual information to increase knowledge and skills, with a particular emphasis on self-regulation and unconscious processes, along with a personalized and close support provided by the researcher. In fact, according to recent studies, free or low-cost programs, with flexible schedules and education on health behaviours, as well as the use of different behaviour change techniques present higher effectiveness in eliciting the adoption of more active and healthier lifestyles (Grigoletto et al., 2021; Hosteng, 2019; Kunstler et al., 2018; Rhodes et al., 2021b).

Considering the overall findings of the present study, it can be concluded that the evidence of the effectiveness of the Brazilian version of the ACCELERATION program is well supported (Puddy & Wilkins, 2011; Richards & Cai, 2016). Future studies with larger sample sizes and with Brazilians living in Brazil are needed to further investigate these results and control for contextual factors. Additionally, the examination of a follow-up period will show whether the changes observed in the intervention are maintained.

6.4.6 Limitations

Although the adherence to and the satisfaction with the Brazilian version of the ACCELERATION program were good, it is possible that the five participants who dropped out could have made more effort to remain until the end if the intervention was more appealing. Despite the generally positive results, more social support could have contributed not only to a

higher retention rate but also better outcomes. Besides directions on how to build and increase a network of support, the intervention did provide some social support, namely through the weekly emails and the in-person attention given during the assessments, mainly at the motivational interviewing. However, some form of closer interaction between the participants and other individuals, for example with the researcher and mainly with other participants, could have led to better results and would likely have been welcomed by those engaged in the program since sharing day to day experiences and feelings can critically affect well-being (Greaves et al., 2011; Kafetsios, 2019).

Indeed, according to Rhodes et al. (2017), interventions based on more supervision, with intensive contact time, tend to be more effective. However, according to the same authors, such an approach demands funds and infrastructure that are frequently unavailable. This is particularly true for LMICs, where cost-effective alternatives that can benefit a large number of individuals are a pressing necessity (Ndubuisi, 2021; Siefken et al., 2021).

Additionally, different from the original project, the adapted version of the program had a much smaller sample size, which prevents further generalization of the findings. While it would be impractical to obtain a similar number of participants given the very limited quantity of Brazilians living in the metropolitan area of Vancouver, the recruitment in partnership with the Brazilian consulate allowed the participation of residents from different cities in the region, which contributes to reducing the limitations related to the size of the sample. Also, the fact that this sample had some different demographic characteristics than the original program prevented a comparison with the entire Canadian cohort. As a consequence, some results were likely affected by the difference in the sample sizes. However, using the effect sizes to compare the samples allowed a fair examination of the similarities and differences among the groups. Another

limitation was the design of the Brazilian trial, which was not truly randomized. Nonetheless, almost no differences were observed between the experimental and the control group at baseline, conferring a high level of reliability of the findings.

6.5 Conclusion

The Brazilian version of the ACCELERATION program presented similar results to the original protocol and reached the specific goals in terms of the proportion of participants changing all the behaviours, which demonstrated the effectiveness of the intervention. Also, the experimental group presented better results than the control group in most variables. Although the number of participants in the Brazilian intervention was smaller than the Canadian one, the overall higher effect sizes of the results of the present trial in comparison to similar studies, along with the levels of satisfaction and adherence of the participants, confirm that the translated and adapted intervention was effective in promoting positive health behaviour changes in Brazilians. A scaled-up initiative based on this program may contribute to the prevention of chronic diseases in this population.

Chapter 7: Conclusions and Future Directions

7.1 General Conclusions

Considering the burden caused by chronic diseases in individuals' lives and in governments' infrastructure, as well as the benefits of preventive interventions to tackle the behavioural risk factors for these diseases, there is a global call for an increase in the number of initiatives addressing this context (UN, 2015; WHO, 2017). While still of significant importance in high-income countries, such approaches are urgently necessary in LMICs, given the growth of the already higher rates of morbidity and mortality due to chronic diseases in these nations (Bull et al., 2020; Liu et al., 2019a; Turner-Moss et al., 2021).

Accordingly, following recent guidelines from the World Health Organization (WHO, 2020b), two reviews were conducted to support the elaboration and application of two practical studies to promote health behaviour change in individuals from the middle-income country of Brazil. The first project was presented in chapter 3, emphasizing that effective behaviour change approaches are necessary to help individuals avoid or mitigate risk factors, engage in behavioural patterns that lead to better health, and consequently, prevent chronic diseases. Increasing the levels of physical activity and healthy eating is currently considered one of the most critical actions to tackle chronic medical conditions (Oni et al., 2020; Turner-Moss et al., 2021). However, although different strategies have been used to reach such a goal, not all of them lead to the expected or desired results. Evidence from studies based on recent theories focusing on healthy behaviours suggests that applying multiple strategies is more effective than the use of individual approaches to translate intention into behaviour (Hathaway & Gregg, 2021; Rhodes et al., 2021a). This includes a combination of techniques that consider personal preferences, such as

those with an emphasis on affective attitudes and perception of opportunities to engage in specific behaviours (Liu et al., 2019b; Walker et al., 2019).

In light of new scientific documents on the prevention of chronic diseases and the elevated rates of overweight and obesity in Brazil and Canada, chapter 4 synthesized and interpreted current aspects regarding dietary and physical activity initiatives in both countries. The pioneering work presented in the latest Brazilian dietary guidelines has been lauded as a model that can be applied globally, given its conceptualization of healthy eating that translates easily to practical guidance (Kirkpatrick et al., 2019; Monteiro et al., 2015; Vandevijvere et al., 2019). The new Canadian Food Guide has incorporated similar aspects, also elevating the country as a leader in dietary guidance (Kirkpatrick et al., 2019; Monteiro & Jaime, 2020; Vandevijvere et al., 2019). With these new recommendations, citizens in Brazil and Canada have access to impactful evidence-informed nutritional guidelines (Brazilian Ministry of Health, 2014; Health Canada, 2019). Both documents propose eating patterns that focus not only on health benefits, such as chronic disease prevention, but also incorporate well-being concerning cultural, economic, sociodemographic, biological, and environmental dimensions (Kirkpatrick et al., 2019; Monteiro et al., 2015). Similarly, a more socially contextualized approach is required for physical activity to allow individuals to have attainable health and life goals and thereby fully enjoy their lives, regardless of geographical location, health status, and socioeconomic condition, a concept recently described as physical activity security (Crochemore-Silva et al., 2020; Lambert et al., 2020). The wholistic dietary guidelines from both countries represent a change in paradigm in public health (Bédard et al., 2020; Kirkpatrick et al., 2019). Likewise, evidence-based initiatives are warranted to reduce disparities in physical activity, mainly in LMICs such as Brazil, to allow healthier and more active lifestyles for everyone.

Chapter 5 presented the translation and adaptation of the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) to the Brazilian population. The evidence-based PAR-Q+, which is the international standard for pre-participation risk stratification and screening, provides safe clearance for participation in physical activity and exercise for individuals of different ages, health conditions, and physical activity levels – including children, seniors, and those living with chronic medical conditions (Gledhill et al., 2016; Goodman et al., 2016; Liguori et al., 2022; Warburton et al., 2011a). This tool reduces barriers to physical activity and exercise participation while providing advice about when further medical clearance is required (Warburton et al., 2011e). The Brazilian version of the questionnaire presented strong reproducibility and is considered a practical and reliable tool to help Brazilians safely start or increase physical activity and exercise participation.

The original study presented in chapter 6 involved translating and adapting the ACCELERATION program, a pan-Canadian lifestyle intervention focused on health behaviour change (University Health Network, 2015), to the Brazilian context. The internationalization of the program aimed to make available to Brazilians a chronic disease prevention initiative based on the successful experiences of different Canadian universities and organizations in the fight against chronic medical conditions (Oh & Nooyen, 2018). The translated and adapted version of the program presented similar results to the original program, with considerable rates of behaviour change among the participants, namely regarding physical inactivity, unhealthy diet, and smoking. These results were significantly better than those from the control group, reinforcing the effectiveness of the intervention.

7.2 Contributions of the Research

The findings from this dissertation have direct implications in both day-to-day

practice and scientific contexts. Brazil has a high prevalence of physical inactivity and chronic diseases, and one of the world's fastest aging populations (Brasil, 2020; Lima-Costa, 2018; Szwarcwald et al., 2021). Additionally, among other reasons, many Brazilians do not take part in physical activities due to fear of injuries and a worsening in their health status (Cruz et al., 2018; Rech et al., 2018; Sousa et al., 2020). Hence, the findings from chapter 5 contribute to daily practice by making available to this population a valid screening instrument that is not limited by age and can be used by individuals with different health statuses as well as physical activity levels, which has long been desired in the country. The PAR-Q+, a practical and evidence-informed tool, culturally adapted to the Brazilian context, can facilitate a large number of individuals to start or increase physical activity participation in a safe manner, and consequently reap all the benefits arising from such behaviour.

The questionnaire can be self-administered, allowing the vast majority of Brazilians, many of whom face significant financial hardship, to self-clear to become more physically active, without the need of a medical appointment, which involves either a long wait or a high cost (Armstrong et al., 2018; Arrais et al., 2021; Santos et al., 2017). The Brazilian version of the PAR-Q+ is also invaluable for supervised physical activity since a quick and free assessment allows those who need the most, such as the tens of millions of chronic disease patients in the country, to have an immediate clearance for engaging in physical activity programs without fearing for their health (Brasil, 2020; Warburton et al., 2011a). Therefore, in addition to being instrumental in gyms and sports clubs, the tool is also essential in clinical facilities such as cardiovascular rehabilitation centres. Moreover, the questionnaire contributes to research surrounding chronic disease by allowing the safe inclusion of participants in any project

involving physical activity, which is particularly important at the moment, when there is a call for such studies in LMICs like Brazil (Bull et al., 2020).

Although the Brazilian Portuguese version of the PAR-Q+ is freely available worldwide, the instrument has been solicited via email by physiotherapists, kinesiologists, and other individuals involved with exercise physiology (personal communications from health professionals, university professors, and researchers in 2021). This is likely due to the experience with other questionnaires, which do require permission to be used (Aldhahi et al., 2021; Nici et al., 2006). Emails have been received not only from Brazilians working in Brazil and abroad but also from professionals from countries other than Brazil, in which a slightly different version of Portuguese is spoken, such as Portugal. In addition to requests to introduce the questionnaire to university students and to use it with clients and research volunteers, some institutions have also made invitations for a presentation regarding the questionnaire.

The current Coronavirus disease pandemic increased the levels of unhealthy behaviours and made it even more explicit the impact of unhealthy lifestyles and resulting chronic diseases (McDonough et al., 2021; Smaira et al., 2021). Such a situation can be illustrated by the fact that not only those who have an unhealthy lifestyle and/or chronic diseases are more susceptible to COVID-19, but the disease is more severe in these individuals (Singh Thakur et al., 2021). The pandemic was declared in 2020, the same year when public health experts convened by the WHO recommended healthy behaviour initiatives in LMICs to compare the health outcomes with those conducted with high-income countries' populations (Boschiero et al., 2021; WHO, 2020b). Therefore, the findings of chapter 6 are also presented at a timely moment.

Up until now, most research has indicated that interventions addressing different health behaviours are less convincing than those tackling only one risk factor, and in-person programs

have been considered more effective than those delivered at a distance (Craike et al., 2018; Prochaska & Prochaska, 2011; Rhodes et al., 2017). The findings presented in chapter 6 add to the current body of knowledge by showing that a comprehensive chronic disease prevention program, delivered online, applying behaviour change techniques based on recent theories, can indeed lead to effective health behaviour change. Such a contribution is significant since chronic medical conditions are caused by multiple and interconnected behavioural risk factors, and many people do not have time or the means to access in-person health care services (Meader et al., 2017; Precoma et al., 2019; Venn & Strazdins, 2017; WHO, 2021c).

Additionally, most studies focusing on health behaviour change, regardless of delivery mode or the number of risk behaviours addressed, have presented results with small to medium effect sizes (Meader et al., 2017; Rhodes et al., 2017). Therefore, the fact that the findings of the Brazilian version of the ACCELERATION program had overall medium to large effect sizes demonstrate that interventions like this can successfully contribute to larger initiatives with those looking to change health behaviours. Moreover, these findings can support the elaboration and delivery of other research projects, and therefore contribute to the work that has been done by outstanding researchers in Brazil and other countries. Ultimately, as recently proposed by Chastin et al. (2020) and Bono and Matranga (2019), an ulterior contribution of the present research lies in the fact that promoting healthy lifestyles in disadvantaged jurisdictions reduces socioeconomic disparities and improves the health status of the entire population.

7.3 Future Studies

The most important reference addressing adults in the newest global guidelines on physical activity is the 2018 Physical Activity Guidelines Advisory Committee Scientific Report, a document initially used to guide the development of the latest physical activity guidelines for

Americans (US Department of Health and Human Services, 2018; WHO, 2020b). This report states that changing behaviour first and maintaining the change over time are two different challenges, which may be governed by distinct factors (Physical Activity Guidelines Advisory Committee, 2018). Accordingly, a subsequent study should investigate a follow-up stage after the delivery of the Brazilian version of the ACCELERATION program, to determine the aspects involved in the maintenance of the changes over longer periods of time.

Also, future studies should aim to have larger sample sizes and a complete randomized sampling for a more accurate replication of the findings (Schoeppe et al., 2016). Moreover, future projects should also aim to include older individuals, aiming at a broader generalization of the data (Rhodes et al., 2006). Notably, a follow-up study should be conducted with Brazilians living in Brazil, in order to control for contextual factors (Duarte et al., 2019; McCool et al., 2018).

Finally, many Brazilians have multiple chronic diseases and therefore are not eligible for primary prevention interventions. Considering the importance of physical activity in the management and secondary prevention of these diseases, there is a need for initiatives to encourage these individuals to start or increase regular physical activity engagement. The electronic Physical Activity Readiness Medical Examination (ePARmed-X+) is a supplement to the PAR-Q+ for individuals who had one or more positive answers to the follow-up questions of the questionnaire or have been referred to the digital tool by a health professional (Warburton et al., 2014). This electronic examination accelerates the physical activity and exercise clearance process, reducing barriers for individuals to become more active. Accordingly, translating and adapting the ePARmed-X+ to the Brazilian context has the potential to contribute to a better life

for several individuals in Brazil, besides an indirect contribution to the country in general, given the benefits of a healthier and more active society.

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Appendices

Appendix A - Brazilian Portuguese Version of the PAR-Q+

PAR-Q+ em português

Questionário de Prontidão para Atividade Física para Todos

Os benefícios da atividade física regular para a saúde são evidentes. Mais pessoas deveriam praticar atividade física todos os dias da semana. Fazer atividade física é muito seguro para a MAIORIA das pessoas. Este questionário indicará se você precisa de orientação adicional de um médico OU profissional de saúde qualificado para atuar com exercício físico, antes de se tornar mais ativo fisicamente.

PERGUNTAS GERAIS SOBRE A SAÚDE

Leia as 7 perguntas abaixo cuidadosamente e responda com sinceridade, assinalando SIM ou NÃO.	SIM	NÃO
1) O médico alguma vez disse que você tem problema de coração ☐ **OU** pressão alta ☐?	☐	☐
2) Você sente dor no peito em repouso, ao fazer suas atividades cotidianas comuns **OU** ao praticar atividade física?	☐	☐
3) Você perde o equilíbrio devido a tontura **OU** ficou inconsciente nos últimos 12 meses? Responda **NÃO** se sua tontura estiver associada a respiração rápida e/ou profunda (inclusive durante exercícios intensos).	☐	☐
4) Você foi diagnosticado com alguma outra condição crônica de saúde (que não seja pressão alta ou doença cardíaca)? **LISTE AS CONDIÇÕES AQUI:** _____	☐	☐
5) Você está tomando medicamentos prescritos pelo médico para uma condição crônica de saúde? **LISTE AS CONDIÇÕES E OS MEDICAMENTOS AQUI:** _____	☐	☐
6) Você atualmente tem (ou teve nos últimos 12 meses) um problema ósseo, articular ou de tecido mole (músculo, ligamento ou tendão) que poderia se agravar se você se tornasse mais ativo fisicamente? Responda **NÃO** se você tiver tido um problema que **hoje não limita mais a sua capacidade** de fazer atividade física. **LISTE AS CONDIÇÕES AQUI:** _____	☐	☐
7) O médico alguma vez disse que você só deveria fazer atividade física sob supervisão médica?	☐	☐

Se você respondeu NÃO a todas as perguntas acima, você está liberado para fazer atividade física. Por favor assine a DECLARAÇÃO DO PARTICIPANTE. Você não precisa preencher as páginas 2 e 3.

- Comece a ser muito mais ativo fisicamente – comece devagar e aumente o ritmo aos poucos
- Siga as recomendações da Organização Mundial de Saúde para a sua idade contidas em International Physical Activity Guidelines (https://www.who.int/dietphysicalactivity/factsheet_recommendations/en/).
- Você está liberado para participar de avaliações de saúde e condicionamento físico.
- Se você tiver acima de 45 anos e **NÃO** estiver acostumado a fazer exercícios intensos ou de esforço máximo, consulte um profissional de saúde qualificado para atuar com exercício físico, antes de participar de exercícios dessa intensidade.
- Caso tenha alguma dúvida adicional, entre em contato com um profissional de saúde qualificado para atuar com exercício físico.

DECLARAÇÃO DO PARTICIPANTE

Se você for menor de idade ou precisar do consentimento de um responsável, seu pai, mãe, responsável legal ou cuidador também precisa assinar este formulário.

Eu, abaixo-assinado, li, compreendi satisfatoriamente e preenchi este questionário. Reconheço que esta liberação para a prática de atividade física é válida por no máximo 12 meses a partir da data do preenchimento, e será invalidada caso minha condição de saúde mude. Reconheço também que o estabelecimento onde irei praticar atividade física pode guardar uma cópia deste formulário para registro. Neste caso, ele manterá a confidencialidade do mesmo, respondendo às leis e regulamentações aplicáveis.

NOME _____ DATA _____

ASSINATURA _____ TESTEMUNHA _____

ASSINATURA DO PAI/MÃE/RESPONSÁVEL/CUIDADOR _____

Se você respondeu SIM a uma ou mais perguntas, PREENCHA AS PÁGINAS 2 E 3.

Deixe para ficar mais ativo mais tarde se:

- Você tiver uma infecção aguda, como resfriado ou febre – é melhor esperar até se sentir bem.
- Você estiver grávida – fale com um profissional de saúde, um médico, um profissional de saúde qualificado para atuar com exercício físico, e/ou preencha o formulário ePARmed-X+ (**www.eparmedx.com**) antes de se tornar mais ativa fisicamente.
- Sua saúde mudar – responda às perguntas das páginas 2 e 3 deste documento e/ou fale com um médico ou um profissional de saúde qualificado para atuar com exercício físico, antes de continuar com qualquer programa de atividade física.

Traduzido por Bianca Bold (tradutora profissional) e Juliano Schwartz (CAPES/UBC), com apoio financeiro da University Health Network

 1/4

PAR-Q+ em português

PERGUNTAS ADICIONAIS SOBRE PROBLEMA(S) DE SAÚDE

1. Você tem artrite, osteoporose ou problemas de coluna?

Se a resposta for positiva, responda às perguntas 1a–1c — Se **NÃO** ☐ pule para a pergunta 2

1a.	Você tem dificuldade em controlar sua condição com medicamentos ou outros tratamentos prescritos por médicos? (Responda **NÃO** se não estiver tomando medicamentos ou fazendo outros tratamentos no momento)	SIM ☐	NÃO ☐
1b.	Você tem problemas articulares que causam dor, uma fratura recente ou fratura causada por osteoporose ou câncer, vértebra deslocada (como espondilolistese) e/ou espondilólise/defeito da pars interarticularis (fratura no anel ósseo na parte posterior da coluna vertebral)?	SIM ☐	NÃO ☐
1c.	Você recebeu injeções de esteroides ou tomou comprimidos de esteroides regularmente por mais de 3 meses?	SIM ☐	NÃO ☐

2. Você tem algum tipo de câncer?

Se a resposta for positiva, responda às perguntas 2a–2b — Se **NÃO** ☐ pule para a pergunta 3

2a.	O seu diagnóstico de câncer inclui algum destes tipos: pulmão/broncogênico, mieloma múltiplo (câncer de células plasmáticas), cabeça e/ou pescoço?	SIM ☐	NÃO ☐
2b.	Você está recebendo tratamento para o câncer (como quimioterapia ou radioterapia)?	SIM ☐	NÃO ☐

3. Você tem algum problema cardíaco ou cardiovascular? Isto inclui doença arterial coronariana, insuficiência cardíaca, anormalidade do ritmo cardíaco

Se a resposta for positiva, responda às perguntas 3a–3d — Se **NÃO** ☐ pule para a pergunta 4

3a.	Você tem dificuldade em controlar sua condição com medicamentos ou outros tratamentos prescritos por médicos? (Responda **NÃO** se não estiver tomando medicamentos ou fazendo outros tratamentos no momento)	SIM ☐	NÃO ☐
3b.	Você tem batimentos cardíacos irregulares que requerem acompanhamento médico (como fibrilação atrial, contração ventricular prematura)?	SIM ☐	NÃO ☐
3c.	Você tem insuficiência cardíaca crônica?	SIM ☐	NÃO ☐
3d.	Você foi diagnosticado com doença arterial coronariana (cardiovascular) e não praticou atividades físicas regulares nos últimos 2 meses?	SIM ☐	NÃO ☐

4. Você tem pressão alta?

Se a resposta for positiva, responda às perguntas 4a–4b — Se **NÃO** ☐ pule para a pergunta 5

4a.	Você tem dificuldade em controlar sua condição com medicamentos ou outros tratamentos prescritos por médicos? (Responda **NÃO** se não estiver tomando medicamentos ou fazendo outros tratamentos no momento)	SIM ☐	NÃO ☐
4b.	Você tem pressão arterial em repouso igual ou superior a 160/90 mmHg com ou sem medicação? (Responda **SIM** se você não souber sua pressão arterial em repouso)	SIM ☐	NÃO ☐

5. Você tem algum problema metabólico? Isto inclui diabetes tipo 1, diabetes tipo 2, pré-diabetes

Se a resposta for positiva, responda às perguntas 5a–5e — Se **NÃO** ☐ pule para a pergunta 6

5a.	Você costuma ter dificuldade em controlar seus níveis de açúcar no sangue com a alimentação, com medicamentos, ou com outros tratamentos prescritos por médicos?	SIM ☐	NÃO ☐
5b.	Você costuma ter sinais e sintomas de pouco açúcar no sangue (hipoglicemia) após exercícios e/ou durante suas atividades cotidianas? Sinais de hipoglicemia podem incluir tremores, nervosismo, irritabilidade fora do comum, transpiração excessiva, tontura, confusão mental, dificuldade para falar, fraqueza ou sonolência.	SIM ☐	NÃO ☐
5c.	Você tem algum sinal ou sintoma de complicações do diabetes, como doença cardíaca ou vascular e/ou complicações que afetam seus olhos, os rins **OU** perda de sensibilidade nos pés e dedos dos pés?	SIM ☐	NÃO ☐
5d.	Você tem outros problemas metabólicos (como diabetes gestacional, doença renal crônica ou problemas no fígado)?	SIM ☐	NÃO ☐
5e.	Você planeja fazer, num futuro próximo, exercícios que para você são mais intensos/vigorosos que o normal?	SIM ☐	NÃO ☐

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PAR-Q+ em português

6. **Você tem problemas de saúde mental ou dificuldades de aprendizagem?** Isto inclui Alzheimer, transtorno de ansiedade, depressão, demência, transtorno alimentar, transtorno psicótico, disfunção intelectual, síndrome de Down

Se a resposta for positiva, responda às perguntas 6a-6b — Se **NÃO** ☐ pule para a pergunta 7

6a.	Você tem dificuldade em controlar sua condição com medicamentos ou outros tratamentos prescritos por médicos? (Responda **NÃO** se não estiver tomando medicamentos ou fazendo outros tratamentos no momento)	SIM ☐	NÃO ☐
6b.	Você tem síndrome de Down **E** problemas na coluna que afetam nervos ou músculos?	SIM ☐	NÃO ☐

7. **Você tem alguma doença respiratória?** Isto inclui doença pulmonar obstrutiva crônica, asma, hipertensão arterial pulmonar

Se a resposta for positiva, responda às perguntas 7a–7d — Se **NÃO** ☐ pule para a pergunta 8

7a.	Você tem dificuldade em controlar sua condição com medicamentos ou outros tratamentos prescritos por médicos? (Responda **NÃO** se não estiver tomando medicamentos ou fazendo outros tratamentos no momento)	SIM ☐	NÃO ☐
7b.	O médico alguma vez disse que você tem baixos níveis de oxigênio no sangue em repouso ou durante exercícios e/ou que você precisa de terapia de oxigênio suplementar?	SIM ☐	NÃO ☐
7c.	Se asmático, você atualmente apresenta sintomas como sensação de aperto no peito, respiração sibilante, dificuldade em respirar, tosse constante (mais de 2 dias/semana) ou você usou sua medicação de resgate mais de 2 vezes na última semana?	SIM ☐	NÃO ☐
7d.	O médico alguma vez disse que você tem pressão alta nos vasos sanguíneos dos pulmões?	SIM ☐	NÃO ☐

8. **Você tem alguma lesão na medula espinhal?** Isto inclui tetraplegia e paraplegia

Se a resposta for positiva, responda às perguntas 8a–8c — Se **NÃO** ☐ pule para a pergunta 9

8a.	Você tem dificuldade em controlar sua condição com medicamentos ou outros tratamentos prescritos por médicos? (Responda **NÃO** se não estiver tomando medicamentos ou fazendo outros tratamentos no momento)	SIM ☐	NÃO ☐
8b.	Você costuma apresentar pressão arterial baixa em repouso a ponto de causar tonturas e/ou desmaios?	SIM ☐	NÃO ☐
8c.	O médico alguma vez mencionou que você apresenta surtos repentinos de pressão arterial alta (conhecidos como disreflexia autonômica)?	SIM ☐	NÃO ☐

9. **Você já teve derrame cerebral alguma vez?** Isto inclui ataque isquêmico transitório ou acidente vascular cerebral

Se a resposta for positiva, responda às perguntas 9a–9c — Se **NÃO** ☐ pule para a pergunta 10

9a.	Você tem dificuldade em controlar sua condição com medicamentos ou outros tratamentos prescritos por médicos? (Responda **NÃO** se não estiver tomando medicamentos ou fazendo outros tratamentos no momento)	SIM ☐	NÃO ☐
9b.	Você tem dificuldade para caminhar ou mobilidade comprometida?	SIM ☐	NÃO ☐
9c.	Você sofreu um derrame ou teve comprometimento nos nervos ou músculos nos últimos 6 meses?	SIM ☐	NÃO ☐

10. Você tem qualquer outro problema de saúde não listado acima, ou você tem dois ou mais problemas de saúde?

Se tiver outras condições, responda às perguntas 10a–10c — Se **NÃO** ☐ leia as recomendações da página 4

10a.	Você sofreu de escurecimento da visão, desmaio ou perda de consciência como resultado de lesão na cabeça nos últimos 12 meses **OU** você teve uma concussão cerebral diagnosticada nos últimos 12 meses?	SIM ☐	NÃO ☐
10b.	Você tem um problema de saúde que não está listado (como epilepsia, problemas neurológicos, problemas renais)?	SIM ☐	NÃO ☐
10c.	Você tem atualmente dois ou mais problemas de saúde?	SIM ☐	NÃO ☐

LISTE OS SEU(S) PROBLEMA(S) DE SAÚDE _____

E RESPECTIVO(S) MEDICAMENTO(S) AQUI: _____

Vá até a página 4 para obter recomendações sobre sua condição atual de saúde e assine a DECLARAÇÃO DO PARTICIPANTE.

Traduzido por Bianca Bold (tradutora profissional) e Juliano Schwartz (CAPES/UBC), com apoio financeiro da University Health Network

PAR-Q+ em português

Se você respondeu NÃO a todas as perguntas ADICIONAIS (páginas 2-3) sobre problemas de saúde, você está apto a se tornar mais ativo fisicamente - Assine a DECLARAÇÃO DO PARTICIPANTE abaixo.

- É aconselhável que você consulte um profissional de saúde qualificado para atuar com exercício físico, para ajudá-lo a desenvolver um plano de atividades físicas seguro e eficaz para atender às suas necessidades de saúde.
- É recomendável que você comece devagar e aumente o ritmo aos poucos – 20–60 minutos de exercícios de intensidade baixa a moderada, 3–5 dias por semana, incluindo exercícios aeróbios e de fortalecimento muscular.
- Ao progredir, tente acumular 150 minutos ou mais de atividades físicas de intensidade moderada por semana.
- Se você tiver mais de 45 anos e **NÃO** estiver acostumado a fazer exercícios intensos ou de esforço máximo, consulte um profissional de saúde qualificado para atuar com exercício físico, antes de participar de exercícios dessa intensidade.

Se você respondeu **SIM** a **uma ou mais das perguntas adicionais** sobre sua condição de saúde:

Você deve se informar melhor antes de se tornar mais ativo fisicamente ou de fazer uma avaliação física. Complete o programa on-line de recomendações para triagem e exercícios, especialmente projetado para esses casos, o eParmed-X+ (**www.eparmedx.com**) e/ou consulte um profissional de saúde qualificado para atuar com exercício físico, para trabalhar com você usando o ePARmed-X+ e para obter mais informações.

Deixe para ficar mais ativo depois se:

- Você tiver uma infecção aguda, como resfriado ou febre – é melhor esperar até se sentir bem.
- Você estiver grávida – fale com um profissional de saúde, um médico, um profissional de saúde qualificado para atuar com exercício físico, e/ou preencha o ePARmed-X+ (**www.eparmedx.com**) antes de se tornar mais ativa fisicamente.
- Sua saúde mudar – fale com um médico ou um profissional de saúde qualificado para atuar com exercício físico, antes de continuar com qualquer programa de atividade física.

- Incentivamos que você faça uma cópia do PAR-Q+. Você deve usar todo o questionário, e alterações NÃO são permitidas.
- Os autores, a PAR-Q+ Collaboration, as organizações parceiras e seus agentes, não assumem qualquer responsabilidade por pessoas que fazem atividades físicas e/ou utilizam o PAR-Q+ ou o ePARmed-X+. Em caso de dúvida após preencher o questionário, consulte um médico antes de fazer alguma atividade física.

DECLARAÇÃO DO PARTICIPANTE

- Pedimos a todos os que preencheram o PAR-Q+ que leiam e assinem a declaração abaixo.
- Se você for menor de idade ou precisar do consentimento de um responsável, seu pai, mãe, responsável legal ou cuidador também precisa assinar este formulário.

Eu, abaixo-assinado, li, compreendi satisfatoriamente e preenchi este questionário. Reconheço que esta liberação para a prática de atividade física é válida por no máximo 12 meses a partir da data do preenchimento, e será invalidada caso minha condição de saúde mude. Reconheço também que o estabelecimento onde irei praticar atividade física pode guardar uma cópia deste formulário para registro. Neste caso, ele manterá a confidencialidade do mesmo, respondendo às leis e regulamentações aplicáveis.

NOME _____ DATA _____

ASSINATURA _____ TESTEMUNHA _____

ASSINATURA DO PAI/MÃE/RESPONSÁVEL/CUIDADOR _____

Para mais informações, entre em contato com
www.eparmedx.com
E-mail: eparmedx@gmail.com

O PAR-Q+ foi criado usando o processo AGREE baseado em evidências (1) pela PAR-Q+ Collaboration, presidida pelo Dr. Darren E. R. Warburton com o Dr. Norman Gledhill, a Dra. Veronica Jamnik e o Dr. Donald C. McKenzie (2). A produção deste documento tornou-se possível graças a contribuições financeiras da Public Health Agency of Canada e do BC Ministry of Health Services. As opiniões aqui expressas não representam necessariamente os pontos de vista da Public Health Agency of Canada ou do BC Ministry of Health Services.

Citação para o PAR-Q+ em português:
Schwartz J, Oh P, Takito MY, Saunders B, Dolan E, Franchini E, Rhodes RE, Bredin SSD, Coelho JP, Santos P, Mazzuco M, and Warburton DER. Translation, cultural adaptation, and reproducibility of the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+): the Brazilian Portuguese version. Front. Cardiovasc. Med. doi: 10.3389/fcvm.2021.712696. 2021

Principais referências:

1. Warburton DER, Jamnik VK, Bredin SSD, and Gledhill N on behalf of the PAR-Q+ Collaboration. The Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and Electronic Physical Activity Readiness Medical Examination (ePARmed-X+). Health & Fitness Journal of Canada 4(2):3-23, 2011.
2. Jamnik VK, Warburton DER, Makarski J, McKenzie DC, Shephard RJ, Stone J, and Gledhill N. Enhancing the effectiveness of clearance for physical activity participation; background and overall process. APNM 36(S1):S3-S13, 2011.
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4. Chisholm DM, Collis ML, Kulak LL, Davenport W, and Gruber N. Physical activity readiness. British Columbia Medical Journal. 1975;17:375-378.
5. Thomas S, Reading J, and Shephard RJ. Revision of the Physical Activity Readiness Questionnaire (PAR-Q). Canadian Journal of Sport Science 1992;17:4 338-345.

Traduzido por Bianca Bold (tradutora profissional) e Juliano Schwartz (CAPES/UBC), com apoio financeiro da University Health Network

Appendix B - Original PAR-Q+

2019 PAR-Q+

The Physical Activity Readiness Questionnaire for Everyone

The health benefits of regular physical activity are clear; more people should engage in physical activity every day of the week. Participating in physical activity is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

GENERAL HEALTH QUESTIONS

Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	YES	NO
1) Has your doctor ever said that you have a heart condition ☐ OR high blood pressure ☐?	☐	☐
2) Do you feel pain in your chest at rest, during your daily activities of living, **OR** when you do physical activity?	☐	☐
3) Do you lose balance because of dizziness **OR** have you lost consciousness in the last 12 months? Please answer **NO** if your dizziness was associated with over-breathing (including during vigorous exercise).	☐	☐
4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)? **PLEASE LIST CONDITION(S) HERE:** _____	☐	☐
5) Are you currently taking prescribed medications for a chronic medical condition? **PLEASE LIST CONDITION(S) AND MEDICATIONS HERE:** _____	☐	☐
6) Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? Please answer **NO** if you had a problem in the past, but it **does not limit your current ability** to be physically active. **PLEASE LIST CONDITION(S) HERE:** _____	☐	☐
7) Has your doctor ever said that you should only do medically supervised physical activity?	☐	☐

If you answered NO to all of the questions above, you are cleared for physical activity.
Please sign the PARTICIPANT DECLARATION. You do not need to complete Pages 2 and 3.

- Start becoming much more physically active – start slowly and build up gradually.
- Follow International Physical Activity Guidelines for your age (www.who.int/dietphysicalactivity/en/).
- You may take part in a health and fitness appraisal.
- If you are over the age of 45 yr and NOT accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.
- If you have any further questions, contact a qualified exercise professional.

PARTICIPANT DECLARATION
If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that the community/fitness center may retain a copy of this form for its records. In these instances, it will maintain the confidentiality of the same, complying with applicable law.

NAME _____ DATE _____

SIGNATURE _____ WITNESS _____

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER _____

If you answered YES to one or more of the questions above, COMPLETE PAGES 2 AND 3.

Delay becoming more active if:

- You have a temporary illness such as a cold or fever; it is best to wait until you feel better.
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ at **www.eparmedx.com** before becoming more physically active.
- Your health changes - answer the questions on Pages 2 and 3 of this document and/or talk to your doctor or a qualified exercise professional before continuing with any physical activity program.

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FOLLOW-UP QUESTIONS ABOUT YOUR MEDICAL CONDITION(S)

1. Do you have Arthritis, Osteoporosis, or Back Problems?

If the above condition(s) is/are present, answer questions 1a-1c — If **NO** ☐ go to question 2

1a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐	NO ☐
1b.	Do you have joint problems causing pain, a recent fracture or fracture caused by osteoporosis or cancer, displaced vertebra (e.g., spondylolisthesis), and/or spondylolysis/pars defect (a crack in the bony ring on the back of the spinal column)?	YES ☐	NO ☐
1c.	Have you had steroid injections or taken steroid tablets regularly for more than 3 months?	YES ☐	NO ☐

2. Do you currently have Cancer of any kind?

If the above condition(s) is/are present, answer questions 2a-2b — If **NO** ☐ go to question 3

2a.	Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and/or neck?	YES ☐	NO ☐
2b.	Are you currently receiving cancer therapy (such as chemotheraphy or radiotherapy)?	YES ☐	NO ☐

3. Do you have a Heart or Cardiovascular Condition? This includes Coronary Artery Disease, Heart Failure, Diagnosed Abnormality of Heart Rhythm

If the above condition(s) is/are present, answer questions 3a-3d — If **NO** ☐ go to question 4

3a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐	NO ☐
3b.	Do you have an irregular heart beat that requires medical management? (e.g., atrial fibrillation, premature ventricular contraction)	YES ☐	NO ☐
3c.	Do you have chronic heart failure?	YES ☐	NO ☐
3d.	Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months?	YES ☐	NO ☐

4. Do you have High Blood Pressure?

If the above condition(s) is/are present, answer questions 4a-4b — If **NO** ☐ go to question 5

4a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐	NO ☐
4b.	Do you have a resting blood pressure equal to or greater than 160/90 mmHg with or without medication? (Answer **YES** if you do not know your resting blood pressure)	YES ☐	NO ☐

5. Do you have any Metabolic Conditions? This includes Type 1 Diabetes, Type 2 Diabetes, Pre-Diabetes

If the above condition(s) is/are present, answer questions 5a-5e — If **NO** ☐ go to question 6

5a.	Do you often have difficulty controlling your blood sugar levels with foods, medications, or other physician-prescribed therapies?	YES ☐	NO ☐
5b.	Do you often suffer from signs and symptoms of low blood sugar (hypoglycemia) following exercise and/or during activities of daily living? Signs of hypoglycemia may include shakiness, nervousness, unusual irritability, abnormal sweating, dizziness or light-headedness, mental confusion, difficulty speaking, weakness, or sleepiness.	YES ☐	NO ☐
5c.	Do you have any signs or symptoms of diabetes complications such as heart or vascular disease and/or complications affecting your eyes, kidneys, **OR** the sensation in your toes and feet?	YES ☐	NO ☐
5d.	Do you have other metabolic conditions (such as current pregnancy-related diabetes, chronic kidney disease, or liver problems)?	YES ☐	NO ☐
5e.	Are you planning to engage in what for you is unusually high (or vigorous) intensity exercise in the near future?	YES ☐	NO ☐

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6. Do you have any Mental Health Problems or Learning Difficulties? This includes Alzheimer's, Dementia, Depression, Anxiety Disorder, Eating Disorder, Psychotic Disorder, Intellectual Disability, Down Syndrome

If the above condition(s) is/are present, answer questions 6a-6b — If **NO** ☐ go to question 7

6a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
6b.	Do you have Down Syndrome **AND** back problems affecting nerves or muscles?	YES ☐ NO ☐

7. Do you have a Respiratory Disease? This includes Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary High Blood Pressure

If the above condition(s) is/are present, answer questions 7a-7d — If **NO** ☐ go to question 8

7a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
7b.	Has your doctor ever said your blood oxygen level is low at rest or during exercise and/or that you require supplemental oxygen therapy?	YES ☐ NO ☐
7c.	If asthmatic, do you currently have symptoms of chest tightness, wheezing, laboured breathing, consistent cough (more than 2 days/week), or have you used your rescue medication more than twice in the last week?	YES ☐ NO ☐
7d.	Has your doctor ever said you have high blood pressure in the blood vessels of your lungs?	YES ☐ NO ☐

8. Do you have a Spinal Cord Injury? This includes Tetraplegia and Paraplegia

If the above condition(s) is/are present, answer questions 8a-8c — If **NO** ☐ go to question 9

8a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
8b.	Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting?	YES ☐ NO ☐
8c.	Has your physician indicated that you exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)?	YES ☐ NO ☐

9. Have you had a Stroke? This includes Transient Ischemic Attack (TIA) or Cerebrovascular Event

If the above condition(s) is/are present, answer questions 9a-9c — If **NO** ☐ go to question 10

9a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	YES ☐ NO ☐
9b.	Do you have any impairment in walking or mobility?	YES ☐ NO ☐
9c.	Have you experienced a stroke or impairment in nerves or muscles in the past 6 months?	YES ☐ NO ☐

10. Do you have any other medical condition not listed above or do you have two or more medical conditions?

If you have other medical conditions, answer questions 10a-10c — If **NO** ☐ read the Page 4 recommendations

10a.	Have you experienced a blackout, fainted, or lost consciousness as a result of a head injury within the last 12 months **OR** have you had a diagnosed concussion within the last 12 months?	YES ☐ NO ☐
10b.	Do you have a medical condition that is not listed (such as epilepsy, neurological conditions, kidney problems)?	YES ☐ NO ☐
10c.	Do you currently live with two or more medical conditions?	YES ☐ NO ☐

PLEASE LIST YOUR MEDICAL CONDITION(S) AND ANY RELATED MEDICATIONS HERE: _____

_____

GO to Page 4 for recommendations about your current medical condition(s) and sign the PARTICIPANT DECLARATION.

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If you answered NO to all of the FOLLOW-UP questions (pgs. 2-3) about your medical condition, you are ready to become more physically active - sign the PARTICIPANT DECLARATION below:

- It is advised that you consult a qualified exercise professional to help you develop a safe and effective physical activity plan to meet your health needs.
- You are encouraged to start slowly and build up gradually - 20 to 60 minutes of low to moderate intensity exercise, 3-5 days per week including aerobic and muscle strengthening exercises.
- As you progress, you should aim to accumulate 150 minutes or more of moderate intensity physical activity per week.
- If you are over the age of 45 yr and **NOT** accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.

If you answered **YES** to **one or more of the follow-up questions** about your medical condition:

You should seek further information before becoming more physically active or engaging in a fitness appraisal. You should complete the specially designed online screening and exercise recommendations program - the **ePARmed-X+ at www.eparmedx.com** and/or visit a qualified exercise professional to work through the ePARmed-X+ and for further information.

Delay becoming more active if:

- You have a temporary illness such as a cold or fever; it is best to wait until you feel better.
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ **at www.eparmedx.com** before becoming more physically active.
- Your health changes - talk to your doctor or qualified exercise professional before continuing with any physical activity program.

- You are encouraged to photocopy the PAR-Q+. You must use the entire questionnaire and NO changes are permitted.
- The authors, the PAR-Q+ Collaboration, partner organizations, and their agents assume no liability for persons who undertake physical activity and/or make use of the PAR-Q+ or ePARmed-X+. If in doubt after completing the questionnaire, consult your doctor prior to physical activity.

PARTICIPANT DECLARATION

- All persons who have completed the PAR-Q+ please read and sign the declaration below.
- If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that the community/fitness center may retain a copy of this form for records. In these instances, it will maintain the confidentiality of the same, complying with applicable law.

NAME _____ DATE _____

SIGNATURE _____ WITNESS _____

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER _____

For more information, please contact
www.eparmedx.com
Email: eparmedx@gmail.com

Citation for PAR-Q+
Warburton DER, Jamnik VK, Bredin SSD, and Gledhill N on behalf of the PAR-Q+ Collaboration. The Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and Electronic Physical Activity Readiness Medical Examination (ePARmed-X+). Health & Fitness Journal of Canada 4(2):3-23, 2011.

The PAR-Q+ was created using the evidence-based AGREE process (1) by the PAR-Q+ Collaboration chaired by Dr. Darren E. R. Warburton with Dr. Norman Gledhill, Dr. Veronica Jamnik, and Dr. Donald C. McKenzie (2). Production of this document has been made possible through financial contributions from the Public Health Agency of Canada and the BC Ministry of Health Services. The views expressed herein do not necessarily represent the views of the Public Health Agency of Canada or the BC Ministry of Health Services.

Key References

1. Jamnik VK, Warburton DER, Makarski J, McKenzie DC, Shephard RJ, Stone J, and Gledhill N. Enhancing the effectiveness of clearance for physical activity participation; background and overall process. APNM 36(S1):S3-S13, 2011.
2. Warburton DER, Gledhill N, Jamnik VK, Bredin SSD, McKenzie DC, Stone J, Charlesworth S, and Shephard RJ. Evidence-based risk assessment and recommendations for physical activity clearance; Consensus Document. APNM 36(S1):S266-s298, 2011.
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4. Thomas S, Reading J, and Shephard RJ. Revision of the Physical Activity Readiness Questionnaire (PAR-Q). Canadian Journal of Sport Science 1992;17:4 338-345.

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Appendix C - Descriptive Statistics

Variable	Skewness Pre-assessment	Kurtosis Pre-assessment	Skewness Post-assessment	Kurtosis Post-assessment
Self-reported light physical activity	1.660	2.442	2.185	5.599
Self-reported moderate physical activity	1.755	2.524	1.506	3.368
Self-reported vigorous physical activity	2.196	4.494	1.481	1.135
Self-reported MVPA	1.363	1.444	0.990	0.990
Self-reported sedentary behaviour	0.253	0.861	0.316	0.241
Accelerometer-measured light physical activity	0.620	0.205	0.397	-0.302
Accelerometer-measured moderate physical activity	1.252	1.834	0.478	-0.745
Accelerometer-measured vigorous physical activity	3.067	8.831	2.977	7.817
Accelerometer-measured MVPA	1.219	1.508	0.529	-0.685
Accelerometer-measured sedentary behaviour	-0.704	2.760	-0.832	0.592
Step count	1.231	2.336	0.236	-0.084
Fruits/vegetables intake	1.396	3.216	0.886	0.777
Fibre intake	1.919	4.046	1.538	3.145
Fat intake	0.310	-0.477	-0.027	-0.706
Sodium intake	-0.06	-0.368	0.268	0.028
Sugar intake	0.199	-0.816	0.442	-0.595
Attitude to become or stay active ≥ 150 min/week	-1.720	3.061	-1.722	3.618
Self-efficacy to become or stay active ≥ 150 min/week	-0.619	0.089	-0.860	1.154
Attitude to start or continue to eat ≥ five fruits/vegetables per day	-1.930	4.682	-1.871	3.883
Self-efficacy to start or continue to eat ≥ five fruits/vegetables per day	-0.925	0.660	-0.955	0.699
Affective judgement to engage in ≥ 150 min/week	-1.794	3.138	-1.626	2.046
Perceived opportunity to engage in ≥ 150 min/week	-1.656	3.604	-0.757	-0.535
Affective judgement to eat ≥ five fruits/vegetables per day	-1.403	1.427	-1.395	1.199

Variable	Skewness Pre-assessment	Kurtosis Pre-assessment	Skewness Post-assessment	Kurtosis Post-assessment
Perceived opportunity to eat ≥ five fruits/vegetables per day	-1.817	3.641	-1.607	2.542
Height	0.312	-0.012	0.312	-0.012
Weight	1.310	2.762	1.371	3.456
Body mass index	1.415	2.626	1.410	2.949
Body fat	-0.181	-0.577	-0.153	-0.496
Waist circumference	1.071	2.416	1.125	2.582
Systolic blood pressure	1.341	2.570	1.048	1.375
Diastolic blood pressure	0.658	0.713	0.480	0.772
Heart rate	0.507	0.887	0.553	0.872
Six-minute walk test distance	-0.311	1.021	-0.182	0.516
Maximal oxygen consumption	-1.041	2.283	-1.108	2.852
Handgrip strength	0.879	0.694	1.074	1.184
Helpfulness of the program	-	-	-1.162	1.54
Ease of the program	-	-	-0.810	0.329
Likelihood of recommending	-	-	-1.669	2.706

MVPA: Moderate-to-vigorous physical activity