The Effect of Online Delivery of the MS-Get-a-Head-Start Programme on Physical Activity and Exercise Self-Efficacy in People with Multiple Sclerosis: A Feasibility Study and Pilot Randomised Controlled Trial.

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2025

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A thesis submitted to
Auckland University of Technology
in fulfilment of the requirements for the degree of Master of Philosophy – Manuscript format two

Abstract

New Zealand has a higher-than-average global prevalence of multiple sclerosis. This prevalence has significantly risen in the last decade and is likely to continue to rise in line with global trends. Despite the well-documented benefits of regular physical activity for people with multiple sclerosis, levels of inactivity within this population remain high. This highlights the pressing need for accessible and tailored physical activity programmes specifically designed to support people with multiple sclerosis. Accurate information on physical activity is one of the highest unmet needs of people with multiple sclerosis. To improve accessibility there has been an increase in online delivery of exercise programmes, however, to date these all still require therapist interaction through the programme. The online MS Get a Head Start programme is one of the first fully automated exercise and education programmes for people with multiple sclerosis. It is a six-week programme incorporating interval-based exercise, education and behaviour change strategies aimed at enhancing the capacity and confidence of people with multiple sclerosis to engage in exercise and physical activity.

A pilot study was completed measuring the feasibility and safety of the online MS Get a Head Start programme as well as the impact on self-reported physical activity levels and exercise self-efficacy. Thirty-five people with multiple sclerosis were randomised to the intervention or waitlist control group. The intervention group received two exercise and one education video weekly for six weeks, plus goal setting and self-reflection course work. Feasibility, self-reported physical activity, and exercise self-efficacy, were assessed at baseline, week seven, and week twelve.

Feasibility outcomes indicated that recruitment to the study was highly successful, reflecting strong interest and demand for an online exercise programme among people with multiple sclerosis in New Zealand. The intervention was found to both useful and easy to use by the participants, and importantly, no adverse events attributable to the programme were observed, supporting its safety. However, the study had a substantial loss to follow-up within the intervention group. The pilot study was not powered to find significance. Physical activity levels remained consistent, although both groups demonstrated a decline in exercise self-efficacy across the study, contrary to the initial hypothesis that the programme would strengthen participants' confidence in their ability to exercise.

Taken together, these findings suggest that the online MS Get a Head Start programme is safe, acceptable, and feasible to deliver in an online automated format to reach more people living with multiple sclerosis across New Zealand. However, further refinement is required before progressing to a larger scale randomised controlled trial.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor used artificial intelligence tools or generative artificial intelligence tools (unless it is clearly stated and referenced, along with the purpose of use), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

21st October 2025

Signature

Date

Co-Authored Works

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Chapter Number:	**4**
Manuscript Title:	A pilot study of the feasibility of the online MS-Get-a-Head-Start programme for people with multiple sclerosis
Publication Status:	**Submitted for Publication**
Reference if published:	

AUTHOR SURNAME: (order as per manuscript)	**CONTRIBUTION** (May copy from the guidelines above)
Davy	Conceptualisation, methodology, software, validation, formal analysis, investigation, resources, data curation, writing – original draft and writing – review and editing, project administration, and funding acquisition (80% contribution).
Saywell	Supervisory support for validation, formal analysis, resources, data review, writing review and editing (10% contribution).
Stavric	Supervisory support for validation, formal analysis, resources, data review, writing review and editing (10% contribution).

Acknowledgements

I would like to take the opportunity to acknowledge and thank all those who have supported me in completing this master's project while still working clinically full-time.

Firstly, I would like to extend my sincere thanks to my two supervisors, Dr Nicola Saywell and Dr Verna Stavric. Who have been so kind with their support, their patience's with my academic writing, while managing to keep me on a relatively straight path. Your eye for detail has taught me a great deal.

This project would not have been possible without the generous funding support from the New Zealand Multiple Sclerosis Research Trust. I am extremely grateful for their support in providing the funding to create the online version of the MS Get a Head Start Programme.

Brad Vose deserves a special acknowledgement for being the brains behind the MS Get a Head Start website and helping me to enable the data collection to be completed entirely online. I would also like to acknowledge Victor D'Alcantara, who spent hours filming exercise and education videos and editing them to look so professional. Thank you to Lisa Pocq Saint Jean, who stepped into the role of research assistance and was meticulous in following the plan and keeping me well informed about the progress of the participants.

To the participants, thank you so much for providing me with your most valuable asset, your time. Without you joining this online journey with me, listening, and watching hours of videos, and completing everything without ever actually meeting or speaking to me in person, I would have nothing to write about.

As a clinician, statistics are not my strong point. Thank you Rueben McGregor for your evenings of data analysis and trying to make a complicated topic digestible. I am also grateful to Nick Garrett for your valuable review and advise on all things statistical. Thank you to Charlotte Jelleyman for your expert proofreading and general academic advice.

Finally, and most importantly, to my husband Glenn Shaw, thank you for being my unwavering support every step of the way and coping with my outbursts of tears. Thank you.

Intellectual Property Rights

MS Get a Head Start is a trademarked protected name and registered company in New Zealand. All intellectual property of the MS Get a Head Start programme remains the property of MS Get a Head Start.

Ethics Approval

Ethics approval was obtained from the Auckland University of Technology Ethics Committee (reference number: 24/7) on 28th May 2024.

See Appendix A – Ethics approval letter.

Positionality

I am a clinical neurological physiotherapist with over 20 years of experience. Originally from the United Kingdom, I have worked in both public and private health care settings in the UK, Australia, and New Zealand. While working in both New Zealand and Australia it became apparent to me that access to experienced neurological rehabilitation professionals was very dependent on where you lived. Patients who lived remotely and wanted to access experienced neurological rehabilitation services would travel an entire day, either by air or by car to attend a one-hour neurological physiotherapy appointment. In 2013, in response to these access problems, I started to provide online telehealth services for people with neurological conditions. At this time, this was not established practice, and I was one of the first private neurological physiotherapists internationally to offer this type of service. I am also passionate about treating people with newly diagnosed neurological conditions, who often find it difficult to access neurological rehabilitation services, as they are still working or have young families.

While working in Australia between 2012 and 2015, there were considerable developments in rehabilitation for people with Parkinson’s disease. However, there seemed to be fewer rehabilitation options and less progression in clinical services for PwMS at the time. Since then, incorporating research, expert insight, and clinical judgement, I created the MS Get a Head Start programme to use in my clinical practice. There was a lack of resources for health professionals regarding MS rehabilitation, and I felt it was important to raise awareness, increase skill level and health professional confidence to enhance overall competency in MS rehabilitation. Therefore, to increase the reach of the programme I initially developed an online course for health professionals designed to train them to deliver the MSGHS programme in person as part of their professional development.

Delivering the MSGHS programme in-person was well received in both my own clinic and by other health professionals through reports of enhanced PA levels, independence, and clinical outcomes. Due to demand, I then delivered the programme one-on-one online to a small number of PwMS in New Zealand who were not able to access a local neurological physiotherapist and had directly reached out to me given my reputation in the field.

To reduce barriers to accessing specialist care, I wanted to be able to provide the MSGHS programme online fully automated, and with the impact of COVID19 creating a greater acceptability of online programmes, it seemed like a perfect time. In addition, I wanted to start the process of the programme being formally evaluated through research which led to me completing this masters research on the feasibility of the online MSGHS programme.

As a researcher operating within a positivist framework, I aimed to minimise personal influence on the research process. The use of standardised outcome measurements and statistical methods helped ensure objectivity. While my clinical background informed the choice of topic, rigorous methodological controls were applied to reduce potential bias in data collection and analysis.

Chapter 1 Introduction

1.1 Background

Multiple sclerosis (MS) is the leading cause of non-traumatic disabling disease to affect young adults (Dobson & Giovannoni, 2019). There is a significant difference in physical activity (PA) volumes when comparing people with multiple sclerosis (PwMS) and the general population (Jeng et al., 2024). Research has suggested that up to 80% of PwMS do not engage in regular PA (Gervasoni et al., 2022a; Kinnett-Hopkins et al., 2017; Klaren et al., 2013). Recently, Jeng et al. (2024) reported that activity levels have increased slightly over the last decade, but low levels of activity still persist, despite increasing research supporting a positive effect of PA for PwMS (Learmonth, 2021).

This physical inactivity could contribute to an increase in disease burden and reduced quality of life for the individual (Marrie et al., 2010) as well as economic impact. In 2021, researchers in New Zealand estimated that the burden of MS cost was $266.3 million NZD. Out of this, $130.5 million NZD was allocated to health system costs, while the rest was attributed to "the combination of lost earnings... and intangible losses in health quality" (Bealing et al., 2021, p. 4).

Multiple sclerosis is a progressive inflammatory neurological autoimmune disorder, where the axons in the central nervous system (CNS) are demyelinated (Trapp & Nave, 2008). There is a combination of pathological, environmental, and psychological changes that are unique and significant to the individual and result in a plethora of symptoms (Learmonth & Motl, 2021). The most common of these symptoms is fatigue, mobility disability, pain, depression and cognitive decline, compromising individuals' participation and quality of life over time (Thompson et al., 2018). There is no current cure for MS which emphasises the importance of disease and symptom management in MS. Symptom management and wellness have become a focus point for the treatment and management of this disease (Motl, Mowry, et al., 2018).

1.2 Prevalence of Multiple Sclerosis

There are approximately 2.8 million PwMS worldwide, with an average global prevalence of 35.9 per 100,000 (Walton et al., 2020). However, in New Zealand, the prevalence of MS is significant higher at 96.6 per 100,000 in 2022 (Boven et al., 2025). The prevalence in New Zealand has significantly increased since the last set of data published, which was 72.4 per 100,000 in 2010 (Taylor et al., 2010). This is likely to continue to rise in line with global trends (Walton et al., 2020), which will result in an increasing financial cost to New Zealand.

In New Zealand, PwMS are predominately of European descent (Pearson et al., 2014). Estimated age-adjusted prevalence was highest for Europeans (124.7 per 100,000), followed by Middle Eastern/Latin American/African (85.5), Māori (41.8), Asian (16.8) and Pacific peoples (11.1) (Boven et al., 2025). The prevalence of MS in Māori is approximately 5% and has also risen over the past decade from 20.6 per 100,000 in 2014(Pearson et al., 2014) to 33.1 per 100,000 in 2022 (Boven et al., 2025).

Traditionally, increased risk of MS has been associated with being Caucasian, geographical living regions (further away from the equator), decreased sun exposure, smoking, and obesity (Handel et al., 2010). Regionally the highest prevalence rate in New Zealand has been found in Southland at 209.8 per 100,000 (Boven et al., 2025). The lower prevalence in Māori could be due to decreased genetic risk, however the increased risk of the other environmental factors such as smoking and obesity could be contributing to the rise in prevalence. The prevalence of MS decreased for people with Māori ethnicity who were among the most deprived quintiles. However, this finding needs to be interpreted with caution as the reduced number of MS diagnoses may be due to barriers accessing and navigating the healthcare system (Boven et al., 2025). The clinical features, including sex ratio, age at onset, time to diagnosis, MS subtype, and disability level in Māori, are not significantly different from the total MS population (Pearson et al., 2014).

1.3 Current Management of Multiple Sclerosis

Managing MS has significantly changed over the past two decades with the development of disease modifying medications (Wei et al., 2021). Although MS is not currently curable, these disease modifying medications are contributing to increased disease stability by helping reduce relapses in MS and slow disease progression (Talanki Manjunatha et al., 2022). However, these medical therapies represent a financial burden globally (Talanki Manjunatha et al., 2022) and do not produce functional or physical improvements. Hence, there is a drive towards symptomatic management through rehabilitation and PA to improve quality of life and day to day functional ability (Talanki Manjunatha et al., 2022). People with MS have highlighted that their highest unmet need has been accurate information on all aspects of PA, such as safety, effectiveness, and accessing reliable guidance (Learmonth et al., 2017; Richardson et al., 2020), and have expressed significant interest in non-pharmacological therapy such as exercise and diet for disease management (Motl, Mowry, et al., 2018).

1.4 Physical Activity and Exercise in Multiple Sclerosis

Regular PA, which includes formal exercise, is one effective self-management strategy for PwMS, as it has wide-ranging benefits on physical, functional, cognitive, and psychological aspects (Learmonth & Motl, 2021). The terms exercise and PA are frequently used interchangeably in MS literature. As such for consistency in this thesis I have used the term PA to represent both exercise and wider PA domains and used the following definition when referring to exercise;

> "Exercise is a form of leisure-time physical activity that is usually performed repeatedly over an extended period of time (exercise training) with a specific external objective such as the improvement of fitness, physical performance, or health." (Bouchard et al., 2012, p. 38).

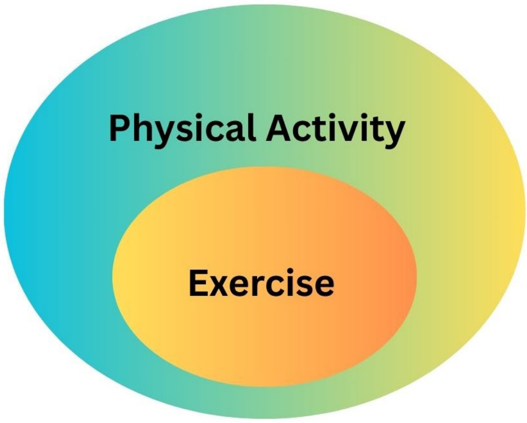
This is also support by the definition of exercise by Caspersen et al (1985) below;

> "Exercise is a subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate objective the improvement or maintenance of physical fitness." (p. 126).

Exercise therefore supports and is a subset of PA. These quotes have been translated into a schematic representation as seen in Figure 1.

Figure 1

The Relationship Between Exercise and Physical Activity; Exercise is a Subset of Physical Activity



Adapted from Alsup (2025)

There has been proliferation of the evidence supporting the extent of the benefits that PA can have on function and quality of life for PwMS (Dalgas et al., 2020; Motl & Sandroff, 2020; Motl & Sandroff, 2022). Learmonth and Motl (2021) narrative review found over 30 years of evidence supporting that regular PA helps PwMS maintain participation and quality of life by improving physical and cognitive performance. Preliminary evidence has shown that PA can decrease neural apoptosis and neurodegeneration and suggests that PA may be effective at stimulating neuroplasticity and slowing symptom progression (Dalgas et al., 2019; Mahalakshmi et al., 2020; Motl & Sandroff, 2022; Sandroff et al., 2018; Wesnes et al., 2018). The latest evidence-based PA guidelines by Kalb et al. (2020) highlight the importance of PwMS regularly completing ≥ 150 minutes per week of exercise and ≥150 minutes per week of lifestyle PA to optimise the benefits of PA for PwMS.

1.5 Physical Inactivity Levels of People living with Multiple Sclerosis

Physical activity levels in PwMS have barely changed over the last 30 years, despite increasing evidence on the benefits of regular PA (Jeng et al., 2024; Kinnett-Hopkins et al., 2017; Klaren et al., 2013; Learmonth & Motl, 2021). This suggests that there is an element missing in the translation of these research findings to helping PwMS maintain or even improve their PA levels (Schüler et al., 2019). Failing to address this inactivity level will result in suboptimal quality of life for PwMS, increased risk of secondary comorbidities, and, as prevalence levels rise, this will lead to an increase in direct and indirect costs (Katzmarzyk et al., 2019; Lin et al., 2024).

One explanation for these high levels of inactivity is that some PwMS worry that PA will make their MS symptoms worse (Kayes et al., 2011; Sieber et al., 2024). This issue is further compounded by the limited availability of accurate information regarding all aspects of PA, including safety, effectiveness, and access to reliable guidance (Learmonth et al., 2017; Richardson et al., 2020). Other major barriers to regular participation in PA are the requirement to travel, physical mobility issues, lack of time, and the scarcity of specialised facilities (Correale et al., 2022).

Temporary symptom exacerbations following PA can cause short-term changes in sensation, vision, balance, weakness, and mobility. This is understandably frightening for PwMS, frequently presenting in the same way as a relapse. This fear is increased by a lack of knowledge and education around temporary symptom exacerbation related to PA (Correale et al., 2022; Šilarová et al., 2024). Even though these exacerbations from PA fully resolve, and it has been well established that PA does not increase relapse rate (Learmonth et al., 2023; Pilutti et al., 2014), PwMS are still very fearful due to a lack of knowledge (Learmonth et al., 2017). Fatigue is another major barrier to participating in regular PA (Correale et al., 2022). These issues make it hard for PwMS to motivate themselves to take part in regular PA. The combination of fear, lack of knowledge and education has resulted in low self-efficacy in PA, which in turn can lead to low PA levels (Almarwani & Alosaimi, 2023; Casey et al., 2017; Ferrier et al., 2010; Motl et al., 2023b; Motl, Pekmezi, et al., 2018; Silveira et al., 2024). Consequently, authors have strongly recommended that behaviour change strategies such as goal setting, education, and demonstration are incorporated into PA programmes for PwMS (Motl et al., 2009; Motl et al., 2013; Suh et al., 2011)

1.6 Self-Efficacy

Self-efficacy is an individual’s belief in their capacity to execute specific behaviours and reflects their confidence (Bandura, 1997). To enable engagement in adequate levels of PA for self-management, an individual must have confidence in their capacity to complete PA safely.(Motl et al., 2009). Physical activity programmes for PwMS need to be more effective in maintaining motivation and engagement in the longer term by building self-efficacy (Casey et al., 2018; Michie & Johnston, 2012; Motl et al., 2023a).

Studies indicate that PwMS express a willingness to take part in an PA programme, but they tend to discontinue exercising once the programme ends (Dennett, Madsen, et al., 2020; Kinnett-Hopkins et al., 2017; Klaren et al., 2013). This strongly suggests that there has not been a change in long-term health behaviour and highlights the challenge of integrating and sustaining PA into the lives of PwMS (Heesen et al., 2015).

Researchers have proposed that interventions that use behaviour change strategies as defined by the Behaviour Change Technique Taxonomy (BCTT v1) developed by Michie et al. (2013), could support an increase in PA behaviour in MS (Motl, Pekmezi, et al., 2018). In particular, behavioural interventions that focus on self-efficacy and goal setting for PA have been shown to be effective in PwMS (Baird et al., 2021). Studies have shown that incorporating behavioural change strategies have been feasible and effective for promoting and sustaining PA in PwMS (Jeng et al., 2024; Motl et al., 2023b). With increased self-efficacy it has also been proposed that PwMS could manage a substantial amount of their own care if they could be provided with an organised self-management framework that encouraged and supported participation in PA (Lorig & Holman, 2003). This article presents a review of literature that supports the use of improving self-efficacy to increase self-management skills.

1.7 Access to Services

Apart from building exercise self-efficacy, PA services specifically designed for PwMS also need to be accessible. Subsequent to fear and fatigue, the next major barriers to regular participation in PA are the difficulties associated with traveling to hospitals and health care centres, physical mobility issues, fatigue, travel related costs, lack of time and lack of specialised facilities (Correale et al., 2022). In addition, the majority of rehabilitation programmes for MS require several consecutive sessions, adding to the difficulty of attending in-person sessions (Baigi et al., 2024).

People with MS need to have easy access to an exercise programme that incorporates behaviour change strategies (Jeng et al., 2024). Currently, there are few MS-specific PA programmes and very little access to rehabilitation and education on PA for PwMS

(Learmonth & Motl, 2021). This limited access to, and dissatisfaction with, the provision of information on PA is a challenge internationally (Learmonth et al., 2017). However, it is a particular problem in New Zealand with high prevalence of MS, limited public funding especially at diagnosis, and, low numbers of health professionals specialising in MS, with only 11 practices found nationwide which explicitly offer physiotherapy for PwMS (Physiotherapy New Zealand, 2025). Alternative modes of delivering rehabilitation need to be considered to address some of these issues. The World Health Organization is currently supporting the development and expansion of mobile health, which includes online rehabilitation and telerehabilitation, to be more accessible on a global scale (World Health Organization, 2025).

1.8 Online Rehabilitation

One way of improving access to services could be the delivery of PA programmes online. This form of delivery is commonly known as telerehabilitation, telerehabilitation involves the delivery of rehabilitation services at a distance utilising electronic information and communication technologies (Peretti et al., 2017).

Telerehabilitation has the potential to provide strategies to engage, educate, and empower PwMS to maximise self-management (Rae-Grant et al., 2011). Delivering rehabilitation online offers the opportunity for PwMS to access rehabilitation and education from the comfort, convenience, and safety of their homes (Fakolade et al., 2017). A study from 2007 in the United States of America, reported that, at the time, 93% of PwMS used the internet and this proportion was higher than the population without a neurological condition (Weiss, 2007). Wardell et al. (2009) reported that in the United States of America 73% of PwMS had a high interest in using online health-care services and 83% were interested in receiving disease related information and education online.

Several systematic reviews have reported that telerehabilitation programmes can positively increase levels of PA (Amatya et al., 2015; Baigi et al., 2024) and reduce depression for PwMS (Kyriakatis et al., 2023). Telerehabilitation has been shown to be at least as effective as conventional care (face-to-face) (Baigi et al., 2024; Zasadzka et al., 2021). Telerehabilitation has also been shown to be an effective education tool to promote and support PA and quality of life for PwMS (Baigi et al., 2024). In 2023, Motl et al. (2023b), reported that delivering a behavioural intervention based on Social Cognitive Theory via the internet, increased and maintained PA in PwMS. A review by Tallner et al. (2016) reported that the internet can be an effective form of delivery of exercise interventions for PwMS.

There are increasing financial constraints on health care systems and there has been a focus to look at alternative ways of providing services in the long term. Telerehabilitation for PwMS has been shown to reduce health care costs (Yeroushalmi et al., 2020; Zasadzka et al., 2021). It is necessary for PA programmes specifically designed for PwMS incorporating education and behaviour change strategies to be easily accessible (VanNostrand et al., 2025). Stavric et al. (2022) systematic review and meta-analysis suggested that digital health interventions, including online PA programmes, have the potential to provide a sustainable means of delivering continued care and support for individuals with chronic health conditions.

In a recent systematic review, Heesen et al. (2023) reported that there was only one study (Nasseri et al., 2020) that was aimed at increasing PA for PwMS in a self-guided way and this was through a mobile app. This lack of autonomous programmes could be due to several reasons, firstly safety concerns. Secondly the development of and demand for online programmes has only significantly risen during and since the COVID-19 restrictions (Brichetto et al., 2022). Thirdly, therapists concerns that automation, technology, and now artificial intelligence could place their job security at risk (Almyranti et al., 2024).

Heesen et al. (2023) highlighted that online interventions that do not require clinician supervision could be distributed widely and at a low cost. The success of these delivery formats and the demand for online programmes during COVID-19 restrictions (Brichetto et al., 2022) have prompted this current research of an MS exercise and education programme, discussed below.

1.9 MS Get a Head Start

The MS Get a Head Start programme (MSGHS) is an exercise programme that integrates education and behaviour change interventions to enhance PA levels and exercise self-efficacy. The aim of the programme is to establish confidence in PwMS who may perceive barriers to taking part in PA, either through a lack of understanding of the benefits, or concerns exercise may exacerbate their MS symptoms.

It is important when designing and developing a programme for a target population they are included in the early phases to ensure the programme delivers what the end users are looking for. The MSGHS programme was initially developed in a clinical face to face environment. Over the 10 years of being used clinically, modifications and changes were made in response to feedback provided by both PwMS participating in the programme and health professionals providing the programme. Although the MSGHS programme was developed with preliminary questions to PwMS and clinical experience it is not a true co-designed programme. Co-design has been described as equal involvement in development, design, implementation, and evaluation of a service between PwMS, clinical therapists and researchers and other key stakeholders for example health system managers (Vargas et al., 2022). However, the implementation of true co-design with PA programmes and PwMS is not yet routine or widespread (Motl, Pekmezi, et al., 2018; Motl & Pilutti, 2024).

Since 2013, the MSGHS programme has been prescribed and used in the clinical setting, in one-on-one sessions and group-based treatment. MSGHS has been delivered as a land-based exercise programme, hydrotherapy based, or as an online telehealth delivered programme. The MSGHS programme focuses on the delivery of exercises, as current evidence shows that structured exercise programmes improve functional PA more than generalised PA programmes in PwMS (Proschinger et al., 2022). There has been no published research conducted on the programme.

Well supported behaviour change strategies were used in the MSGHS programme, including goal setting, activity diary recording, education, and self-reflections, highlighted by previous systematic reviews as key strategies to include for PwMS (Casey et al., 2017). A range of behavioural strategies were used in the MSGHS programme as there is evidence that a self-guided intervention using strategies from three behaviour change strategy clusters has more potential to produce positive effects on PA levels (McEwan et al., 2019; Stavric et al., 2022).

The MSGHS programme has been developed incorporating values of Te Tiriti o Waitangi including taha whānau (family health), taha tinana (physical health), taha hinengaro (mental), and taha wairua (spiritual health) (Durie, 1985; Ministry of Health, 2025). Throughout the programme, there is active encouragement to include whānau, such as sharing the educational videos and materials with them. The exercise component addresses physical health in addition to educating about diet and healthy lifestyle. The exercise components have been specifically designed to require no equipment to reduce barriers to participation. There is one section focussed entirely on addressing how to care for mental wellbeing, and within this section there is reference to the importance of spiritual health. The MS Get a Head Start programme is a transferable, low-cost exercise programme that has the potential to be integrated into the public health system in New Zealand.

1.10 A Solution to the Physical Inactivity Levels in Multiple Sclerosis

The MSGHS programme will be delivered online autonomously with no therapist interaction, allowing PwMS to participate on their own schedule. This self-guided delivery format will enable PwMS who have faced barriers around access to PA to learn about and be encouraged to engage with PA.

Huynh et al. (2021) reported that there are few behavioural change intervention programmes on PA for those newly diagnosed with MS or early on in the disease duration. This could be a missed opportunity in influencing exercise self-efficacy and PA levels when disease impairments are less severe. It has also been reported that at diagnosis PwMS are already taking up to 40% fewer daily steps than age matched healthy controls (Dlugonski et al., 2013). If PwMS can become more comfortable and less fearful of PA early in the disease course they could take advantage of the benefits of PA for MS earlier.

1.11 Significance of this Study

There is an increasing emphasis on the development of telerehabilitation services to enable increase access to healthcare. This has been highlighted as an aim of the World Health Organisation (World Health Organization, 2025). Health New Zealand's telehealth strategy centres around the vision of telehealth being fully integrated into the health system as a way to deliver care (Health New Zealand, 2025). To date telerehabilitation programmes have been shown to be as effective as in-person rehabilitation programmes at increasing PA levels for PwMS (Baigi et al., 2024; Zasadzka et al., 2021). As far as I am aware the online MSGHS programme and feasibility study is one of the first self-guided fully automated online exercise programmes for PwMS.

The overarching question of this thesis is:

"Is it feasible to deliver the MS Get a Head Start programme online fully automated and what influence will this programme have on physical activity levels and exercise self-efficacy for people living with multiple sclerosis."

This question will be addressed by a feasibility study of a pilot randomised controlled trial. It will provide information to demonstrate if a larger randomised controlled trial can be undertaken or if further development is required, for example recruitment and outcome measurement selection.

1.12 Delimiters

To ensure the study remained focused and manageable, several delimiters were established to define the scope and boundaries of the research. Specifically, the study recruited PwMS who were only mildly physically affected by their condition, to prioritise participant safety during the trial. The intervention was delivered autonomously, with no long-term follow-up, no metadata collection, and no qualitative data gathered. These parameters were set to focus on evaluating the core intervention.

1.13 Objectives

The primary objectives of this thesis were to;

1. Review the existing literature on online exercise programmes and multiple sclerosis.
2. To review the feasibility of the MS Get a Head Start programme regarding recruitment, outcome measure suitability, and usability,
3. To explore trends that the MS Get a Head Start programme would have on self-reported PA levels and exercise self-efficacy.

1.14 Thesis Outline and Structure

This thesis includes one manuscript which sits within the structure.

1.14.1 Chapter One - Introduction

This chapter outlined the background, aims and significance of the research study.

1.14.2 Chapter Two - Literature Review

In this narrative literature review, a systematic search strategy was used to investigate online exercise programmes and MS. This was done to establish any current trends from online exercise programmes aiming to increase PA levels and exercise self-efficacy in PwMS, as well as to inform and contextualise the interpretation of the results obtained from the feasibility study of the online MSGHS programme.

1.14.3 Chapter Three – Methodology and Method

In this chapter, the ontology and epistemological underpinnings of the study are explained. There is a section on my positionality and background. The methods also include the details of how the feasibility study was conducted.

1.14.4 Chapter Four - Results

This chapter includes the manuscript, submitted to the New Zealand Journal of Physiotherapy. The results presented report on the feasibility of the online delivery of the MSGHS programme and trends in changes to PA levels and exercise self-efficacy.

1.14.5 Chapter Five - Discussion

This chapter presents the key findings and their relationship to other current research. The strengths and limitations of the study are discussed, and recommendations are made for the next steps of this research, including the implications of these finding for clinical practice and a larger scale randomised control trial.

1.14.6 Chapter Six - Conclusion

This closing chapter finishes with the conclusion which summarises the research study and its findings.

Chapter 2 - Literature Review

This chapter presents a systematic search and narrative review of the literature on online exercise programmes and MS. The review was undertaken to establish any current trends from online exercise programmes aiming to increase physical activity (PA) levels and exercise self-efficacy in PwMS. As well as to inform and contextualise the interpretation of the results obtained from the feasibility study of the online MSGHS programme.

2.1 Introduction

Physical inactivity levels in PwMS have been well documented by Jeng et al. (2024) and several solutions have been proposed, one of these is to increase access to exercise programmes with online delivery known as telerehabilitation (Baigi et al., 2024). It has been proposed that combining exercise with behaviour change strategies might increase long-term engagement with PA levels with increased exercise self-efficacy (Motl et al., 2023b).

Previous systematic reviews have shown low level evidence that a range of telerehabilitation programmes have been beneficial in improving different aspects of activities and participation in PwMS (Amatya et al., 2015; Baigi et al., 2024; Khan et al., 2015; Yeroushalmi et al., 2020; Zasadzka et al., 2021).

The purpose of this review is to synthesise current evidence on the use of online delivery of exercise programmes. This includes both the online delivery of education and other behaviour change strategies aimed at increasing exercise or PA, and physical exercise programmes designed to increase the PA levels and exercise self-efficacy for PwMS.

An initial search of the literature was undertaken to identify if online exercise programmes can influence exercise self-efficacy in PwMS using the following question: *"Does an online exercise programme increase self-efficacy in people with multiple sclerosis?."* However, only one paper met the inclusion criteria resulting in a review of the research question. Consequently, a broader question was developed: *"Does an* *online exercise programme increase physical activity or physical activity self-efficacy in people with multiple sclerosis?"*

2.2 Method

The search included four databases, MEDLINE, CINAHL, SPORTDiscuss, and SCOPUS and was conducted during November 2024. The search strategy is presented in Table 1. Although the PICO search strategy framework was initially employed, incorporating both comparison and outcome components did not yield a sufficient number of relevant articles. To refine the search, a "NOT" operator was introduced to limit the intervention to online delivery methods, thereby excluding telephone-based interventions, as these delivery modes were considered substantively different.

Table 1

Search Strategy

Concept	Search term	Level of texted searched
Population	"Multiple sclerosis"	Full text
Intervention - What	Exercis* OR "physical activity" OR "physical therapy" OR "physiotherapy"	Abstract
Intervention - How	Online OR tele* OR "E Health" OR virtual OR digital OR remote OR distance OR app OR mobile OR mhealth	Abstract
NOT	Telephone	Title

Inclusion and exclusion criteria are listed in Table 2. Titles of studies were screened initially, if it appeared they met the inclusion criteria, the abstracts were read. Consensus was sought on whether articles met the inclusion and exclusion criteria, with 15% of article abstracts reviewed independently by two supervisors, NS and VS, to ensure rigor and consistency was achieved. In addition, if the primary reviewer (GD) was unsure, then the supervisory reviewers (NS or VS) evaluated the full text.

Table 2

Inclusion and Exclusion Search Criteria

Concept	Inclusion	Exclusion
Study Design		Systematic reviews, expert opinion, design/development of online interventions, qualitative/perceptions of online delivery. Editorials, magazine articles, conference and poster abstracts and non-English language.
Population	multiple sclerosis	If people with MS are in a mixed cohort and their results are not reported separately
Intervention - What	Exercise or education on exercise or PA delivered individually or a group	Only focused on a reduction sedentary behaviour
Intervention - how	Must be delivered digitally or remotely Can be synchronous or asynchronous	Does not have any have any online, remote, or digital delivery. Only telephone interaction or digital tracking monitor only
Intervention - What	Declared or undeclared behaviour change strategies	
Comparison	Any	
Outcome	Physical activity level or volume	
Outcome	Self-efficacy measures that may affect PA levels.	

Results data from the included studies were collected and grouped, and descriptive statistics are reported. For this literature review, only the results relevant to the research question will be reported. Behaviour change strategies used in the studies were analysed using the Behaviour Change Technique Taxonomy (BCTT v1) developed by (Michie et al., 2013).

2.3 Results

The search initially identified 1094 studies, with 556 remaining once duplicates were removed. After screening of titles and abstracts, 75 articles remained, with a further 49 excluded after reading the full text. On review of references, one study not found in the original search was added. This article had used “internet” as a keyword, leading to a repeat search with "internet" added to the search by abstract (Table 1). The first 100 studies were screened. Only one additional reference was found which was a study protocol. This led to confidence that the original search had not missed any pertinent articles.

A total of 26 studies, published between 2008 and 2024, met the inclusion criteria. A flow chart of the article screening and selection process is presented in Figure 2 and specific details of the included studies can be found in Table 3 and 4.

2.3.1 Study Designs

Of the 26 studies, six were randomised controlled studies and eight were non-randomised clinical studies. Seven of the 26 studies were non-inferiority studies, with three of these having both an active control group and a usual care group for comparison. Twelve were feasibility or pilot studies and of those, five were randomised. This high number of feasibility and pilot studies suggests that this is an area of emerging interest. Nineteen studies are listed by their design with details provided in Table 3, and the seven non-inferiority studies are listed in Table 4.

Figure 2

PRISMA Flow Chart of Literature Search Selection Process.

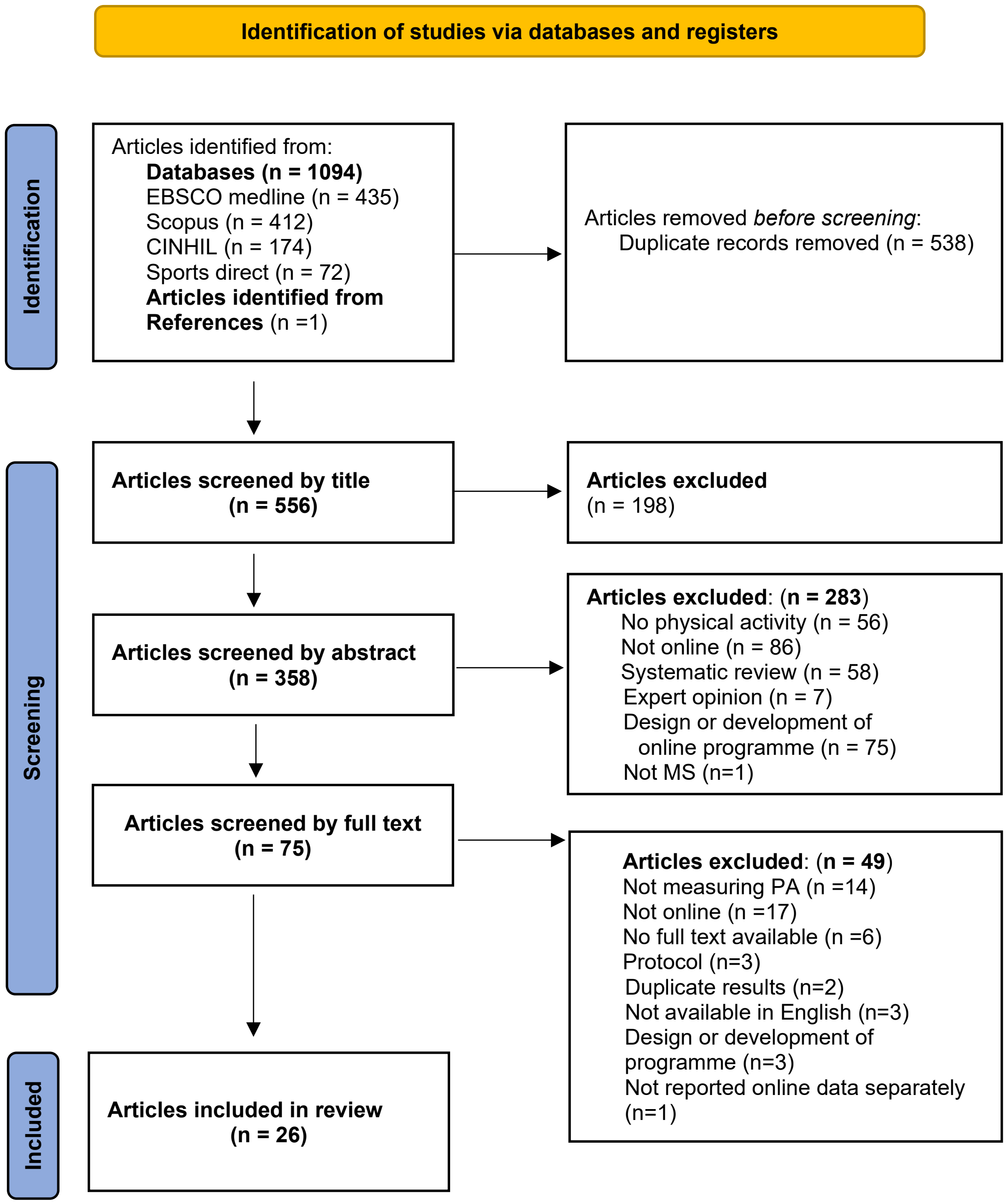


Table 3

Summary of Studies and Telerehabilitation Intervention Details

Study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Main Physical Activity Intervention	Primary Outcome and Outcomes of interest
Controlled Studies (Randomised controlled trials and clinical trials with control group)						
Bruce et al. (2023)	**n = 64** Int (n = 36) Con (n = 35) Female (n= 53) Male (n=11) Age mean and SD (46.7 ± 10.7) PDDS range (0-3) PDDS median/mean (NR)	Synchronous Live online video call Group & individual Education	D = 6 months F = 60 minutes x1 a week group F = 30-45 minutes x1 a month individual Long term follow-up = No	Waitlist control	Education - Participants encouraged to gradually increase physical activity up to 150 min/week of moderate intensity	**Weight Loss** Accelerometery T25FW 6MWT TUG
Cameron et al. (2024)	**n = 78** Int (n = 40) Con (n =38) Female (n= 47) Male (n=31) Age mean and SD (55.4 ± 11.5) EDSS range (5.5-6.5) EDSS median (6)	Synchronous Live online video call Individual Exercise and	D = 6 weeks F = 40 minutes x1 a week Long term follow-up = 8 months	Leaflets provided on falls prevention	Education on walking aid selection, fit, and use. Progressive task-oriented walking training, including, turning, walking on different surfaces, stairs, outdoors, and manual and/or cognitive dual tasks.	**Mean fall rate** IPAQ MGES DGI MSWS

Study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Main Physical Activity Intervention	Primary Outcome and Outcomes of interest
		education				
Conroy et al. (2018)	**n = 51** Int (n = 26) Con (n = 25) Female (n= 30) Male (n= 21) Age mean and SD (51± 8.1) PDDS range (1 to 6) PDDS mean and SD (4.1 ±1.5)	Asynchronous Computer programme Individual Exercise	D = 6 months F = self-directed (encouraged daily) Long term follow-up = No	Home exercise programme provided as paper handout.	MS HAT system is an internet-based education and exercise information and communication platform.	**T25FW** 6MWT BBS MSWS
Eldemir et al. (2024)	**n = 30** Int (n = 15) Con (n = 15) Female (n=28) Male (n=2) Int age mean and SD (41 ± 7.82) Con age mean and SD (38.4 ±10.86) EDSS range (1-4) EDSS mean and SD (1.5 ± 1-3)	Synchronous Live online video call Individual Exercise	D = 6 weeks F = 60 minutes 3 x a week Long term follow-up = No	Waitlist control	Pilates exercises	**Lower limb muscle strength** 6MWT BBS T25FW
Motl et al. (2011)	**n = 54** Int (n = 27)	Asynchronous and synchronous	D = 12 weeks F = calls x 2 a week	Waitlist control	Website education - The content was text and video. Four modules, Getting Started, Planning for	**GLTEQ** ESES

Study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Main Physical Activity Intervention	Primary Outcome and Outcomes of interest
	Con (n =27) Female (n= 43) Male (n= 5) Int age mean and SD (46.1 ± 10.4) Con age mean and SD (45.6 ± 9.2) PDDS range (NR) Int PDDS mean and SD (2.0 ±1.8) Con PDDS mean and SD (2.1 ±1.9)	Website and live calls Individual Education	Website – self directed Long term follow-up = No		Success, Beating the Odds, and Sticking with It, with 10 total Chapters. Additionally conducted chat sessions twice per week.	
Najafi et al. (2023)	**N = 56** Int Pilates (n = 20) Int yoga (n = 19) Con (n = 17) Female (n= 56) Male (n= 0) Age mean and SD (38 ±5.46) EDSS range (NR) EDSS mean and SD (2.5)	Synchronous Live video calls Group Exercise	D = 8 weeks F = 60 minutes x 3 a week Long term follow-up = No	Waitlist control	Online yoga OR Pilates group class.	**Cortisol and prolactin serum levels** IPAQ T25FW
Novotna et al. (2019)	**n = 39** Int (n =23) Con (n = 16) Female (n=19)	Asynchronous Computer game	D = 4 weeks F = 15 minutes daily Long term follow-up =	Waitlist control	Individually tailored home-based balance exercise training using Homebalance®.	**BBS** TUG MSWS GAITRite

Study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Main Physical Activity Intervention	Primary Outcome and Outcomes of interest
	Male (n=10) Int age mean and SD (39.39 ±9.68) Con Age mean and SD (42.56 ±10.63) EDSS range (1.5 -7) Int EDSS median (4) Con EDSS median (3.75)	Individual Exercise	4 weeks			Mini-BESTest Falls efficacy scale ABC
Sandroff et al. (2014)	**n = 82** Int (n =41) Con (n =41) Female (n= 57) Male (n= 17) Age range (NR) Int PDDS >2 age mean and SD (49.0 ±10.0) Int PDDS 3-6 age mean and SD (51.6 ±6.7) Con PDDS >2 age mean and SD (45.4 ±10.1) Con PDDS 3-6 age mean and SD (52.1 ±6.4)	Synchronous & asynchronous Combination of live online video calls and website Individual Education	D = 6 months F = 1 x a week call Long term follow-up = No	Waitlist control	Education for increasing physical activity delivered via the website, and one-on-one video chat sessions with a behaviour change coach.	**SDMT** IPAQ 6MWT

Study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Main Physical Activity Intervention	Primary Outcome and Outcomes of interest
	PDDS range (0-6) PDDS median (NR)					
Vural et al. (2023)	**n = 21** Int (n = 11) Con (n =10) Female (n=17) Male (n=3) Age range (NR) Int Age mean and SD (16.30 ±1.15) Con Age mean and SD (17.40 ±1.57) EDSS range (NR) Int EDSS mean and SD (1.2 ±0.78) Con EDSS mean and SD (1.65 ±0.81)	Synchronous Live online video call Group Exercise	D = 8 weeks F = 60 minutes x 2 a week Long term follow-up = 32 weeks	Waitlist control	Exercise program via Zoom that included aerobics, strengthening, and balance exercises.	**GLTEQ** Step count 6MWT TUG Muscle strength T25FW
			Feasibility or Pilot Studies with control group			
Nasseri et al. (2020)	**n = 38** Int (n = 18) Con (n = 20) Female (n= 20)	Asynchronous Mobile App	D = 12 weeks F = Self-paced Long term follow-up = No	Participants received a leaflet with non-specific information about	Smart phone with education app including activity feedback, texts, figures and videos	**2MWT** **6MWT** T25FW Timed Tandem Walk

Study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Main Physical Activity Intervention	Primary Outcome and Outcomes of interest
	Male (n= 19) Age range (NR) Int Age mean and SD (49.6 ±8.5) Con Age mean and SD (52.5 ±7.3) EDSS range (2.5 -6) EDSS median (3.5)	Individual Education		exercising in general.		5x Sit to Stand MSWS Actigraph GLTEQ Feasibility = self rated comprehensibility and usability.
Paul et al. (2014)	**n = 30** Int (n = 15) Con (n = 15) Female (n= 24) Male (n= 6) Age range (NR) Age mean and SD (51.7 ±11.2) EDSS range (NR) EDSS mean and SD (5.9 ±0.5)	Synchronous and Asynchronous Website and phone calls Individual Exercise and education	D = 12 weeks F = 2 x a week Long term follow-up = No	Usual care	Individualised therapeutic exercise programmes. Participants were telephoned weekly and exercise programmes altered remotely by the physiotherapist as required. The website consists of exercise pages and an advice section.	**T25FT** BBS TUG
Feasibility or Pilot Studies with No control						
Chanpimol et al. (2020)	**n = 10** Female (n= 8)	Asynchronous	D = 12 weeks F = 30 minutes x3 a	Nil	Exergaming (Jintronix®) telerehabilitation intervention.	**Feasibility = adherence and self rated**

Study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Main Physical Activity Intervention	Primary Outcome and Outcomes of interest
	Male (n= 2) Age range (NR) Age mean and SD (49.6 ±9.0) EDSS range (3.5 -6) PDDS median (5)	Video game Individual Exercise	week Long term follow-up = No			**satisfaction** T25FW 2MWT MSWS
Finkelstein et al. (2008)	**n = 12** Female (n= 10) Male (n= 2) Age range (NR) Age mean and SD (52 ±4) PDDS range (2 -5) PDDS mean and SD (3.7 ±1.1)	Asynchronous Computer programme Individual Exercise and education	D = 12 weeks F = Self directed Long term follow-up = No	Nil	The MS HAT programmed is an internet-based education and exercise information and communication platform to prescribed personalized exercise programmes.	**T25FW** 6MWT BBS MSWS MSSE
Huynh et al. (2024)	**n = 16** Female (n= 13) Male (n= 3) Age range (25-67) Age mean and SD (41.9 ±12.2) PDDS range (NR) PDDS median (1)	Synchronous Live online video call Individual Education	D = 12 weeks F = 30 minutes x 7 throughout the trial Long term follow-up = No	Nil	Participants were given a program manual. Newsletters were provided that targeted components of the COM-B model (Capability-Opportunity-Motivation-Behaviour model). Participants further received one-on-one coaching calls (15–30 min each) with a trained behaviour coach, targeting components of the	**Feasibility = process, resource, management, and scientific metrics.** GLTEQ IPAQ

Study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Main Physical Activity Intervention	Primary Outcome and Outcomes of interest
					COM-B model.	FStep count
Stephens et al. (2022)	**n = 15** Female (n= 13) Male (n= 2) Age range (NR) Age mean and SD (16.6 ±1.2) EDSS range (NR) EDSS median (1.5)	Asynchronous Mobile App Individual Education	D = 12 weeks F = self-directed and x 3 calls Long term follow-up = No	Nil	ATOMIC app – education on increasing PA. Coaches supported with phone sessions and through text messaging through the app to support PA change.	**Feasibility = accrual rates, dropout rates, adherence rates, adverse event rates, proportion of completed study questionnaires**. Accelerometery Self-efficacy PA enjoyment
Van Geel et al. (2020)	**n = 19** *Female (n= 12) Male (n= 0) Age range (35-65) Age median (42.5) PDDS or EDSS (NR)	Asynchronous Mobile App Individual Exercise	D = 10 weeks F = Self directed Long term follow-up = No	Nil	Individualised goals were set for each person at initial testing. Using the WalkWithMe mobile app users track their walking activities and follow up on progress. The app gives feedback during walking with verbal feedback by the virtual coach towards the personal goal. Participants started the first week by walking at least two times a week.	**IPAQ** **6MWT** T25FW MSWS 5xSTS

Study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Main Physical Activity Intervention	Primary Outcome and Outcomes of interest
					Each week a maximum of five minutes was added.	
Vetrovska et al. (2024)	**n = 22** Female (n= 22) Male (n= 0) Age range (28-70) Age median (47) EDSS range (1.5-6.5) EDSS median (3)	Synchronous Live online video call Group Exercise	D = 12 weeks F = 45 minutes + 30 minutes x 2 a week Long term follow-up = 24 weeks	Nil	Pilates exercise combined with 30 min of aerobic activity based on participants’ preferences.	**Self-efficacy** **ABC** Sit to stand 1 Leg standing
			No control group studies			
Daniel et al. (2024)	**n = 43** Female (n= 35) Male (n= 8) Age range (NR) Age mean and SD (49.5 ±9.29) PDDS range (NR) PDDS mean and SD (2.2 ±1.47)	Asynchronous Website Individual Education	D = 12 weeks F = Self directed Long term follow-up = No	Nil	Activity Matters encourages participants to engage in a self-chosen PA in their living environment, the web-based programme guides them in eleven "structured modules"	**Feasibility Questionnaire** GLTEQ Niggs PA**
Jeong et al. (2020)	**n = 17** Female (n= 15) Male (n= 2) Age range (39-76)	Asynchronous Computer programme	D = Average of 20 weeks F = Self-directed	Not reported	The HAT programmed presented prescribed personalized exercise programme.	**Feasibility = total system usage time** 2MWT

Study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Main Physical Activity Intervention	Primary Outcome and Outcomes of interest
	Age median (NR) PDDS range (NR) PDDS median (NR)	Individual Exercise and education				

Bold, primary outcome; 2MWT, 2 minute Walk Test; 6MWT, 6 minute walk test; ABC, Activities Balance Confidence Scale; BBS, Berb Balance Scale; Con, control; DGI, Dynamic Gait Index; EDSS, Expanded Disability Status Scale; ESES, Exercise Self-Efficacy Scale; GLTEQ, Godin Leisure Time Exercise Questionnaire; HAT, home automated telemanagement; int, intervention; IPAQ, International Physical Activity Questionnaire; MGES, Modified Gait Efficacy Scale; MSSE, Multiple Sclerosis Self-Efficacy; MSWS, Multiple Sclerosis 12 point Walking Scale; N, number of participants; NR, not reported; PDDS, Patient-Determined Disease Steps; SD, Standard deviation; SDMT, Symbol Digit Modalities Test; T25FW, Timed 25-foot walk; TUG, Timed Up and Go; * number of participants not fully reported; **based on descriptive reporting of a version modified by the authors.

Table 4

Summary of Non-Inferiority Studies and Telerehabilitation Intervention Details.

Study	Type of study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Active control group	Online Physical Activity Intervention	Primary Outcomes and Outcome of interest
				Studies with both active control group and usual care group studies				
Fjeldstad-Pardo et al. (2018)	Feasibility pilot study	**n = 30** Int (n = 10) Con 1 (n = 10) Active con (n= 9) Female (n= 20) Male (n= 9) Age range (NR) Age mean and SD (54.7 ±12.3) EDSS range (NR) EDSS mean and SD (4.3 ±1.1)	Synchronous Live online video call Individual Exercise	D = 8 weeks F = 2 x a week Long term follow-up = No	Unsupervised customised home-based exercise program 5 days a week (control group)	In-person physiotherapy at medical facility twice weekly	1:1 individualised telecommunication exercise programme twice weekly.	**FGA** T25FW BBS MS SES ABC

Study	Type of study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Active control group	Online Physical Activity Intervention	Primary Outcomes and Outcome of interest
Kaur et al. (2024)	Clinical trial	**n = 72** Int GE (n= 24) Int AE (n = 24) Con (n = 24) Female (n= 64) Male (n=8) Age range (25-72) Age mean and SD (43.8 ±11.6) PDDS range (0-4) PDDS mean and SD (1.2 ±1.3)	Synchronous and Asynchronous Live online video calls and computer programme Individual Exercise and education	D =16 weeks F = 6 x a week exercise with 7 online calls over the duration Long term follow-up = 11 months	Usual care	Advanced Exercise, (AE) who at screening did meet the current recommendations. Progressive aerobic and strength programme based on MS exercise guidelines via clinical coaches online.	General Exercise (GE) who at screening did not meet current exercise recommendations. Progressive aerobic and strength programme based on MS exercise guidelines via clinical coaches online.	**GLTEQ** ESES ABC MSWS Feasibility = recruitment adherence, communication, cost, data management, and scientific outcomes

Study	Type of study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Active control group	Online Physical Activity Intervention	Primary Outcomes and Outcome of interest
Leavitt et al. (2021)	Pilot randomised controlled trial	**n = 28** Int eFit (n = 11) Int eJournal (n=6) Con (n = 11) Female (66.7%) Male (33.3%) Age range (23-64) Age mean and SD (44.1 ±11.3) EDSS range (0-6) Int Efit EDSS mean and SD (2.5 ±1.9) Int Ejou EDSS mean and SD (1.0 ±0.9) Con EDSS mean and SD (1.9 ±1.3)	Synchronous Live video calls Group Education	D = 12 weeks F = 60 minutes 2 x a week	Usual care	eJournal participants completed independent weekly online structured journaling.	eFIT participants joined live online group session and received education focusing on the benefits of PA.	**Feasibility = completion of surveys and adherence** IPAQ

Study	Type of study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Active control group	Online Physical Activity Intervention	Primary Outcomes and Outcome of interest
Gutiérrez et al. (2013)	Randomised controlled trial	**n = 50** Int (n = 25) Con (n = 25) Female (n= 27)* Male (n= 20)* Int age mean and SD (39.69 ± 8.13) Con age mean and SD (42.78 ± 7.38) EDSS range (3-5) EDSS median (NR)	Synchronous video game Individual Exercise	D = 10 weeks F = 20 minutes 4 x a week Long term follow-up = No	N/A	Physiotherapy treatment 2x a week (40 min per session)	Rehabilitation treatment using the Xbox 360® console monitored via videoconference.	**BBS** Tinetti

Study	Type of study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Active control group	Online Physical Activity Intervention	Primary Outcomes and Outcome of interest
Tarakci et al. (2021)	Randomised controlled trial	**n = 30** Int (n = 20) Con (n = 21) Female (n= 23) Male (n= 7) Age range (NR) Int Age mean and SD (39.46 ±10.59) Con Age mean and SD (41 ±11.09) EDSS range (NR) Int EDSS mean and SD (3.46 ±1.13) Con EDSS mean and SD (3.40 ±11.09)	Synchronous Live online video call Individual Exercise	D = 12 weeks F = 3 x a week Long term follow-up = No	N/A	In person structured supervised exercise group completed under the supervision of a physical therapist.	A structured home-based exercise program customised for each participant. Participants received an individual video call 3 x a week to check adherence and revise exercises. Additionally, participants visited the physiotherapy department once a month to check and revise their exercises. The same exercises were prescribed for both groups.	**FIM- total**

Study	Type of study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Active control group	Online Physical Activity Intervention	Primary Outcomes and Outcome of interest
Adamson et al. (2024)	Feasibility or Pilot Studies with control group	**n = 22** Int (n = 11) Con (n = 11) Female (n=16) Male (n= 6) Age range (NR) Age mean and SD (50.8 ±12.5) EDSS range (0-6+) EDSS median (NR)	Synchronous Live online video call Group Exercise	D = 12 weeks F = 60 minutes twice a week Long term follow-up = No	N/A	Seated Pilates group class	Seated Pilates group also incorporated hip and shoulder-cuff activation exercises.	**Feasibility = process, management and scientific feasibility** GLTEQ T25W TUG BBS

Study	Type of study	Number of participants and EDSS or PDDS	Delivery method	Intervention duration (D) Frequency of delivery (F)	Control group	Active control group	Online Physical Activity Intervention	Primary Outcomes and Outcome of interest
Grosserová et al. (2024)	Feasibility or Pilot Studies with control group	**n = 20** Int (n = 10) Con (n = 10) Female (n= 18) Male (n= 2) Age range (NR) Int Age mean and SD (50.7 ±11.1) Con Age mean and SD (45 ±7.2) EDSS range (NR) Int EDSS mean and SD (5.35 ±1.0) Con EDSS mean and SD (5.35 ±1.0)	Synchronous Live online video call Individual Exercise	D = 12 weeks F = 45 minutes x 2 a week Long term follow-up = No	N/A	Conventional outpatient physiotherapy 4–6 individual sessions of 60 minutes. And provided daily home exercises (minimum 15 minutes) .	Live individual physiotherapy programme consisting of balance and strength exercises.	**BBS** TUG 1 Leg standing MSWS ABC FES-I

Bold, primary outcome; 2MWT, 2 minute Walk Test; 6MWT, 6 minute walk test; ABC, Activities Balance Confidence Scale; BBS, Berb Balance Scale; Con, control; DGI, Dynamic Gait Index; EDSS, Expanded Disability Status Scale; ESES, Exercise Self-Efficacy Scale; GLTEQ, Godin Leisure Time Exercise Questionnaire; HAT, home automated telemanagement; int, intervention; IPAQ, International Physical Activity Questionnaire; MGES, Modified Gait Efficacy Scale; MSSE, Multiple Sclerosis Self-Efficacy; MSWS, Multiple Sclerosis 12 point Walking Scale; N, number of participants; NR, not reported; PDDS, Patient-Determined Disease Steps; SD, Standard deviation; T25FW, Timed 25-foot walk; TUG, Timed Up and Go; * number of participants not fully reported; **based on descriptive reporting of a version modified by the authors.

2.3.2 Study Participants

Sample sizes ranged between 10 and 82 participants, and all included only PwMS. Twenty-four studies covered a large adult age range and two were aimed at younger PwMS (Stephens et al., 2022; Vural et al., 2023). One study recruited only females (Najafi et al., 2023). One focused on newly diagnosed (Huynh et al., 2024). Participant details, including age, are in Table 3.

2.3.3 Disability Status

Disability status was recorded using two different measures, the Expanded Disability Status Scale (EDSS) or the Patient Determined Disease Steps (PDDS). The PDDS has been shown to correlate closely with the EDSS and removes the need for the participants to complete an in-person assessment by a neurologist (Ann Marrie et al., 2022). Sixteen of the 26 studies used the EDSS and eight used the PDDS to report disability status. Two did not report disability status (Jeong et al., 2020; Van Geel et al., 2020). The EDSS scores ranged between 0 and 7 (EDSS scale 0-9) and the PDDS scores ranged between 0 and 6 (PDDS scale 0-8), displayed in Table 3. In ten studies, participants had lower disability scores, scoring less than 4 on the EDSS or PDDS (Bruce et al., 2023; Daniel et al., 2024; Eldemir et al., 2024; Huynh et al., 2024; Kaur et al., 2024; Leavitt et al., 2021; Motl et al., 2011; Najafi et al., 2023; Stephens et al., 2022; Vural et al., 2023). Two studies included participants with higher disability levels who scored over 5 on the EDSS (Cameron et al., 2024; Paul et al., 2014).

2.3.4 The Included Studies' Interventions

Duration and Frequency of Intervention

There was a range of duration of interventions with the shortest being 4 weeks (Novotná et al., 2022) and the longest 6 months (Bruce et al., 2023; Conroy et al., 2018; Sandroff et al., 2014). The majority of studies (N=19) lasted between eight and 16 weeks.

Eight studies delivered their intervention twice a week. Five studies had a frequency of three times a week (Chanpimol et al., 2020; Eldemir et al., 2024; Najafi et al., 2023; Stephens et al., 2022; Tarakci et al., 2021) and six studies' frequency was self-directed (Conroy et al., 2018; Daniel et al., 2024; Finkelstein et al., 2008; Jeong et al., 2020;

Nasseri et al., 2020; Van Geel et al., 2020). The remaining studies' delivery frequency ranged from daily to fortnightly and these results are detailed in Tables 3 and 4.

Five studies had a follow-up between 4 weeks and 11 months after the end of the intervention (Cameron et al., 2024; Kaur et al., 2024; Novotna et al., 2019; Vetrovska et al., 2024; Vural et al., 2023).

Intervention Delivery

Nineteen studies provided individual programmes, or the participant accessed the programme as an individual, detailed in Tables 3 and 4. Six delivered group-based programmes (Adamson et al., 2023; Bruce et al., 2023; Leavitt et al., 2021; Najafi et al., 2023; Vetrovska et al., 2024; Vural et al., 2023). One study delivered a combination of group and individual input (Sandroff et al., 2014). Nine studies delivered their intervention asynchronously, 13 synchronously and four used a combination of asynchronous and synchronous delivery (Kaur et al., 2024; Motl et al., 2011; Paul et al., 2014; Sandroff et al., 2014).

The type of digital delivery of the interventions was live online video calls for 12 of the studies, three studies delivered the intervention via a computer game (Chanpimol et al., 2020; Gutiérrez et al., 2013; Novotna et al., 2019), three studies delivered the intervention via a computer programme (Conroy et al., 2018; Finkelstein et al., 2008; Jeong et al., 2020), three further studies delivered the intervention via a mobile App (Nasseri et al., 2020; Stephens et al., 2022; Van Geel et al., 2020), and one study via a website (Daniel et al., 2024). There were four studies that delivered a combination of live video calls with a computer website or programme (Kaur et al., 2024; Motl et al., 2011; Paul et al., 2014; Sandroff et al., 2014) (see Table 3 and 4).

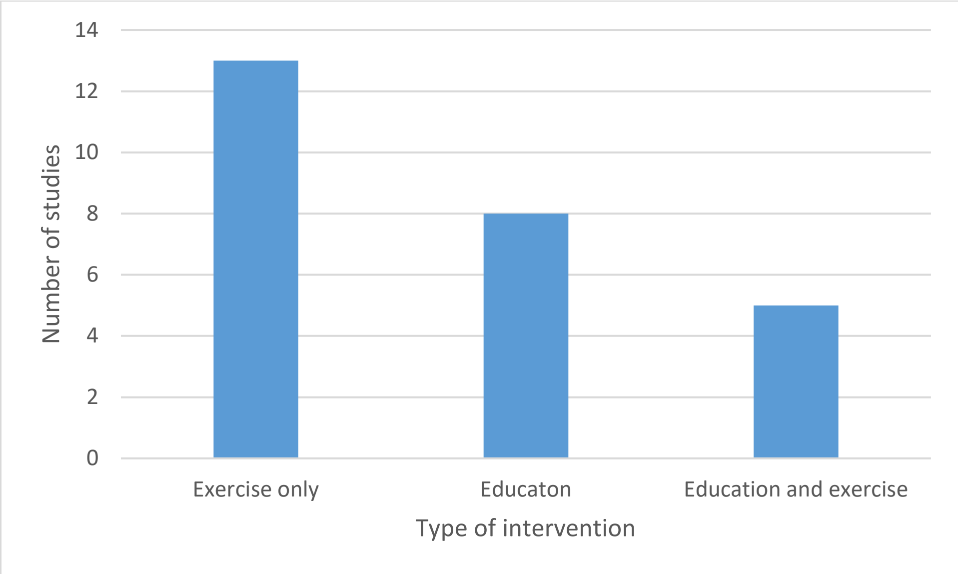
2.3.5 Intervention Content

Exercise or Education Content

Thirteen studies provided exercise-only interventions and eight provided education-only (Bruce et al., 2023; Daniel et al., 2024; Huynh et al., 2024; Leavitt et al., 2021; Motl et al., 2011; Nasseri et al., 2020; Sandroff et al., 2014; Stephens et al., 2022), the remaining five studies provided a combination of exercise and education (Cameron et al., 2024; Finkelstein et al., 2008; Jeong et al., 2020; Kaur et al., 2024; Paul et al., 2014) detailed in Figure 3. While education may be classified as a behavioural strategy, this review focused on a broader conceptualisation of 'educational approach' in terms of the studies' methods of intervention delivery. The aim was to investigate whether a combined approach incorporating both education and exercise was associated with more favourable outcomes.

Figure 3

Type of Intervention – Exercise or Education



Behaviour Change Strategies Content

Of the 26 studies, eight declared the use of some form of behaviour change strategies to increase PA levels or exercise self-efficacy. However, the majority, 16 studies did not decare intentional use of any behaviour change strategies. When coding the interventions using the BCTTv1 taxonomy as a guide, a wide range of behaviour change strategies were noted to be used in all the studies. Details are provided in Table 5.

Of the eight that did declare the use of some form of behaviour change strategies, only one study provided a combination of exercise and education (Kaur et al., 2024). The remaining seven provided education only. As a contrast 12 of the 13 studies providing a combination of exercise and education did not declare using a behaviour change strategy.

Table 5

Behaviour Change Strategies

	Goals and planning	Feedback and monitoring	Social Support	Shaping knowledge	Natural consequences	Comparison of behaviour	Association	Repetition and substitution	Comparison of outcome	Reward and threat	Antecedents	Self-Belief
Declared behaviour strategies												
Bruce et al. (2023)	X	X	X	X	X	X	X	X	X	X		X
Daniel et al. (2024)	X	X	X	X	X	X	X		X	X		X
Huynh et al. (2024)	X	X		X	X	X	X	X	X		X	X
Kaur et al. (2024)	X	X	X	X	X	X	X	X	X			X
Leavitt et al. (2021)	X	X	X	X	X	X	X	X	X	X		X
Motl et al. (2011)	X	X	X	X	X	X	X	X	X			X
Sandroff et al. (2014)	X	X	X	X	X	X	X	X	X		X	X
Stephens et al. (2022)	X	X	X	X	X	X	X	X	X		X	X
Undeclared behaviour strategies												
Adamson et al. (2024)	X	X		X		X		X				X
Cameron et al. (2024)	X	X		X			X	X	X		X	X
Chanpimol et al. (2020)	X	X		X							X	
Conroy et al. (2018)	X	X		X		X	X	X	X			X
Eldemir et al. (2024)	X			X		X		X				X

	Goals and planning	Feedback and monitoring	Social Support	Shaping knowledge	Natural consequences	Comparison of behaviour	Association	Repetition and substitution	Comparison of outcome	Reward and threat	Antecedents	Self-Belief
Finkelstein et al. (2008)	X	X		X		X	X	X	X			X
Fjeldstad-Pardo et al. (2018)	X	X		X		X		X				X
Grosserová et al. (2024)	X	X		X		X		X	X			X
Gutiérrez et al. (2013)	X	X		X				X				
Jeong et al. (2020)	X	X		X		X	X	X	X			X
Najafi et al. (2023)	X	X	X	X		X		X		X		X
Nasseri et al. (2020)	X	X		X	X		X	X				
Novotna et al. (2019)	X	X		X				X		X	X	
Paul et al. (2014)	X	X		X	X	X		X	X			X
Tarakci et al. (2021)	X	X		X		X		X	X			X
Van Geel et al. (2020)	X	X		X			X	X			X	
Vetrovska et al. (2024)	X	X		X		X	X	X	X			X
Vural et al. (2023)	X	X	X	X		X		X	X			X

The behaviour change strategies described in the Table 5 are part of a comprehensive list based on the Behaviour Change Technique Taxonomy (BCTT v1) developed by (Michie et al., 2013). X = behaviour strategies used in study.

2.3.6 Control Groups

Seven of the 26 studies were non-inferiority studies (Table 4). Of these, three studies compared an active control group and usual care group to the intervention group. Fjeldstad-Pardo et al. (2018) had two active control groups, an unsupervised home exercise programme or an in-person physiotherapy group. Leavitt et al. (2021) compared the intervention to a usual care control group and an active control group of weekly structured journaling. The active control used the same psychoeducational modules as the intervention group but omitted the accountability content. Kaur et al. (2024) compared providing telerehabilitation coaching to either a low active group, a high active group or a usual care group. Three further studies provided in-person physiotherapy exercise as an active control group (Grosserová et al., 2024; Gutiérrez et al., 2013; Tarakci et al., 2021), one study provided online seated Pilates as a comparison (Adamson et al., 2024).

Three studies out of the twenty-six studies provided a passive control group for comparison (Table 3). Of these, one provided a leaflet on falls prevention (Cameron et al., 2024) and one on general PA guidelines (Nasseri et al., 2020). One study provided individualised exercise prescription on a paper handout (Conroy et al., 2018).

Ten of the included studies used either a waitlist control or usual care group (Table 3), and seven did not use any form of control group (Chanpimol et al., 2020; Daniel et al., 2024; Finkelstein et al., 2008; Huynh et al., 2024; Stephens et al., 2022; Van Geel et al., 2020; Vetrovska et al., 2024). One study did not report if a control group was used or not in their investigation (Jeong et al., 2020).

2.3.7 Outcome Measurements

Measurement of Physical Activity

A range of outcome measures were used to record PA ability or level. Any change in exercise or PA outcome measurements were considered relevant in this review as they would in turn have the potential to improve PA level. For example, an improvement in balance measured by the Berg Balance Scale could lead to an increase in mobility due to safer mobility, an improvement in the time of a 25-foot walking test, could potentially lead to increased PA level. This meant that Tarakci et al. (2021) was included in this literature review as they used the Functional Independence Measure (FIM). An improvement in the total FIM score demonstrates an increase in the functional status which could lead to increased PA levels.

Twenty studies used thirteen different PA outcome measures (Table 6). The PA outcome measures used most were the Timed 25-foot walk test used in 12 studies. The Berg Balance Test was used in nine studies (Adamson et al., 2024; Conroy et al., 2018; Eldemir et al., 2024; Finkelstein et al., 2008; Fjeldstad-Pardo et al., 2018; Grosserová et al., 2024; Gutiérrez et al., 2013; Novotna et al., 2019; Paul et al., 2014), and the 6-minute walk test was used in eight (Bruce et al., 2023; Conroy et al., 2018; Eldemir et al., 2024; Finkelstein et al., 2008; Nasseri et al., 2020; Sandroff et al., 2014; Van Geel et al., 2020; Vural et al., 2023).

Fourteen studies specifically measured PA level. Two measures were used most frequently. The Godin Leisure-Time Exercise Questionnaire (GLTEQ) was used in seven studies, (Adamson et al., 2024; Daniel et al., 2024; Huynh et al., 2024; Kaur et al., 2024; Motl et al., 2011; Nasseri et al., 2020; Vural et al., 2023) and the International Physical Activity Questionnaire (IPAQ) was used by six studies (Cameron et al., 2024; Huynh et al., 2024; Leavitt et al., 2021; Najafi et al., 2023; Sandroff et al., 2014; Van Geel et al., 2020). The other measures included accelerometery (Bruce et al., 2023; Nasseri et al., 2020; Stephens et al., 2022), step count (Huynh et al., 2024) and NIGGs Physical Activity (Daniel et al., 2024), details are provided in Table 6.

Measurement of Self-Efficacy

Thirteen studies measured exercise self-efficacy (Cameron et al., 2024; Chanpimol et al., 2020; Conroy et al., 2018; Finkelstein et al., 2008; Fjeldstad-Pardo et al., 2018; Grosserová et al., 2024; Kaur et al., 2024; Motl et al., 2011; Nasseri et al., 2020; Novotna et al., 2019; Stephens et al., 2022; Van Geel et al., 2020; Vetrovska et al., 2024). There was a range of additional self-efficacy measures used, details provided in Table 6.

2.4 Study Results

The results of the studies were reported using a range of different statistics, including p-values, confidence intervals, and Cohen's D. Relevant results are reported verbatim in Tables 6 and 7. To accommodate the diversity of the statistical methods used and the way results were reported and to optimise interpretability, outcomes in Tables 6 and 7 have been categorised as either 'likely to have an effect' or 'unlikely to have an effect' on increasing PA levels or exercise self-efficacy for PwMS." Further details including study design, screening, dropouts, and adverse events will also be discussed in the following sections.

Of the twenty studies that reported on a PA outcome measure, sixteen reported that an online exercise programme was likely to have an effect on improving a that outcome. Fourteen studies reported on PA levels; with ten reporting an online exercise programme was likely to have an effect on improving a PA levels.

Five studies reported that both a PA outcome measure and PA level together were likely to be improved with an online exercise programme (Cameron et al., 2024; Najafi et al., 2023; Sandroff et al., 2014; Van Geel et al., 2020; Vural et al., 2023).

Thirteen studies reported on exercise self-efficacy and, of these, only two reported that an online exercise programme was likely to have an effect on exercise self-efficacy (Grosserová et al., 2024; Kaur et al., 2024).

Three studies measured all three areas, PA outcome measures, PA levels and exercise self-efficacy, and none of them reported a positive outcome across all three areas (Cameron et al., 2024; Nasseri et al., 2020; Van Geel et al., 2020).

The following results will be reported by study design and outcomes and detailed in Tables 6 and 7.

Table 6

Results of Studies

Study	Physical activity outcome measure		Physical activity level		Self-efficacy measure	
	Likely to have an effect	Unlikely to have an effect	Likely to have an effect	Unlikely to have an effect	Likely to have an effect	Unlikely to have an effect
Controlled Studies (Randomised controlled trials and clinical trials with control group)						
Bruce et al. (2023)		T25FW 6MWT TUG	Accelerometery			
Cameron et al. (2024)	Mean fall rate	Self-assessed DGI	IPAQ = sub scores: Walking (days/week)	IPAQ = sub scores: Walking (minutes/week) Moderate exercise (minutes/week) Vigorous exercise (minutes/week)		MGES MSWS = NR
Conroy et al. (2018)		T25FW 6MWT BBS				MSWS
Eldemir et al. (2024)	Lower limb muscle Strength 6MWT BBS	T25FW				

Study	Physical activity outcome measure		Physical activity level		Self-efficacy measure	
	Likely to have an effect	Unlikely to have an effect	Likely to have an effect	Unlikely to have an effect	Likely to have an effect	Unlikely to have an effect
Motl et al. (2011)			GLTEQ			ESES
Najafi et al. (2023)	T25FW		IPAQ			
Novotna et al. (2019)	BBS Mini-BESTest	TUG GAITRite				Falls efficacy scale ABC MSWS
Sandroff et al. (2014)	6MWT		IPAQ			
Vural et al. (2023)	6MWT TUG Muscle strength	T25FW	Step count GLTEQ			
Feasibility or Pilot Studies with control group						
Nasseri et al. (2020)		T25FW 2MWT 6MWT Timed Tandem Walk 5x Sit to Stand		Actigraph GLTEQ		MSWS
Paul et al. (2014)		T25FT BBS TUG				
Feasibility or Pilot Studies with No control						

Study	Physical activity outcome measure		Physical activity level		Self-efficacy measure	
	Likely to have an effect	Unlikely to have an effect	Likely to have an effect	Unlikely to have an effect	Likely to have an effect	Unlikely to have an effect
Chanpimol et al. (2020)	T25FW 2MWT					MSWS
Finkelstein et al. (2008)	T25FW 6MWT BBS					MSSE MSWS
Huynh et al. (2024)			GLTEQ IPAQ	Step count		
Stephens et al. (2022)				Accelerometery		Self-efficacy PA enjoyment
Van Geel et al. (2020)	5xSTS	6MWT T25FW	IPAQ = sub scores: Leisure time Walking			MSWS
Vetrovska et al. (2024)	Sit to stand	1 Leg standing				Self-efficacy ABC
No control group studies						
Daniel et al. (2024)			GLTEQ Niggs PA*			
Jeong et al. (2020)	2MWT					

Dark shaded area indicates outcome category not tested in the study; Light shaded area indicates no reported outcome within this category;2MWT, 2 minute Walk Test; 6MWT, 6 minute walk test; ABC, Activities Balance Confidence Scale; BBS, Berg Balance Scale; DGI, Dynamic Gait Index; ESES, Exercise Self-Efficacy Scale; FIM-total, Functional Independence Measure Total; GLTEQ, Godin Leisure Time Exercise Questionnaire; IPAQ, International Physical Activity Questionnaire; MGES, Modified Gait Efficacy Scale; MSSE, Multiple Sclerosis Self-Efficacy; MSSES, Multiple Sclerosis Self-Efficacy Scale; MSWS, Multiple Sclerosis 12 point Walking Scale; T25FW, Timed 25 foot walk; Tinett, Tinett Balance Scale; TUG, Timed Up and Go.

Table 7

Non-Inferiority Study Results

Non-inferiority Studies			
Study	**Physical activity outcome measure** Likely to have an effect	**Physical activity level** Likely to have an effect	**Self-efficacy measure** Likely to have an effect
Fjeldstad-Pardo et al. (2018)	Comparison to active control; FGA ↔ T25FW ↔ BBS ↔		Comparison to active control; MSSE ↔ ABC↔
	Comparison to usual care group; FGA ↔ T25FW ↔ BBS ↔		Comparison to usual care group; MSSE ↓ ABC ↓
	Comparison to baseline (within group): FGA ↑ T25FW ↓ BBS ↑		Comparison to baseline: MSSE ↓ ABC ↓
Kaur et al. (2024)		Comparison to active control; GLTEQ ↔	Comparison to active control; ESSE ↔ ABC ↔ MSWS ↔

Non-inferiority Studies			
Study	**Physical activity outcome measure** Likely to have an effect	**Physical activity level** Likely to have an effect	**Self-efficacy measure** Likely to have an effect
Leavitt et al. (2021)		Comparison to usual care group; GLTEQ ↔ Comparison to baseline: GLTEQ ↓ Comparison to active control; IPAQ ↔ Comparison to usual care group; IPAQ ↑ Comparison to baseline: IPAQ ↑	Comparison to usual care group; ESSE ↑ ABC ↔ MSWS ↑ Comparison to baseline: ESSE ↑ ABC ↓ MSWS ↑
Gutiérrez et al. (2013)	Comparison to active control; BBS ↑ Tinetti ↑ Comparison to baseline: BBS ↑ Tinetti ↑		

Non-inferiority Studies			
Study	**Physical activity outcome measure** Likely to have an effect	**Physical activity level** Likely to have an effect	**Self-efficacy measure** Likely to have an effect
Tarakci et al. (2021)	Comparison to active control; FIM- total ↔ Comparison to baseline: FIM-total ↑		
Adamson et al. (2024)	Comparison to active control; T25W ↔ TUG ↔ BBS ↑ Comparison to baseline: T25W ↓ TUG ↓ BBS ↑	Comparison to active control; GLTEQ ↔ Comparison to baseline: GLTEQ ↓	
Grosserová et al. (2024)	Comparison to active control; TUG ↑ BBS ↑ 1 Leg standing ↑ MSWS ↑ Comparison to baseline: TUG ↑ BBS ↑		Comparison to active control; ABC ↑ FES-I ↔ Comparison to baseline: ABC ↑ FES-I ↓

Non-inferiority Studies			
Study	**Physical activity outcome measure** Likely to have an effect	**Physical activity level** Likely to have an effect	**Self-efficacy measure** Likely to have an effect
	1 Leg standing ↑ MSWS ↑		

Dark shaded area, this was not tested in this study; ↑ likely to have an effect; ↔ Equal (non-inferior) to active control or usual care; ↓ unlikely to have an effect; 2MWT, 2 minute Walk Test; 6MWT, 6 minute walk test; ABC, Activities Balance Confidence Scale; BBS, Berb Balance Scale; DGI, Dynamic Gait Index; ESES, Exercise Self-Efficacy Scale; FES-I, Falls Efficacy Scale – International; FIM-total, Functional Independence Measure Total; GLTEQ, Godin Leisure Time Exercise Questionnaire; IPAQ, International Physical Activity Questionnaire; MGES, Modified Gait Efficacy Scale; MSWS, Multiple Sclerosis 12 point Walking Scale; T25FW, Timed 25 foot walk; Tinett, Tinett Balance Scale; TUG, Timed Up and Go

Controlled Studies (Randomised Controlled Trials and Clinical Studies with a Comparative Control Group)

Physical Activity Outcome Measurements

Details of these findings can be found in Table 6. Of the nine controlled studies, six demonstrated one or more PA outcome measurements were likely to have improved due to an online exercise programme compared to a control group. There was likely to be an effect in the 6MWT (Eldemir et al., 2024; Sandroff et al., 2014; Vural et al., 2023), muscule strength (Eldemir et al., 2024; Vural et al., 2023), BBS (Eldemir et al., 2024; Novotna et al., 2019) mean fall rate (Cameron et al., 2024), T25FW (Najafi et al., 2023) and the mini-BESTest (Novotna et al., 2019). However of these six studies, four also reported that other PA outcome measures were unlikely to show an effect compared to the control group following an online exercise programme (Cameron et al., 2024; Eldemir et al., 2024; Novotna et al., 2019; Vural et al., 2023). Two studies reported that an online exercise programme was unlikely to have an effect compared to a control group (Bruce et al., 2023; Conroy et al., 2018). These outcomes inlcuded T25FW, 6MWT, TUG, BBS, Gaitrite and the self assessed DGI.

One of the nine controlled studies did not report on a PA outcome measurement (Motl et al., 2011).

Physical Activity Level

The six studies that reported on PA levels all reported that an online exercise programme was more likely than the control group to increase PA levels. However, one of these six studies only demonstrated a positive result by reporting the IPAQ in sub scores and the total IPAQ would actually have been unlikely to have shown an effect (Cameron et al., 2024).

Three of the controlled studies did not report on PA level (Conroy et al., 2018; Eldemir et al., 2024; Novotna et al., 2019).

Self-Efficacy

Four of the nine controlled studies reported on exercise self-efficacy, each of these studies reported that an online exercise programme unlikely to affect exercise self-efficacy levels (Cameron et al., 2024; Conroy et al., 2018; Motl et al., 2011; Novotna et al., 2019).

Feasibility and Pilot Studies

Although the studies conducted by Nasseri et al. (2020) and Paul et al. (2014) were not powered to find a significant change, they do compare between-group results. See Table 6 for details.

Physical Activity Outcome Measurements

Both Nasseri et al. (2020) and Paul et al. (2014) reported that an online exercise programme was unlikely to have an effect.

Physical Activity Level

Nasseri et al. (2020), using the GLTEQ and Actigraph, reported that the online intervention group was unlikely to have an effect compared to a control group that was provided an education leaflet on general exercise. Paul et al. (2014) did not report on PA levels.

Self-Efficacy

Nasseri et al. (2020) reported that the online intervention group was unlikely to have an effect on exercise self-efficacy compared to a control using the MSWS. Paul et al. (2014) did not report on exercise self-efficacy.

Feasibility and Pilot Studies with no Control

These six studies were also not powered to find a significant change and only reported on within group differences. See Table 6 for details.

Physical Activity Outcome Measurements

Four out of six studies reported on PA outcome measurements within group, these four all reported the online exercise programmes were likely to have an effect with improvements in T25FW (Chanpimol et al., 2020; Finkelstein et al., 2008), sit to stand (Van Geel et al., 2020; Vetrovska et al., 2024), 2MWT (Chanpimol et al., 2020), the 6MWT and BBS (Finkelstein et al., 2008). These four studies each also demonstrated one or more PA outcome measurements that were unlikely to have been affected by the intervention (Table 6).

Physical Activity Level

Three out of the six feasibility and pilot studies with no control group reported on PA levels. Two reported that an online exercise programme is likely to have an effect

(Huynh et al., 2024; Van Geel et al., 2020) and one reported unlikely to have an effect (Stephens et al., 2022).

Self-Efficacy

Five out of the six studies reported on exercise self-efficacy and these all reported that an online exercise programme is unlikely to have an effect, this was over a range of exercise self-efficacy measures, MSWS (Chanpimol et al., 2020; Van Geel et al., 2020), MSSE and MSWS (Finkelstein et al., 2008), PA enjoyment (Stephens et al., 2022), and ABC scale (Vetrovska et al., 2024).

No Control Studies

Two clinical studies reported within group only results due to no control group. See Table 6 for details.

Physical Activity Outcome Measurements

Jeong et al. (2020) reported an improvement in the 2MWT that is likely to have been an effect of an online exercise programme.

Physical Activity Level

Daniel et al. (2024) reported that their intervention was likely to have an effect when comparing within group results.

Self-Efficacy

Neither study reported on exercise self-efficacy.

Non-Inferiority Studies

The seven non-inferiority studies are reported in Table 7 and compare an online exercise programme to active control (Table 4).

Physical Activity Outcome Measurements

Five studies reported on a PA outcome measurement. Gutiérrez et al. (2013) and Grosserová et al. (2024) both reported a likely effect of a online intervention with all their PA outcome measurements (BBS, Tinetti, TUG, 1 leg standing and MSWS) compared to the active control groups. Although Grosserová et al. (2024) study would not have been powered to find a statistical difference as a pilot study. Three studies reported that the online intervention was equal to standard in-person rehabilitation.

The results of the intervention group were as effective as the active control groups and all groups demonstrated an improvement in at least one PA outcome measurement from basline BBS and FGA (Fjeldstad-Pardo et al., 2018), BBS (Adamson et al., 2024), and the FIM-total (Tarakci et al., 2021).

Physical Activity Level

Three of the seven non-inferiority studies report on PA levels. Leavitt et al. (2021) reported that the online intervention group was as effective as the active control group, but more effective when compared to the usual care group in the IPAQ. Kaur et al. (2024) and Adamson et al. (2024) both reported that the online intervention was as effective as the active control group using the GLTEQ, however neither study reported a statistically significant change compared to usual care or baseline.

Self-Efficacy

Three of the seven non-inferiority studies reported on exercise self-efficacy (Fjeldstad-Pardo et al., 2018; Grosserová et al., 2024; Kaur et al., 2024). Fjeldstad-Pardo et al. (2018) reported that the online intervention was unlikely to have an effect on exercise self-efficacy using the MSSE and ABC and this was an equal result in the in-person therapy group. However, the third comparison group of unsupervised home-based exercises did improve their self-efficacy.

Kaur et al. (2024) reported a likely effect of the online intervention compared to usual care in the ESSE and MSWS. When compared the general exercise and the advance exercise were equally effective.

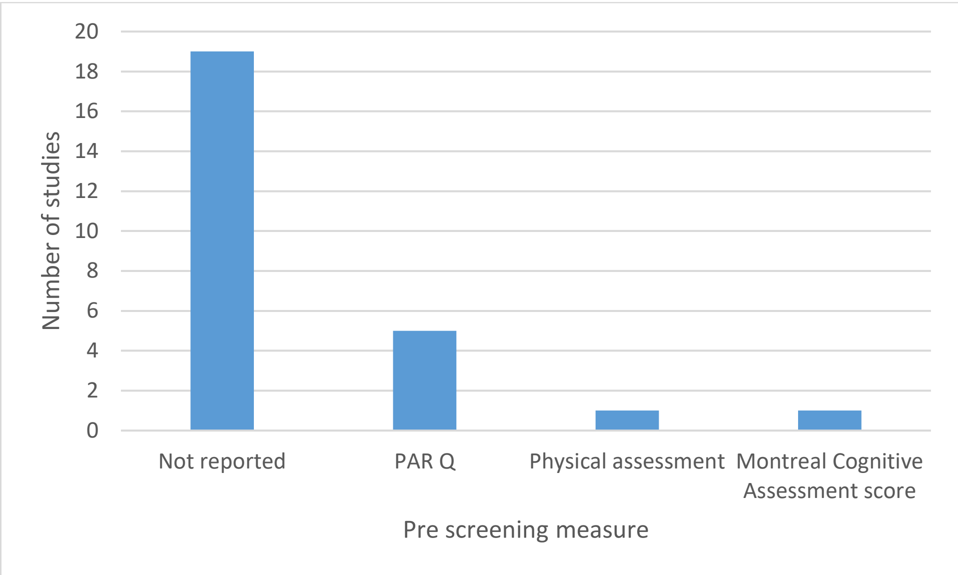
Grosserová et al. (2024) reported that the online intervention group was likely to have an effect on the ABC scale but not the FES-I, again caution needs to be taken interpreting these results as the study was not adequately powered to find a significant difference, being a pilot study.

2.4.1 Initial Safety Screening

Participating in an online exercise programme has potential risks to the participant if their past medical history or ability to participate in exercise is unknown. Studies often have robust exclusion criteria that include past medical history to mitigate risk, but this does not ensure the participant is safe to participate in PA. Due to the remoteness of online delivery, if an adverse event occurred there could be a significant delay in accessing medical attention compared to a face to face programme. Of the 26 included studies, only seven reported using a screening tool prior to participating in a PA or exercise programme (Adamson et al., 2024; Chanpimol et al., 2020; Huynh et al., 2024; Leavitt et al., 2021; Motl et al., 2011; Sandroff et al., 2014; Stephens et al., 2022). Out of these seven studies, one used a neurologist and exercise physiologist assessment (Stephens et al., 2022), and one study completed a cognitive screen (Chanpimol et al., 2020) to ensure participants had the cognitive capacity to participate in an exergaming programme. The remaining five of these studies used the Physical Activity Readiness Questionnaire. These results are reflected in Figure 4.

Figure 4

Pre-Screening for Safety to Participate in an Online Physical Activity Programme.



2.4.2 Drop-Out Rate

Recording dropout rates is important to understand acceptability and engagement, as well as to assess the potential for attrition bias, reductions in statistical power, or concerns about safety if many adverse events and dropouts occur. Providing dropout rates increases the transparency and trustworthiness of a study. While analyses such as intention-to-treat (ITT) and per-protocol (PP) can help interpret the impact of dropouts, by showing effects under real-world conditions (ITT) versus ideal adherence (PP), this literature review did not examine this level of detail.

Seven studies reported no participants drop out (Adamson et al., 2024; Chanpimol et al., 2020; Eldemir et al., 2024; Finkelstein et al., 2008; Grosserová et al., 2024; Jeong et al., 2020; Novotna et al., 2019). One study did not report on the number of participants who dropped out (Vetrovska et al., 2024). The remaining eighteen studies reported how many participants either dropped out or were lost of follow up, details provided in Table 8. Five studies reported a greater than 25% drop out rate (Conroy et al., 2018; Huynh et al., 2024; Kaur et al., 2024; Tarakci et al., 2021; Van Geel et al., 2020).

Table 8

Number of Participants that Dropped Out of Each Study at the Follow up.

Study	Number of participants	Number of participants that dropped out or lost to follow up	Percentage of reported dropouts
Adamson et al. (2023)	22	0	0%
Bruce et al. (2023)	64	7	11%
Cameron et al. (2024)	78	3	4%
Chanpimol et al. (2020)	10	0	0%
Conroy et al. (2018)	51	27	53%
Daniel et al. (2024)	43	4	9%
Eldemir et al. (2024)	30	0	0%
Fjeldstad-Pardo et al. (2018)	30	1	3%
Grosserová et al. (2024)	20	0	0%
Gutiérrez et al. (2013)	50	3	6%
Huynh et al. (2024)	16	4	25%
Jeong et al. (2020)	17	0	0%
Kaur et al. (2024)	72	21	29%
Leavitt et al. (2021)	28	5	18%
Motl et al. (2011)	54	5	9%
Najafi et al. (2023)	56	11	20%
Nasseri et al. (2020)	38	4	11%
Novotna et al. (2019)	39	0	0%
Paul et al. (2014)	30	1	3%
Sandroff et al. (2014)	82	6	7%
Stephens et al. (2022)	15	2	13%

Tarakci et al. (2021)	30	11	37%
Van Geel et al. (2020)	19	7	37%
Vetrovska et al. (2024)	22	NR	NR
Vural et al. (2023)	21	4	19%

NR, Not reported.

2.4.3 Adverse Events

It is important with all PA programmes that safety is monitored, particularly when delivering online interventions as the participant may be alone if an issue occurred. If online exercise programmes are to be recommended alongside standard face to face delivery the participant needs to be reassured that the risks of participating in the programme are minimal. Hence gathering accurate information on adverse events is essential (Dalgas et al., 2020). Out of the 26 studies, 13 did not report monitoring for adverse events (Conroy et al., 2018; Daniel et al., 2024; Finkelstein et al., 2008; Gutiérrez et al., 2013; Jeong et al., 2020; Leavitt et al., 2021; Motl et al., 2011; Najafi et al., 2023; Nasseri et al., 2020; Sandroff et al., 2014; Tarakci et al., 2021; Van Geel et al., 2020; Vetrovska et al., 2024). Nine monitored for adverse events and reported none (Adamson et al., 2024; Chanpimol et al., 2020; Eldemir et al., 2024; Fjeldstad-Pardo et al., 2018; Grosserová et al., 2024; Kaur et al., 2024; Novotna et al., 2019; Stephens et al., 2022; Vural et al., 2023). Four studies reported adverse events had occurred, however none of the events was linked to the intervention (Bruce et al., 2023; Cameron et al., 2024; Huynh et al., 2024; Paul et al., 2014).

2.5 Discussion

This narrative literature review summarised results from 26 studies that delivered a form of an online exercise programme for PwMS. The majority of studies reported that an online exercise programme was likely to positively influence PA levels but not exercise self-efficacy for PwMS.

There was strong support that online exercise programmes are at least as effective as traditional face to face programmes on PA levels. All the non-inferiority studies reported that the online delivery was as effective as an active control, and two studies reported that the online exercise programme was superior to an active control group (Grosserová et al., 2024; Gutiérrez et al., 2013). Systematic reviews by Baigi et al.

(2024) and Zasadzka et al. (2021) reported similar results, showing that telerehabilitation was as least as effective as the conventional face to face care.

Out of the 26 studies only 14 specifically measured PA levels, whereas 20 of the studies used some form of PA outcome measure. I used a working assumption that an improvement in a PA outcome measure had the potential to positively influence overall PA levels; this proposes that if someone has increased lower limb strength, balance or walking speed there is a possibility that they would then participate in more PA. However, this is speculative and there can be a non-linear relationship between physical fitness, and activity and participation (Bruseghini et al., 2020), hence further studies need to be completed specifically measuring PA levels, not just PA outcome measurements. The results of this review are similar to Adnan et al. (2024) who reported in their scoping review that the majority of their included studies for PwMS, 80% (43 studies) did not measure PA levels. A systematic review by Rintala et al. (2018) reported that although online exercise programmes for PwMS had a large effect on PA, they had no effect on improving walking outcomes. There was a wide range of outcome measures used in their included studies, which made synthesis of findings difficult. A systematic review by Amatya et al. (2015), found that there is a need for more research to establish a stronger consensus on suitable outcome measures of PA levels in PwMS.

The majority of studies in this review reported a positive effect of online exercise programmes on PA outcomes and PA levels. This is similar to other systematic reviews on telehealth programmes for PwMS. Amatya et al. (2015) found 10 out of 12 telerehabilitation studies reported a positive change in PA levels. The systematic review by Baigi et al. (2024) supports that most studies demonstrated a significant improvement in PA levels, PA outcome measurements and self-efficacy in telerehabilitation groups versus control groups, and Tallner et al. (2016) in a literature review reported that the internet can be effective for delivery of exercise interventions for PwMS.

The synthesis of the results demonstrated that exercise self-efficacy was unlikely to be influenced by online exercise programmes. It has been hypothesised that providing education on PA and using behaviour change strategies such as the social cognitive theory would help to improve exercise self-efficacy in PwMS (Baird et al., 2021; Motl, Pekmezi, et al., 2018). However, from the reviewed studies, the eight studies that declared a focus on behaviour change strategies, only one of them reported a positive result on exercise self-efficacy (Kaur et al., 2024). The one study, Kaur et al. (2024) that did combine education and exercise with focused behaviour change strategies did report a result of their online exercise programme being likely to positively affect exercise self-efficacy. The remaining seven of the eight studies only provided education, this might account for the lack of impact on exercise self-efficacy.

There is a potential that education combined with exercise and the implementation of purposeful behaviour change strategies would have had a more positive outcome on exercise self-efficacy (Motl et al., 2023b), demonstrated in the Kaur et al. (2024) study. However, combining education and exercise without purposeful behaviour change strategies such as goal setting and reflection did not demonstrate favourable results in exercise self-efficacy. The studies that declared using a behaviour change strategy all used a wide range of the taxonomy clusters. Many used Social Support and Natural Consequences strategies consistently, compared to those that did not declare using behaviour change strategies. Social Support cluster includes a programme that provides either practical or emotional support, such as encouragement and counselling (Michie et al., 2013). El Kirat et al. (2024) reported in their recent scoping review that Social Support has been shown to be one of the most common and effective techniques to increase PA levels in physically inactive populations including people with and without an underlying health condition. On the other hand, Natural Consequences cluster, which include information about health consequences of performing a behaviour (Michie et al., 2013), rarely emerges as a key driver for increasing PA levels, particularly when compared with clusters such as Social Support, Goal setting, Feedback and Monitoring (Nadal et al., 2024).

It has been reported that using strategies from three behaviour change strategy clusters are needed to produce effects on PA in both face-to-face and self-guided interventions in the general population (McEwan et al., 2019) and chronic health conditions (Stavric et al., 2022). One recent study by Motl et al. (2023a) providing a 6-month online programme for PwMS using intentional declared behaviour change strategies, did demonstrated an improvement in exercise self-efficacy, supported by a further analysis paper Motl et al. (2023b). However, the results of this literature review demonstrated that adding a declared behaviour change strategy did not increase exercise self-efficacy in PwMS through an online intervention. When comparing the (Motl et al., 2023a) study to the studies in this literature review there does not seem to be any obvious difference in participant demographics or intervention delivery. A possible explanation for the decline seen in the self-reported exercise self-efficacy, proposed by Motl et al. (2011), is that participants may initially overestimate their physical activity self-efficacy, and that later assessments represent a more accurate self-appraisal as their awareness and understanding increase throughout the course of the intervention.

Fjeldstad-Pardo et al. (2018) in a non-inferiority study compared an online individualised programme delivered twice a week, to an in-person programme delivered in a clinic twice a week and to an unsupervised home programme (encouraged to be completed 5 days a week). All three groups demonstrated significant improvements in PA outcome measures, with no between group differences. However, of interest the only group that made improvements in the exercise self-efficacy measures was the unsupervised home programme group. The authors speculated that this result may be secondary to personal empowerment after successfully completing an 8-week exercise programme without direct supervision.

Grosserová et al. (2024) conducted the only study to report significant between group differences in both PA outcome measures and exercise self-efficacy. Their live individual online exercise programme was found to be superior to a conventional outpatient rehabilitation programme. This was a pilot study, and it will be interesting to see the effect when investigated in a fully powered study.

Fifty percent of the studies evaluated in this review were either feasibility or pilot studies, reflecting a growing interest in delivering exercise programmes online. This trend suggests a strengthening of research quality in the field, likely influenced by the consensus recommendations provided by Dalgas et al. (2020). These were aimed at improving the methodological rigor of exercise research in MS, by the implementation of robust pilot and feasibility studies as essential precursors to larger trials (Dalgas et al., 2020). These recommendations built upon earlier work by Learmonth and Motl

(2017), which outlined critical considerations for designing feasibility studies in PA research involving PwMS. They emphasised recruitment strategies, participant adherence, safety, and acceptability of interventions.

There was still a large number of studies (N=13) that did not report on adverse events, and the majority of studies (N=19) did not report perform any pre-screening safety checks. This low level of safety has been previously highlighted by Dalgas et al. (2020) who stipulates that future research needs to ensure safety is paramount. Out of the 13 studies that did not report on adverse events, three of these also reported over 25% dropout rate (Conroy et al., 2018; Tarakci et al., 2021; Van Geel et al., 2020). This raises ethical concerns around why the participants did not continue with the intervention, was there injuries or ill health caused by the intervention.

There was a significant variation across the online exercise programmes in content, duration, and the use of behaviour change strategies. This makes it difficult to determine whether it is any more likely of an improved outcome between education only, exercise online or combined education and exercise programmes. High levels of heterogeneity of characteristics, type, and mode of delivery of the interventions, outcome measurements, treatment, and control protocols have been raised in previous systematic reviews on PwMS (Adnan et al., 2024; Amatya et al., 2015). This limits the ability to know which type of online exercise programme would be most influential, although the diverse delivery methods may be more real-life and hence increase generalisability. In the systematic review by Rintala et al. (2018) they reported that they were unable to determine if different delivery methods of telerehabilitation lead to differing outcomes and suggested that similar positive effects on PA levels in PwMS might occur regardless of the type of telerehabilitation delivery.

The majority of the studies (N=17) in this review required regular therapist input or time by providing online delivery synchronously. It would be valuable to know if positive results can be achieved from fully asynchronous and ultimately automated online exercise programmes; this would enable a greater access to the programmes. Out of the nine that were delivering online content asynchronously in this review, three still provided regular weekly online communication from therapists with participants (Conroy et al., 2018; Finkelstein et al., 2008; Jeong et al., 2020). The six remaining asynchronous studies included three mobile apps (Nasseri et al., 2020; Stephens et al., 2022; Van Geel et al., 2020), a video game (Chanpimol et al., 2020), a computer game (Novotna et al., 2019) and a website (Daniel et al., 2024). However, all of them had some form of health professional interaction at the start or the end of the programme. None of the non-inferiority studies used an asynchronous delivery method. The asynchronous studies results were equally as likely to have an effect in increasing PA levels as the synchronous studies.

2.6 Strengths and Limitations of the Narrative Review

The strength of this narrative review is the comprehensive search followed a structured systematic process with strict inclusion criteria. The results and trends reported are similar to other systematic reviews within this area of interest. As discussed, the content was clinically heterogeneous, the potential strength is that it is real world, and findings can be applied more generally which can then be easier for larger deliver of the online intervention.

The limitations of this review include that this is a narrative review, I did not assess the quality of the studies as it was outside of the scope of this review. Twelve of the 26 studies were either pilot or feasibility studies and lack the adequate power to provide a statistically significant result, and two studies had no control group for comparison and so only reported within-group changes.

2.7 Conclusion

This narrative literature review shows that online exercise programmes are likely to increase PA levels in PwMS, however, there was no impact of on exercise self-efficacy for PwMS. Online exercise programmes are also as effective as traditional in person rehabilitation. The online delivery of exercise programmes is a practical real world option that could enable more PwMS to access information on how to participate in PA alongside managing their MS. Framed within the ICF model, such interventions have the potential to impact not only body functions but also activity and participation, supporting a more holistic approach to health and quality of life for PwMS.

Chapter 3 - Methodology and Method

This chapter outlines the methodological approach adopted and details the methods used in the research study. This includes the research design, data collection procedures, and data analysis methods to objectively examine the feasibility and impact of the online MS Get a Head Start (MSGHS) programme on PA levels and exercise self-efficacy in PwMS.

3.1 Research Paradigm

The quantitative descriptive approach employed in this study sits within the positivist paradigm. This paradigm assumes a single, objective reality that can be measured and understood through empirical observation (Creswell & Creswell, 2017). The study which is exploring the feasibility of the online MSGHS programme uses a deductive approach, testing the pre-established hypothesis, that the online MSGHS programme will increase PA levels with increased exercise self-efficacy in PwMS.

Data were collected using valid and reliable quantitative outcome measurements. Quantitative measures are integral to the logico-deductive scientific method typical of the positivist paradigm. Quantitative measures enable accurate testing of theoretical hypothesis through observable, measurable data (Bryman, 2016; Kerlinger, 1986) that align with the positivist paradigm and quantitative descriptive approach that help answer the research question.

3.2 The Online Delivery of MS Get a Head Start

To date, I am not aware of a study that has looked at a programme for PwMS with a fully automated online delivery. This form of delivery has been shown to have good immediate effects and sustained improvement in PA for people with other chronic health conditions, particularly if it includes behavioural strategies (Stavric et al., 2022).

The online MSGHS programme (www.ms-ghs.com) was delivered autonomously allowing PwMS to participate on their own schedule anywhere in New Zealand with an internet connection. This style of delivery will enable a larger number of PwMS to access PA resources and with less time demand on health professionals compared with previous telerehabilitation programmes.

A pilot randomised controlled trial was selected as the most appropriate design to test the feasibility of the online MSGHS programme, as it allows preliminary evaluation of feasibility, acceptability, and retention within a controlled framework. Unlike observational or uncontrolled designs, a pilot randomised controlled trial provides early insight into the programme's potential efficacy while identifying methodological challenges, such as recruitment, adherence, and outcome measure completion, before scaling to a fully powered larger randomised controlled trial. This design is particularly valuable for digital, self-guided interventions in PwMS, where engagement patterns and attrition rates are known challenges (Motl et al., 2011; Tallner et al., 2016). The pilot randomised controlled trial therefore offers a rigorous yet pragmatic approach to refine procedures and inform the design of a future adequately powered randomised controlled trial.

Ethical approval 24/7 was granted on 28th May 2024 see Appendix A – ethics approval letter.

3.2.1 Aims

The aim of this feasibility study of the pilot randomised controlled trial of the online MSGHS programme is to explore the feasibility of recruitment, outcome measure suitability, and usability, and to explore initial trends in self-reported PA levels and exercise self-efficacy in PwMS. These could be used to inform sample size calculation if a fully powered randomised control trial is undertaken at a later date.

3.2.2 Recruitment and Eligibility

The sample size for this feasibility study was based on the rule of thumb where if the data being considered are ordinal or continuous, a sample size of approximately 35 participants for the pilot study is proposed. However, as this is a feasibility study and the ability to recruit sufficient participants was also investigated, there was a cutoff recruitment time of 8 weeks. If a minimum number of 20 participants had not signed up to the study by this cut off an extension could have occurred.

Recruitment for the study occurred through distribution of an advertising flyer (appendix B) and social media post (appendix C). These contain a QR code and clickable link that took interested PwMS to a webpage containing the participant information sheet (appendix D) and a short video describing the intervention programme (appendix E). Recruitment information was also sent to neurologists, MS nurses, MS Regional Societies, MS New Zealand, MS New Zealand Research Trust, and the Physiotherapy New Zealand Neuro Special Interest Group.

People with MS who indicated interest by emailing the primary researcher (GD) were sent a link to complete screening questionnaires (appendix F and G). Both the Physical Activity Readiness Questionnaire (Thomas et al., 1992) and the Patient-Determined Disease Steps screening measure (Ann Marrie et al., 2022; Learmonth et al., 2013) were used to establish whether they meet the inclusion criteria (see Table 9). Eligibility was determined through online screening with no in-person interaction. Current PA volumes did not influence eligibility.

Table 9

Participant Inclusion Criteria

Inclusion criteria	**Exclusion criteria**
Have a diagnosis of MS	Self-report inability to follow a remote video led exercise programme
Score between 0-4 on the Expanded Disability Status Scale (EDSS) score if known and score 3 or less on the Patient-Determined Disease Steps questionnaire	Have had a relapse within the last 3 months
Score “no” to all questions on the Physical Activity Readiness Questionnaire. If a “yes” was scored on the first question, they can seek medical approval from their GP. They will not be considered if they scored “yes” on any of the other questions	Are not able to access the internet on a twice-weekly basis to watch the videos
Men and women aged 18 to 70 years	Have previously been treated clinically by primary author (GD) or already participated in the MSGHS programme
Able to get on and off the ground independently	Have heart disease, high blood pressure, any respiratory condition (mild asthma excluded), any illness, infection or injury that prevents them from participating in a PA programme
Have access to the internet	

Those who chose to participate and met the inclusion criteria completed the consent form online (appendix H). Participants were then randomised to the intervention or control group using a computer random number generator.

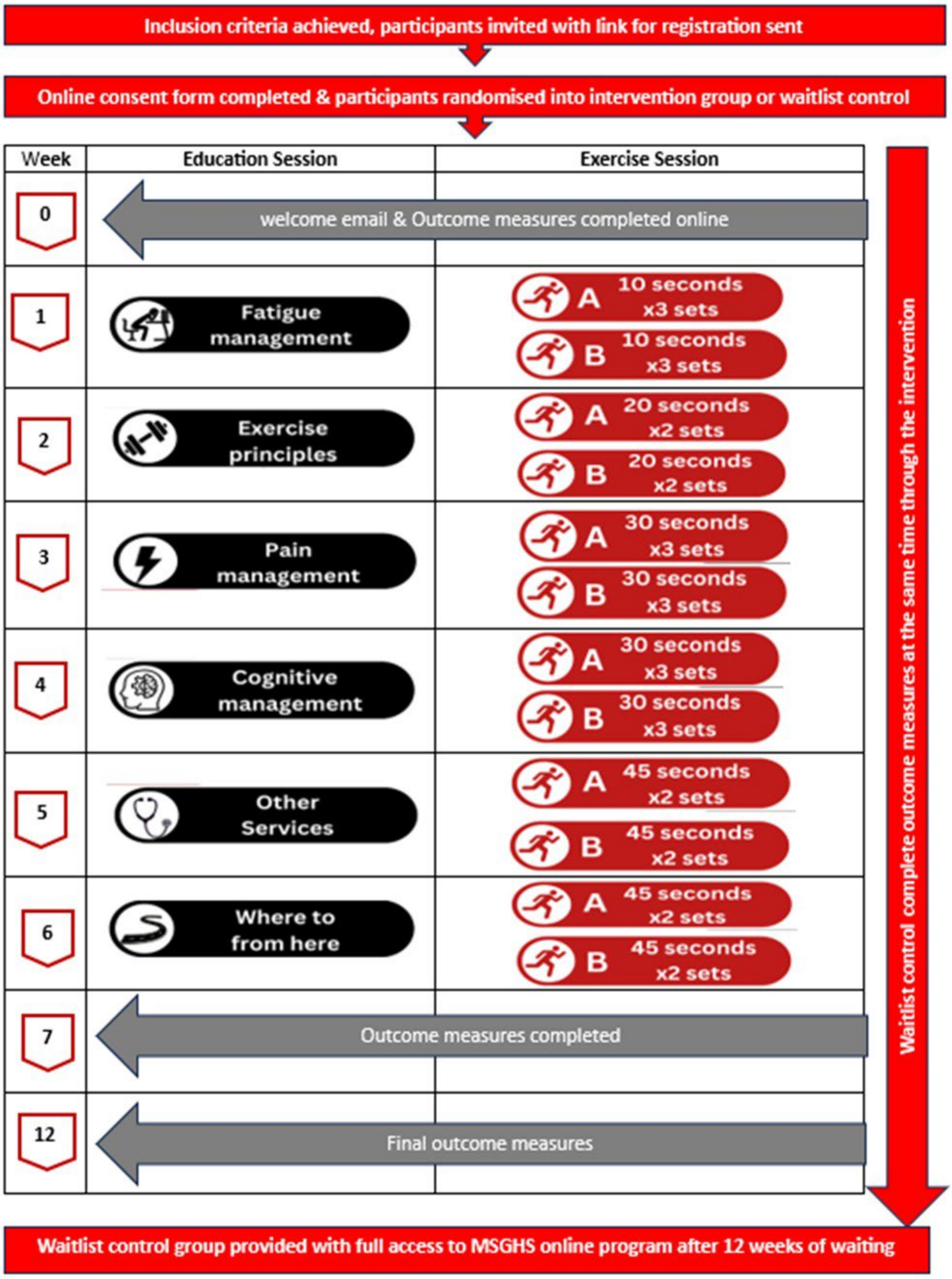
3.2.3 Intervention Procedures

The MSGHS six-week interval-based exercise and education programme was delivered online via pre-recorded videos. There is a 20-minute welcome and introduction video that outlines what participants should expect (appendix E). It covers information on proactive heat sensitivity management and how to set up a safe exercise space. Each subsequent week participants received an automated email with links to two interval-based exercise videos and one education video (appendix E).

There are nine exercises in each video that cover strength, balance, fitness, and core stability. Participants were encouraged to complete the two exercise videos each week and were welcome to repeat these videos if they choose. The six educational videos cover a range of topics that cover MS symptoms and practical management strategies: 1. Fatigue management, 2. Exercise prescription, 3. Pain management, 4. Cognitive and psychological well-being, 5. Multi-disciplinary services, and 6. “Where to from here?”, helping participants consider how to continue with long-term PA. See Figure 5. for details of the study progression.

Figure 5

Participant Progression Through the MS Get a Head Start Pilot Programme



Each of the weekly emails detailed coursework for that week. Participants had a choice of receiving an online course handbook or a physical copy posted to them. The handbook provided contained all the material that supports the educational videos (appendix E). The handbook featured several behavioural change strategies, including goal setting, activity diary recording, weekly reflections, education, and problem-solving solutions (Michie & Johnston, 2012). After the programme finished at week 6, participants also received an automated motivational email fortnightly between week six and week 12, encouraging then to keep physically active. Full details of the programme can be found in the appendix I and J. Appendix I - Template for intervention description and replication (TIDierR) and appendix J for MS Get a Head Start Online Delivery – Exercises delivered Supplementary material which was provided for the appendix of the manuscript in Chapter 4.

Completing the online MSGHS programme takes approximately 2.5 hours each week. This includes the two exercise sessions (both approximately 45 minutes), the education session (approximately 45 minutes), and the course work (60 minutes). Participants were encouraged to have a sturdy chair and either an exercise mat or a towel /rug on which they could complete floor exercises. No further exercise equipment was needed. The programme was unsupervised and fully automated, and participants were encouraged to take ownership of their progress through the programme. They could complete the exercise and education videos at a time and location that suited them.

The MSGHS programme incorporates exercise interval training with regular rest times. Interval training has been shown to be safe and beneficial for PwMS (Learmonth et al., 2023). It can improve management of neuromuscular fatigue (Karpatkin et al., 2015; Mamoei et al., 2020) and shorter exercise intervals have been suggested to reduce the impact of heat sensitivity (Gervasoni et al., 2022; Skjerbæk et al., 2013). Participants could choose not to progress the interval time if they felt fatigued and were encouraged to pause the video if they needed a longer rest period. The education topics provide information on how to modify PA around common MS symptoms such as fatigue, heat sensitivity and pain as well as discuss potential solutions to barriers around PA.

3.2.4 Control Procedures

Those allocated to the waitlist control were sent the online links to complete the outcome measures at baseline, week seven and week twelve. At the end of the 12-week wait period an invitation link for the online MSGHS programme was sent to them. They were then able to access the full programme after the last set of outcome measures were collected at week twelve.

3.2.5 Feasibility Measures

To measure the feasibility of this study, I will be reporting on; rate of recruitment, the percentage of potential participants meeting the inclusion criteria, randomisation process, acceptability of data collection and process, data completeness at baseline, follow up and number of errors, website capacity for data collection, suitability of outcome measures, and safety including monitoring adverse events. We will monitor the ease of using and navigating the MSGHS online platform using the Health Information Technology Usability Evaluation Scale (Schnall et al., 2018) see appendix K.

3.2.6 Outcome Measures

As part of the online MSGHS study, we will also be evaluating if the selected outcome measures are suitable and if they demonstrate promise for future studies to inform required sample size. These outcome measures will measure self-reported PA volumes and exercise self-efficacy. The measures that were used are; The Godin Leisure-Time Exercise Questionnaire (Sikes et al., 2019) appendix L, Incidental and Planned Exercise Questionnaire (Merom et al., 2014) appendix M, The Self-Efficacy for Exercise Scale (Resnick & Jenkins, 2000) appendix N, Self-Efficacy for Managing Chronic Disease (Ritter & Lorig, 2014) appendix O, and the 12-Item MS Walking Scale (Hobart et al., 2003; Motl & Snook, 2008) appendix P.

The outcome measurements selected are similar to other online studies on PA in PwMS (Adamson et al., 2024; Huynh et al., 2024; Kaur et al., 2024; Vural et al., 2023). Since there is currently no well-established scale specifically for PA self-efficacy, this study will assess exercise self-efficacy as a representative measure of PA self-efficacy.

All outcome measurements are self-reported to ensure the trial remained fully automated and mimics clinical practice, where commercial grade accelerometers are often not available. A recent meta-analysis indicated that either accelerometers or self-reported methods were each able to measure a change in PA in PwMS (Jeng et al., 2024).

All the measures were collected through online questionnaires via a link that directed participants to their unique account login on the MSGHS website. The link to complete the questionnaires was emailed to participants at the start of the study, at the completion of the six-week intervention (week seven), and at the 12-week follow up.

Additional information listed in Table 10 was collected to look at the feasibility of the study and demographic characteristics of participants (appendix G).

Table 10

Additional Information or Measures Collected.

Information or measure
Age
Sex
Approximate living region
EDSS score if known
PDDS
Time since diagnosis

EDSS, Expanded Disability Status Scale; PDDS, Patient-Determined Disease Steps.

3.2.7 Data Management and Analysis

The principal researcher (GD) was responsible for data management. All data collection was completed online via the MSGHS secure server. Data were downloaded and securely saved. No data were retained on the MSGHS server for future use and was destroyed after 6 months.

Data analysis included a descriptive summary of each group, such as the mean (central tendency) and standard deviation. A pilot study is not expected to be able to hypothesise a between-group difference, but findings will help calculate required numbers for an adequately powered randomised controlled trial to establish effectiveness. The descriptive data was analysed to explore which outcome measures demonstrated change at baseline, week seven, and 12 weeks post-intervention. To provide a good depth of analysis, descriptive statistics such as mean baseline values were used to establish an understanding of the raw data. Reporting baseline means demonstrates the central tendency of each group, offering a meaningful reference point for subsequent analyses.

The calculation of mean differences and standard deviations provided further depth to the descriptive analysis. Mean differences are particularly valuable in assessing the extent of change between the intervention and control groups. Standard deviations, quantify the degree of variability within each group, highlighting whether the data are tightly clustered around the mean or widely dispersed. Including these measures ensures that the interpretation of results is not solely based on central tendencies but also considers the consistency and reliability of the results.

Beyond descriptive measures, inferential statistics were employed to test the significance and magnitude of observed effects. The paired t-test was chosen as it is well suited for comparing mean values between groups, providing an assessment of whether observed differences are likely due to chance. However, statistical significance alone does not convey the practical importance of findings, and thus Cohen's d was included as a measure of effect size. By reporting both p-values from the t-test and standardised effect sizes, the analysis provides a more comprehensive interpretation that combines statistical rigor with practical relevance. Statistics were analysed using R Studio version 4.4.2 for Windows.

3.2.8 Adverse Events Management

All adverse events (AEs) were monitored and recorded. Participants were asked, via their automatic weekly emails, the following question "Have you experienced any incidents that has affected your health this week such as a fall, injury or illness?". They were encouraged to reply to the email by clicking the "yes" button under the question. Once a reply was received the participant was contacted by the research assistant (LPSJ) to ensure the principal researcher remained blinded. All AEs were assessed for severity and relatedness to the intervention (U.S. Department of Health and Human Services, 2009) appendix Q and R. The study would have been terminated if three AEs that score 3 or more on the severity scale were adjudicated to be related to the intervention. Participants were also able to contact the research assistant at any time during the programme if they had any concerns. Please see appendix Q for a copy of the Adverse events procedure and appendix S for a copy of the Withdrawal procedure.

Chapter 4 - Results

This chapter presents the findings of the online MSGHS pilot study. It is presented as per the submission guidelines for the New Zealand Journal of Physiotherapy; this manuscript is currently under review at the journal. Owing to the manuscript format, some sections necessarily reiterate material from other parts of the thesis. Additional details that were not able to be included in the manuscript have been presented at the end of this chapter in section 4.19 Additional information.

Article Submitted

20-Word Limit Title:

A pilot study of the feasibility of the online MS-Get-a-Head-Start programme for people with multiple sclerosis.

Short Title:

Online delivery of MS Get a Head Start.

4.1 Abstract

The benefits of regular physical activity for people with multiple sclerosis are well established, leading to increased demand for accessible physical activity programmes designed for people with multiple sclerosis. Exercise interventions incorporating education and behaviour change strategies can enhance the confidence and capacity of people with multiple sclerosis to engage in physical activity. The MS Get a Head Start programme delivers a six-week exercise and education intervention with integrated behaviour change strategies. To improve accessibility, we are evaluating an automated online delivery model without any health professional involvement. Thirty-five people with multiple sclerosis were randomised to either the intervention or waitlist control group. The intervention group received two exercise and one education videos weekly for six weeks, plus goal setting and self-reflection course work. Feasibility, self-reported physical activity, and exercise self-efficacy were assessed at baseline, week 7, and week 12. Feasibility measures demonstrated strong recruitment, participants rated the intervention useful and easy to use, and no adverse events related to the intervention were recorded. There was a high loss to follow up in the intervention group. There was a moderate effect size of increased physical activity levels within the intervention group. Both groups declined in exercise self-efficacy. The MS Get a Head Start programme was safe and easy to use but did not significantly improve physical activity levels or exercise self-efficacy as hypothesised. The strong recruitment highlighted the demand for an online automated exercise programme for people with multiple sclerosis in New Zealand.

Australian New Zealand Clinical Trial Registry: ACTRN12624000998549

4.2 Keywords

Multiple Sclerosis

Exercise

Physical activity

Telerehabilitation

Self-efficacy

4.3 Abbreviations

MS – multiple sclerosis

PwMS – people living with multiple sclerosis

PA – physical activity

MSGHS – MS Get a Head Start programme

EDSS - Expanded Disability Status Scale

PDDS – Patient Determined Disease Steps

AE – Adverse events

4.4 Introduction

Multiple sclerosis (MS) is the leading cause of non-traumatic disabling disease to affect young adults (Dobson & Giovannoni, 2019). New Zealand has a significantly higher prevalence of MS at 96.6 per 100,000 as reported in 2022 (Boven et al., 2025), compared to the average global prevalence of 35.9 per 100,000 (Walton et al., 2020). There has been an increased demand for rehabilitation and physical activity (PA) programmes for people with multiple sclerosis (PwMS) (Learmonth & Motl, 2016). Anecdotally, in New Zealand, there is a low number of health professionals specialising in MS, with only 11 practices found nationwide which explicitly offer physiotherapy for PwMS (Physiotherapy New Zealand, 2025), and very limited public funding. Consequently, there is a lack of accessible accurate information for PwMS regarding all aspects of PA such as safety and effectiveness; this finding is echoed internationally (Learmonth et al., 2017; Richardson et al., 2020).

One difficulty in MS research is that the terms PA and exercise are frequently used interchangeably. Caspersen et al (1985) defines exercises as “a subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate objective the improvement or maintenance of physical fitness.” (p. 126). For the purpose of this study, we have characterised exercise as a subset of PA, understanding that exercise supports the performance of PA.

There is a significant reported difference in PA levels when comparing PwMS and the general population (Jeng et al., 2024). This persists despite the proliferation of evidence supporting the benefits PA can have on function and quality of life for PwMS (Motl & Sandroff, 2020; Motl & Sandroff, 2022). Preliminary evidence has demonstrated that PA can decrease neurodegeneration, and research has suggested that it may be effective at stimulating neuroplasticity and slowing symptom progression (Dalgas et al., 2019; Motl & Sandroff, 2022; Sandroff et al., 2018). Increased strength, balance and cardiovascular fitness from exercise training can also lead to increased PA volumes in PwMS (Edwards et al., 2022; Kim et al., 2020). The evidence-based PA guidelines by Kalb et al. (2020) highlight the importance of PwMS regularly completing ≥ 150 minutes per week of exercise and ≥150 minutes per week of lifestyle PA to optimise the benefits of PA for PwMS.

To enable engagement in adequate PA levels for self-management, PwMS must have confidence (self-efficacy) in their capacity to complete PA safely. Evidence suggests that some PwMS worry that PA will make their MS symptoms worse (Sieber et al., 2024). The combination of fear, lack of knowledge, and fatigue results in low exercise self-efficacy (Almarwani & Alosaimi, 2023). Consequently, authors have strongly recommended that behaviour change strategies such as goal setting, education, and exercise demonstration, are incorporated into PA programmes for PwMS (Motl et al., 2009; Suh et al., 2011).

Other major barriers to regular participation in PA are the requirement to travel, physical mobility issues, lack of time, and the scarcity of specialised facilities (Correale et al., 2022). To address the need for increased PA levels and to improve accessibility, there has been an increase in online and telerehabilitation programmes which have been shown to be effective delivery methods to promote and support PA and quality of life for PwMS (Amatya et al., 2015; Baigi et al., 2024), and have been shown to be as effective as conventional face-to-face care (Baigi et al., 2024; Zasadzka et al., 2021). However, current online programmes often still require regular health professional input throughout the programme, which can constrain participants' access both from a financial and timing perspective. A programme that is fully automated would expand the availability and enable greater access. The online MS Get a Head Start programme (MSGHS) is a fully automated self-paced 6-week interval-based exercise and education programme aimed at increasing PA levels and exercise self-efficacy.

4.4.1 Aims

The aim of this feasibility study of the pilot randomised controlled trial of the online MSGHS programme is to explore the feasibility of recruitment, outcome measure suitability, and usability, and to explore initial trends in self-reported PA levels and exercise self-efficacy in PwMS.

4.5 Ethics Approval

Ethics approval was obtained from the Auckland University of Technology Ethics Committee (reference number: 24/7).

4.6 Methods

4.6.1 Sample Size, Recruitment and Eligibility

A pragmatic sample size of 35 was selected for this feasibility study. Recruitment was completed across New Zealand by distributing information flyers to neurologists, MS nurses, MS Regional and National Societies, and Physiotherapy New Zealand. Participants who expressed interest in the study were emailed three forms to confirm eligibility. These established the inclusion criteria which are detailed in Table 11. All screening was completed online through the MSGHS website with no in-person interaction. Forms were checked by the principal investigator to establish eligibility. There was no attempt made to limit other treatment or activities that participants could participate in during the trial.

Table 11

Participant Eligibility Criteria

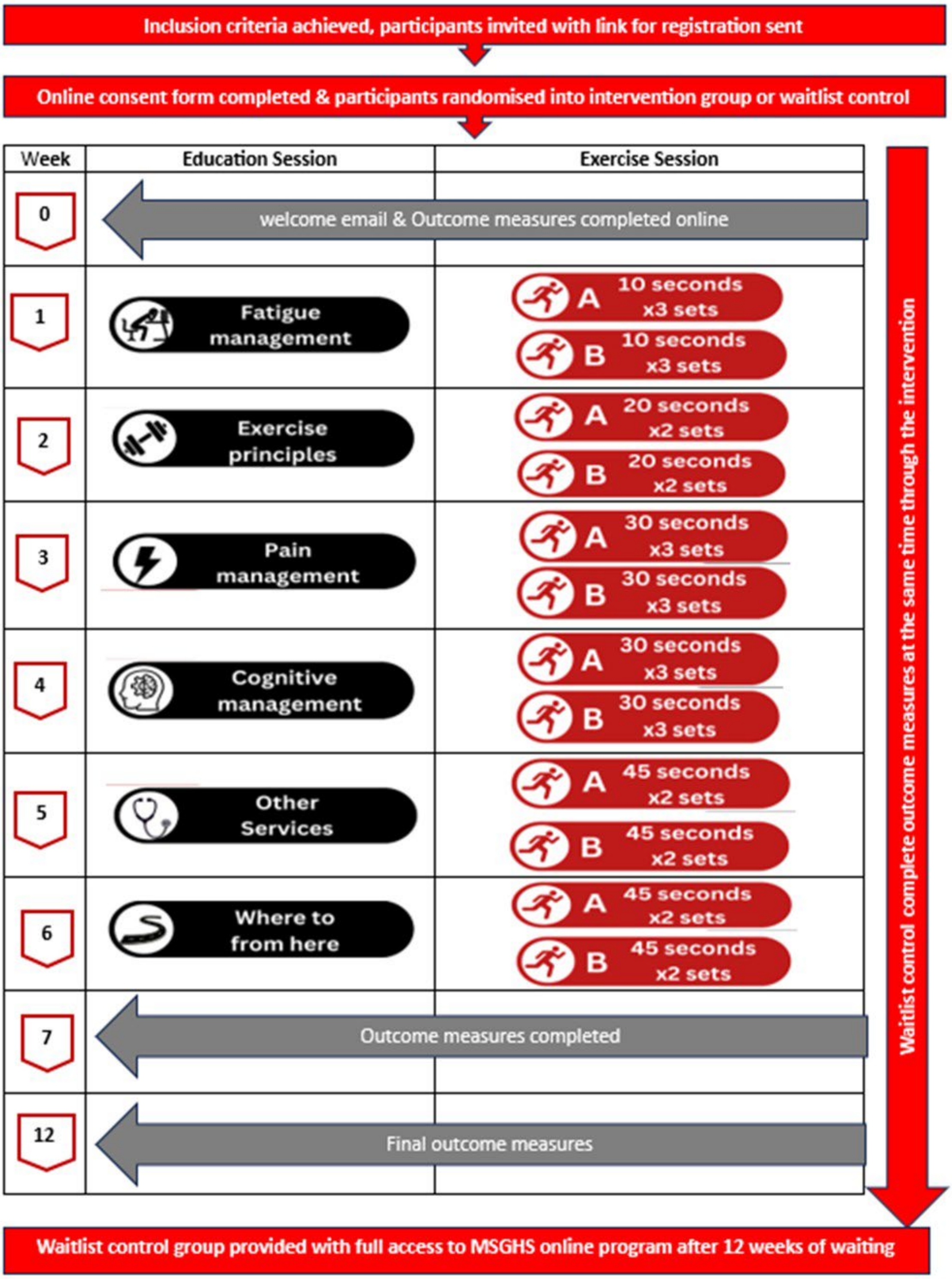
Inclusion criteria	Exclusion criteria
Men and women aged 18 to 70 years	Self-report inability to follow a remote video led exercise programme
Have a diagnosis of MS	Have had a relapse within the last 3 months
Score between 0-4 on the Expanded Disability Status Scale (EDSS) score if known and score 3 or less on the Patient-Determined Disease Steps questionnaire	Are not able to access the internet on a twice-weekly basis to watch the videos
Score “no” to all questions on the Physical Activity Readiness Questionnaire. If a “yes” was scored on the first question, they can seek medical approval from their GP. They will not be considered if they scored “yes” on any of the other questions	Have previously been treated clinically by primary author (GD) or already participated in the MSGHS programme
Able to get on and off the ground independently	Have heart disease, high blood pressure, any respiratory condition (mild asthma excluded), any illness, infection or injury that prevents them from participating in a PA programme
Have access to the internet	

4.6.2 Intervention Procedures

The MSGHS six-week interval-based exercise and education programme was delivered online through www.ms-ghs.com via pre-recorded videos and course work. Each week, participants received an automated email linking them directly to their weekly programme page on the MSGHS website that featured two interval-based exercise videos of approximately 45 minutes each, one education video of approximately 45 minutes, and course work of approximately 30 minutes each week. There were nine exercises in each exercise video that covered strength, balance, fitness, and core stability. The six weekly educational videos covered a range of topics on 1. fatigue management, 2. exercise prescription, 3. pain management, 4. cognitive and psychological well-being, 5. multi-disciplinary services, and 6. “where to from here?”, helping participants consider how to continue with long-term PA. The course work featured several behavioural change strategies, including goal setting, activity diary recording, weekly reflections, education, and problem-solving solutions (Michie & Johnston, 2012). At the end of the six-week programme, participants received automated motivational emails fortnightly until week 12. See Figure 6 for participant progression through the MSGHS programme. Further details of the MSGHS programme can be found in Appendix J. MS Get a Head Start Online Delivery – Exercises delivered.

Figure 6

Participant Progression Through the MS Get a Head Start Programme.



4.6.3 Control Procedures

The control group was placed on a waiting list and after 12 weeks, this group was offered access to the MSGHS programme.

4.6.4 Feasibility Measures

To report on the feasibility of the study, we measured rate of recruitment, the percentage of potential participants meeting the inclusion criteria, randomisation process, automation of data collection, website capacity for data collection, suitability of outcome measures, and safety, including monitoring of adverse events. We monitored the impact, ease of use and usefulness of the MSGHS online platform using the Health Information Technology Usability Evaluation Scale (Schnall et al., 2018).

4.6.5 Outcome Measures

All outcome measurements were self-reported to ensure that the trial remained fully automated. The outcome measures were: the Godin Leisure-Time Exercise Questionnaire (Motl, Bollaert, et al., 2018), the Incidental and Planned Exercise Questionnaire (Merom et al., 2014), the Self-Efficacy for Exercise Scale (Resnick & Jenkins, 2000), the Self-Efficacy for Managing Chronic Disease (Ritter & Lorig, 2014), and the 12-Item MS Walking Scale (Motl & Snook, 2008). There is currently no well-established scale specifically for PA self-efficacy, this study will assess exercise self-efficacy as a representative measure of PA self-efficacy.

4.6.6 Data Analysis

The primary author analysed all the data and was blinded to group allocation. All statistics were analysed using R Studio version 4.4.2 for Windows. The data analysis included calculations of mean baseline values, mean differences, and standard deviations, along with inferential testing using the *t*-test and effect size estimation with Cohen's *d*.

4.7 Results

Demographic data of the participants are presented in Table 12. There were no obvious differences between groups at baseline. The female to male ratio of the participants is reflective of the wider population of PwMS. The mean age group of participants meant they were likely to be comfortable with using online resources. The two groups had similar EDSS and PDDS scores and both had a large variation in time since diagnosis. There was a high number of participants living in suburban or rural regions.

Table 12

Demographic Data of the Participants

Information or measure		**Intervention**	**Control**
Sex	Female	13	15
	Male	3	3
	Preferred not to say	1	0
Approximate living region	Rural	5	6
	Suburbs	8	8
	City/Urban	4	4
Age	Median	48.0	51.5
	IQR	40-52	40-53
	Range	30-58	38-65
Ethnicity	European NZ	14	14
	European	2	0
	Māori	0	0
	Asian	0	2
	Other	1	2
EDSS score if known	Mean	1.86	1.88
(0-9 scale range)	Standard dev	1.02	1.38
	Range	0-4	0-4
PDDS	Median	1	1
(0-8 scale range)	IQR	0-3	0-2
	Range	0-3	0-3
Time since diagnosis in years	Median	7	10
	IQR	4-17	3-14
	Range	1-29	range 1-28

EDSS, Expanded Disability Status Scale; IQR, Interquartile range; PDDS, Patient-Determined Disease Steps; SD, Standard deviation. The mean and standard deviation have been provided for data that was normally distributed, and the median and interquartile range have been provided for data that had a skewed distribution

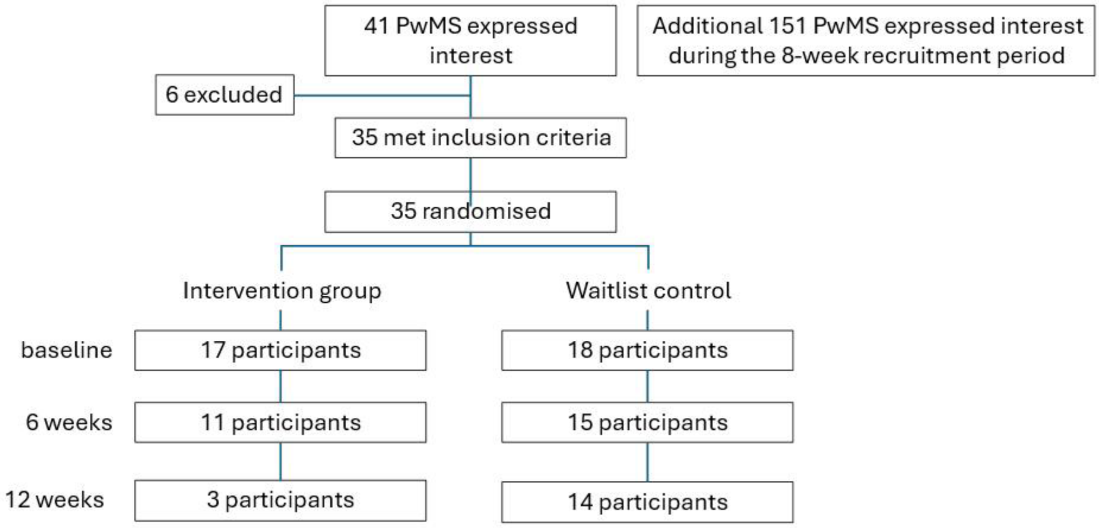
4.8 Feasibility Results

4.8.1 Recruitment, Suitability of Inclusion Criteria and Randomisation Process

Forty-one PwMS expressed interest in the MSGHS programme and 86% met the inclusion criteria. Six did not meet the criteria following pre-screening with four answering yes to one or more of the questions on the Physical Activity Readiness Questionnaire (Thomas et al., 1992) and two scoring higher than four on the Patient-Determined Disease Steps measure (Ann Marrie et al., 2022). The target cohort of 35 participants were recruited in the first two weeks. In the eight-week recruitment period, a further 151 PwMS contacted the researcher expressing an interest in the trial. Randomisation was completed by a computer-generated programme. See Figure 7 for details on recruitment, randomisation and flow through the study.

Figure 7

Participant Flow Chart



4.8.2 Participant Retention

Retention (74% at week 7) and (49% at week 12) was calculated on data completeness. It was unknown when participants were lost to follow up, if they had stopped participating in the MSGHS programme or had just not completed the outcome measures. We did not collect any qualitative measures from participants, meta-data from the website or email reminders such as click rates, watch numbers, or individual user interaction with the website. There was a loss of five participants in the intervention group at week seven and a loss of a further seven participants at twelve weeks. One of these was a withdrawal due to unrelated health issues. The control group lost two participants at week seven and one further participant at week twelve. See Figure 7 for details on participant numbers through the programme.

4.8.3 Data Collection and Process

All data collection was completed on the MSGHS website. For those who accessed the website the data collection process was successful, as all measures were completed in full. This demonstrates that the MSGHS website has the capacity and capability to gather outcome measure data. There was one participant in the intervention group who completed no outcome measure at baseline or at either follow up. Ethical restrictions prevented individual follow up to ascertain the reasons.

4.8.4 Adverse Events

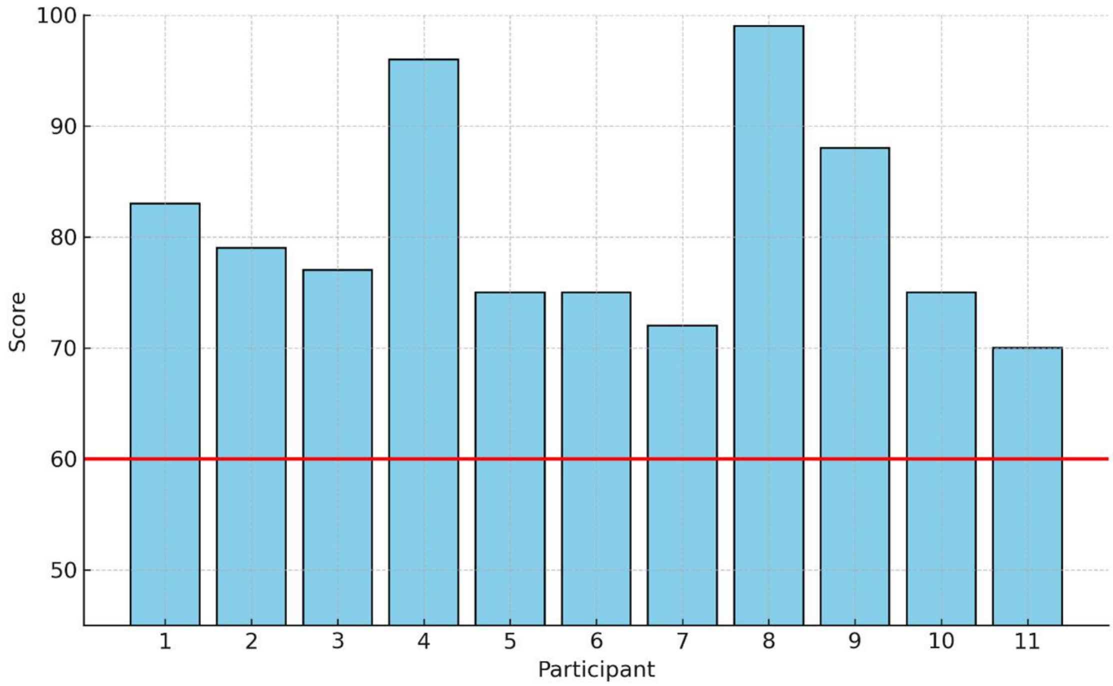
Adverse events (AEs) were measured for severity and relatedness to the intervention. Four AEs were reported in the intervention group and one in the control group, none were related to the MSGHS intervention. The AEs were rated on a severity scale of 1 to 5 on the Common Terminology Criteria for Adverse Events. The AE's reported in our trial were 1 and 2 (1= mild requiring no medical intervention, 2 = moderate). There was one withdrawal in the intervention group, again, unrelated to the MSGHS intervention programme. Further details are provided in Appendix R: Common Terminology Criteria for Adverse Events.

4.8.5 Ease of Using and Navigating the MSGHS Online Programme

Those who completed the intervention rated the MSGHS programme as useful and easy to use, demonstrated by a statistically significant score on the Health Information Technology Usability Evaluation Scale (HiTec) ($p=0.00003$). Figure 8 illustrates these findings at week 7, where a score of 60 out of 100 represents the neutral point on the Likert scale employed by the measure. All participants' scores exceeded this, indicating positive experiences of the programme. A copy of the HiTec is included in Appendix K. The results indicate, with 95% confidence, that PwMS would exceed a score of 60 on the HiTec when reviewing the online MSGHS programme.

Figure 8

Health Information Technology Usability Evaluation Scale Results at Week 7.



HiTec results per participant in the intervention group, red line represents line of neutrality.

4.9 Outcome Measure Results

Due to the high loss to follow-up by week 12, analyses were limited to between group comparisons at week 7. These analyses included the 11 participants in the intervention group and 15 participants in the control group who completed the week 7 outcome measures. Data from the nine participants with missing week 7 data were excluded from the analysis. Between group results are reported in Table 13. There was only one outcome showing a within group difference, reported in Table 14, no other within group results will be discussed.

Table 13

Comparing Between Group Results from Baseline to Week 7

Outcome Measure	Group	Mean baseline data	Mean differences and standard deviation	t-test statistic	Cohen's D Effect size	P-Value
The Godin Leisure-Time Exercise Questionnaire *(higher score more active)*	Intervention	23.52 Active	16.64 (SD 23.29)	-1.79	-0.60 moderate	0.09
	Control	32.77 Active	1.67 (SD 17.65)			
Incidental and Planned Exercise Questionnaire *(168 highest score)*	Intervention	24.96	0.47 (SD 19.71)	0.09	-0.30 small	0.93
	Control	27.96	1.04 (SD 11.53)			
Self-efficacy for Exercise Scale *(0-90 higher = more confident)*	Intervention	53.06	-6.73 (SD 14.19)	-1.32	-0.33 small	0.20
	Control	56.33	-13.13 (SD 8.97)			
Self-Efficacy for Managing Chronic Disease Scale *(0-10 higher = more confident)*	Intervention	6.50	0.27 (SD 1.67)	-1.01	-0.33 small	0.33
	Control	7.48	-0.39 (SD 1.64)			
12 Item MS Walking Scale *(0-60 higher = increased impairment)*	Intervention	22.62	-1.55 (SD 4.34)	0.27	0.32 small	0.79
	Control	22.77	-0.52 (SD 13.97)			

Table 14

Comparing Within Group Results from Baseline to Week 7

Outcome Measure	Group	Mean differences and standard deviation	t-test statistic	Effect size Cohen's D	P-Value
The Godin leisure-time exercise questionnaire	Intervention	16.64 (SD 23.29)	-1.98	-0.78 moderate	0.06
	Control	1.67 (SD 17.65)	0.59	0.21 small	0.55

4.9.1 The Godin Leisure-Time Exercise Questionnaire

There was a moderate effect size using Cohen's D of the intervention group increasing their activity levels from baseline to week seven within group, although not significant. (Table 14). There is no statistically significant difference between groups when compared to the control group at week 7 (Table 13).

4.9.2 Incidental and Planned Exercise Questionnaire

There is no statistically significant difference between groups on self-reported activity levels when recorded using the incidental and planned exercise questionnaire (Table 13).

4.9.3 Self-Efficacy for Exercise Scale

At baseline there was no statistically significant difference between the intervention and the control group in self-reported exercise self-efficacy. Both the intervention and control groups significantly decreased in exercise self-efficacy at week 7 (control group $p=0.005$ and intervention group $p= 0.019$). There was no statistically significant between-group difference in the decline in confidence, meaning that both groups lost confidence at a similar rate (Table 13).

4.9.4 Self-Efficacy for Managing Chronic Disease Scale

There was no statistically significant difference between groups in their self-reported confidence around self-management of their MS (Table 13).

4.9.5 12 Item MS Walking Scale

There was no change reported between groups on how PwMS perceived their walking ability (Table 13).

4.10 Discussion

The aim of this study was to explore the feasibility and initial trends on self-reported PA levels and exercise self-efficacy for PwMS who participated in the online automated delivery of the MSGHS programme.

4.10.1 Feasibility of the MSGHS Programme

The recruitment rate provided evidence of the high demand for this type of accessible online exercise and education programme. This is consistent with the study by Learmonth et al. (2017) who highlighted that accurate information on PA for PwMS was their highest unmet need. A high percentage of interested applications met the inclusion criteria, demonstrating that the MSGHS programme was advertised and aimed at an audience for whom MSGHS was intended for.

The majority of participants lived in suburban or rural regions and might normally have struggled to access specialist care. Remote access to the programme for these participants would have been particularly important. Someone living with MS who either had visual problems, cognitive challenges or was older may find a fully automated online programme more difficult to interact with. The study reported no Māori participants, with most identifying as European, aligning with national data showing the highest age-adjusted prevalence among Europeans (Boven et al., 2025) compared to other ethnic groups. A small number identified as Asian or "other."

One of the main points of the feasibility study was to explore if PwMS would find the MSGHS programme useful and if a fully automated programme was safe. The HiTec Scale asked participants to rate how much they agreed with statements such as: "I think MSGHS would be a positive addition for persons living with MS", "MSGHS is an important part of meeting my information needs related to symptom self-management" and "Learning to operate MSGHS is easy for me". The results demonstrate that the MSGHS programme was rated to be useful and easy to use. This provides strong support for the usability of the programme and underscores its potential acceptability for PwMS. The MSGHS programme was found to be safe with no adverse events related to the programme, demonstrating that the pre-screening questionnaires allowed selection of an appropriate population.

The outcome measurements are similar to other online studies on PA and PwMS (Adamson et al., 2024; Huynh et al., 2024; Kaur et al., 2024; Vural et al., 2023). However, the GLETQ had a ceiling effect, and the use of an accelerometer might have provided more accurate recording of PA levels. The MSGSH website was a suitable platform for gathering the data, and all submitted questionnaires were completed in full.

4.10.2 Physical Activity Levels and Exercise Self-Efficacy Trends

This pilot study was not powered to find significance in the outcome measures. However, there were some interesting trends that will be addressed here. The slight increase in PA levels in the intervention group suggests this group may have started to become more active. While there was not a between-group difference, a trend was noted. In the systematic review by Baigi et al. (2024) they found that most studies demonstrated a significant improvement in PA levels following a telerehabilitation programme. However, none of the studies included in the systematic review had a fully automated delivery, unlike our study. Of interest, baseline PA levels in our study population were higher than those typically reported in the MS population, where inactivity is common (Jeng et al., 2024). Notably, 24 of 35 participants in our study reported moderate (n = 7) to high (n = 17) PA levels, potentially creating a ceiling effect and limiting detectable change. Evidence suggests PwMS with lower baseline PA benefit more from online interventions (Silveira et al., 2025).

The lack of a definitive difference of PA levels may also be explained by variability in participant engagement in the intervention protocols, individual variability in response to the intervention, and the relatively short duration of the study (Proschinger et al., 2022). There could also have been limitations in sensitivity of the outcome measurements to detect subtle changes in PA levels (Motl et al., 2005). Although the GLTEQ demonstrated a within group increase in the intervention group this was not supported by any changes in the IPEQ. While the use of an accelerometer could have provided greater insight into changes in PA levels, our intention was to design a study that reflects real-world clinical settings, where access to such technology may be limited.

Rintala et al. (2018)’s systematic review reported that they were unable to determine if different delivery methods of telerehabilitation led to differing outcomes. They suggested that similar positive effects on PA levels in PwMS might occur regardless of the type of telerehabilitation delivery. This is built upon by further research that found that a range of telerehabilitation programmes were at least as effective as the conventional face to face care (Baigi et al., 2024; Zasadzka et al., 2021). This suggests that the automated delivery of the online MSGHS programme has the potential to support PA levels, however, a fully powered randomised controlled trial would be needed to investigate this.

Another trend in our study was that exercise self-efficacy was found to be significantly lower in both groups at week 7. This is a disappointing finding in view of the behaviour change strategies included in the programme but is consistent with results from other telerehabilitation programmes (Conroy et al., 2018; Motl et al., 2011; Stephens et al., 2022). It has been suggested that this could be due to an overestimation at baseline, and a correction factor operating at the end of the study (Motl et al., 2011). The intervention group received educational material detailing the latest PA guidelines for MS (Kalb et al., 2020). This could have highlighted to the participants that they were not doing enough exercise, leading to a reduction in confidence. Although, this would not explain the decline also seen in the control group, the decline in the control group could have been due to the initial overestimation. Stephens et al. (2022) also proposed in their study that the absence of a positive change in self-efficacy may be attributed to difficulties encountered in effectively implementing the core constructs of self-efficacy during an intervention.

Physical activity programmes for PwMS need to be easily accessible (VanNostrand et al., 2025) and our results suggest that the MSGHS programme is accessible. To our knowledge the MSGHS programme is one of the first online telerehabilitation programmes that is fully automated, meaning it has the potential to be distributed widely at a low cost (Heesen et al., 2023). Any automated online PA programme for PwMS must be safe and perceived to be useful by the end user and the results from this feasibility pilot study demonstrate MSGHS fulfils both criteria well, the next step is the exploration of effectiveness in a randomised controlled trial.

4.10.3 Strengths and Limitations

The strengths of the study were in the feasibility, with high recruitment rates, appropriate inclusion and screening criteria, safety, and the report by PwMS that they found the programme useful and easy to use.

The limitations are the high loss to follow up in the intervention group, especially at week 12. It is not possible to know if this was caused by participants stopping the programme or simply forgetting to complete the outcome measures, as no qualitative or meta-data (click rate, watching times, and engagement on programme pages) was collected, as it was beyond the scope of this study. As such, there was no opportunity to further investigate the reasons for the loss to follow up. One explanation is that participants underestimated the demands of trial participation and outcome data completion. Another is that the high control group completion rate may be seen as having been incentivised, as they did not receive access to the MSGHS programme until they had completed all the data collection stages. The 74% retention at week 7 is acceptable for MS feasibility studies (Learmonth & Motl, 2017). However, sustaining PA participation remains challenging for PwMS, with many disengaging during or after interventions (Dennett, Coulter, et al., 2020). This pattern is also evident in online PA programmes, where early engagement is strong but declines over time (Motl et al., 2011; Tallner et al., 2016).

4.10.4 Future Recommendations

To improve retention a research assistant could speak with participants prior to eligibility screening to ensure participants understood outcome measure completion. A previous scoping review by Adnan et al. (2024) found that communication by a physiotherapist about the expectations of participating in a study did improve adherence and increase motivation. However, to keep the MSGHS programme’s self-guided automated nature, contact with participants should be minimised after the eligibility screening as contact is costly, so would limit scalability to a larger cohort. Incorporating a qualitative investigation of participant experience and perceptions of MSGHS and monitoring of meta data (clicks per videos and watch length) following strict ethical data policies, would provide more information about engagement in the programme. Using accelerometers would be useful to explore changes in PA levels and a trackable quantitative measure of PA may be another behaviour change strategy to enhance exercise self-efficacy.

4.11 Conclusion

The automated online MSGHS programme was safe, useful and easy to use. Recruitment was extremely strong, highlighting the demand for an online PA programme for PwMS in New Zealand. MSGHS is a scalable, transferable, low-cost exercise and health behaviour change programme that has the potential to be integrated into existing health services for PwMS. This study demonstrated that it would be feasible to undertake a full randomised controlled trial. However, there were difficulties with high loss to follow up in the intervention group and strategies would need to be implemented to improve this prior to such a trial.

4.12 Key points

1. There is a strong demand for improved access to exercise programmes for PwMS in New Zealand.
2. The MS Get a Head Start programme has been developed to increase physical activity levels and build exercise self-efficacy.
3. The MS Get a Head Start programme is safe, useful, and easy to use.
4. It would be feasible to expand this study to a full randomised controlled trial.

4.13 Impact Statement

People with multiple sclerosis (MS) have low levels of physical activity, despite research reporting that increasing PA could improve their function and potentially slow disease progression. They report difficulty accessing accurate information and guidance on exercise. The MS Get a Head Start programme is a fully automated 6-week exercise and education programme delivered online. This research has demonstrated that there is a high demand for this type of programme and in New Zealand where there is a high prevalence of MS. This easily accessible programme has the potential to fill this gap and offers potential benefits to people with MS.

4.14 Disclosures

4.14.1 Funding Statement:

Funding received from New Zealand MS Research Trust. The funder has had no input on the development of the MSGHS project or management of the research project.

4.14.2 Declaration of Conflicting Interest:

Gilly Davy declares that she is the founder and owner of the MS Get a Head Start programme.

Nicola Saywell and Verna Stavric declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

There has been no use of generative AI or AI-assisted technologies in this study or writing process.

4.15 Permissions

Ethical considerations:

Auckland University of Technology Ethics Committee: 24/7 approved on 28 May 2024

4.16 Data statement

Individual participant data not available. The data that has been used is confidential as defined by the ethical approval.

4.17 Acknowledgements

Lisa Pocq Saint Jean (LPSJ) - Research assistant.

Nick Garrett – Auckland University of Technology Statistician

4.18 Contributions of Authors

Conceptualisation and Methodology, GD, NS, VS; Software, GD; Validation, GD, NS, VS; Formal Analysis, Investigation, Resources and Data Curation, GD, NS, VS; Writing –

Original Draft and Writing – Review and Editing, GD, NS, VS; Supervision, NS, VS, Project Administration, GD; Funding acquisition, GD.

End of the submitted article

4.19 Additional Information

Due to substantial loss at follow-up, the study results alone would not be able to be used to calculate a sample size for a full randomised control trial. The New Zealand Physiotherapy journal also asked for a copy of the CONSORT 2025 Checklist Item Description to be provided on submission, and this is provided in Appendix T.

4.19.1 Additional Data

Due to focusing on reporting between group differences in the manuscript for the online MSGHS study only one of the within group outcome measures, the GLETQ was presented in the manuscript. Please see Table 15 for the remaining within group results. There were no statistically significant difference or meaningful trends in any of the remaining outcome measures.

Table 15. *Within Group Results from Baseline to Week 7*

Outcome Measure	**Group**	**t-test statistic**	**degrees of freedom**	**P-Value**	**Effect size Cohen's D**
Self-efficacy for exercise scale	Intervention	2.50	23.61	0.019	0.92
	Control	3.02	30.50	0.005	1.04
Self-efficacy for managing chronic disease scale	Intervention	-1.47	23.38	0.15	-0.54
	Control	0.92	28.92	0.36	0.32
The Godin leisure-time exercise questionnaire	Intervention	-1.98	21.06	0.06	-0.78
	Control	0.59	29.51	0.55	0.21
Incidental and planned exercise questionnaire	Intervention	-0.45	17.93	0.66	-0.18
	Control	0.91	25.19	0.37	0.31
12 item MS walking scale	Intervention	0.50	20.70	0.62	0.20
	Control	-0.38	29.44	0.71	-0.13

4.19.2 Additional Data Analysis

As reported due to the high loss to follow up at week 12, data analysis was only completed on week 7 data.

The demographic results (Table 12) of the online MSGHS study reported no one who identified as Māori, two participants identified as Asian, and three participants selected “other”. The rest of the participants all identified as European NZ or European, which is in line with the recent New Zealand data reporting an age-adjusted prevalence highest for Europeans (124.7 per 100,000), followed by Middle Eastern/Latin American/African (85.5), Māori (41.8), Asian (16.8) and Pacific peoples (11.1) ethnic groups (Boven et al., 2025).

Chapter 5 – Discussion

This chapter outlines the principal findings from the feasibility study of the pilot randomised controlled trial on the online MSGHS programme, situating them within the context of existing research. It also examines the implications of these findings for clinical practice and highlights the study's strengths and limitations. Next there is a discussion of the strengths and limitations of the thesis. Finally, this chapter discusses recommendations for future research directions including the potential justification for a larger randomised controlled trial.

5.1 Objectives and Results

The primary objectives of this thesis were to;

1. Review the existing literature on online exercise programmes and multiple sclerosis.
2. To review the feasibility of the online MS Get a Head Start programme regarding recruitment, outcome measure suitability, and usability.
3. To explore trends in effect of the online MS Get a Head Start programme on outcome measures of self-reported PA and exercise self-efficacy.

Findings from the feasibility study of the pilot randomised controlled trial on the effect of the online delivery of the MS Get a Head Start programme on PA levels and exercise self-efficacy in PwMS, indicated that there was strong recruitment, the programme was safe, user-friendly, and useful. Recruitment rates were notably high, suggesting a substantial demand for online PA interventions tailored to PwMS in New Zealand. These results support the potential for scaling the study into a full randomised controlled trial. However, challenges were observed, particularly regarding high loss to follow up in the intervention group.

As a pilot study, this study was not adequately powered to find a statistical difference in the results. However, there was some key findings and themes within the results which will be discussed in detail through this chapter. The results showed a ~~small~~ non statistically significant trend within the intervention group for increased self-reported PA levels, but a decline in exercise self-efficacy. Due to the high loss to follow up results were only reported at week 7 and no long-term results at week 12 are reported.

5.2 Feasibility of the Online Delivery of the MS Get a Head Start Programme

5.2.1 Hight Recruitment Rates

The online MSGHS study confirmed that there is strong demand for an online exercise programme here in New Zealand. With an over recruitment rate of over 430% within the 8-week recruitment period. Traditionally in PA based research studies in PwMS recruitment can be slow and challenging (Carter et al., 2015). The results highlight accessing information and guidance on PA is a need for PwMS. This supports the research from Learmonth et al. (2017) who has reported that accurate information and guidance on PA is one of the highest unmet needs of PwMS.

Being able to provide an accessible online programme is paramount in New Zealand as there is very limited public funding and poor access to experienced MS health professionals. This is of particular concern with New Zealand's higher than global prevalence level and increasing prevalence of MS in Māori (Boven et al., 2025). Delivery using an online programme decreases several of the barriers often associated with rehabilitation access, including travel, cost, fatigue, mobility, and time (Correale et al., 2022).

5.2.2 Engagement, Adherence, Retention and Drop out

The online MSGHS study lost a significant number of the intervention group to follow up, but as I did not collect any metadata or qualitative results I do not know when or why people were lost. I do not know if the engagement levels declined over time as reported in previous studies (Tallner et al., 2016), or abruptly at some point. Another explanation could have been that participants just did not complete the follow up outcome measurements, despite having engaged in the online MSGHS study. I have hypothesised a few reasons why this might have occurred in the online MSGHS study.

Firstly, the patient information sheet (see appendix D) was 7 pages long following the incorporation of all the information required by the ethics committee. This is unlikely to be read in full, which could have resulted in the participants being unaware of outcome measures at week 7 and week 12. I did predict this and tried to mitigate this issue by providing a welcome introductory video (appendix E), stipulating the importance of the outcome measures. This was also repeated in week 6 videos. Automated email reminders with direct links to complete the outcome measures with follow up reminders were sent. However, without collecting metadata it was impossible to understand how participants interacted with the content.

Secondly because I was trying to facilitate real world delivery of the online MSGHS study, I choose to fully automate the programme and removed any form of therapist interaction or involvement. On reflection speaking with potential participants prior may have reduced some of the loss to follow up and still allowed fully automated programme delivery.

The increased loss to follow up over time in this study has been seen by others. It has been well established that PwMS struggle to sustain PA and often discontinue either during or when a PA programme ends (Dennett, Madsen, et al., 2020). This is evident in online exercise programmes, where studies have shown excellent online interaction in the first week of the programme with then a steady decrease in interaction over time (Motl et al., 2011; Tallner et al., 2016; Yeroushalmi et al., 2020).

When comparing the online MSGHS study to other studies, the literature review demonstrated five studies that had a similar loss to follow-up at a greater than 25% drop out rate. Interestingly Conroy et al. (2018) was the only study from the literature review that reported on the characteristics of groups, the non-adherent group tended to have a lower PDDS score compared to the adherent group that had more progressive MS. However, on observation of the online MSGHS study data, there was an even distribution of participants who completed the programme with a PDDS score of 0 to 3, demonstrating no difference in physical limitation ability.

Another interesting finding in the online MSGHS study results is that out of the five participants that were lost to follow up at week 7, three of them reported to be sedentary at baseline. This is notable as the majority of participants in the study scored moderate to high activity levels at baseline. This raises the question of whether the participants who were sedentary initially found it harder to engage and stay motivated throughout the programme compared to those who were already quite active.

Feasibility benchmarks of acceptable retention rates in MS specific studies, considers 75% acceptable (Learmonth & Motl, 2017) and maintaining 70% is more commonly accepted standard in behavioural intervention feasibility (Pfledderer et al., 2024). Combining the intervention and control groups in the online MSGHS study demonstrated a retention rate of 74% at week 7, the loss of 26% is similar to Kaur et al. (2024); Tarakci et al. (2021); Van Geel et al. (2020). There are few if any other fully automated interventions for PwMS, so I am unable to compare the engagement, retention, and loss to follow up directly with similar research studies.

5.2.3 Usability and Enjoyment

It was essential that the online MSGHS programmed was straight forward and easy to use and navigate by PwMS. The online MSGHS study results were statistically significant in usability, suggesting this was successful. Measuring participants satisfaction and ease of use of a programme can highlight engagement issues. To increase the research rigour of the pilot study it was felt that it would be superior to use an established valid and reliable outcome measurement. The Health Information Technology Usability Evaluation Scale (HiTec) (appendix K) which measures impact, perceived usefulness, perceived ease of use and user control has been previous used by Block et al. (2024) to evaluate the use of a App to record information on falls in PwMS. However out of the 26 the studies reviewed in the literature review, only one used a standardised satisfaction outcome measures (Finkelstein et al., 2008), ten created their own satisfaction scales and 15 did not report measuring satisfaction or usability. A recent scoping review by Tea et al. (2024) reported that there is a major gap in the application of standardised usability assessments in online and digital health technologies targeting PwMS.

5.2.4 Safety of Online Exercise Programmes

The online MSGHS study reported that the online programme was safe for PwMS with a disability level between 0-4 EDSS. There were no adverse events related to the online MSGHS study, this high level of safety is similar to several other studies (Bruce et al., 2023; Cameron et al., 2024; Huynh et al., 2024; Paul et al., 2014).

This level of safety is paramount when working with population who are at a high risk of falling and sustaining injuries when compared to a healthy population. Dalgas et al. (2020) highlighted that gathering accurate information on adverse events is essential for PA programmes for PwMS, concerningly the literature review highlighted that 50% of the studies did not report monitoring for adverse events.

The positive safety result from the online MSGHS study was also important in regard to the delivery being fully automated. There was a potential increase in risk to safety due to no therapist interaction. There is likely to be a perceived safety risk from researchers, health professional, family, and others which may be a barrier to encouraging PwMS to participate in a less monitored online exercise programme. The results of the study help to support that a less monitored online exercise programme could be safe and suitable for PwMS.

5.3 Online Exercise Programmes Effect on Physical Activity Levels

The online MSGHS study reported no statistically significant changes between groups in self-reported PA levels. Although the GLTEQ demonstrated a moderate effect size using Cohen's D for within group increase in exercise volumes, this was not supported by any changes in the self-reported IPEQ. The use of the GLTEQ and IPEQ in measuring PA could have recall and social desirability bias as a self-reported measure (Motl et al., 2005).

Interestingly the PA levels at baseline were already higher in the study participants than the general MS population. However, at baseline, twenty four of the thirty-five participants were already reporting moderate (n = 7) to high (n = 17) PA levels. This may have influenced the findings by introducing a ceiling effect, limiting the potential magnitude of observable change. Recent research has shown that PwMS who had a lower baseline PA level were more likely to improve PA levels using an online intervention (Silveira et al., 2025).

It has been reported that the PwMS that often volunteer to participate in research studies are already participating in higher levels of PA and have a more positive attitude towards exercise compared to the general MS population (Learmonth & Motl, 2016). This motivation bias can create a ceiling effect as the potential measurable improvement in activity is smaller. The results may not be truly reflective of the broader MS population, and those who find participating in regular PA difficult may have more to gain from an education and a supportive exercise programme.

The online MSGHS study findings indicated no significant differences in PA levels and contrast with previous systematic reviews that report that online exercise programmes are likely to increase PA levels (Amatya et al., 2015; Baigi et al., 2024; Tallner et al., 2016). The literature review also supported that online exercise programmes are likely to increase PA levels. The outcome from the online MSGHS study was not unexpected, as the study was exploratory in nature and designed as a pilot, where neither statistical significance nor measurable effects were necessarily anticipated.

5.4 Online Exercise Programmes Effect on Exercise Self-Efficacy

The online MSGHS study results demonstrated no positive impact on exercise self-efficacy for PwMS. There was a statistically significant within group decline in self-reported exercise self-efficacy in both groups. There was no statistical difference between groups highlighting that the level of decline was similar. The relatively large standard deviation observed in the intervention group may indicate the presence of a subgroup of participants who responded differently to the intervention. This variability suggests that some individuals may have experienced positive changes in exercise self-efficacy, which could be masked when analysing group means alone. However, given the small sample size in this pilot study, investigating subgroup effects would not have been meaningful, limiting the ability to draw definitive conclusions.

One explanation for the decline in exercise self-efficacy seen in the online MSGHS study is proposed by Motl et al. (2011) that participants may overestimate their exercise self-efficacy at baseline, and subsequent assessments reflect a more realistic self-appraisal as they gain awareness during the intervention. This inflated perception could arise from a lack of experience or limited awareness of recommended PA levels. As participants progress through an intervention and are exposed to the practical demands of maintaining regular PA as well as receiving education on evidence-based guidelines of PA levels, their exercise self-efficacy ratings may shift to reflect a more accurate and realistic self-appraisal. In this sense, a decline in exercise self-efficacy does not necessarily indicate a negative outcome, but rather a recalibration process whereby individuals reassess their capabilities considering actual experiences. Such findings underscore the importance of interpreting changes in exercise self-efficacy cautiously, as they may represent increased self-awareness rather than diminished motivation or ability. For the intervention group in the online MSGHS study, the inclusion of educational content on current PA recommendations for PwMS (Kalb et al., 2020) may have inadvertently contributed to a drop in confidence, as participants became more aware that their activity levels fell short of those guidelines.

However, this would not account for the decline also reported in the control group. The decline seen in the control group may reflect an initial overestimation of their exercise self-efficacy, followed by a downward adjustment over time. This reduction could also signify a growing desire to engage with the online MSGH study, as they were on the waitlist control and aware they could not access the online MSGHS programme until after the study completion. Participants could have perceived potential value and benefits compared to their usual routines.

The results are similar to several other online exercise programme study results. The literature review showed that only two of the 13 studies reviewed demonstrated a positive impact of online exercise interventions on exercise self-efficacy. The majority either showed no significant change or, in some cases similar to the online MSGHS study results, a reduction in self-efficacy (Conroy et al., 2018; Motl et al., 2011; Novotna et al., 2019; Stephens et al., 2022).

Another explanation for the absence of improvements in exercise self-efficacy may stem from insufficient implementation of core theoretical constructs. According to Bandura's self-efficacy theory, mastery experiences, modelling, verbal persuasion, and affective regulation are necessary for building self-efficacy (Bandura, 1997). If an intervention lacks these components or fails to implement them thoroughly, such as inconsistent delivery, limited mastery opportunities, or poor system usability it may not produce measurable improvements in self-efficacy, even if the programme content is nominally theory based. When these theoretical building blocks are not fully operationalised, even well-intentioned programmes may fail to enhance confidence as predicted. Subedi et al. (2020) reported that telerehabilitation studies frequently lack high fidelity to these mechanisms. A limitation linked to technical issues and inconsistent programme delivery which may compromise the online intervention's theoretical effectiveness.

Well supported behaviour change strategies were used in the online MSGHS study. These were implemented by the accompanying course workbook. However, there was no monitoring of participant activity or engagement in the course work booklets, as this was outside the scope of the pilot study. There was also no collection of data on engagement in the actual programme. For example, it is unknown if participants watched all the videos or even watched the full length of each video. If their engagement was low then there would have been significant inconsistency of the proposed delivery education, intensity, and fewer opportunities to increase mastery. Although behaviour change strategies were incorporated into the online MSGHS study to enhance exercise self-efficacy, I did not systematically collect or record whether participants engaged with key components such as goal setting, daily activity diaries, and weekly reflections. In retrospect, this represents a limitation in closing the feedback loop and raises concerns regarding intervention fidelity. Without confirmation of participant engagement, it remains unclear whether the observed decline in exercise self-efficacy was a consequence of the online MSGHS study itself or a result of insufficient adherence to its intended protocol.

The online MSGHS study results and a number of other online exercise programme interventions lack of exercise self-efficacy improvement (Conroy et al., 2018; Motl et al., 2011; Novotna et al., 2019; Stephens et al., 2022), is in contrast to the face-to-face interventions delivered by Baird et al. (2021) and Motl, Pekmezi, et al. (2018). Both these authors suggested that focusing on exercise self-efficacy with goal setting and using behaviour change strategies such as those used in Social Cognitive Theory (SCT) would help to improve exercise self-efficacy in PwMS. As both studies were comparing face to face interventions this may highlight that there is a difference in the ability to influence exercise self-efficacy depending on the mode of delivery. However, the more recent study by Motl et al. (2023b) reports that delivering a 6-month online education programme using SCT did increase exercise self-efficacy in MS. The programme by Motl et al. (2023b) used a website to deliver education, as well as live one on one video calls with a trained health behavioural coach. It could be the addition of the personalised coaching providing a more interactive programme that influences exercise self-efficacy.

Currently there is an inconsistency in the impact of online exercise programmes on exercise self-efficacy. The question is also raised around the impact of exercise self-efficacy's impact on PA levels. As the majority of online studies reported on an increase in PA levels irrespective of changes in exercise self-efficacy. An important question to ask though regarding PA levels in PwMS is the long-term engagement and maintenance of a PA lifestyle. The literature review and the recent systematic review by Sladeckova et al. (2024) highlighted the limited long term follow up on PA levels post online intervention. It is unknown currently if the improvements seen in PA levels from online exercise programmes are sustained. It could be argued that without the accompanying improvement in exercise self-efficacy the PA levels may decline back to baseline in the long term (Motl, Pekmezi, et al., 2018). Previous studies indicate that PwMS often stop PA once the programme ends (Dennett, Madsen, et al., 2020; Kinnett-Hopkins et al., 2017; Klaren et al., 2013).

5.4.1 Declared Behaviour Change Strategies

The online MSGHS study declared that behaviour change strategies were going to be used during the intervention. This was following research advice that purposefully declaring behaviour change strategies were more likely to positively increase PA levels and exercise self-efficacy in PwMS (Casey et al., 2018) and in other chronic neurological conditions such as stroke (Wróbel et al., 2025).

However, as described above the online MSGHS study did not report any significant improvement in PA levels or exercise self-efficacy even with the incorporation of declaring behaviour change strategies. Of interest the literature review analysis demonstrated that adding a declared behaviour change strategy did not increase exercise self-efficacy in PwMS through an online intervention. This contrasts with previous research in a stroke population, where declaring or using explicit behaviour change strategies has been shown to be more effective than undeclared implicit strategies at increasing exercise self-efficacy (Dobkin, 2016). The lack of change in exercise self-efficacy may to be more related to the online delivery than the MS population, as previous studies have reported declared behaviour change strategies positively improving exercise self-efficacy in PwMS in face-to-face interventions (Casey et al., 2018).

5.5 Difference in Intervention Delivery

5.5.1 Combined Exercise, Education and Behaviour Change

The online MSGHS study combined weekly exercise videos, education videos and course work incorporating behaviour change strategies. Previous research has highlighted the combination of all three to be likely to increase positive outcomes in PA levels and exercise self-efficacy for PwMS (Motl et al., 2022). However, this was not the case for the online MSGHS study results. The literature review results reported that combining exercise, education and declared behaviour change strategies did not result in a superior effect on PA levels and exercise self-efficacy compared to those that only used exercise or education. However, Motl et al. (2023a) and Kaur et al. (2024) who both report an improvement in exercise self-efficacy by providing a combined exercise and education intervention, were much longer in duration when compared to the online MSGHS study, 6 months by Motl et al. (2023a) and 3 months with an 11-month follow-up by Kaur et al. (2024). This increased length of delivery may have a greater impact on changing exercise self-efficacy.

5.6 Implications For Clinical Practice

5.6.1 MS Get a Head Start a Potential Solution

New Zealand has a higher than global average of PwMS, the high recruitment rates of the MSGHS study support the high demand for an accessible exercise programme for PwMS in New Zealand. The online MSGHS study reported the online delivery was safe to those of an EDSS score less than 4.

Telerehabilitation for PwMS has been shown to reduce health care costs (Zasadzka et al., 2021). The online MSGHS programme is scalable and could be easily rolled out nationally and internationally if future studies are able to show an effectiveness in PA levels and exercise self-efficacy. Digital interventions that do not require clinician supervision could be distributed more widely, and cost data could be collected to confirm whether the assumption that it is cost effective is supported (Heesen et al., 2023). Kyriakatis et al. (2023) systematic review reports that remote PA programmes are significantly more effective than waitlist control group interventions. Which means while someone is waiting to see a health professional in person they could participate in an online programme to increase their knowledge and participation levels.

5.6.2 Potential Challenges Around Implementation

The high loss to follow up was a concern in the online MSGHS study. This is not an isolated problem as there are potential challenges and barriers with online exercise programme integration into practice. For example, PwMS who have visual changes or cognitive changes, and reduced metacognition and attention may struggle to use an online platform (İpek Halatcı et al., 2025). The online delivery also relies on individuals being able to afford access to the internet and on the reliability of the internet connection and speed to allow access to the programme. Galway et al. (2024) examined the perceptions and experiences of online exercise programming among PwMS. They strongly recommended that health professionals should attempt to discuss and address the challenges prior to PwMS embarking on an online exercise programme, as they are a trusted source of PA advice.

With the online MSGHS study being one of the first studies using a fully automated programme, and a high loss to follow up. There may be the need to have health professional interaction either at the start or during the programme, which would then reduce the scalability and increase the cost of the programme. Online rehabilitation programmes for PwMS can complement traditional rehabilitation care, but it has been highlighted that online programmes are not sufficient to fully replace traditional face to face input (Tallner et al., 2016).

Further research on automated online exercise programmes for PwMS will need to be investigated before any informed conclusions can be made around their potential impact.

5.7 Strengths

5.7.1 Recruitment

Recruitment rate was a very positive outcome of online MSGHS study, highlighting the strong recruitment strategy and existing relationships with the MS community. It had been reported through research that PwMS had a strong desire to have access to accurate information on exercise specifically for MS. Recruitment was completed using an advertising flyer and a short video description which was kindly distributed by a range of trusted resources for PwMS, including neurologists, MS nurses, MS Regional and National Societies, and Physiotherapy New Zealand. An effort was made to actively recruit Māori, after I sought consultation from Witana Petley Māori lecturer at Otago University and head of Tae Ora Tinana on the development of the participation information sheet and advertising flyer. I encouraged the MS nurses and MS Regional Societies to actively pass the advertising flyer direct to any Māori individuals they were working with, unfortunately no participants identifying as Māori enrolled.

Due to the more significant barriers that people living rural or remote in New Zealand have to access expert MS services, the online nature of the online MSGHS study provides an increased opportunity for this population. There was an even distribution of approximate living regions for participants from city/urban, suburbs or rural. Providing a positive indication that the MSGHS programme was able to be accessed from all locations.

5.7.2 The MSGHS Platform

Part of the online MSGHS study was to also explore the feasibility of the MSGHS website for hosting the programme and collecting the outcome measure data. The ease of use and usability of the online MSGHS programme from the Hitec outcome measure provides confidence that the programme could be rolled out to a larger population. All outcome measures completed were completed in full, with no administration errors. The reporting of adverse events provided confirmation that both the monitoring processes and the subsequent management of these events were conducted effectively.

5.8 Limitations

5.8.1 Loss to Follow-Up

The high loss to follow up in the intervention group at week 7 and an even greater loss a week 12 is a major limitation. It is unknown if participants did not complete the programme, what stage they might have potentially dropped out or become less engaged or whether they did complete the programme but then did not complete the outcome measures. It is unknown whether there were any potential barriers to collecting the outcomes at follow-up, and this will need to be further explored.

On reflection, it would have been interesting to have also collected outcome measure data from the control group going through the online MSGHS programme which they accessed after the intervention, as this could have provided a comparison with the initial intervention group. However, doing so would have altered the original pilot study design and therefore was not undertaken.

5.8.2 No Qualitative and Metadata Collection

Collecting qualitative data including exit interviews was beyond the scope of a master's research project. Qualitative information would have provided valuable knowledge on the programme engagement and loss to follow up rates. Not including qualitative information is a limitation of the study.

There was an expectation that we would be able to collect some metadata from the MSGHS website, however, this was discouraged by the ethics committee. Although we did not appreciate at the time of the ethics application how valuable this information would have been. No metadata was collected during this study. Metadata results could have provided extremely valuable insight into engagement and retention rates of the MSGHS programme.

5.8.3 Suitability of the Online MSGHS Programme

Interacting with a self-directed programme like MSGHS could have been very challenging for individuals with impairments of cognition, metacognition and attention. That is also the same for those living with visual impairments, which is a very common impairment for PwMS.

The online MSGHS study aimed to recruit a range of participants from diverse backgrounds. This included ethnic background, including Māori, and baseline levels of physical activity. The lack of Māori participants reflects the lower prevalence, but further collaboration and discussions will need to be had with key Māori representatives to increase recruitment for future trials. The participants in this study were also more active than the general MS population. This may represent volunteer bias as those that volunteered for this trial were already being more motivated by exercise.

5.9 Research Implications and Recommendations for the Future

This feasibility study on the online MSGHS programme has demonstrated some strong feasibility aspects, for example, recruitment, safety, and user enjoyment. Due to the strong recruitment rates and safety, it is likely that a larger randomised control trial of the online MSGHS study could be adequately recruited too. The MSGHS website platform worked well confirming that the existing website platform could be rolled out to a larger randomised controlled trial.

Self-managed online exercise programmes offer a promising solution for increasing self-management in PwMS in regard to exercise, diet, management of fatigue, pain and cognition (Rae-Grant et al., 2011). However, the online MSGHS study results did not support an improvement as hypothesised in PA levels or exercise self-efficacy. Changes to the study protocol are needed to increase retention of participants; I would propose the following changes prior to scaling to a full clinical trial.

5.9.1 Initial Screening and Recruitment

To ensure participants fully understood the online MSGHS programme and the requirements of participating in a research study they would receive a phone or video call with the research assistant. The research assistant would be able to go through the participant information sheet and answer any questions that the potential participants may have. The research assistant would confirm that the online MSGHS programme is self-directed, and they would have no live contact again unless they had not completed the outcome measures. The research assistant would also ensure they were aware to fill out the outcome measures on each follow-up. A scoping review by Adnan et al. (2024), highlighted that communication and supervision by a physiotherapist of the participants about their expectations did improve adherence and increase motivation.

Further collaboration with Māori health representatives would be conducted to increase the expose and invitation for Māori to participate in the online MSGHS study.

5.9.2 Follow-Up

To increase outcome measure completion at week 7 and week 12, the research assistant would call any participants that had not submitted their outcome measures by the end of week 7. The research assistant would be able to ask if the participant wanted to withdraw from the study using the established withdrawal process (appendix S) or would provide them with another 5 days to complete the outcome measures. This process would also be completed at week 12 and 24.

To investigate if the online MSGHS study had made a sustained health behaviour change on increasing PA levels follow up would be extended to twenty-four weeks. Proschinger et al. (2022) highlighted in their systematic review that one of the major limitations in previous MS PA research has been the short intervention duration and absence of long-term follow-up.

5.9.3 Qualitative Follow-Up

A qualitative study would be undertaken as part of a mixed methods study, to understand more around the experiences and perceptions of PwMS on the online MSGHS programme. This would also allow exploration of the reasons why participants did not want to continue engaging in the programme. I would recommend collective purposively sampling to gather rich data about peoples experienced. To continue with the online nature of the programme one on one interviews can be conducted online to maintain the accessibility. This qualitative section would require ethical approval.

5.9.4 Metadata Collection

The online MSGHS website has the functionality to collect metadata such as click rates, session duration, number of watches or repeated watches, progress through the course and course work collection. The metadata would have provide valuable information on the engagement in the online MSGHS programme. Not collecting the metadata was a missed opportunity.

Through metadata collection, it would also have been useful to have been able to link exercise self-efficacy with engagement levels with the online MSGHS study. A higher engagement through website activity might correlate to an increased likelihood of improving exercise self-efficacy (Jeong et al., 2020). Jeong et al. (2020) study investigated the association between usage patterns (engagement) of an online exercise programme and clinical outcomes; their results demonstrate that the participants had more pronounced outcome improvements when they increased the time using and interacting with the online programme.

However, the collection of metadata is also fraught with ethical challenges around privacy. Even with strict rules metadata can sometimes be deanonymised, and there are different international rules for consent, retention and sharing of the data. Not all websites implement tracking in the same way, leading to uneven or incompatible metadata. There can be significant issues around ownership of the metadata and most important there is security risks around websites being hacked. Due to these negative issues there was concerns around ethical approval and more funding and time would have been required to consult with an expert in this area.

Funding would need to be sourced to support consultation with researchers who are experienced in metadata collection and ethical security to explore what metadata the MSGHS website could safely collect and store for the use in a larger randomised controlled trial. Ideally the following information would be collected;

- Number of different users who watch a video
- The average length of time a video is watched
- Progress through the web pages for each week of the programme

5.9.5 Outcome Measure Changes

The outcome measures originally selected were chosen due to their validity and reliability in a MS population and PA research studies. There was a difference in the results between the GLTEQ and the IPEQ both designed to assess PA levels. The literature review's second most common measure of PA levels was the International Physical Activity Questionnaire (IPAQ) after the GLTEQ. I would recommend replacing the IPEQ with the IPAQ due to its likelihood to be able to report a more sensitive change in PA levels. There could also be the introduction of accelerometers alongside the GLTEQ. However, this has significant cost and logistic implications, especially if trying to reach PwMS throughout rural and remote areas of New Zealand.

It would also provide valuable insight into the MSGHS programme and engagement levels if the PA diaries of each week were collected. This could be collected digitally through the MSGHS website. Individuals' goals and reflections could also be collected and used to augment the findings form the qualitative enquiry.

Chapter 6 – Conclusion

Although inactivity levels in PwMS remain high, there has been an increased demand for PA programmes for PwMS (Learmonth & Motl, 2016). Increasing access opportunities has been proposed by using online delivery of PA programmes. As far as I am aware the online MSGHS programme is the first fully automated programme for PwMS. The feasibility study of the pilot randomised controlled trial results concluded that the online automated MSGHS programme proved to be safe, useful, and easy to use. Recruitment levels were exceptionally high, underscoring the strong demand for an online digital PA programme tailored for PwMS in New Zealand. The results demonstrated no significant change in PA levels, there was no impact observed by the online MSGHS study on exercise self-efficacy.

As a low-cost, scalable, and adaptable intervention, the online MSGHS programme has the potential to be embedded within current health service frameworks for PwMS in New Zealand. Findings from this study indicate that conducting a full-scale randomised controlled trial would be feasible. Nonetheless, challenges with high loss to follow up in the intervention group were evident, highlighting the need for strategies to enhance retention before progressing to a larger trial.

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Glossary

MS – multiple sclerosis

PwMS – people living with multiple sclerosis

PA – physical activity

MSGHS – MS Get a Head Start programme

EDSS - Expanded Disability Status Scale

PDDS – Patient Determined Disease Steps

Appendices

Appendix A Ethics Approval Letter

Auckland University of Technology Ethics Committee (AUTEC)

28 May 2024

Nicola Saywell
Faculty of Health and Environmental Sciences

Dear Nicola

Re Ethics Application: **24/7 The effect of online delivery of the MS-Get-a-Head-Start programme on physical activity self-efficacy of people with multiple sclerosis: a randomised pilot trial.**

Thank you for your responses to AUTEC's conditions.

Your ethics application has been approved for three years until 28 May 2027.

Standard Conditions of Approval

1. The research is to be undertaken in accordance with the Auckland University of Technology Code of Conduct for Research and as approved by AUTEC.
2. All public facing documents must have the AUTEC approval number and be of a high standard of spelling and grammar. Dates on the Information Sheet(s) and Consent Form(s) must be consistent.
3. Any amendments to the project must be approved by AUTEC prior to being implemented.
4. A progress report is due annually on the anniversary of the approval date.
5. A final report is due at the expiration of the approval period, or, upon completion of project.
6. Any serious or adverse events must be reported to AUTEC, this includes unforeseen issues that might affect continued ethical acceptability of the project.
7. AUTEC grants ethical approval only. You are responsible for obtaining management permission for access from any institution or organisation at which your research is being conducted and you need to meet all ethical, legal, public health, and locality obligations or requirements for the jurisdictions in which the research is being undertaken.

The application number and title need to be referenced on all correspondence related to this project.

All forms are available online http://www.aut.ac.nz/research/researchethics

For any enquiries, please contact ethics@aut.ac.nz
(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat
Auckland University of Technology Ethics Committee

Cc: Gilly@ms-ghs.com; verna.stavric@aut.ac.nz

Appendix B Advertising Flyer

AUT
TE WĀNANGA ARONUI
O TĀMAKI MAKAU RAU

MS
Get a Head Start

Do you want to know more about exercise specifically for Multiple Sclerosis as part of a student research study?

We are looking for people living with Multiple Sclerosis to take part in a 6-week online exercise and education programme, as part of a research study with AUT. The good news is that you can complete the programme in the comfort of your own home, on days and times that suit you.

If you can access the internet, walk unaided and are able to take part in exercises which need you to get on and off the floor, we would like to invite you to consider taking part in the study. If you decide to join the study you will receive 6 weeks of MS-specific exercises and six educational sessions, designed to help you manage your MS better.

You can find out more and access the full information about this research study by clicking here or scanning the QR code below or visiting https://www.ms-ghs.com/aut-research-project-msghs-patient-program/

Contact Gilly Davy on gilly@ms-ghs.com for details

Recruitment for the study is open until the 31st July 2024

AUTEC Reference Number 24/7

New Zealand
Multiple Sclerosis
Research Trust
Knowledge brings hope

Appendix C Social Media Tile

MS Get a Head Start

AUT
TE WĀNANGA ARONUI
O TĀMAKI MAKAU RAU

Do you want to know more about exercise specifically for Multiple Sclerosis as part of a student research study?

We invite you to participate in the 6-week MS Get a Head Start Program as part of a student research study with AUT from the comfort of your home as its delivered fully online!

New Zealand Multiple Sclerosis Research Trust
Knowledge brings hope

Contact Gilly on gilly@ms-ghs.com for details

AUTEC reference number 24/7

Appendix D Participant Information Sheet

Participant Information Sheet

New Zealand Multiple Sclerosis Research Trust
Knowledge brings hope

Date Information Sheet Produced:

10/05/24

Project Title

The effect of online delivery of the MS-Get-a-Head-Start programme on physical activity self-efficacy of people with Multiple Sclerosis: a randomised pilot trial.

An Invitation

Kia ora, talofa lava, and hello, my name is Gilly Davy, and I would like to invite you to take part in a student research study looking at physical activity levels and confidence to exercise, for people with multiple sclerosis (MS). It is not easy to find accurate information on how to exercise with MS, especially when dealing with fatigue, heat sensitivity, and symptom changes. The MS-Get-a-Head-Start (MSGHS) programme provides you with this information.

This invitation is to take part in MSGHS, which is a six-week online programme delivering education and exercise sessions designed specifically for people with MS. I am completing this research project for my master's qualification.

This information sheet will explain the research study. Please contact me and ask about anything that you do not understand, or with questions you would like to discuss.

Please remember when considering this invitation that participating in this study:

- Is entirely voluntary (your choice).
- If you agree to take part, you can withdraw at any time if you feel uncomfortable continuing without and penalty.
- Whanau/ Family/ Carers are encouraged and welcomed to be involved and engaged at any stage.

We would like to thank New Zealand Multiple Sclerosis Research Trust who have kindly provided funding to support this study.

What is the purpose of this research?

This is a pilot study that will look at the impact of the MSGHS programme on your confidence and engagement in regular physical activity.

MS can cause physical and cognitive deterioration, which can affect your ability to take part in activities you enjoy and reduce your quality of life. Research has shown that regular physical activity has many physical and cognitive benefits. However, in Aotearoa NZ there is limited access to rehabilitation or accurate information on how to exercise safely with MS. The result of this is that around 80% of people living with MS do not engage in regular physical activity, which increases the risk of other health problems.

By carrying out this pilot study, I am testing the feasibility of expanding it to a larger randomised controlled study that will test if the MSGHS programme can improve confidence and participation in physical activity in people with MS. I will be looking to see if there are any differences between those who have used MSGHS and those who are on the waiting list.

The MSGHS programme was developed by me, Gilly Davy, the primary researcher, to provide exercises and education for people with MS. Since 2013, the MSGHS programme has been used in the clinical setting for people living with MS in both individual and group therapy.

If you decide to take part in this study, you will be asked to complete the MSGHS programme over six weeks. The programme will be delivered fully online. You will receive a weekly email containing two exercise videos and a recorded education video. The email will also detail coursework to complete each week.

You will be randomly assigned to either the MSGHS programme or the waitlist. The waitlist will be for 12 weeks and then you will have access to the 6-week MSGHS programme. During the waitlist period, you will still be asked to complete the study questionnaires at the start, at week 7 and week 12.

The results of this study will help us understand the effect of the MSGHS programme, and to make any changes needed to improve the programme for future use. We will present and publish the results in both public and professional settings.

How was I identified and why am I being invited to participate in this research?

You have been invited to take part in the research because you are living with MS, aged between 18 and 70 years old, and are currently living in New Zealand. You will have expressed an interest after seeing the advertisements or hearing about this study from a health professional, via your local MS society or through word of mouth.

Before formally being part of the study, it would be beneficial for us to build a relationship (whakawhanaungatanga). You can watch the video link here so I can introduce myself and the study. You can also find out more about the MSGHS programme through the www.ms-ghs.com website. If you are interested to find out more about this study, we can also schedule a phone call.

I want to ensure your safety to participate in a remotely delivered exercise programme, so you can only participate in this study if you can still walk unaided and can get on and off the ground by yourself safely. You also need to be otherwise healthy with any other health conditions well managed. You will be asked to complete two short questionnaires to ensure you meet the entry criteria, which will check your current level of ability and readiness to safely complete exercise. I will also need find out more about you, such as your age, gender, ethnicity, the region you live in and when you were diagnosed with MS.

We are limited in the number of people who can participate in the study. If you do meet the selection criteria but miss out on being included in the study, you will still be given the opportunity to access the MSGHS programme after the study results have been collected.

How do I agree to participate in this research?

Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will not affect any future healthcare. You can withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

If you agree to take part in this study, please email me gilly@ms-ghs.com to indicate your willingness to be involved. As this study is measuring the digital delivery of the MSGHS programme the majority of our communication will be via email.

If you would like to discuss the study over a phone call we can then schedule a time to speak. Otherwise, I will reply to your email with the link to complete the screening questionnaires. Once you have completed these, I will review them and let you know if you have met the study criteria. If you have met the criteria, I will email you a consent form to complete and return. I will then let you know by email if you will be able to start the programme straight away or if you are in the control group and will have access to the programme after 12 weeks.

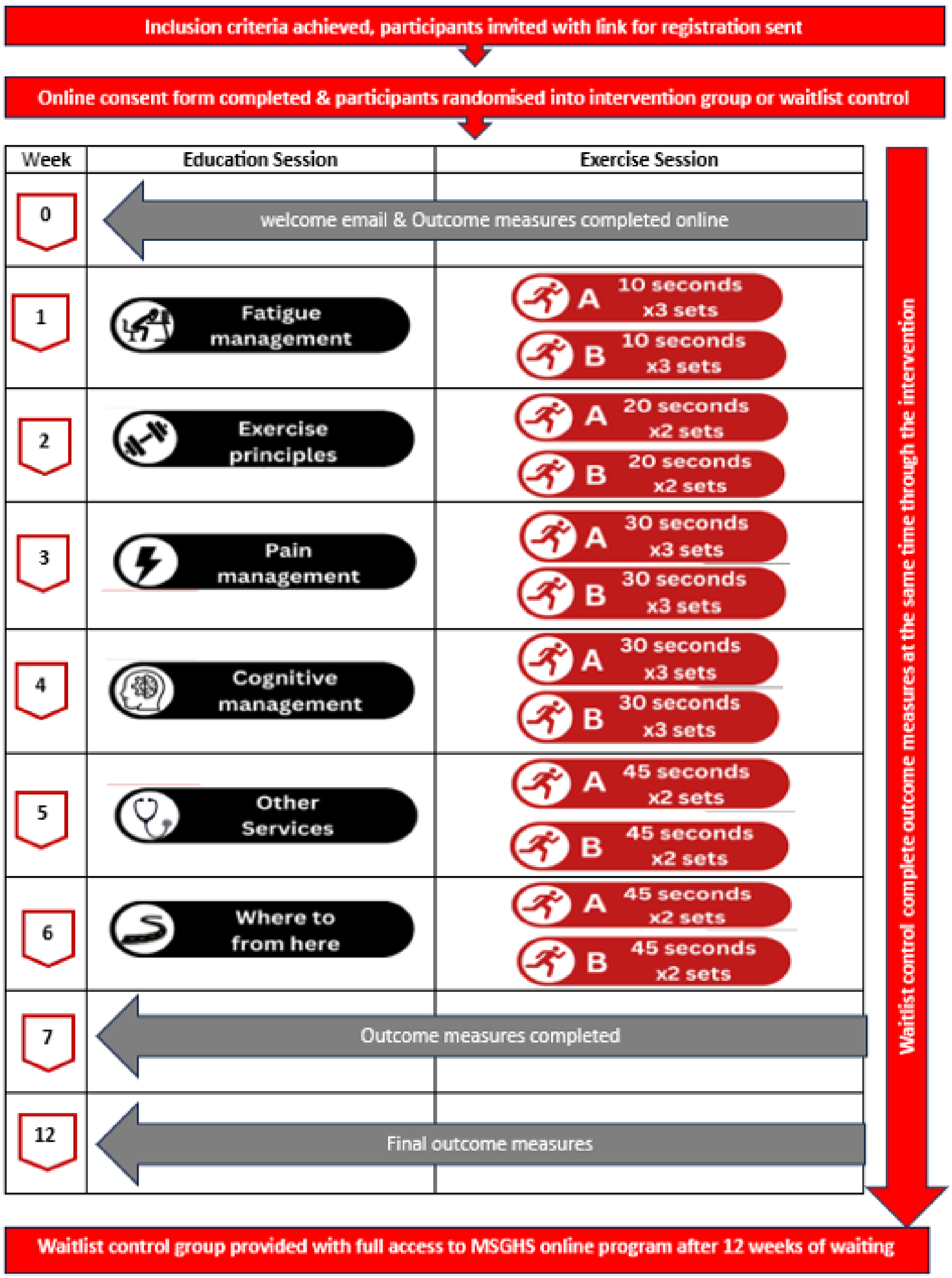
What will happen in this research?

The MSGHS programme will be delivered fully online over 6 weeks. You will receive a weekly email containing two exercise videos of approximately 45 -60 minutes and an education video of approximately 30 -45 minutes. You will also be asked to fill out some course work, which will take approximately 30 minutes a week. The whole programme will take approximately 2.5 hrs a week.

We recommend you complete at least two exercise sessions each week. Each exercise video is made up of 9 exercises delivered in intervals and includes strengthening, balance, and fitness. You will be encouraged to work hard during each exercise. However, you only need to work as hard as you feel comfortable. You repeat each exercise for a short interval of time, rest and then repeat the same exercise three times. As the weeks continue the exercise and rest time increases. You do not require any specific equipment, only a sturdy chair and an exercise mat or towel to use on the floor.

Alongside the education videos, an online digital (PDF) copy of the MSGHS workbook will be provided which you can download and save on your computer. We do not gather any of the information you fill into the workbook. If you prefer, we will post you a physical copy of the workbook. This contains all the supporting educational material for the programme. The six educational topics cover a range of MS symptoms and practical management strategies: fatigue management, exercise prescription, pain management, cognitive and psychological well-being, multi-disciplinary services and finally "where to from here" in the final week.

The figure below shows the process of the study.



To help you understand what this research study is about please watch the short video by clicking on [this link].

What are the discomforts and risks?

The exercise programme intensity is gradually increased over the six weeks to minimise potential discomfort. However, you may experience muscle soreness for up to 48 hours after the exercise sessions. You are encouraged to work hard during the sessions and to get out of breath. However, you are in control of how hard you work during the exercise sessions.

If participating in this amount of exercise is new for you then you may experience a temporary increase in fatigue levels. However, the MSGHS programme has been specifically designed to minimise increases in fatigue.

You will be completing the exercise sessions unsupervised by a health professional in an environment that suits you. This could have potential hazards and I will remind you at the start of each video to ensure your environment is clear of items to minimise any risk of falling during this programme. I encourage you to have someone present with you if you have any concerns.

You may find information delivered in the education videos confronting or helpful. If you do find some information distressing, or struggle to move forward with the information, I encourage you to reply to the weekly email and we can try to answer any questions you may have.

How will these discomforts and risks be alleviated?

You will be asked to watch a welcome video at the start to help prepare you for the programme. In the exercise videos you will be shown how to set up your exercise area to be safe. Each exercise is demonstrated, and options of making the exercise easier or harder are provided, so you can tailor the exercise to your own abilities. You are welcome to rest at any time by pausing the video or by missing an exercise if you do not think it is appropriate for you to complete.

To monitor issues, events or injuries that might arise while participating in this programme, you will be asked in each of the automated emails;

> "*Have you experienced any incidents that has affected your health this week such as a fall, injury or illness?*"

If yes, you will simply click the "yes" button below. Our research assistant will then contact you within 48 hours to discuss the incident and ask a few questions. However please be aware the research assistant is not a medical professional and will not be able to assist you medically.

If sensitive or distressing issues do arise during the programme, and you would like to discuss these with someone, please let us know so we can connect you with some support.

AUT Student Counselling and Mental Health is able to offer three free sessions of confidential counselling support for adults participating in an AUT research project. These sessions are only available for issues that have arisen directly as a result of participation in the research and are not for other general counselling needs. Should you wish to access these services, you will need to:

- drop into our centre at WB203 City Campus, email counselling@aut.ac.nz or call 09-921 9292.
- let the receptionist know that you are a research participant and provide the title of my research and my name and contact details as given in this Information Sheet.

You can find out more information about AUT counsellors and counselling on https://www.aut.ac.nz/student-life/student-health-and-wellbeing/counselling-and-mental-health-support

If the counselling by AUT proved to be not sufficient to address directly linked to this study please contact Gilly Davy for information on further options at no cost to you.

What are the benefits?

For You: You will hopefully feel benefits from regular exercise, which may be reflected in noticeable physical improvements. You will learn how exercise can positively influence management of your MS and be aware of ways you can exercise to make being physically active more achievable and enjoyable. You will also learn some alternate ways to manage your fatigue, pain, and mental health, and have an increased understanding of which healthcare providers can assist you to keep engaged in regular physical activity. If you involve your whanau/family/cares, this could assist them in their understanding of your MS and how to support you. Once you have completed the MSGHS programme you will continue to have access to the resources for a further 12-month period.

For the researcher: the results will help me find out the effect of the MSGHS programme on confidence and engagement in regular physical activity for people with MS. It will help to highlight any further work or changes to the programme to achieve good outcomes for people with MS and help make a decision whether we progress to a larger randomised control trial. This study is the final part of my Master's qualification. MS GHS is a commercial company, and all intellectual property remains the property of MS Get a Head Start. This programme or any portion thereof may not be reproduced or used in any manner whatsoever without the express written permission of Gilly Davy, Copyright© 2019 MS Get a Head Start. After this research study is completed, there is the potential that this online MS GHS programme for people living with MS may be delivered commercially. This may lead to some potential financial gain for the researcher. There are no financial benefits or costs for your participation in this study.

For the wider community: The wider community includes people living with and supporting those with MS, MS societies, MS Nurses, Neurologists and Allied health professionals. The MSGHS programme is already established for face-to-face delivery and this study will help establish whether the programme can be delivered online in an automated fashion. This will significantly improve access to evidence-based education and exercise guidance for those living with MS throughout Aotearoa, filling a significant gap in access to rehabilitation. The online delivery may also change how practices can work through their waiting lists and what services they offer. As this programme is being delivered in people's homes, it could also benefit whānau of PwMS and those caring/supporting PwMS by helping to increase their knowledge and understanding of MS and self-management strategies.

What compensation is available for injury or negligence?

In the unlikely event of a physical injury as a result of your participation in this study, rehabilitation and compensation for injury by accident may be available from the Accident Compensation Corporation, providing the incident details satisfy the requirements of the law and the Corporation's regulations.

What compensation is available for injury or negligence?

In the unlikely event of a physical injury as a result of your participation in this study, rehabilitation and compensation for injury by accident may be available from the Accident Compensation Corporation, providing the incident details satisfy the requirements of the law and the Corporation's regulations.

How will my privacy be protected?

Once you are formally invited to participate in this study, you will be asked to create an online account on the MSGHS website which is a securer server and only Gilly Davy, the research assistant and website IT support individual have access to this information. You will set your own unique password and you will be assigned an exclusive identifier, so your results can be reported without being able to be linked to you. You do not need to provide your full name at any point.

No material that could personally identify you will be used in any reports from this study. On completion of the study all primary data will be deleted from the MSGHS secure server after 6 months. The collated results from all participants will be electronically stored for 6 years in a secure AUT password protected folder. All the information collected will only be used for this study. We will not be collecting any meta-data such as such as time-spent with the videos while you are logged in.

What are the costs of participating in this research?

There will be no financial costs to taking part in this research except the existing costs of accessing the emails and videos through your normal internet data provider. The programme will take approximately two and half hours a week for 6 weeks.

What opportunity do I have to consider this invitation?

Once you have expressed your interest to take part in the study and you have been emailed the link to complete the screening questionnaires you will have 2 weeks to consider if you would like to take part. If you have not completed the screening questionnaires after 2 weeks, I will contact you and I will be happy to answer any further questions you may have.

You are welcome to take extra time to consider your involvement however study recruitment will close on the 31st July 2024.

Will I receive feedback on the results of this research?

You will have the option on the consent form to confirm if you would like to receive a copy of your individual results and a one-page summary of the results of the study once it has been completed.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Nicola Saywell, nicola.saywell@aut.ac.nz, 09 921- 9502.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, *ethics@aut.ac.nz* , (+649) 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details

Gilly Davy
Gilly@ms-ghs.com

Administrative or IT Support:

Lisa Pocq Saint Jean
Admin@ms-ghs.com

Project Supervisor Contact Details:

Nicola Saywell, nicola.saywell@aut.ac.nz

Verna Stavric, verna.stavric@aut.ac.nz

This research study has received funding from New Zealand MS Research Trust

Approved by the Auckland University of Technology Ethics Committee on *29th April 2024*, AUTEC Reference number 24/7.

Appendix E Website Links

Please click on the links below to watch the video content recorded for the intervention.

- Welcome page with participant information video and link for participant information sheet:

https://www.ms-ghs.com/aut-research-project-msghs-patient-program/

- Screening questions and outcome measurement lists:

https://www.ms-ghs.com/research-forms/ password: msresearch2023

- Welcome to the MS Get a Head Start programme

https://www.dropbox.com/scl/fi/66da08ijwkipn9g09eosr/Welcome-Video-AUT-LOGO.mp4?rlkey=vhsa8bph5g1xyov5i281bfg7l&dl=0

- Week 1 session 1 exercise session

https://vimeo.com/manage/videos/904943194/e423d1da7f/privacy

- Week 1 education session

https://vimeo.com/manage/videos/904878052/ef7534cb30/privacy

Link to PDF copy to the MSGHS Course booklet provided to participants

Appendix F Initial Screening Forms

Initial Screening Questions Form

General information ------ PARQ ------ PDDS

Email address *

Your email address*

Date *

22nd March 2024

What year were you diagnosed with MS? *

Enter or select year you were diagnosed with MS*

What is your current Expanded Disability Status Scale (EDSS) score?

EDSS Not Applicable ☐ N/A

Please select current EDSS Score

Are you able to walk without a walking aid? *

○ Yes ○ No

Are you able to get on and off the floor independently? *

○ Yes ○ No

NEXT

Physical Activity Readiness Questionnaire (PAR-Q)

Step 1 ------ Step 2

This form is used to identify if it is safe for you to commence unsupervised exercise. Please read the questions carefully and answer each one to the best of your knowledge.

Has your doctor ever said that you have a heart condition or have you ever suffered a stroke? *

○ Yes ○ No

Do you feel unexplained pain in your chest at rest or when you do physical activity? *

○ Yes ○ No

Do you ever lose your balance because of dizziness during physical activity? *

○ Yes ○ No

Have you had an asthma attack requiring medical attention at any time over the last 12 months? *

○ Yes ○ No

If you have diabetes, have you had trouble controlling your blood glucose at any time over the last 6 months? *

○ Yes ○ No

Do you have a bone or joint problem that could be made worse by participating in exercise? *

○ Yes ○ No

Do you have any other medical condition that may make it dangerous for you to participate in exercise? *

○ Yes ○ No

SUBMIT

PDDS Patient-Determined Disease Steps

Step 1 —— Step 2

Please read the choices listed below and choose the one that best describes your own situation. This scale focuses mainly on how well you walk. Not everyone will find a description that reflects their condition exactly, but please mark the one category that describes your situation the closest.

○ 0 Normal:
I may have some mild symptoms, mostly sensory due to MS but they do not limit my activity. If I do have an attack, I return to normal when the attack has passed.

○ 1 Mild Disability:
I have some noticeable symptoms from my MS but they are minor and have only a small effect on my lifestyle.

○ 2 Moderate Disability:
I don't have any limitations in my walking ability. However, I do have significant problems due to MS that limit daily activities in other ways.

○ 3 Gait Disability:
MS does interfere with my activities, especially my walking. I can work a full day, but athletic or physically demanding activities are more difficult than they used to be. I usually don't need a cane or other assistance to walk, but I might need some assistance during an attack.

○ 4 Early Cane:
I use a cane or a single crutch or some other form of support (such as touching a wall or leaning on someone's arm) for walking all the time or part of the time, especially when walking outside. I think I can walk 25 feet in 20 seconds without a cane or crutch. I always need some assistance (cane or crutch) if I want to walk as far as 3 blocks.

○ 5 Late Cane:
To be able to walk 25 feet, I have to have a cane, crutch or someone to hold onto. I can get around the house or other buildings by holding onto furniture or touching the walls for support. I may use a scooter or wheelchair if I want to go greater distances.

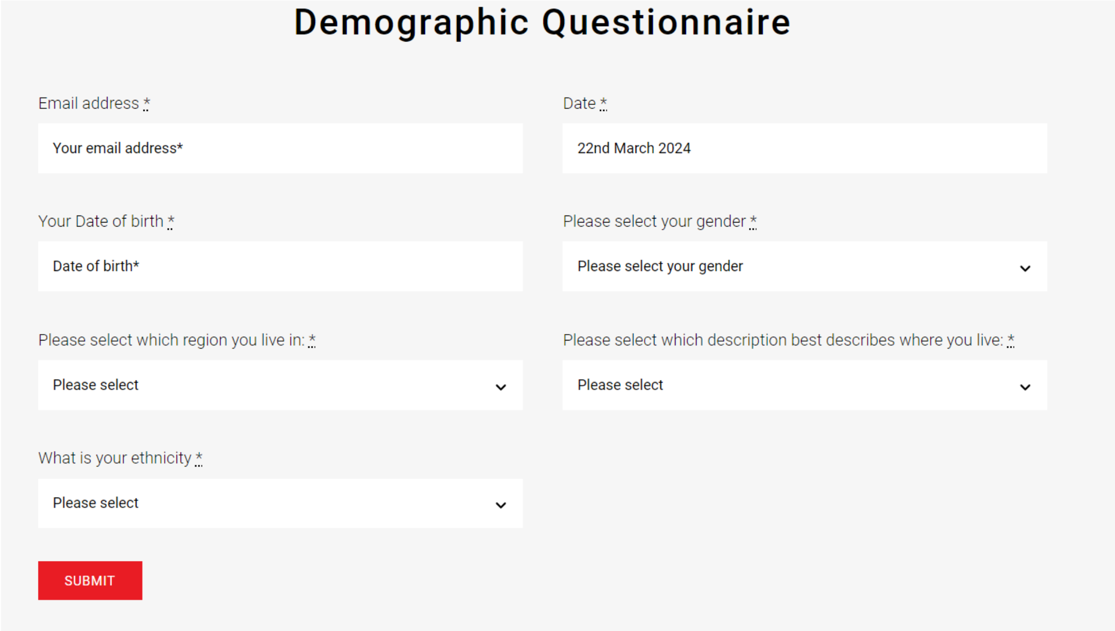
○ 6 Bilateral Support:
To be able to walk as far as 25 feet I must have 2 canes or crutches or a walker. I may use a scooter or wheelchair for longer distances.

○ 7 Wheelchair / Scooter:
My main form of mobility is a wheelchair. I may be able to stand and/or take one or two steps, but I can't walk 25 feet, even with crutches or a walker.

○ 8 Bedridden:
Unable to sit in a wheelchair for more than one hour.

SUBMIT

Appendix G Demographic Questionnaire



Demographic Questionnaire

Email address *

Your email address*

Date *

22nd March 2024

Your Date of birth *

Date of birth*

Please select your gender *

Please select your gender

Please select which region you live in: *

Please select

Please select which description best describes where you live: *

Please select

What is your ethnicity *

Please select

SUBMIT

Appendix H Consent Form

TE WĀNANGA ARONUI O TĀMAKI MAKAU RAU

Consent Form

Project title: The effect of online delivery of the MS-Get-a-Head-Start programme on physical activity self-efficacy of people with Multiple Sclerosis: a randomised pilot trial.

Project Supervisor: *Dr Nicola Saywell and Dr Verna Stavric*

Researcher: ***Gilly Davy***

- ○ I have read and understood the information provided about this research project in the Information Sheet dated 10th May 2024.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ○ I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- ○ I am not suffering from heart disease, high blood pressure, any respiratory condition (mild asthma excluded), any illness, any infection or injury that prevents me from participating in an exercise programme.
- ○ I agree to take part in this research.
- ○ I wish to receive a summary of the research findings (please tick one): Yes○ No○
- ○ I wish to receive a copy of my individual results (please tick one): Yes○ No○

Participants signature: ....

Participants name: ....

Participant's Contact Details (if appropriate):

....

....

....

....

Date:

Approved by the Auckland University of Technology Ethics Committee on 29th April 2024
AUTEC Reference number 24/7

Note: The Participant should retain a copy of this form.

New Zealand Multiple Sclerosis Research Trust
Knowledge brings hope

Appendix I TIDierR (Template for intervention description and replication) for MS Get a Head Start

1. **Name:**
   The online MS Get a Head Start (MSGHS)

2. **Why:**
   The MSGHS programme is a six-week exercise and education programme that has been specifically designed to help empower people living with MS to increase their physical activity and exercise participation, as well as increase their confidence in their self-management of their MS. MS specific exercise guidelines have been published backed by extensive research which supports exercise as a significant befit for those living with MS. However, there are significant challenges that can make it difficult for PwMS to exercise. These include fatigue, heat sensitivity and temporary symptom exacerbation with exercise.

3. **What:**
   This study specifically refers to the ONLINE MS Get a Head Start programme. The six-week interval-based exercise and education programme is delivered fully online via prerecorded videos. The programme commences with participants watching a 20-minute welcome video that introduces them to the programme and outlines what they should expect. It also covers educational information on proactive heat sensitivity management and setting up a safe exercise space. Each week the participants receive an email with two exercise videos and one education video to watch.

   All participants receive an online PDF course handbook prior to starting and are also offered a physical copy of the programme posted to them. The handbook provides all the supporting education material for the intervention. This includes the education sections for each week as well as goal setting, activity diary recording, and weekly reflective work.

   Participants are encouraged to have a sturdy chair and either an exercise mat or a towel /rug on which they can complete floor exercises. No further exercise equipment is needed.

4. **Procedure for the AUT "The effect of online delivery of the MS-Get-a-Head-Start programme on physical activity self-efficacy of people with multiple sclerosis: a randomised pilot trial"**
   a. Advertising flyer distributed
   b. Potential participants directed to the website with the participant information form and short explanatory video
   c. Interested participants email the researcher and can ask any further questions about the study via email or a scheduled a phone call. If still interested, the researcher then emails them a link to fill out a form gathering key screening information. If suitable, they are directed to complete the following screening questionnaires;
      i. Physical Activity Readiness Questionnaire

   ii. The patient-determined disease steps screening measure

d. If the participants meet the inclusion requirements they will be emailed a link to complete the consent form online.
e. Once the consent form is completed, they will then be randomized into either the intervention group or the waitlist control group. The intervention group will be sent a link to register themselves to the online MSGHS programme, this will then start the automated programme. Both groups will be emailed a link which asks them to provide some basic demographic data (age, gender, ethnicity, and which region they live in) and will be asked to complete the outcome measures at week 0, week 7 and week 12. After the outcome measures have been completed in week 12 the waitlist control group will be notified that they can access and complete the online MSGHS programme. The waitlist group will have the identical experience and access to the programme as the intervention group (but will not be asked to complete the outcome measures).
f. Once the intervention group registers for the MSGHS programme they receive an automated welcome email containing the supporting PDF booklet, welcome video and the link to complete the outcome measures. They can download and save the workable PDF booklet on their own computer. We do not collect any data from the PDF workbook. They will be given the option to request a hard copy of the booklet to be sent to them if they prefer.
g. The intervention group then receives one email each week for 6 weeks. This email contains two exercise videos and one education video. It also details what the expected course work is for that week and asks the participants to reply to the email if they have experienced and injuries, issues or adverse events during the programme.
h. The exercise videos deliver interval training, which gradually increases over the 6 weeks. As detailed in the table below, the rest period to exercise is a 1:1 ratio between each set. There are nine different exercises delivered in each video. Participants are encouraged to take at least a 1 minute rest after the third and sixth exercise, but can pause the video to extend this rest if needed.

Week	Time	Number of sets
1	10 seconds	3
2	20 seconds	3
3	30 seconds	3
4	30 seconds	3
5	45 seconds	2
6	45 seconds	2

i. The nine exercises are a combination of cardiovascular, strength and balance exercises. Participants are encouraged to work as hard as they can during each exercise, an explanation on what “hard” can feel like safely is explained in the welcome video. Each exercise is demonstrated and then options of regressions and progressions are demonstrated to allow participants to find a level that is appropriate for them. The exercise videos last for approximately 35 – 45 minutes and safety introduction is provided at the start of each video. Participants are encouraged to leave at least one day between completing the first exercise video of the week and then the second. The tables below list the exercises delivered.

WEEK 1 Session 1	WEEK 1 Session 2
Calf raises	Dorsiflexion seated
Sit to Stand	Wrist extension seated
Speed box	1 leg alphabet
4-point kneeling leg extension	Tabletop holds
Bridging	Side plank
Plank	Side leg lifts
Feet together head turns	Knee drive
Tandem stand	Heel kick in standing
Toe extension stretch	Prone quad stretch

WEEK 2 Session 1	WEEK 2 Session 2
Shoulder circles	1 leg alphabet
Speed squats	Tandem walk
Mountain climbs	Push ups
Dead Bug	Plank
Side leg lifts	Rotational reach sit up
Bridging	4 point alt arm and leg
VOR	Lunges
Step taps	STS
Boxing	Tip toe Walk

WEEK 3 Session 1	WEEK 3 Session 2
1 leg calf raise	Boxing
VOR horizontal	Bunny hops
Standing dorsiflexion	On and off the floor
Bicycle crunch	4 point kneeling leg abd
Side plank	Plank
Bridging	Dead bug
Ball throwing	Ticep dips
Knee drive	Speed squats
Heel kicks	Hip flexor stretch

WEEK 4 Session 1	WEEK 4 Session 2
Seated dorsi	STS
Seated wrist extension	1 leg calf raise
Tandem standing	Hamstring curls
Side leg lifts	Mountain climbs
Side plank	Plank to pike
4 point alt arm and leg	Bridge
Boxing	Lunge back step
Bounding	Tricep dips
Step tap	Side lunge

WEEK 5 Session 1	WEEK 5 Session 2
Lunges	Boxing
VOR	Standing dorsiflex
Ball toss	Side lunge
Side planks	Walk outs
Plank with hip dips	Press ups
Hip thrusts	Reverse crunch
Tricep dips	Dead bug
Heel kicks	Squat pulse
Knee drive	Plank shoulder tap

WEEK 6 Session 1	WEEK 6 Session 2
1 leg calf raise	Squat pulse
On and off the ground	Standing dorsiflexion
Boxing	Hopping
Bounding	Walkouts
Bicycle crunch	Tadem VOR
Bridge 1 leg	Mountain climbs
VOR	1 leg alphabet
High knee run	Boxing
Lunge	Lateral knee plank

**STS = Sit to Stand, VOR = gaze stability vestibular ocular reflex 1 exercise.*

j. Each education video lasts approximately 30 – 40 minutes and the PDF handout of the power point presented is attached to each weekly email. The six topics discussed are listed in the table below. The main education points are also delivered within the MSGHS PDF booklet.

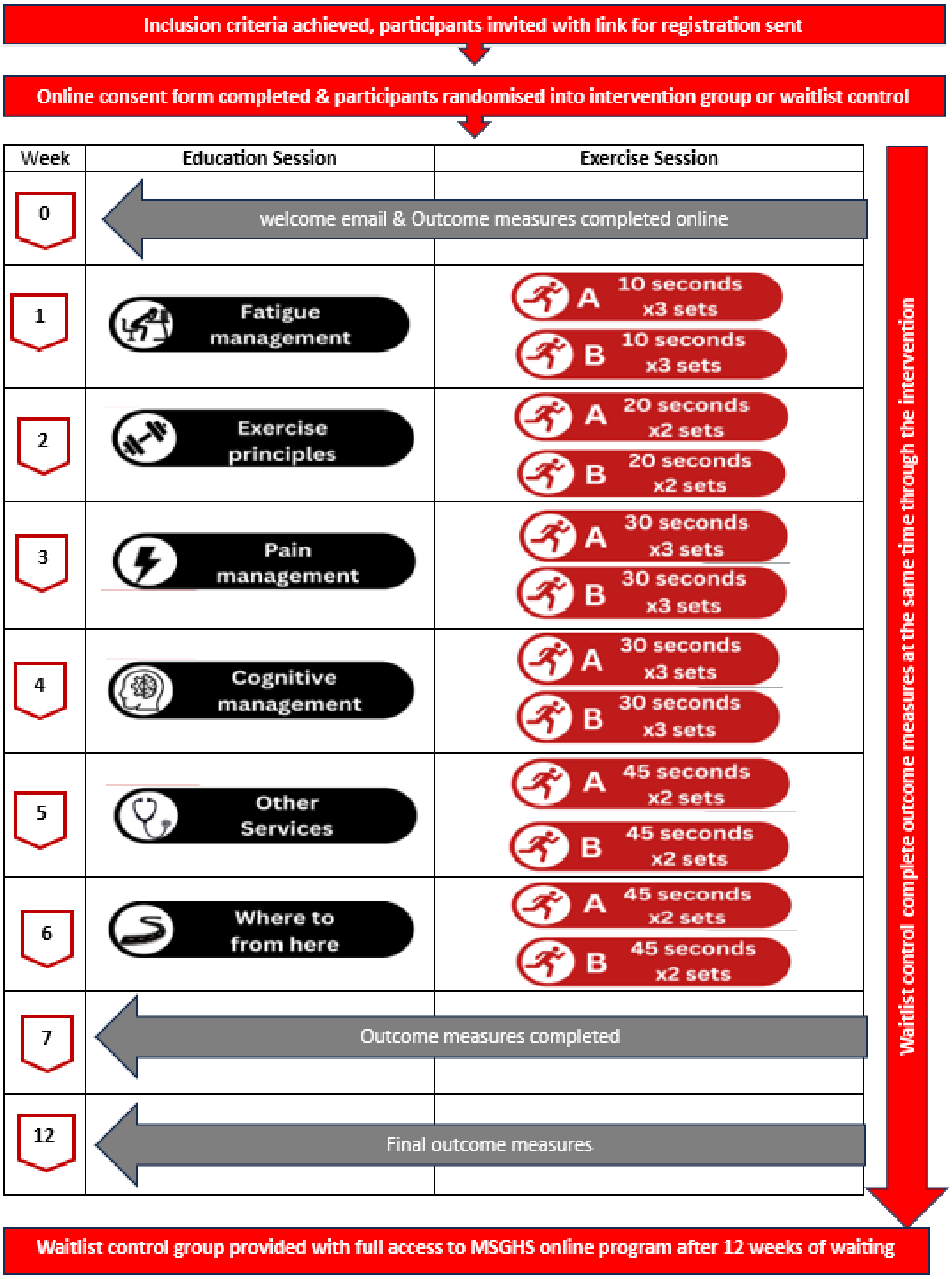
Week	Education Topic
1	Fatigue Management
2	Exercise Prescription
3	Pain Management
4	Cognitive Management
5	Other Services
6	Where to from here

k. Each week participants are also asked to complete the following course work.

Week	Course Work
0	Goals section, list main impairments, reasons for doing MSGHS and barriers and solutions to exercise
1	Fill out their exercise “before MSGHS” table. Schedule a 10 -20 min rest daily. Complete week 1 reflections and activity recording table.
2	Fill out exercise “during MSGHS” table. Complete week 2 reflections and activity recording table.
3	Complete week 3 reflections and activity recording table.
4	Schedule something nice / make a list of the things that bring you joy. Complete week 4 reflections and activity recording table.
5	Complete week 5 reflections and activity recording table.
6	Fill out exercise “After MSGHS” table. Complete week 6 reflections and activity recording table.
7	Complete final completion reflection

l. All the participants have access to all the exercise and education videos provided at the end of the programme via their own login to the MSGHS website. They have access to these for 12 months.

m. The figure below demonstrates the flow of the total intervention



5. **Who is Providing:**

Gilly Davy is the founder and clinical lead of the MSGHS programme and has provided all online recordings. She has a BSc Hons Physiotherapy and Post Grad Certificate in Health and Rehabilitation Science. With 20 years of experience as a clinical neurological physiotherapist, she has spent the last 15 years specialising in assessing and treating individuals with multiple sclerosis.

MSGHS is a company that also provides health professional education courses both online and in person www.ms-ghs.com

6. **How:**
The programme is delivered online via pre-recorded material that is provided in automated weekly emails. Each email contains two exercise videos and one education video. The email also includes the course work for each week and asks participants to respond if they have perceived any incidents or adverse effects during the programme.

7. **Where:**
As MSGHS online intervention is provided fully online via pre-recoded material and automated delivered, participants can choose where and when they want to complete the intervention each week.

8. **When and How Much:**
Participants complete a minimum of the two exercise videos each week, lasting approximately 35- 45 minutes. They also watch the education video lasting approximately 30 -40 minutes and then have approximately 30 minutes of course week to complete each week. The participants can choose to complete any part of the intervention at a time that suits them during the week.

9. **Tailoring:**
Each exercise is demonstrated, and a regression and progression option are provided so individuals could choose on the day which level of the exercise they want to do. They are encouraged to complete the whole video in one go, but can pause and rest as many times as they need.
They are encouraged to complete the two exercise videos and reassured that they can repeat the video sessions more times through the week if they choose to. The course work which they are encouraged to complete in the PDF booklet also helps to make the programme tailored.

10. **Modifications:**
Each exercise is demonstrated, and a regression and progression option are provided so individuals could choose on the day which level of the exercise they want to do.

Appendix J MS Get a Head Start Online Delivery – Exercises Delivered

The MSGHS six-week interval-based exercise and education programme is delivered online via pre-recorded videos. There is a 20-minute welcome and introduction video that outlines what participants should expect. It covers information on proactive heat sensitivity management and how to set up a safe exercise space. Each subsequent week participants will receive an automated email with links to two interval-based exercise videos and one education video.

Participants will be encouraged to complete the two exercise videos each week and are welcome to repeat these videos if they choose. There are nine exercises in each video that cover strength, balance, fitness, and core stability. The six educational videos cover a range of topics that cover MS symptoms and practical management strategies: 1. fatigue management, 2. exercise prescription, 3. pain management, 4. cognitive and psychological well-being, 5. multi-disciplinary services, and 6. "where to from here?", helping participants consider how to continue with long-term PA.

Each of the weekly emails detail coursework for that week. Participants will have a choice of receiving an online course handbook or a physical copy posted to them. The handbook provides all the material that supports the educational videos. This features several behavioural change strategies, including goal setting, activity diary recording, weekly reflections, education and problem-solving solutions. After the programme has finished, participants will also receive an automated motivational email fortnightly between week six and week 12.

Completing the MSGHS programme will take approximately 2.5 hours each week. This includes the two exercise sessions (both approximately 45 minutes), the education session (approximately 45 minutes), and the course work (60 minutes). Participants are encouraged to have a sturdy chair and either an exercise mat or a towel /rug on which they can complete floor exercises. No further exercise equipment is needed. The programme is unsupervised and fully automated, and participants will be encouraged to take ownership of their progress through the programme. They can complete the exercise and education videos at a time and location that suits them.

The tables below list the exercises delivered.

WEEK 1 Session 1	WEEK 1 Session 2
Calf raises	Dorsiflexion seated
Sit to Stand	Wrist extension seated
Speed box	1 leg alphabet
4-point kneeling leg extension	Tabletop holds
Bridging	Side plank
Plank	Side leg lifts
Feet together head turns	Knee drive
Tandem stand	Heel kick in standing
Toe extension stretch	Prone quad stretch

WEEK 2 Session 1	WEEK 2 Session 2
Shoulder circles	1 leg alphabet
Speed squats	Tandem walk
Mountain climbs	Push ups
Dead Bug	Plank
Side leg lifts	Rotational reach sit up
Bridging	4 point alt arm and leg
VOR	Lunges
Step taps	STS
Boxing	Tip toe Walk

WEEK 3 Session 1	WEEK 3 Session 2
1 leg calf raise	Boxing
VOR horizontal	Bunny hops
Standing dorsiflexion	On and off the floor
Bicycle crunch	4 point kneeling leg abd
Side plank	Plank
Bridging	Dead bug
Ball throwing	Triceps dips
Knee drive	Speed squats
Heel kicks	Hip flexor stretch

WEEK 4 Session 1	WEEK 4 Session 2
Seated dorsi	STS
Seated wrist extension	1 leg calf raise
Tandem standing	Hamstring curls
Side leg lifts	Mountain climbs
Side plank	Plank to pike
4 point alt arm and leg	Bridge
Boxing	Lunge back step
Bounding	Triceps dips
Step tap	Side lunge

WEEK 5 Session 1	WEEK 5 Session 2
Lunges	Boxing
VOR	Standing dorsiflex
Ball toss	Side lunge
Side planks	Walk outs
Plank with hip dips	Press ups
Hip thrusts	Reverse crunch
Triceps dips	Dead bug
Heel kicks	Squat pulse
Knee drive	Plank shoulder tap

WEEK 6 Session 1	WEEK 6 Session 2
1 leg calf raise	Squat pulse
On and off the ground	Standing dorsiflexion
Boxing	Hopping
Bounding	Walkouts
Bicycle crunch	Tandem VOR
Bridge 1 leg	Mountain climbs
VOR	1 leg alphabet
High knee run	Boxing
Lunge	Lateral knee plank

STS = Sit to Stand, VOR = gaze stability vestibular ocular reflex 1 exercise.

Alongside the six educational videos each week, participants are also asked to complete the following course work.

Week	Course Work
0	Goals section, listing main impairments, reasons for doing MSGHS, barriers and solutions to exercise
1	Fill out their exercise “before MSGHS” table. Schedule a 10 -20 min rest daily. Complete week 1 reflection and activity recording table.
2	Fill out exercise “during MSGHS” table. Complete week 2 reflections and activity recording table.
3	Complete week 3 reflections and activity recording table.
4	Schedule something nice / make a list of the things that bring you joy. Complete week 4 reflections and activity recording table.
5	Complete week 5 reflections and activity recording table.
6	Fill out exercise “After MSGHS” table. Complete week 6 reflections and activity recording table.
7	Complete final completion reflection

All the participants have access to all the exercise and education videos provided at the end of the programme via their own login to the MSGHS website. They have access to these for 12 months.

Appendix K Health Information Technology Usability Evaluation Scale

Health Information Technology Usability Evaluation Scale

On a scale from 1 to 5. **1 being Strongly Disagree** and **5 being Strongly Agree**

Impact

1. I think MSGHS would be a positive addition for persons living with MS. *

Strongly Disagree — 3 — Strongly Agree

Not Applicable
☐ N/A

2. I think MSGHS would improve the Quality of Life of persons living with MS. *

Strongly Disagree — 3 — Strongly Agree

Not Applicable
☐ N/A

3.MSGHS is an important part of meeting my information needs related to symptom self management. *

Strongly Disagree — 3 — Strongly Agree

Not Applicable
☐ N/A

NEXT

Health Information Technology Usability Evaluation Scale

On a scale from 1 to 5. **1 being Strongly Disagree** and **5 being Strongly Agree**

Perceived Usefulness

4. Using MSGHS makes it easier to self-manage my MS related symptoms.

Strongly Disagree — 3 — Strongly Agree

Not Applicable
☐ N/A

5. Using MSGHS enables me to self-manage my MS related symptoms more quickly.

Strongly Disagree — 3 — Strongly Agree

Not Applicable
☐ N/A

6. Using MSGHS makes it more likely that I can self manage my MS related symptoms.

Strongly Disagree — 3 — Strongly Agree

Not Applicable
☐ N/A

7. Using MSGHS is useful for self-management of MS related symptoms.

Strongly Disagree — 3 — Strongly Agree

Not Applicable

▢ N/A

8. I think MSGHS presents a more equitable process for self-management of MS related symptoms.

Strongly Disagree — 3 — Strongly Agree

Not Applicable

▢ N/A

9. I am satisfied with MSGHS for self-management of MS related symptoms.

Strongly Disagree — 3 — Strongly Agree

Not Applicable

▢ N/A

10. I self manage my MS symptoms in a timely manner because of MSGHS.

Strongly Disagree — 3 — Strongly Agree

Not Applicable

▢ N/A

11. Using MSGHS increases my ability to self manage my MS related symptoms.

Strongly Disagree — 3 — Strongly Agree

Not Applicable

▢ N/A

12. I am able to self manage my MS related symptoms whenever I use MSGHS.

Strongly Disagree — 3 — Strongly Agree

Not Applicable

▢ N/A

NEXT

Perceived Ease of Use

13. I am comfortable with my ability to use MSGHS.

Strongly Disagree — 3 — Strongly Agree

Not Applicable

▢ N/A

14. Learning to operate MSGHS is easy for me.

Strongly Disagree — 3 — Strongly Agree

Not Applicable

▢ N/A

15. It is easy for me to become skilful at using MSGHS.

Strongly Disagree — 3 — Strongly Agree

Not Applicable

▢ N/A

16. I find MSGHS easy to use.

Strongly Disagree — 3 — Strongly Agree

Not Applicable

▢ N/A

17. I can always remember how to log onto and use MSGHS.

Strongly Disagree — 3 — Strongly Agree

Not Applicable

▢ N/A

NEXT

User Control

18. MSGHS gives error messages that clearly tell me how to fix problems.

Strongly Disagree 3 Strongly Agree

Not Applicable

N/A

19. Whenever I make mistake using MSGHS, I recover easily and quickly.

Strongly Disagree 3 Strongly Agree

Not Applicable

N/A

20. The information (such as the handouts and booklet) provided with MSGHS is clear.

Strongly Disagree 3 Strongly Agree

Not Applicable

N/A

SUBMIT

Appendix L The Godin Leisure-Time Exercise Questionnaire

The Godin Leisure-Time Exercise Questionnaire

Step 1 — Step 2

1. Considering a **7-Day period** (a week), how many times on the average do you do the following kinds of exercise for **more than 15 minutes** during your free time.

Times Per Week

a) **STRENUOUS EXERCISE (HEART BEATS RAPIDLY)**

(i.e., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)

Enter a number*

b) **MODERATE EXERCISE (NOT EXHAUSTING)**

(i.e., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, alpine skiing, easy swimming, popular and folk dancing)

Enter a number*

c) **MILD EXERCISE (MINIMAL EFFORT)**

(i.e., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)

Enter a number*

2. Considering a 7-day period (a week), during your leisure-time, how often do you engage in any regular physical activity long enough to work up a sweat (heart beats rapidly)?

Times per week *

Enter a number*

SUBMIT

Appendix M Incidental and Planned Exercise Questionnaire

Incidental and Planned Exercise Questionnaire

Step 1 —— Step 2

Please select an answer for each question below that best reflects your activity levels over the last week.

1. In the last week, how often have you been on walks specifically for exercise? i.e. walking in the park, in the streets, cross-country walking, walking the dog etc.

- ○ Every day
- ○ 3-6 times per week
- ○ Twice per week
- ○ Once per week
- ○ Less than once per week
- ○ Never

2. In these walks for exercise, how long did you walk for?

- ○ Less than 15 mins per day
- ○ 15 mins to less than 30 mins per day
- ○ 30 mins to less than 1 hour per day
- ○ 1 hour to less than 2 hours per day
- ○ 2 hours to less than 4 hours per day
- ○ 4 or more hours per day

3. In the last week, how often have you attended exercise classes?

- ○ Every day
- ○ Six times
- ○ Five times
- ○ Four times
- ○ Three times
- ○ Twice
- ○ Once
- ○ Never

4. How long did these exercise classes last per session?

- ○ Less than 30 mins
- ○ 30 mins to less than 45 mins
- ○ 45 mins to less than 1 hour
- ○ 1 hour to less than 2 hours
- ○ 2 hours to less than 4 hours

5. In the last week, how often have you undertaken home activities for exercise? Examples of activities: stationary bicycle, stretching etc.

- ○ Every day
- ○ Six times
- ○ Five times
- ○ Four times
- ○ Three times
- ○ Twice
- ○ Once
- ○ Never

6. How long was your home exercise session on average per session?

- ○ Less than 30 mins
- ○ 30 mins to less than 45 mins
- ○ 45 mins to less than 1 hour
- ○ 1 hour to less than 2 hours
- ○ 2 hours to less than 4 hours

7. In the last week, how often have you undertaken other types of activities for exercise? Examples of other activities: bowls, golf, tennis, swimming, dancing, jogging, bicycling etc.

- ○ Every day
- ○ Six times
- ○ Five times
- ○ Four times
- ○ Three times
- ○ Twice
- ○ Once
- ○ Never

8. In these activities for exercise, how long was each session?

- ○ Less than 30 mins
- ○ 30 mins to less than 45 mins
- ○ 45 mins to less than 1 hour
- ○ 1 hour to less than 2 hours
- ○ 2 hours to less than 4 hours

9. During the last week, how often have you been on walks NOT specifically for exercise? For example walking to the general practitioner, pharmacy or store

- ○ Every day
- ○ 3-6 times per week
- ○ Twice per week
- ○ Once per week
- ○ Less than once per week
- ○ Never

10. In these other walks, how long did you walk for?

- ○ Less than 15 mins per day
- ○ 15 mins to less than 30 mins per day
- ○ 30 mins to less than 1 hour per day
- ○ 1 hour to less than 2 hours per day
- ○ 2 hours to less than 4 hours per day
- ○ 4 or more hours per day

11. During the last week, in addition to the walking you mentioned previously, how much time did you spend each day outdoors doing other physical activity such as house maintenance, gardening and community work? (Excluding activities inside the house.)

- ○ Never
- ○ Less than 15 mins per day
- ○ 15 mins to less than 30 mins per day
- ○ 30 mins to less than 1 hour per day
- ○ 1 hour to less than 2 hours per day
- ○ 2 hours to less than 4 hours per day
- ○ 4 or more hours per day

12. During the last week, how many hours did you spend on your feet each day indoors at home doing tasks like housework, self-care or care for another person?

- ○ Never (Living in hostel, assisted living)
- ○ Less than 15 mins per day
- ○ 15 mins to less than 30 mins per day
- ○ 30 mins to less than 1 hour per day
- ○ 1 hour to less than 2 hours per day
- ○ 2 hours to less than 4 hours per day
- ○ 4 or more hours per day

SUBMIT

Appendix N Self-Efficacy for Exercise Scale

Self-efficacy For Exercise (SEE) Scale

Step 1 — Step 2

On a scale from 0 to 10. **0 being Not Confident** and **10 being Very Confident**

How confident are you right now that you could exercise three times per week for 20 minutes if:

1. The weather was bothering you *

5

Not Confident **Very Confident**

2. You were bored by the program or activity *

5

Not Confident **Very Confident**

3. You felt pain when exercising *

5

Not Confident **Very Confident**

4. You had to exercise alone *

5

Not Confident **Very Confident**

5. You did not enjoy it *

5

Not Confident **Very Confident**

6. You were too busy with other activities *

5

Not Confident **Very Confident**

7. You felt tired *

5

Not Confident **Very Confident**

8.You felt stressed *

5

Not Confident **Very Confident**

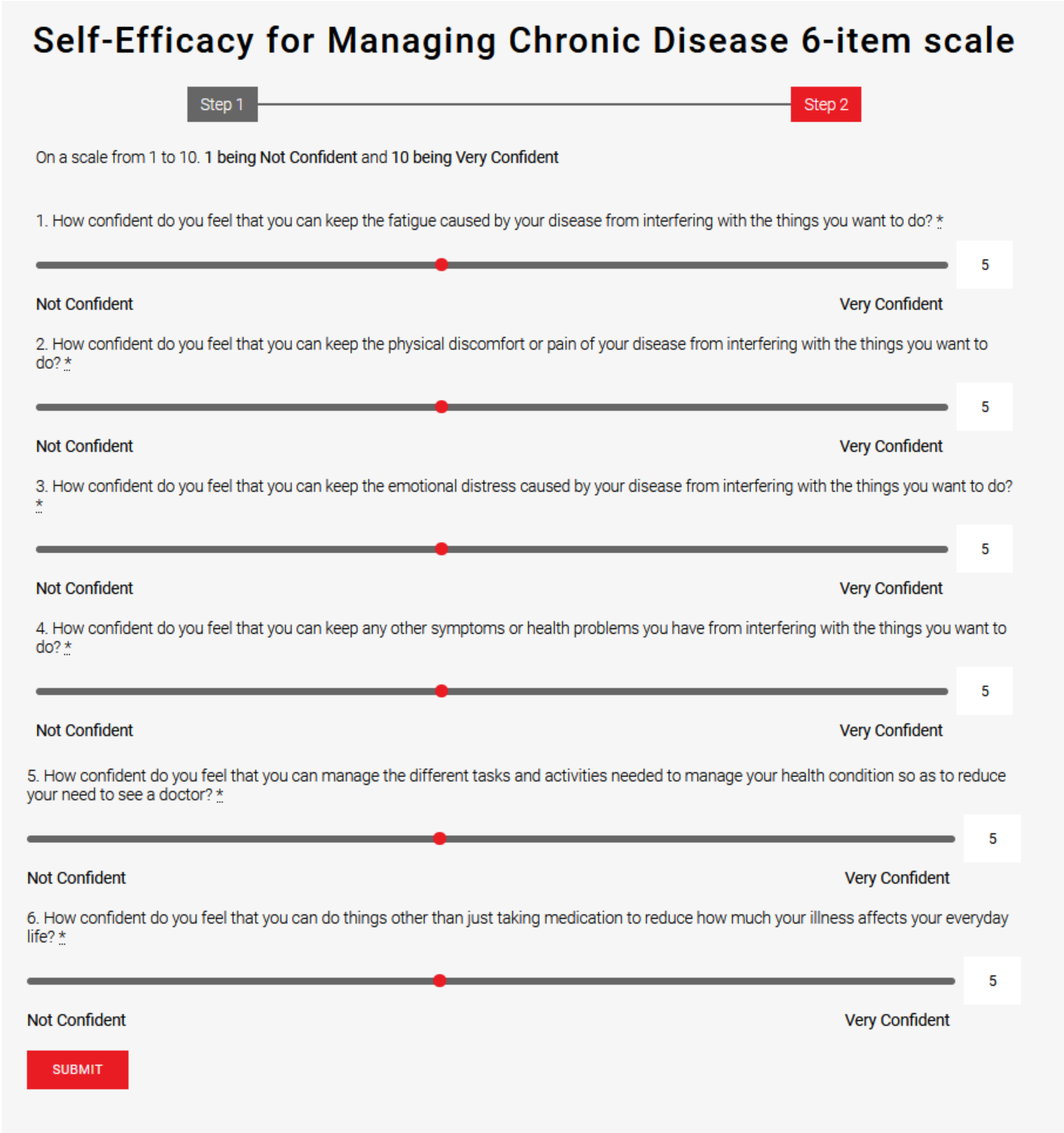
9. You felt depressed *

5

Not Confident **Very Confident**

SUBMIT

Appendix O Self-Efficacy for Managing Chronic Disease 6-iteam scale



Self-Efficacy for Managing Chronic Disease 6-item scale

Step 1 Step 2

On a scale from 1 to 10. **1 being Not Confident** and **10 being Very Confident**

1. How confident do you feel that you can keep the fatigue caused by your disease from interfering with the things you want to do? *

5

Not Confident **Very Confident**

2. How confident do you feel that you can keep the physical discomfort or pain of your disease from interfering with the things you want to do? *

5

Not Confident **Very Confident**

3. How confident do you feel that you can keep the emotional distress caused by your disease from interfering with the things you want to do? *

5

Not Confident **Very Confident**

4. How confident do you feel that you can keep any other symptoms or health problems you have from interfering with the things you want to do? *

5

Not Confident **Very Confident**

5. How confident do you feel that you can manage the different tasks and activities needed to manage your health condition so as to reduce your need to see a doctor? *

5

Not Confident **Very Confident**

6. How confident do you feel that you can do things other than just taking medication to reduce how much your illness affects your everyday life? *

5

Not Confident **Very Confident**

SUBMIT

Appendix P 12 Item MS Walking Scale

12-Item MS Walking Scale (MSWS-12)

Step 1 — Step 2

These questions ask about limitations to your walking due to MS during the past 2 weeks. For each statement, please select one option that best describes your degree of limitation. Please answer all questions even if some seem rather similar to others, or seem irrelevant to you.

If you cannot walk at all, please tick this box.

☐ Cannot Walk

In the past two weeks, how much has your MS...

1. Limited your ability to walk? *

○ Not at all ○ A little ○ Moderately ○ Quite a bit ○ Extremely

2. Limited your ability to run? *

○ Not at all ○ A little ○ Moderately ○ Quite a bit ○ Extremely

3. Limited your ability to climb up and down stairs? *

○ Not at all ○ A little ○ Moderately ○ Quite a bit ○ Extremely

4. Made standing when doing things more difficult? *

○ Not at all ○ A little ○ Moderately ○ Quite a bit ○ Extremely

5. Limited your balance when standing or walking? *

○ Not at all ○ A little ○ Moderately ○ Quite a bit ○ Extremely

6. Limited how far you are able to walk? *

○ Not at all ○ A little ○ Moderately ○ Quite a bit ○ Extremely

7. Increased the effort needed for you to walk? *

○ Not at all ○ A little ○ Moderately ○ Quite a bit ○ Extremely

8. Made it necessary for you to use support when walking indoors (e.g., holding on to furniture, using a stick, etc.)? *

○ Not at all ○ A little ○ Moderately ○ Quite a bit ○ Extremely

9. Made it necessary for you to use support when walking outdoors (e.g., using a stick, a frame, etc.)? *

○ Not at all ○ A little ○ Moderately ○ Quite a bit ○ Extremely

10. Slowed down your walking? *

○ Not at all ○ A little ○ Moderately ○ Quite a bit ○ Extremely

11. Affected how smoothly you walk? *

○ Not at all ○ A little ○ Moderately ○ Quite a bit ○ Extremely

12. Made you concentrate on your walking? *

○ Not at all ○ A little ○ Moderately ○ Quite a bit ○ Extremely

SUBMIT

Appendix Q Adverse Events Procedure

MS Get a Head Start Adverse Events Procedure

TE WĀNANGA ARONUI O TĀMAKI MAKAU RAU

1. Participants will be informed in the Welcome Video, and at the start of every exercise and education video to reply to the automate email if they have experienced any incidents or adverse events. We state clearly in the exercise videos that if the participant experiences any shortness of breath or chest pain to contact either their GP or emergency services immediately and to stop exercising.

2. Participants receive a weekly automated email which will ask the following question;
"Have you experienced any incidents that has affected your health this week such as a fall, injury or illness?

If they answer yes, they will be asked to reply to the email by clicking on the "yes" button that will feature below the question. Participants are also reminded twice a week at the start of the exercise session to reply to the email if they have experienced any adverse events.

3. Once an email notification has come in regarding an adverse event, this will be forwarded to the research assistant who will complete the following.

    a. Contact will be made within 48 hours, an email will be sent asking for a suitable contact number.
    b. Open adverse events report form stored in the AUT OneDrive folder.
    c. Call the participant within 48 hours and record details on the Adverse Events form and save in the adverse events folder in the AUT OneDrive folder, using the P number and date of event as file name.
    d. Record adverse event in the excel spreadsheet in the AUT onedrive folder.
    e. Participants will be reminded that the research assistant is not a medical professional, however the research assistant will encourage participants to see their GP if there are any concerns raised about their health. They will also refer to the participant information sheet to remind participants that they can access ACC if they have had an accident and provide the contract details for the AUT Student Counselling and Mental Health.

4. If the participant is not safe or able to complete the study due to the adverse event they will be withdrawn and the research assistant will complete the withdrawal form.

5. All adverse events will be coded according to the current Common Terminology Criteria for Adverse Events. Each event will be adjudicated for severity (on a scale of 1 to 5, with 1 being mild, requiring no medical intervention and 5 being death) and relatedness to the intervention (yes or no). These will be reported in the results of the study.

6. The trial will be stopped if three adverse events that score 3 or more on the severity scale are adjudicated to be related to the intervention.

Appendix R Common Terminology Criteria for Adverse Events

Common Terminology Criteria for Adverse Events

Grade 1	Mild: Asymptomatic or mild symptoms. Clinical or diagnostic observations only, with no medical intervention required.
Grade 2	Moderate: Mild to moderate symptoms requiring minimal local or non-invasive intervention, and limiting instrumental ADL (e.g., cooking, shopping, managing finances).
Grade 3	Severe: Medically significant but not immediately life-threatening; may require hospitalisation or prolongation of hospital stay, and limits self-care ADL (e.g., bathing, dressing, eating).
Grade 4	Life threatening: Life-threatening consequences requiring urgent intervention.
Grade 5	Death: Death related to the adverse event.

U.S. Department of Health and Human Services. (2009). *Common Terminology Criteria for Adverse Events (CTCAE)*. https://evs.nci.nih.gov/ftp1/CTCAE/CTCAE_4.03/Archive/CTCAE_4.0_2009-05-29_QuickReference_8.5x11.pdf

Adverse events recorded

Grade	Reason	Intervention or Control
2	Minor surgery to remove a lump on thigh, and the participant was prescribed 2 months of minimal exercise to safeguard the stiches.	Control
1	Viral cold with respiratory symptoms, leading to fatigue	Intervention
2	Viral infection	Intervention
2	Covid	Intervention
1	Migraines and fatigue/exhaustion around their monthly cycle	Intervention

Total of 5 adverse events recorded

Withdrawal recorded

Grade 2: Intervention group

After contracting a respiratory infection, the participant has been left with lethargy symptoms that are quite overwhelming and affect the quality of their daily life, along with issues relating to another medical condition they have.

Guidelines for stopping the trial

The trial will be stopped if three adverse events that score 3 or more on the severity scale are adjudicated to be related to the intervention.

Appendix S Withdrawal from Study Procedure

MS Get a Head Start Withdrawal from study Procedure

TE WĀNANGA ARONUI O TĀMAKI MAKAU RAU

If at any stage the participant wishes to withdraw from the study they can do so.

1. Participants will have the option to withdraw each week with a link embedded in the weekly emails. "*If you would like to withdraw from the study please click on the I would like to withdraw*".

2. Once an email notification has come in regarding wanting to withdraw, this will be forwarded to the research assistant who will complete the following.

    a. Contact will be made within 48 hours.
    b. Open the Withdrawal report form stored in the AUT OneDrive folder and the participant's registration form with contact email or phone number. If there is no contact number, an email will be sent asking for a suitable contact number.
3. Call the participant within 48 hours and record details on the Withdrawal form and save in the Withdrawals folder in the AUT OneDrive folder.

4. Withdrawal data will be reported in the results of the study.

Appendix T CONSORT 2025 Checklist Item Description

Section/topic	No	CONSORT 2025 checklist item description	Reported on page no.
Title and abstract			
Title and structured abstract	1a	Identification as a randomised trial	1, 2
	1b	Structured summary of the trial design, methods, results, and conclusions	2
Open science			
Trial registration	2	Name of trial registry, identifying number (with URL) and date of registration	2
Protocol and statistical analysis plan	3	Where the trial protocol and statistical analysis plan can be accessed	9, 30
Data sharing	4	Where and how the individual de-identified participant data (including data dictionary), statistical code and any other materials can be accessed	23
Funding and conflicts of interest	5a	Sources of funding and other support (eg, supply of drugs), and role of funders in the design, conduct, analysis and reporting of the trial	22
	5b	Financial and other conflicts of interest of the manuscript authors	22
Introduction			
Background and rationale	6	Scientific background and rationale	4-6
Objectives	7	Specific objectives related to benefits and harms	6
Methods			
Patient and public involvement	8	Details of patient or public involvement in the design, conduct and reporting of the trial	31
Trial design	9	Description of trial design including type of trial (eg, parallel group, crossover), allocation ratio, and framework (eg, superiority, equivalence, non-inferiority, exploratory)	6-9
Changes to trial protocol	10	Important changes to the trial after it commenced including any outcomes or analyses that were not prespecified, with reason	none
Trial setting	11	Settings (eg, community, hospital) and locations (eg, countries, sites) where the trial was conducted	7
Eligibility criteria	12a	Eligibility criteria for participants	6-7
	12b	If applicable, eligibility criteria for sites and for individuals delivering the interventions (eg, surgeons, physiotherapists)	n/a

			Reported on page no.
Intervention and comparator	13	Intervention and comparator with sufficient details to allow replication. If relevant, where additional materials describing the intervention and comparator (eg, intervention manual) can be accessed	6-8
Outcomes	14	Prespecified primary and secondary outcomes, including the specific measurement variable (eg, systolic blood pressure), analysis metric (eg, change from baseline, final value, time to event), method of aggregation (eg, median, proportion), and time point for each outcome	8
Harms	15	How harms were defined and assessed (eg, systematically, non-systematically)	11
Sample size	16a	How sample size was determined, including all assumptions supporting the sample size calculation	6
	16b	Explanation of any interim analyses and stopping guidelines	36
Randomisation:			10
Sequence generation	17a	Who generated the random allocation sequence and the method used	
	17b	Type of randomisation and details of any restriction (eg, stratification, blocking and block size)	10
Allocation concealment mechanism	18	Mechanism used to implement the random allocation sequence (eg, central computer/telephone; sequentially numbered, opaque, sealed containers), describing any steps to conceal the sequence until interventions were assigned	10
Implementation	19	Whether the personnel who enrolled and those who assigned participants to the interventions had access to the random allocation sequence	9-10
Blinding	20a	Who was blinded after assignment to interventions (eg, participants, care providers, outcome assessors, data analysts)	6-8
	20b	If blinded, how blinding was achieved and description of the similarity of interventions	7 and 9
Statistical methods	21a	Statistical methods used to compare groups for primary and secondary outcomes, including harms	9-11
	21b	Definition of who is included in each analysis (eg, all randomised participants), and in which group	10
	21c	How missing data were handled in the analysis	12
	21d	Methods for any additional analyses (eg, subgroup and sensitivity analyses), distinguishing prespecified from post hoc	n/a

Results			
Participant flow, including flow diagram	22a	For each group, the numbers of participants who were randomly assigned, received intended intervention, and were analysed for the primary outcome	9,10
	22b	For each group, losses and exclusions after randomisation, together with reasons	9-12
Recruitment	23a	Dates defining the periods of recruitment and follow-up for outcomes of benefits and harms	9, 10
	23b	If relevant, why the trial ended or was stopped	n/a
Intervention and comparator delivery	24a	Intervention and comparator as they were actually administered (eg, where appropriate, who delivered the intervention/comparator, how participants adhered, whether they were delivered as intended (fidelity))	7 and 10, 31-34
	24b	Concomitant care received during the trial for each group	7
Baseline data	25	A table showing baseline demographic and clinical characteristics for each group	9
Numbers analysed, outcomes and estimation	26	For each primary and secondary outcome, by group: ● the number of participants included in the analysis ● the number of participants with available data at the outcome time point ● result for each group, and the estimated effect size and its precision (such as 95% confidence interval) ● for binary outcomes, presentation of both absolute and relative effect size	11-13
Harms	27	All harms or unintended events in each group	11
Ancillary analyses	28	Any other analyses performed, including subgroup and sensitivity analyses, distinguishing pre-specified from post hoc	n/a
Discussion			
Interpretation	29	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	13-17
Limitations	30	Trial limitations, addressing sources of potential bias, imprecision, generalisability, and, if relevant, multiplicity of analyses	17

Citation: Hopewell S, Chan AW, Collins GS, Hróbjartsson A, Moher D, Schulz KF, et al. CONSORT 2025 Statement: updated guideline for reporting randomised trials. BMJ. 2025; 388:e081123. https://dx.doi.org/10.1136/bmj-2024-081123

*We strongly recommend reading this statement in conjunction with the CONSORT 2025 Explanation and Elaboration and/or the CONSORT 2025 Expanded Checklist for important clarifications on all the items. We also recommend reading relevant CONSORT extensions. See www.consort-spirit.org.