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RESEARCH ARTICLE

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The feasibility of a flexible exercise participation programme (FEPP) for individuals with multiple sclerosis

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Abstract

Background and purpose: Individuals with multiple sclerosis (MS) want health advice regarding participation in their choice of exercise. To address this need, a flexible exercise participation programme (FEPP) was developed, underpinned by the MS aerobic exercise guidelines and supported by a physiotherapist using behaviour change techniques. The aim of this study was to investigate the feasibility of the FEPP for individuals with minimal disability from MS.

Methods: A feasibility study utilising a single group pre/post-intervention design was conducted. The 12-week FEPP was completed by 10 individuals with MS (EDSS 0–3.5). Exercise progression in duration, intensity or frequency of exercise (in line with MS exercise guidelines) was guided by a self-perceived weekly energy level score, and weekly telephone coaching sessions using behavioural change techniques. Trial feasibility was assessed via measures of process (recruitment and retention), resources/management (communication time; data entry) and scientific feasibility (safety; compliance). Secondary FEPP feasibility outcomes included the Goal Attainment Scale (GAS) T-score, exercise participation (weekly exercise diary), high-level mobility (HiMAT), vitality (Subjective Vitality Scale), biomarkers for inflammation (cytokines levels [IL2, IL4, IL6, IL10, TNF and IFNγ]), and acceptability (participant survey).

Results: Process: In total, 11 (85%) of 13 eligible participants enroled at baseline with 10 (91%) completing the study. Resources/management: Coaching sessions included a baseline interview—mean 39 min (SD: 6.6) and telephone coaching—mean 10 min (SD: 3.8) per week. Outcome measure data collection time—mean 44 min (SD: 2.1). Scientific feasibility: Two participants experienced a fall during their exercise participation. Self-reported compliance was high (99%). GAS T-scores increased significantly, indicating achievement of exercise participation goals. Secondary outcomes showed trends towards improvement.

Discussion: The FEPP was feasible, safe and highly acceptable for use with individuals with MS and warrants a larger trial to explore effectiveness.

KEYWORDS
behaviour change techniques, cytokines, exercise, multiple sclerosis

1 | INTRODUCTION

Multiple sclerosis (MS) hits at a point in life when most are engaged in employment, family activities, sport and active leisure (average age of diagnosis is 32 years) (MS International Federation, 2020). Individuals with MS wishing to have an active lifestyle seek to fit different and challenging forms of exercise into their routine, including sporting activities such as running, cycling or squash (Akbar et al., 2021; Smith et al., 2019). However, they want health professional support to ensure they get the balance right between too much and too little exercise (Smith et al., 2019).

A flexible exercise participation programme (FEPP) was developed to enable individuals with minimal disability from MS to participate in an exercise or sport of their choice and to achieve personal exercise participation goals (Smith et al., 2020). The FEPP was underpinned by four key concepts. Firstly, health professional support to safely exercise within or beyond the MS aerobic exercise guidelines (general or advanced) (Kim et al., 2019). Secondly, the FEPP provides a method to self-monitor energy levels and allay concerns expressed by individuals with MS, around fatigue during or after exercise (Gullo et al., 2019; Smith et al., 2019). Thirdly, behaviour change techniques grounded in social cognitive theory underpin the health professional support provided, to enable exercise participation (Bandura, 2004; Motl et al., 2018). Finally, the concept of a person-centred programme with choice of exercise mode is an important component of the FEPP. Rather than fitting individuals to a pre-determined programme, the programme is fitted to individual priorities and goals.

The need for such a programme was evident given that in the early stages of MS, even with no disability (EDSS 0–2.5), physical activity has been shown to be reduced compared to healthy controls (Gervasoni et al., 2022). This reduction in activity can be attributed to fatigue (Gervasoni et al., 2022), yet exercise can reduce fatigue and improve strength, aerobic capacity and quality of life for individuals with MS (Motl et al., 2012). Improvements in walking (Pearson et al., 2015) and balance (Gunn et al., 2015) have also been demonstrated following exercise, yet changes in higher levels of mobility such as running, jumping and sporting activity have been largely unreported. Hence further exploration of exercise participation for individuals with MS with minimal disability was required (Smith et al., 2020).

Exercise may also have a neuroprotective effect and slow the rate of neuronal atrophy for individuals with MS (Dalgas et al., 2019). The mechanism of neuroprotection is not yet known but may be linked to changes in biomarkers (Faramarzi et al., 2020; Negaresh et al., 2018, 2019). With MS there is an increased presence of pro-inflammatory cytokines such as tumour necrosis factor (TNF), interferon (INF)-γ, interleukin (IL)6 (Negaresh et al., 2018; Palle et al., 2017) (noting that IL6 also has anti-inflammatory properties (Scheller et al., 2011)) and a reduction in anti-inflammatory cytokines IL10 and IL4 (Negaresh et al., 2018; Palle et al., 2017). This creates a pro-inflammatory environment which may intensify myelin destruction and prevent remyelination (Negaresh et al., 2018). There is some evidence that exercise may improve the cytokine balance that is, reduce pro-inflammatory and increase anti-inflammatory cytokines, hence reducing the overall inflammation. However further research is required (Negaresh et al., 2018).

Given the potential for exercise participation to have an impact on the disease process, it is essential that programs for engaging and sustaining exercise participation are explored. The objectives of this study were to:

1. Assess the feasibility of the FEPP for individuals with minimal disability from MS.
2. Assess the feasibility of a larger clinical trial to evaluate the impact of the FEPP.

2 | METHODS

2.1 | Study design

This feasibility study consisted of a single group pre/post-intervention design. Ethical approval was granted by the James Cook University University Human Research Ethics Committee (H7956) and the study was registered with the Australian New Zealand Clinical Trials Registry, ACTRN12620000076976. The study was conducted according to the published FEPP protocol (Smith, Williams, et al., 2020), with one minor deviation which allowed email instead of telephone contact if a participant could not be contacted for the weekly coaching call.

2.2 | Participants

Participants were recruited in northern Queensland, Australia via MS Queensland, local neurologists and media sources (i.e., television, social media). Inclusion criteria were: (i) diagnosis of relapsing remitting MS as defined by the 2017 McDonald criteria (Thompson et al., 2018); (ii) independent mobility as defined by EDSS level 0–3.5 (Kurtzke, 1983); (iii) stable that is, not worsening in past 3 months (Lublin, 2014); (iv) aged ≥18 years; (v) able to provide informed consent. Potential participants were excluded if they had: (i) any concomitant neurological condition or (ii) an additional health condition that prohibited participation in exercise. Written informed consent was provided.

2.3 | Sample size

Feasibility studies do not require a formal sample size calculation, instead a sample size of 12 is recommended (Julious, 2005). Recruitment of 16 participants was planned, thereby allowing for a 25% dropout rate.

2.4 | Intervention

Following a baseline interview with a physiotherapist, participants engaged in the 12-week FEPP (Smith, Williams, et al., 2020) in which they chose their preferred exercise or sport, set goals for exercise participation and completed the exercise at a time and place suitable to them. Participants recorded their baseline exercise during week zero, detailing exercise mode, frequency, intensity and duration in their exercise diary. From week 1 onwards, exercise progression, maintenance or regression was guided by use of a FEPP flowchart and their perceived energy levels each week (measured with a 5-point Likert scale, ranging from no energy to maximum energy). Energy levels 3–5 resulted in progression, energy level 2—maintenance, and energy level 1—regression. Figures 1 and 2 illustrate the FEPP flowcharts.

The FEPP has two streams. Stream 1 was for participants who did not meet the MS general aerobic exercise guidelines of at least 30 min of moderate intensity exercise three times per week (Kim et al., 2019). This stream allowed gradual progression of exercise to meet the guidelines. Once the guidelines were reached, participants could maintain this activity level for the rest of the programme (if in accordance with their goals) or progress to stream 2.

Stream 2 was for participants who met the MS general aerobic exercise guidelines and enabled progression towards or beyond the MS advanced aerobic exercise guidelines. The advanced guidelines recommend an exercise duration approaching 40 min; frequency approaching 5 days per week and intensity approaching 15 on an RPE scale of 6–20 points (Kim et al., 2019). In both streams, modification of frequency, intensity or duration of exercise enabled progression or regression of exercise, in line with MS exercise guidelines, to facilitate goal achievement.

Participants were supported remotely by a physiotherapist (with more than 20 years' experience) via a weekly coaching telephone call over the 12-week period. To promote self-management of exercise, coaching sessions focussed on behaviour change techniques drawn from the behaviour change taxonomy (Michie et al., 2011). Techniques included goal setting, problem solving and action planning (Table 1), which are known to assist with participation in exercise and sport for individuals with MS (Silveira et al., 2021).

2.5 | Measurement—Trial feasibility

Feasibility of a larger trial of the FEPP was assessed by measures of process (recruitment and retention), resources, management (communication time and data entry) and scientific feasibility (safety, serious adverse events/effects [e.g., death/hospitalisation], adverse

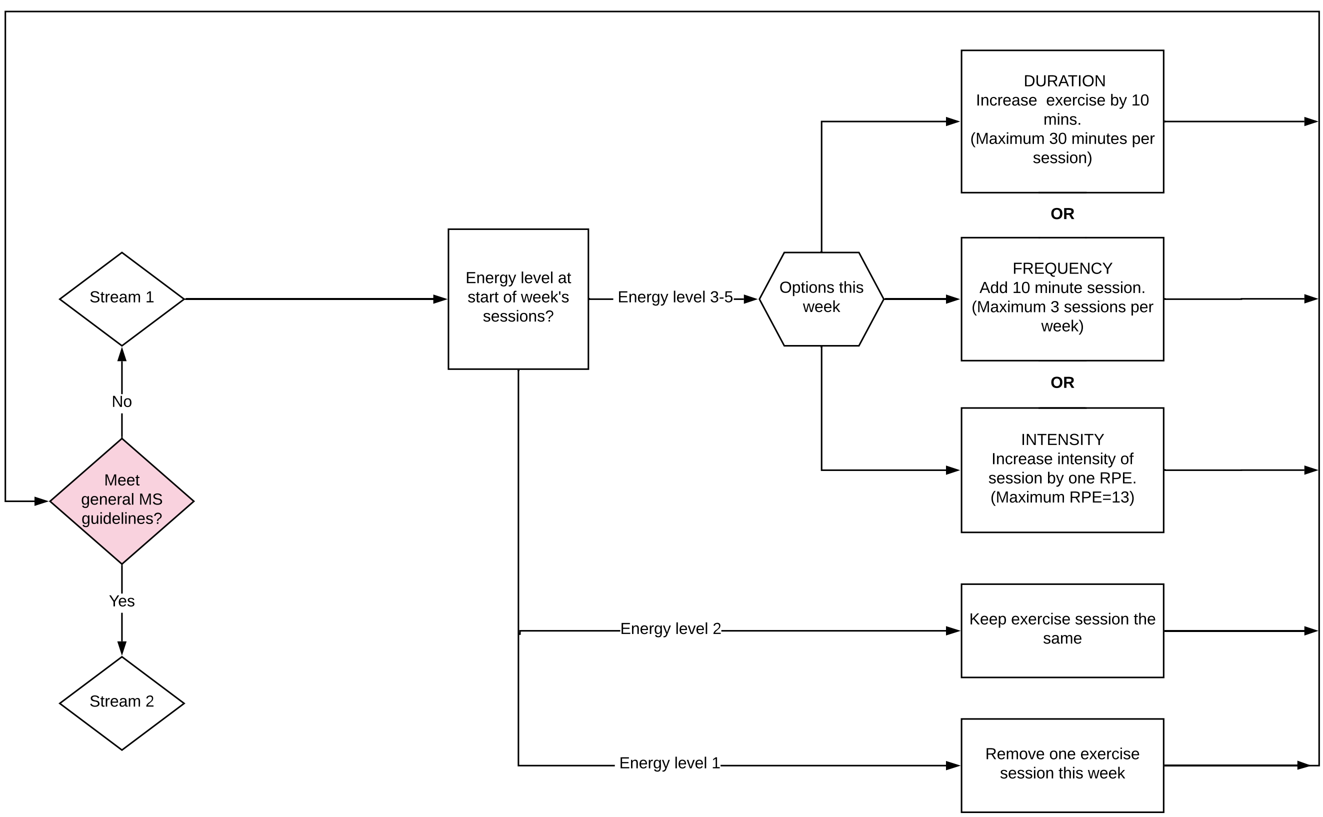

FIGURE 1 Flexible exercise participation programme (FEPP) stream 1

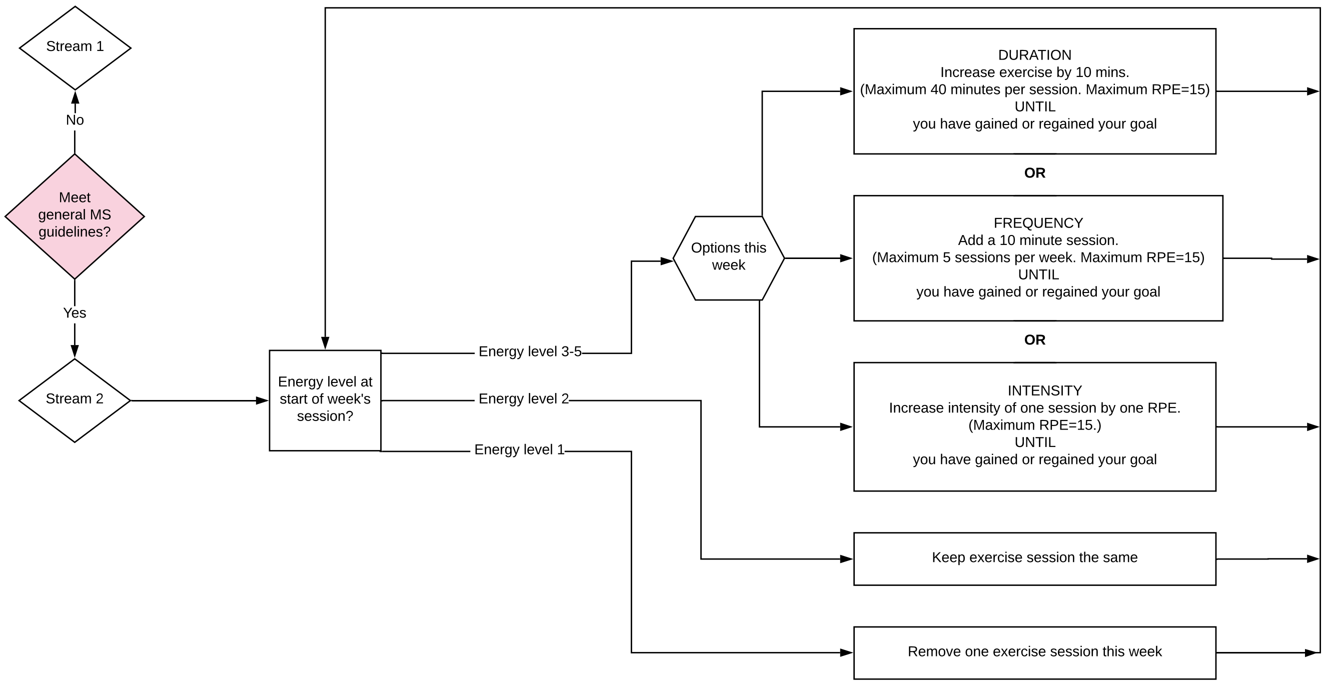

FIGURE 2 Flexible exercise participation programme (FEPP) stream 2

TABLE 1 Behaviour change techniques, definitions and application framework

Technique	Taxonomy definition (brief)	Application framework
Goal setting	The person is encouraged to set a goal that can be achieved by behavioural means but is not defined in terms of behaviour.	Exercise and sport participation goals will be set by the participant following consultation with the physiotherapist. Session: Initial interview.
Action planning	Involves detailed planning of what the person will do including, as a minimum, when, in which situation and/or where to act. 'When' may describe frequency or duration.	Guidance on application of the FEPP to ensure appropriate and correct usage. Session: Initial interview and weekly coaching.
Barrier identification/ problem solving	The person is prompted to think about potential barriers and identify the ways of overcoming them. Barriers may include competing goals in specified situations. This may be described as 'problem solving'. Examples of barriers may include behavioural, cognitive, emotional, environmental, social and/or physical barriers.	Discussion of barriers to participating in sport and exercise and potential ways of overcoming them. Session: Weekly coaching.
Prompt review of outcome goals	Involves a review or analysis of the extent to which previously set outcome goals were achieved.	Discussion of progress towards participation goals. Session: Weekly coaching.
Prompt self-monitoring of behaviour	The person is asked to keep a record of specified measures expected to be influenced by the behaviour change, for example, blood pressure, blood glucose, weight loss, physical fitness.	Completion and submission of exercise diary each week. Session: Weekly coaching.
Provide feedback on performance	This involves providing the participant with data about their own recorded behaviour	Discussion and feedback on activity recorded in exercise diary. Session: Weekly coaching.

events/effects [e.g., falls] and compliance). The a priori minimum success criteria (Smith, Williams, et al., 2020) were:

i. A minimum of 75% recruitment of the intended 16 participants
ii. A minimum of 20% attrition from the 12-week FEPP
iii. A minimum of 80% of participants able to modify exercise participation using the FEPP
iv. A minimum of 75% completion of each outcome measure
v. No reports of serious adverse events or effects as a result of completing the FEPP

vi. A minimum of 80% of participants reporting satisfaction with the FEPP

2.6 | Measurement—FEPP feasibility

Feasibility of the FEPP was assessed in relation to its suitability to enable exercise participation, its potential relationship with clinical outcomes and its acceptability, via the following primary and secondary outcomes obtained at baseline (week 0) and post-intervention (week 13).

2.6.1 | Primary outcome measure

The primary outcome was achievement of exercise participation goals as measured by the Goal Attainment Scale (GAS) (Turner-Stokes, 2009). The GAS measures goal achievement on a 5-point scale, quantified as a single aggregated goal attainment score (GAS T-score) for analysis (Turner-Stokes, 2009). The GAS is a responsive measure for individuals with MS (Khan et al., 2008).

2.6.2 | Secondary outcome measures

Exercise participation was recorded by the participant, using a weekly exercise diary, to detail mode of exercise, duration, frequency and intensity (rating of perceived exertion [RPE] scale). This information identified whether the participant met, did not meet, or exceeded the MS aerobic exercise guideline in their stream each week.

High-level mobility was measured using the High-Level Mobility Assessment Tool (HiMAT) (Williams et al., 2004) to assess 13 items important for sport such as running, jumping and bounding. Scored out of 54, higher scores indicate higher levels of mobility. The HiMAT is a valid and reliable tool for assessing high-level mobility for individuals with neurological conditions (Williams et al., 2012). The HiMAT was assessed by one of two physiotherapists (with more than 6 years' experience) who were not providing the intervention.

Vitality was self-reported by participants using the Subjective Vitality Scale (SVS) (Bostic et al., 2000) at weeks 0, 4, 8 and 12. This six-question survey is rated on a 7-point Likert scale and provided an average score of participant's energy (out of 7), with higher scores indicative of greater energy. This scale is validated for use with the general population (Bostic et al., 2000) and has been used with the MS population previously (Dawes et al., 2014).

Cytokine response to exercise was assessed via blood plasma samples collected from each participant pre- and post-intervention, as per the published protocol (Smith, Williams, et al., 2020). Cytokine levels IL-2, IL-4, IL-6, IL-10, IFN-γ and TNF were tested following the manufacturer's protocol using the commercially available kit: BD Cytometric Bead Array (CBA) Hu Th1/Th2 Cytokine Kit II[a]. Manufacturer reported detection limits were: 2.6 pg/ml (IL-2); 2.6 pg/ml (IL-4); 3.0 pg/ml (IL-6); 2.8 pg/ml (IL-10); 2.8 pg/ml (TNF); 7.1 pg/ml (IFN-γ). Increased TNF and IFN-γ is indicative of a pro-inflammatory response and an increase in IL4 or IL10 indicates an anti-inflammatory response. IL2 and IL6 can exert either a pro or anti-inflammatory response (Boyman & Sprent, 2012; Scheller et al., 2011).

Acceptability of the FEPP by participants was assessed via an online survey at the end of the 12-week programme (Appendix). The survey explored satisfaction, usability and suitability using a 5-point Likert scale (where one indicated low satisfaction/agreement and five indicated high satisfaction/agreement). In a study published previously, survey results were also used to develop a question guide for interviews with participants during the 6-week period post-intervention to gain further insight into participants' experience of the FEPP (Smith et al., 2021).

2.7 | Data analysis

Participant characteristics were summarised using descriptive statistics. Feasibility of a larger trial was assessed by comparing a priori minimum success criteria to measures of process, resources, management and scientific safety using descriptive statistics.

Changes from pre- to post-intervention for the GAS, HiMAT, and SVS were described quantitatively and compared using the Wilcoxon signed-rank test (statistical significance set at $p < 0.05$). Exercise participation was categorised into number of sessions completed below, between or beyond the exercise guidelines and reported as a percentage for each category. Changes from pre- to post-intervention for cytokine levels were described quantitatively and compared using a paired *t*-test (statistical significance set at $p < 0.05$). A one-sample Kolmogorov-Smirnov test was used to check for normal distribution of the data.

Survey responses on acceptability of the FEPP were analysed descriptively. Statistical analyses were conducted using SPSS Statistics[b] version 27. Cytokine analyses and graphs were generated in GraphPad[c] version 9.1.2.

3 | RESULTS

3.1 | Participants

Eleven participants were enroled in the study, nine were female, with a mean age of 47 years (SD: 9.9; range 30–65). Mean EDSS was 1.8 (SD: 0.5; range 1.5–3) and mean duration of MS was 11 years (SD: 7.3 range 0.33–24). Participants chose to participate in a range of exercises and sport which included, but were not limited to, walking, running, dancing, aerobic gym sessions, cycling, golf, swimming, water aerobics and touch football. At baseline, three participants (27%) were exercising below the general aerobic exercise guidelines, six

(55%) between the general and advanced exercise guidelines and two (18%) beyond the advanced exercise guidelines.

3.2 | Trial feasibility

3.2.1 | Process

Recruitment commenced in January 2020 and was impacted with the onset of the COVID-19 pandemic in February 2020. Participant flow through the trial is presented in Figure 3. Eighty-five percent of the total eligible participants consented to enrol in the study. Retention was high at 91% with only one participant withdrawing at week 4 due to the personal impact of the COVID-19 restrictions.

3.2.2 | Resources and management

Coaching sessions included an in-person baseline interview with each participant—mean duration 39 min (SD: 6.6, range 30–50 min); and telephone coaching—mean duration 10 min (SD: 3.8, range 3–26) per week. Eighty-nine percent of the coaching calls made were received by participants, with the remaining 11% conducted via email contact. Time spent on data collection and entry for outcome measures by the researcher included face-to-face contact time per participant (pre-intervention plus post-intervention) of a mean of 44 min (SD: 2.1, range 42–49).

3.2.3 | Scientific safety and compliance

No serious adverse events or effects occurred. Two adverse events were reported, with two participants experiencing a fall during their exercise participation. One participant was working between the general and advanced MS exercise guidelines, and one was working beyond the advanced MS exercise guidelines during the fall week. Both participants sustained minor injuries and were able to continue with the study within 2 days. Both participants received telephone support from the physiotherapist and were advised to contact their GP if medical attention was required, as per the protocol. Compliance with electronic submission of the exercise diary each week reached 99%.

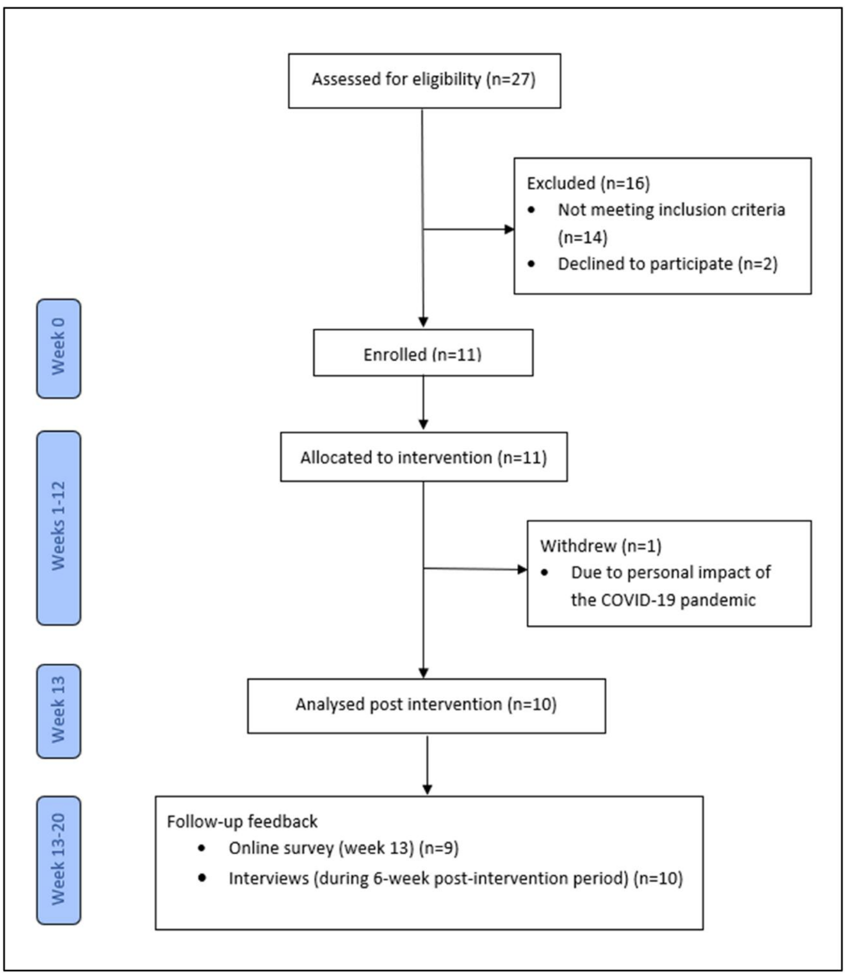

FIGURE 3 Participant flow diagram

3.2.4 | A priori minimum success criteria

All criteria were met except for criteria (i) a minimum of 75% recruitment of the intended 16 participants (11 participants were recruited). This was impacted by the COVID-19 pandemic due to halted recruitment and lockdown during the data collection period of March–May 2020.

3.3 | FEPP feasibility

3.3.1 | Primary outcome

GAS T-scores increased significantly indicating achievement of exercise participation goals ($z = 2.68$, $p = 0.01$). The median change in GAS T-score was 11.4 (IQR: 8.0–18.2) with 16/26 goals achieved (Table 2).

3.3.2 | Secondary outcomes

Table 3 provides a breakdown of the weekly exercise participation for each participant, whether it fell below, between or beyond aerobic exercise guidelines. Exercise participation recorded each week indicated that 7/10 participants achieved beyond the advanced exercise guidelines. Importantly, participants were able to safely progress, maintain or regress their exercise participation depending on their energy levels. For example, participants 4, 5, 6 and 7 commenced the programme at a level between the general and advanced guidelines but had to regress during some weeks to a level below the general guidelines (Table 3). This ability to manage exercise participation allowed continued participation with exercise during periods of low energy. Other participants showed clear progression through the different guidelines (participants 1, 2 and 3) whilst some were able to maintain participation beyond the guidelines (participants 8, 9 and 10).

HiMAT scores improved significantly from pre- to post-intervention ($z = 2.50$, $p = 0.01$) (Table 2) indicating an improvement in high-level mobility. Table 3 demonstrates the pre-post HiMAT change per participant in relation to their exercise participation category. Eight participants improved, with three improving by an amount greater than the minimal detectable change (Figure 4). There was no difference in SVS pre- to post-intervention ($z = 1.36$, $p = 0.17$) (Table 2).

Cytokine concentrations of IL2 significantly increased post-intervention ($t[9] = 2.5$; $p = 0.03$) which may indicate a pro- or anti-

TABLE 2 Pre and post intervention clinical outcomes

Outcome measure	Pre-intervention: Median (IQR)	Post-intervention: Median (IQR)	Median difference: Median (IQR)	Wilcoxon signed-rank test	
				z	p
GAS	36.3 (36.3–38.4)	50.0 (44.3–54.6)	11.4 (8.0–18.2)	2.68	<0.01*
HiMAT	36.0 (24.0–46.0)	40.5 (26.5–47.5)	2.5 (0.8–5.0)	2.50	0.01*
SVS	5.5 (4.4–6.0)	5.6 (5.0–6.3)	0.3 (−0.2-0.9)	1.36	0.17

Abbreviations: GAS, Goal Attainment Scale; HiMAT, High-level Mobility Assessment Tool; IQR, interquartile range; SVS, Subjective Vitality Scale.
*Statistically significant.

TABLE 3 Number of weeks spent in each exercise participation category and HiMAT change, per participant

		Number of weeks in each exercise participation category			
Participant	Baseline exercise level (week 0)	Below general	Between general and advanced	Beyond advanced	HiMAT change pre-post
1	Below general	1	9	2	⇧
2	Below general	0	1	11	⇧
3	Between general and advanced	0	0	12	⇧
4	Between general and advanced	3	9	0	⇩
5	Between general and advanced	5	7	0	⇔
6	Between general and advanced	1	1	10	⇧
7	Between general and advanced	4	8	0	⇧
8	Between general and advanced	0	0	12	⇧
9	Beyond advanced	0	0	12	⇧
10	Beyond advanced	0	0	12	⇧
Total sessions in each category		14 (12%)	35 (29%)	71 (59%)	

Note: ⇧, increase; ⇩, decrease; ⇔, no change.

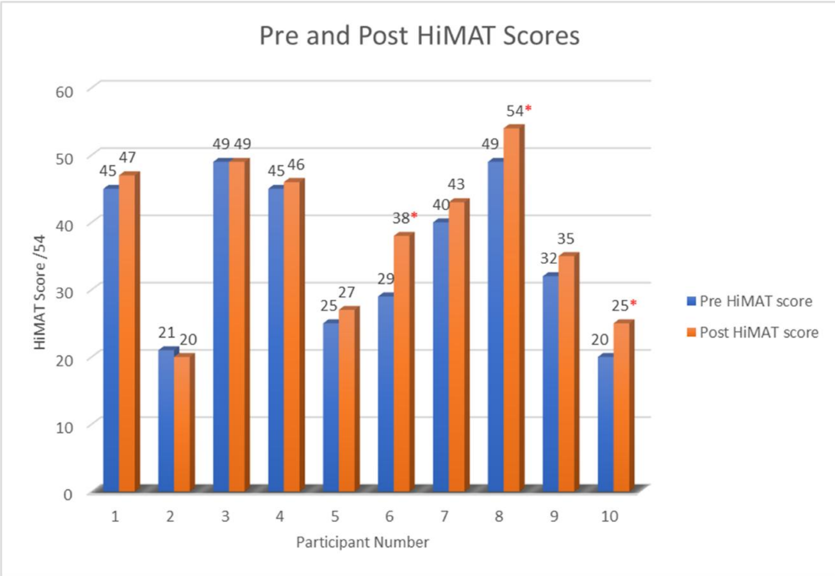

FIGURE 4 Pre and post HiMAT scores per participant. * increase beyond the minimal detectable change

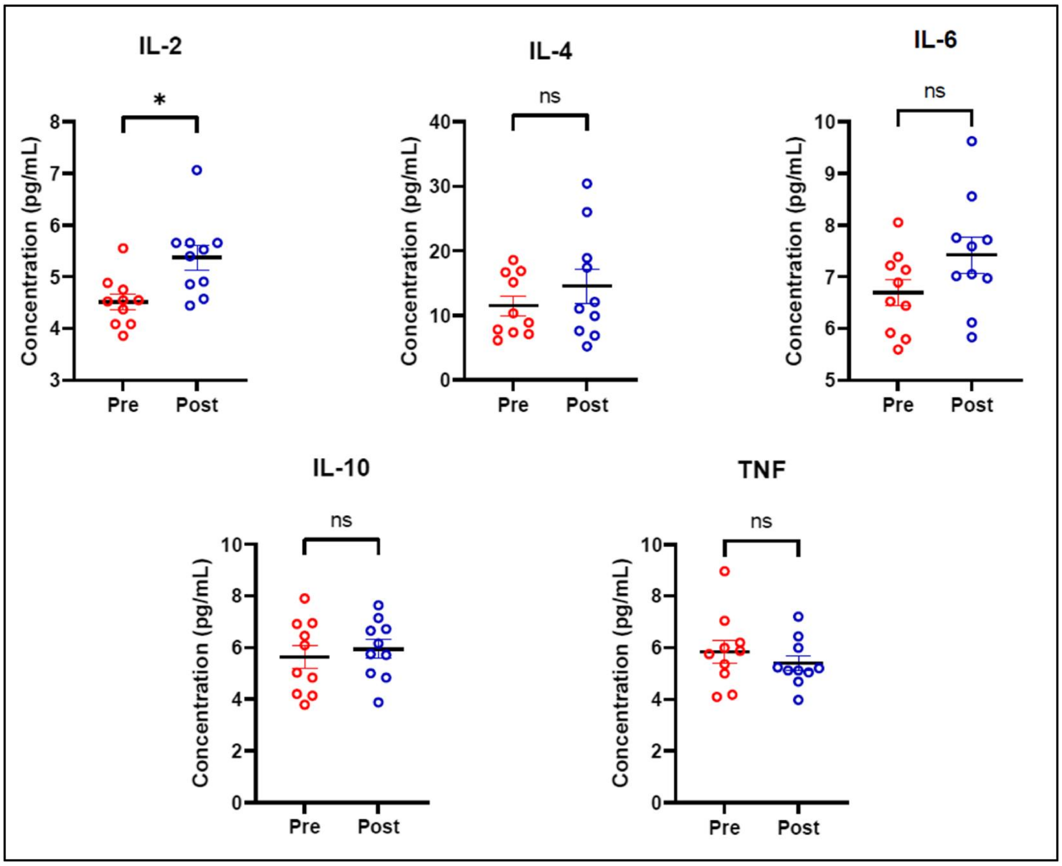

FIGURE 5 Cytokine responses to exercise (pg/ml). Data presented pre and post 12-week flexible exercise participation programme (FEPP) as individual values, group mean ± SE. Wilcoxon signed-rank test statistical significance set at $^*p < 0.05$; ns = not significant.

inflammatory response due to its dual action. The trend for the remaining interleukins (IL4, IL6, IL10) was to increase post-intervention and for TNF to decrease which may indicate an anti-inflammatory response; however, statistical significance was not reached (Figure 5). Concentrations of IFN-γ fell below the level of detection and were not reported.

The FEPP acceptability survey was returned electronically by nine out of 10 participants. Overall, participants were satisfied with

TABLE 4 Acceptability of the FEPP, survey results

Topic area	Question content	Survey score (1–5) Median (IRQ)	Range
Satisfaction	FEPP overall	5 (5–5)	4–5
	Telephone contact—amount	5 (5–5)	5–5
	Telephone contact—advice	5 (5–5)	5–5
Utility	FEPP flowchart	5 (5–5)	4–5
	Energy monitoring tool	5 (4.5–5)	3–5
	Exercise diary	5 (5–5)	4–5
Suitability	Fitness level	5 (5–5)	5–5
	Time requirement	5 (5–5)	5–5
	Exercise progression	5 (5–5)	5–5

the FEPP, its utility and its suitability with a median score of five out of five (Table 4). The associated study, which further explored participants' experience of the FEPP, revealed that participants found the FEPP to be highly acceptable and that they valued the flexibility to choose their own activity and appreciated the health professional support (Smith et al., 2021).

4 | DISCUSSION

This study demonstrated that the FEPP is feasible, safe and highly acceptable for individuals with MS with minimal disability. This novel intervention enabled individuals with MS to participate in an exercise or sport of interest to them, which fitted with their lifestyle, and which often demanded a high level of mobility such as running, dancing or football. In essence, the FEPP was individually tailored and led to personal goal achievement. Furthermore, the findings suggest that a larger clinical trial to evaluate the impact of the FEPP is feasible and warranted.

The FEPP is the first exercise programme for individuals with MS to involve challenging high-level exercise of their choice and that demonstrated improvement in high-level mobility, which is not commonly assessed or targeted in this population (Smith, Barker, et al., 2020). Improvements in high-level mobility were noted with most participants. Where high-level mobility remained the same ($n = 1$) or reduced ($n = 1$), those participants fluctuated between working below or above the general exercise guidelines. However, other participants who fluctuated accordingly, showed an increase in HiMAT score, demonstrating no clear relationship with score change and exercise level. A larger sample size is required to investigate further.

The FEPP enabled progression of exercise at a rate that was acceptable to the individual depending on personal goals and that met or exceeded MS aerobic exercise guidelines (Kim et al., 2019). With 59% of weekly sessions completed beyond the advanced aerobic exercise guidelines, the capacity and desire of some individuals with MS to push the boundaries of exercise participation was evident. Exploring the capacity to exercise, particularly in the early stage of the disease process, is essential to identify any relationship with neuroprotection and to provide early implementation of an optimal exercise prescription (Dalgas et al., 2019; Riemenschneider et al., 2021; Riemenschneider et al., 2018).

Multiple sclerosis exercise guidelines (Kim et al., 2019; Latimer-Cheung et al., 2013) recommend a gradual progression of exercise, whereas the FEPP provides an individualised approach to safe progression and regression with greater specificity, depending on the energy levels of the participant each week. Results showed that participants effectively made use of the FEPP to increase, maintain or decrease their exercise each week and that they could still progress towards their goals with this flexible approach. In effect, they could navigate through daily life by fluctuating exercise participation. They were able to participate in exercise at a level that was suitable and appropriate for them on a week-by-week basis, based on their energy levels. Finding the right balance with exercise can be difficult for people with MS (Smith et al., 2019) therefore provision of a tool to navigate periods of low energy is a novel approach encouraging self-efficacy. This enabled variability in the programme on a weekly basis to fit the individual whilst still addressing a need for exercise to combat fatigue (Motl & Sandroff, 2020; Razazian et al., 2020).

Cytokine data were cautiously suggestive of an anti-inflammatory response to exercise. IL2 demonstrated a significant increase post-exercise which can indicate either an anti-inflammatory response (stimulation of regulatory T cells) or a pro-inflammatory response (stimulation of cytotoxic T cells) (Boyman & Sprent, 2012). Given the trend towards an anti-inflammatory response from the other cytokines (decrease in TNF, increase in IL4, IL10 and IL6), it is possible that IL2 was activating an anti-inflammatory response. An anti-inflammatory response to exercise has been identified in healthy adults with an increase in IL10 and IL6 post exercise (Sharif et al., 2018). In previous studies with people with MS, findings have been inconsistent (Negaresh et al., 2018). However, increases in IL6 (Berkowitz et al., 2019; Devasahayam et al., 2021) and IL10 (Barry et al., 2019) have been identified post exercise, similar to trends in this study. Findings from this study cautiously suggest an anti-inflammatory response to exercise, however, a larger sample size and controlled trial are required to explore the neuroprotective benefits of the FEPP.

A larger clinical trial to evaluate the impact of the FEPP is feasible and warranted given that all a priori minimum success criteria were met, except for recruitment, which was halted and the target sample size not met due to COVID-19 government restrictions. Data has been collected on process, resources and management to guide requirements of a larger trial. Preliminary findings suggest this intervention is safe, acknowledging two falls during exercise as adverse events. No changes to the FEPP protocol are required for a larger trial based on the data from this study. However, the associated study, which further explored the participants' experience of the FEPP highlighted the need for refinement of the energy monitoring tool, by measuring energy levels daily and calculating an average value for the week (Smith et al., 2021).

4.1 | Study limitations

This feasibility study had a small sample size and no control group hence the findings regarding the FEPP outcomes should be interpreted with caution. Volunteer bias may have occurred as the FEPP is likely to have attracted individuals with an interest in exercise, which may influence motivation to become more active. In addition, participants were only recruited from and exercised within the environment of regional northern Queensland and may therefore not be representative of the general population. A larger sufficiently powered RCT with longer term follow-up is feasible and warranted to confirm the efficacy and sustainability of the FEPP. In addition, there is opportunity to extend the FEPP to include individuals with moderate disability from MS, with consideration of participant safety.

5 | IMPLICATIONS FOR PHYSIOTHERAPY PRACTICE

The FEPP was highly acceptable, safe and feasible for use with individuals with MS with minimal disability. FEPP participants achieved their personal exercise participation goals across a variety of exercises and sport, whilst monitoring energy levels. Individuals with MS can engage with exercise that demands a high level of mobility and can push beyond the MS aerobic exercise guidelines with health professional support. A larger trial is both feasible and warranted to evaluate the impact of FEPP, neuroprotective effects, and to enable individuals with MS to find the right balance with participation in exercise and sport.

AUTHOR CONTRIBUTIONS

Moira Smith was the principal investigator. Moira Smith, Gavin Williams, Margaret Jordan and Ruth Barker conceived and designed the study. Moira Smith, Margaret Jordan and Annie Willson conducted data collection and analysis. Moira Smith wrote the first draft of the study with subsequent revisions from Gavin Williams, Margaret Jordan and Ruth Barker.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

CLINICAL TRIAL REGISTRATION NUMBER

Australian New Zealand Clinical Trials Registry (ANZCTR), ACTRN 12620000076976.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX

Suppliers

a. BD Cytometric Bead Array (CBA) Hu Th1/Th2 Cytokine Kit II; BD Biosciences.
b. SPSS Statistics version 27; IBM Corp
c. GraphPad version 9.1.2; Prism