Power-assisted exercise for people with complex neurological impairment: a feasibility study

Rachel Elizabeth Young, Emma Richards, Neha Darji, Suchitra Velpula, Sara Goddard, Christine Smith, David Broom

Abstract

Background/Aims: Participation in physical activity and exercise presents a challenge for adults with complex neurological impairment. Power-assisted exercise facilitates combined limb and trunk movement and may be an option for people with movement impairment. The aim of this study was to determine whether power-assisted exercise is a feasible activity option for people with complex neurological impairment.

Methods: Seven adults with complex neurological impairment were recruited to take part in a 4-week programme of twice weekly power-assisted exercise. Programme attendance and completion was recorded and adverse events or effects documented. Mobility was monitored using the Timed Up and Go test (TUG). Upon completion of the programme, participants were interviewed regarding their experience of using the equipment.

Findings: All seven participants completed the programme and the overall attendance was 96%. No adverse events occurred; two participants reported minor adverse effects, which were temporary. The TUG scores improved and participants enjoyed the programme, reporting perceived benefits in physical function and wellbeing.

Conclusions: The findings of this study demonstrate that people with complex neurological impairment can participate in a programme of power-assisted exercise. Reported improvements in physical mobility suggest that further research in this area is indicated.

Key words: ■ Feasibility ■ Mobility ■ Neurology ■ Power-assisted exercise

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Long-term neurological impairment results from disease or injury to the brain, spinal cord or peripheral nerves. It is estimated that 10 million people in the UK have a neurological diagnosis; the most prevalent adult neurological conditions in the UK include stroke, Parkinson's disease, multiple sclerosis and traumatic brain injury (Neurological Alliance, 2015). People who live with a neurological condition often experience impaired movement, sensory changes and communication difficulties. These symptoms can impact physical function, reduce independence, limit participation in recreational activities, and severely affect quality of life (Perez et al, 2008).

Reported levels of physical activity amongneurological groups are lower than the general population (English et al, 2014). Low levels of physical activity are associated with reduced physical fitness and aerobic capacity (Morie et al, 2010). Limited cardiorespiratory performance is a risk factor for the development of a range of comorbidities, including heart disease and diabetes (Gill and Cooper, 2008; Soares-Miranda et al, 2015). There is increased focus on the promotion of exercise and physical activity for people living with a neurological condition. Improvements in function, cardiovascular fitness and mental health are reported for neurological participants who have engaged with exercise programmes (Billinger et al, 2012; Marzolini et al 2014; Sandberg et al, 2016).

Most exercise intervention studies have excluded participants with complex or severe neurological impairment, stipulating independent mobility of at least 5 metres within the inclusion criteria (Billinger et al, 2012; Latimer-Cheung et al, 2013; Marzolini et al, 2014; Sandberg et al, 2016). Interestingly, the neurological population also perceive that balance and independent mobility are prerequisites for participation in an exercise programme (Simpson et al, 2011); however, it has been demonstrated that people with moderate or severe motor deficits can engage with and benefit from supervised exercise programmes (Kim et al, 2014).

Barriers to exercise for individuals with a neurological condition include access to facilities and ability to use equipment (Simpson et al, 2011; Rimmer et al, 2014). The fitness industry is focused on developing equipment and facilities that accommodate the specific needs of individuals with long-term conditions (English Federation of Disability Sport, 2017). Conventional resistance machines can be accessed by people with neurological deficits and are associated with improved agonist recruitment as the machine facilitates a linear motion (Vinstrup et al, 2016). However, the use of resistance machines does require a minimum level of activity to activate and sustain muscular contraction through the available range of movement that might limit their use by people with neurological deficits.

Research has explored the use of isokinetic equipment with neurological participants. Findings indicate that isokinetic exercise can improve strength performance for people with stroke, but its impact upon mobility and function is inconclusive (Lee and Kang, 2013; Chen et al, 2015). Power-assisted exercise machines are comparable to isokinetic equipment in that the machine generates the movement. The ethos of power-assisted exercise is to offer an inclusive, client-centred exercise experience as an alternative to more conventional exercise programmes. Power-assisted exercise has been associated with increased muscular performance, balance and function in healthy older adults (Jacobson et al, 2012). The machines are designed to support the limbs and simultaneously generate bilateral movement; participants are encouraged to move with the machine to stimulate an exercise response from the cardiorespiratory and muscular systems. To date, the feasibility of a power-assisted exercise programme for participants with a neurological condition has not been explored.

The primary aim of this study was to determine the feasibility of a power-assisted exercise programme for individuals with complex neurological impairment. Feasibility was defined in terms of the participants' ability to access the equipment, commit to regular attendance and complete the programme. The secondary aim was to explore the participants' perceptions of the exercise programme through semi-structured interviews. Timed Up and Go (TUG) data were recorded to provide an indication of mobility at baseline and upon completion of the programme to describe trends.

METHOD

Setting

The feasibility study was located in the research suite at Sheffield Hallam University.

Ethics

Ethical permission was gained from the Faculty of Health and Wellbeing Ethics Committee at Sheffield Hallam University (SHU 66359) who permit research to be conducted within the institution in accordance with the Helsinki declaration of 1975 (revised in 2000). All participants provided informed, signed consent and understood that they could withdraw from the study at any time.

Participants

Participants volunteered to undertake a 4-week power-assisted exercise programme through convenience sampling from two private physiotherapy services in Sheffield.

In order to be eligible for inclusion in the study participants needed to:

- Have a long-term neurological condition
- Be able to transfer with assistance
- Be able to provide informed consent

Participants with significant cardiovascular instability or other contraindications to exercise as identified by the American College of Sports Medicine ([ACSM], 2013) were excluded from the study.

Ten potential participants were provided with an information sheet and had the opportunity to discuss the study with the research therapists (ER and RY). Three people declined due to concerns regarding the time commitment. Seven participants were recruited and their respective GPs were contacted by the research therapists to gain approval for their involvement in the study. The anonymity and confidentiality of all data were assured through use of code numbers for each participant. The exercise programme was supervised by two physiotherapists (SV and ND), who are Health Care Professions Council (HCPC) registered. For monitoring purposes, blood pressure and heart rate was recorded at the start and end of each session to ensure that participants were working within recommended cardiovascular parameters as stipulated by the ACSM (2013).

Intervention

A 4-week programme of exercise was conducted, in which participants attended a group session two times a week. Attendance was monitored and recorded by the research therapists. Two physiotherapists (SV and ND) supervised the exercise sessions and assisted participants on and off the equipment as required. Each exercise session lasted 40 minutes. During the first session, participants were assessed to determine how much assistance was required to access the equipment. A step and some bolster cushions were used by smaller participants to enable access to the machines. Two participants with a history of stroke required additional straps to secure their paretic hand to the equipment.

Six power-assisted machines that facilitated upper limb, lower limb and trunk movements were used in this study (*Figures 1 and 2*). Participants spent 5 minutes on each machine and rested for approximately 2 minutes between each machine. In order to facilitate group support, participants attended the sessions together, meaning that the sequence of accessing each machine varied from one session to the next. Participants were advised to warm up by working at a rate of perceived exertion (RPE) of three out of ten on the first machine. This was achieved by instructing participants to 'move with' but not to try to 'speed up' the machine.

The main component of the workout involved predominantly exercising on the seated machines. Participants were instructed to work at an RPE of six or seven out of ten. This was achieved by instructing participants to try to 'speed up' the movement generated by the machines. The aim was to stimulate active assisted movements through concentric muscle contraction. A cool down phase was included by having each participant complete their work out on one of the supine lying machines. They were instructed to allow the machine to stretch the body without generating muscular activity. *Figure 3* illustrates an example of a typical workout in terms of machine sequence and the targeted RPE. The duration of the exercises and guidance related to perceived effort remained the same throughout the course of the study.

Taxi transport was provided to access the facility on the university campus. The participants continued to receive their usual physiotherapy treatment during the intervention period.

Measurement

Feasibility was defined by amount of attendance and ability to safely use the equipment. Attendance at the exercise sessions was monitored and adverse events such as falls, pain or individual concerns were

1: Hip abduction/adduction plus shoulder horizontal abduction/adduction
2: Hip flexion/extension plus shoulder and elbow flexion/extension
3: Hip and knee flexion/extension plus elbow extension/flexion
4: Trunk flexion and extension plus hip flexion/extension

Figure 1. Seated machines

1: Lateral flexion of the trunk
2: Flexion/extension of the hips

Figure 2. Supine machines

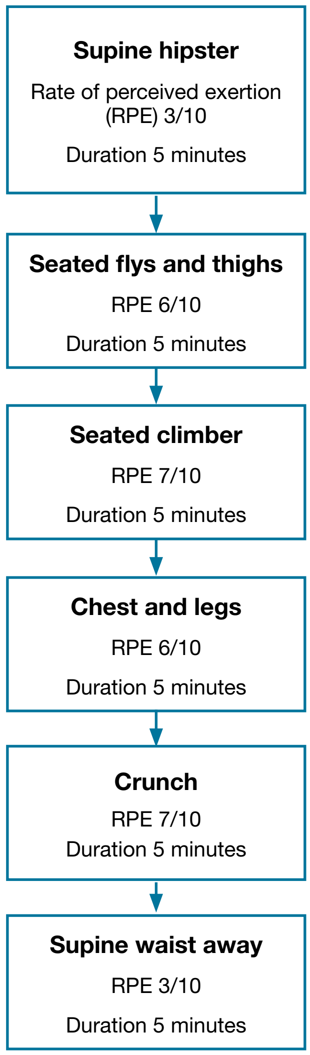

Figure 3. Exercise programme

recorded. Participants were asked at the start of the session to report if they had experienced any pain or discomfort following the previous session. They were also observed for any signs of pain during their exercise sessions. The amount of assistance required to use the equipment was noted for each participant.

The participant's experience of the exercise intervention was explored through semi-structured interviews scheduled 1 week following completion of the intervention period. All seven interviews were conducted by a physiotherapist (SV) in the participant's homes and recorded with a digital voice recorder. The topic guide included questions related to their experience of using the equipment, perceived benefits, limitations and suggestions for future use (*Table 1*).

Mobility was assessed through the Timed Up and Go (TUG) test (Nilsagard et al, 2007). The test has been validated as a measure of balance and mobility among people with neurological deficits (Bonnyaud et al, 2015). One participant (P05) did not have sufficient mobility to attempt the test, but did partake in the interviews. The TUG test was conducted upon the six remaining participants. A 3 metre walkway was measured and a 50 cm chair with arms was positioned at the start point. Participants were allowed to use their usual walking aid to complete the test. Each participant was required to practise the test once before measurements were recorded. A 5 minute rest was scheduled between the practice and formal testing procedures. The test was timed using a stopwatch by the second research therapist. The TUG test was scheduled at baseline before the exercise programme and repeated at the end of the programme 1 hour following the final exercise session.

Data analysis

Overall attendance and programme completion were calculated as a percentage score for each of the participants. Reported adverse incidents or responses were recorded in text format.

Data recorded from the interviews were transcribed. Framework analysis was used to facilitate the grouping and synthesis of identified themes with individual cases. This method generates transparent results that can be related back to the original data (Ward et al, 2013). Following initial familiarisation with the data, VP and ND independently coded the first three interviews. The themes identified and agreed through this process were charted and case-by-case data from the remaining interviews were added by the first research therapist. The data were mapped and interpreted to generate a descriptive summary; specific quotes from the transcripts were selected to illustrate key points.

Data from the TUG were recorded for each participant at baseline and on completion of the 4-week programme. The TUG data provided an indication of baseline ability in the sample and enabled observation of any mobility trends among the participants.

RESULTS

Seven local service users volunteered to take part in the study and all participants completed the 4-week trial period. Information regarding age, gender and diagnosis are detailed in *Table 2*.

Table 1. Topic guide

Perceptions of the equipment	Were the machines easy to use? Did you feel safe and comfortable whilst using the equipment? Did you identify any limitations associated with the machines? Would you suggest any modifications to the machines?
Delivery of the exercise programme	Did you enjoy working in a group or would you prefer a one to one session? How regularly would you like to use the equipment? Is five minutes per machine a suitable duration for each exercise? How much assistance or supervision is needed to use the machines safely?
Impact of the exercise programme	Did you notice any benefits from using the machines in terms of your physical function? Did you experience any pain during or after the exercise session? Did you notice any unwanted or adverse effects from using the equipment? Would you continue with the exercise programme if it was available?

Table 2. Participant Information

Gender	Age	Diagnosis and code number	Type of motor deficit	Time since onset (years)
Female	73	CVA (P01)	Left hemiparesis	5
Male	69	CVA (P02)	Left hemiparesis	2
Male	84	CVA (P03)	Right hemiparesis	3
Female	39	MS (P04)	Ataxia	8
Female	55	MS (P05)	Tetraparesis	17
Male	30	TBI (P06)	Ataxia	9
Male	54	TBI (P07)	Ataxia	14
Mean (SD)	**57.7 (17.6)**			**8.2 (5.1)**

CVA: cerebrovascular accident; MS: multiple sclerosis; TBI: traumatic brain injury; SD: standard deviation

Table 3. Attendance and support record

Participant Number	Programme completion (yes/no)	Sessions attended (maximum 8)	Support required	Adverse event or effect
1	Yes	7	Assistance of one therapist to access machines. Step, bolster cushion and hand strap for seated machines	None
2	Yes	7	Supervision	Shoulder pain post first session, resolved within 2 days
3	Yes	8	Assistance of one therapist to access machines. Hand strap for hemiplegic upper limb	None
4	Yes	8	Supervision	None
5	Yes	8	Assistance of two therapists. Bolster cushion and hand strap for seated machines	Increased fatigue reported
6	Yes	8	Supervision	None
7	Yes	8	Supervision	None
Total % completion	**100%**			
Total % attendance		**96%**		

Access and attendance

There was 100% completion with all seven participants finishing the 4-week schedule. Attendance was 96% with all participants completing at least seven of the eight scheduled group sessions (see *Table 3*). Four of the participants (P02, P04, P06, P07) were able to access the equipment with supervision only. The three remaining participants (P01, P03, P05) required assistance from the physiotherapists to mount the machines. A step and bolster cushion were used to facilitate access for these individuals. An adapted hand strap was used by P01 and P03 to enable attachment of their paretic upper limb to the machines. Once positioned on the machines, all participants were able to independently continue the machine assisted exercise.

Adverse events

No falls or adverse events occurred during any of the sessions. One participant (P05) reported increased fatigue during the course of the study; however, the participant was able to continue with the programme and attended all eight sessions. A different participant (P02) reported a brief episode of shoulder pain on the paretic side at the start of the programme; this resolved spontaneously and the participant was able to continue with the programme without interruption or adaptation.

Three central themes emerged through analysis of the data; experience of using the equipment, physical response to the programme, and recommendations for future developments.

Experience of using the equipment

All participants confirmed that they had enjoyed the programme and looked forward to the sessions. The participants reported feeling safe while using the equipment, although two participants (P01, P05) did recall experiencing some anxiety about using the machines during the first session:

> **'I was anxious the first day; I looked at the equipment and thought "goodness, I have to climb onto them." But the step helped a lot and then I was okay after that.' (P01)**

The specialist support of a physiotherapist was important during the initial session for those participants with greater mobility restrictions (P01, P03, P05). The physiotherapists advised on the use of steps, bolster cushions and hand straps according to height and mobility. This helped reduce initial anxiety and facilitated sustained engagement with the programme.

Following the initial session, there was variation in the perceived need for assistance to use the equipment. Two participants (P02, P06) reported that they felt that they could use the equipment without any direct assistance. Those participants with more significant motor impairment did indicate that they needed some physical assistance throughout the programme.

> **'I needed help to get on and off the machines and also to secure my limbs with the extra strap. My left leg and arm would have kept flopping down without that strap.' (P03)**

All participants thought that continuous supervision was required throughout the programme, but several commented that this would not necessarily need to be a physiotherapist.

'I think we need someone to keep an eye and monitor what we are doing. I think we may not need, say, a physiotherapist; just somebody there to call on.' (P07)

Feedback about the group activity was positive and the participants perceived that a friendly and supportive atmosphere was generated during the sessions. Communication and comparison between group members was important and several participants indicated that they gained confidence and reassurance through the support of other group members.

'I think the group worked out well, we all came to know one another. I would prefer group work rather than one-to-one sessions for this type of exercise.' (P02)

Six of the participants felt that two sessions a week was manageable and indicated that they would commit to a longer-term programme on this basis. One participant with MS (P04) did experience increased fatigue following the exercise sessions:

'I noticed my eyes getting foggy and [got a] headache and I think that's fatigue setting in. Overall I think doing twice a week might have been too much for me with my MS.' (P04)

Physical response to the programme

All seven participants stated a general improvement in their physical health during the intervention period. The perceived physical benefits included increased strength, decreased stiffness and improved symmetry. With the exception of P04, remaining participants described feeling energised during the course of the programme.

Decreased stiffness was reported by both participants with MS (P04, P05).

'I feel it's made me much looser in my frame and I feel that I can move better.' (P05)

Two of the stroke participants also described feeling more flexible and linked this to the exercise programme:

'The main benefit was stretching ... feeling that the body was getting moved for the first time in ages. I liked the combined leg and upper body movements.' (P03)

All participants felt that their balance and symmetry improved during the programme. Specific improvements in mobility and gait pattern were also described by three participants (P02, P06, P07):

'I feel like I'm taking better strides with my left leg, more equal.' (P02)

'I noticed that my walking is more controlled. I definitely feel more controlled when out and about.' (P06)

'I'm steadier and feel like I can walk a bit further.' (P07)

Changes in leg strength were noted by several participants (P04, P05, P06). One participant (P05) with a diagnosis of MS and severe motor impairment reported enhanced lower limb movement and strength, which was most apparent during regular hydrotherapy sessions:

'It helps the strength in my thighs; when I have gone swimming I noticed a lot more activity in my bad leg and I have been able to use my thigh muscles more effectively in water.' (P05)

Pre-existing musculoskeletal symptoms appeared to respond positively to the intervention, with three participants (P03, P05, P07) commenting that they had long-term low back pain that noticeably decreased during the study. One participant (P01) with a history of stroke had a stiff and painful shoulder on her non-paretic side before commencing the study. This resolved during the intervention period with reported recovery of full, pain free range of movement in the symptomatic joint.

The routine monitoring of blood pressure and heart rate was reassuring for several participants. Although this data was not analysed, three participants reported that they had noticed decreasing trends in blood pressure and heart rate during the intervention period and this boosted their overall perceived health status.

'I have always been concerned about my blood pressure so it was interesting to see it go down after a bit of exercise. I am glad that it seemed to do some good.' (P05)

Recommendations

All seven participants suggested that the duration of each machine should be increased from five to approximately seven or eight minutes. Two participants also commented on the rate of the assisted movement, indicating that a graduated warm up and cool down would improve the effectiveness of the programme:

'Probably a bit more time on each equipment. Well, you get used to it and you feel that effort is stretching you so you want

it to continue because it's a good feeling, like the movement in your body.' (P03)

'You build your heart rate up in the first three minutes and then down again. I really liked the way you could adjust the speed.' (P06)

Adaptations to improve access to the equipment were suggested by several participants (P01, P03, P05). The recommendations included foldaway footrests, adjustable handles, adjustable range settings, and flat foot plates. The availability of an access step, bolster cushions and hand straps were also important for smaller participants (P01) and those with severe motor impairment (P02, P05).

All seven participants reported that they would like to continue with the exercise programme and felt that this type of equipment should be available within community fitness settings or rehabilitation centres.

Mobility measurement

Six of the seven participants completed the TUG. One participant (P05) did not have sufficient mobility to complete the mobility assessment. The range of baseline scores was 8.8 to 25.2 (mean 17.36) seconds. The follow up TUG scores recorded upon completion of the programme ranged from 7.1 to 22.4 (mean 11.96) seconds (*Table 4*).

Table 4: TUG Results

Participant	Pre Intervention TUG (seconds)	Post intervention TUG (seconds)	Pre and post intervention difference
PO1	15.0	14.3	0.7
PO2	8.8	7.0	1.8
PO3	25.2	22.4	2.8
PO4	18.1	13.1	5.0
PO6	19.0	7.9	11.1
Mean (SD)	**17.36 (4.9)**	**11.96 (5.48)**	**5.4 (4.19)**

DISCUSSION

Attendance and adherence

The primary purpose of this study was to determine the feasibility of using power-assisted exercise for a neurological population. This adds to a growing body of research focused on exercise interventions with a neurological population. The unique contribution of this paper is the implementation of novel, power-assisted equipment to explore its feasibility for people with complex, long-term impairments. The participants in this study were varied in terms of age, neurological diagnosis and the nature of their physical impairment. They all completed the programme and the recorded attendance was 96%.

Exercise programmes with twice weekly sessions are associated with improved attendance and adherence when compared to more intensive schedules (Sandberg et al, 2016). Most of the participants felt that twice weekly sessions were manageable, although one participant (P04) with multiple sclerosis did report increased fatigue-related symptoms during the study period and suggested that one session a week would have been preferable. Evidence related to the impact of exercise upon reported fatigue in multiple sclerosis is inconclusive (Latimer-Cheung et al, 2013; Heine and de Groot, 2016). Future studies could explore the optimal frequency of power-assisted exercise sessions in relation to the management of specific symptoms.

Other factors that may have supported attendance on the programme was the provision of transport and availability of professional personnel. Limited transport and concerns regarding staff expertise are recognised barriers to engagement with community based exercise among the neurological population (Rimmer et al, 2014). This aside, the attendance and completion recorded in this study indicate that the programme was enjoyed by the diverse group of neurological participants. No major adverse events were recorded and all participants were able to safely access and use the equipment. The reported shoulder pain was recorded as an adverse effect. The participant was monitored by the research team and the symptoms subsided quickly; no further occurrence was reported. Once the power-assisted mechanism was started all participants were able to continue independently, enabling an autonomous exercise experience.

According to the TUG data collected at baseline, all except one participant had impaired mobility (Barron and Guidon, 2011; Kear et al, 2017) and one participant was not able to complete the test. Most of the participants included in this study would not have met the mobility criteria for the larger studies that have investigated exercise interventions on neurological populations (Saunders et al, 2016).

Ploughman et al (2014) also recruited a heterogeneous population that aimed to measure the effectiveness of a community exercise programme for people with moderate to severe neurological disability. The 10-week intervention achieved a high completion rate of 93%, and 44% of participants continued to engage with the programme following the study period. These findings indicate that people with moderate or severe neurological disability can sustain engagement with exercise programmes.

Experience of using equipment

Previous research on the use of power-assisted exercise among older participants established that it is perceived as a non-threatening exercise option (Jacobson et al, 2012). The participants in this study reported that they enjoyed using the equipment and did not experience any notable physical discomfort during or after the exercise sessions. The participants were encouraged to generate an effort of up to 7/10 RPE, but this was not quantified. Newer models of the manufactured equipment incorporate sensitivity to the force generated by the user and will provide visual and numerical feedback related to performance. Future research will process this additional data to enable more accurate analysis of effort muscular recruitment.

It has been hypothesised that power-assisted exercise does not require eccentric muscle contraction as key muscle groups work concentrically with the direction of movement (Jacobson et al, 2012). Eccentric contraction can induce micro-injury at a greater frequency and severity than other types of muscle actions, causing delayed soreness following exercise (Cheung et al, 2003). The proposed avoidance of eccentric muscle contraction in power-assisted exercise may contribute to its acceptability among complex populations. However, the importance of eccentric muscle contraction during everyday activities such as sitting from standing is recognised; therefore, an effective exercise programme should include components of eccentric muscle work. The current study did not accurately record the muscular activity generated by participants; this could be the focus of future research.

The support of qualified personnel has been identified as a key facilitator for engagement with community-based exercise among the stroke population (Simpson et al, 2011). The participants in this study felt that some level of professional support was required, but the continuous supervision and support of a qualified physiotherapist was not necessary. Future research could explore the staffing requirements for power-assisted exercise programmes for people with complex neurological deficits.

Peer support has been identified as an important factor in sustaining engagement with exercise for neurological groups (Simpson et al, 2011). Power-assisted exercise equipment does facilitate interaction between participants as users can see and speak to each other throughout the session. Group cohesion is correlated with adherence in exercise groups (Spink et al, 2014). The participants in this study reported positive group support despite considerable variation in age and demographic status within the group.

Physical response

All participants interviewed in this study reported perceived improvements in their physical status. Participants across the three diagnostic groups felt that their balance and strength had improved. Improved flexibility was reported by those participants with a history of stroke or multiple sclerosis; in comparison, the participants with traumatic brain injury felt that their walking had improved. These perceived areas of improvement concur with the mobility scores recorded through the TUG test; the participants with a history of TBI demonstrated the greatest improvements, while those people with a history of stroke gained only marginal changes in TUG scores.

> 'The participants in this study reported that they enjoyed using the equipment and did not experience any notable physical discomfort during or after the exercise sessions.'

The purpose of recording TUG scores on completion of the exercise programme was to observe overall trends in mobility, as it is acknowledged that the small sample size does not enable valid statistical analysis of the numerical data. Observation of individual TUG data for the participants with a history of TBI is comparable to that recorded by Vaz et al (2008), who implemented the test to monitor the impact of treadmill training on two comparable adults with ataxia following TBI. The possibility of a test learning component should be acknowledged in relation to these scores. The validity of TUG measurements could have been improved by calculating the mean time across three trials for each participant (Bonnyaud et al, 2015). Further research to explore the effect of power-assisted exercise upon functional mobility is indicated.

Previous research has identified a trend of decreased physical activity associated with the uptake of specific exercise among a neurological population (Elsworth et al, 2011). Exploring the effect of a power-assisted exercise programme upon overall physical activity levels could be the focus of future studies.

Blood pressure and heart rate were monitored to ensure participant safety throughout the study. This data was recorded for screening and safety purposes only but the effect of power-assisted exercise on health outcomes is an important area of enquiry. One participant specifically commented upon the downward trend in blood pressure over the course of the 4 weeks. It is possible that blood pressure may have been elevated during the initial sessions due to anxiety related to the new intervention (Edmondson et al, 2015); therefore, the observed reduction in blood pressure cannot be directly attributed to the exercise programme. Saunders et al (2014) identify limited evidence related to exercise and blood pressure among the stroke population, particularly interventions that have included strength training. Future research could formally record and analyse blood pressure data.

'Power-assisted exercise enables people to experience continuous movement without direct assistance and has potential as a cost-effective option for the neurological population.'

Recommendations

Responses from interviews did generate numerous recommendations for the future development of the machines. All participants recommended that the default duration for each exercise should be set between 6 to 8 minutes. This would allow for a gradual warm up, an interval of intense activity and cool down on each machine. It was recognised that transitions between the machines were difficult for some of the participants, which may have contributed towards the perception that a longer duration on each machine would be preferable.

Limitations

It is acknowledged that this study was conducted on a small convenience sample. The diverse range of participants enriched the evaluation of feasibility, but valid statistical analysis could not be conducted on the TUG data. The duration of the study was 4 weeks; this enabled an evaluation of feasibility in terms of safe use of the equipment for this population group; however, the physiological effect and functional impact of the programme could be more accurately measured through the implementation of a longer programme. This would also establish whether sustained engagement with the intervention can be achieved.

The effort generated by participants and types of muscle contraction recruited were not measured. This limits the depth of physiological understanding related to power-assisted exercise and also the impact of the programme upon physical performance during the study period. The programme did not incorporate any specific progression targets within the 4-week period. Future research could explore ways in which a power-assisted exercise programme can be progressed to support the achievement of physical goals. Although the type of motor deficit was recorded for each participant, the severity of impairment was not measured. Future studies could aim to evaluate the longer-term impact of a power-assisted exercise programme with a neurological population with examination between severity of impairment and response to the programme.

The participants did not comment on their general levels of physical activity in relation to participation in the programme. This reflects a limitation within the topic guide as it would have been relevant to directly ask the participant about their overall physical activity levels. Previous research has identified a trend of decreased physical activity associated with the uptake of specific exercise among a neurological population (Elsworth et al, 2011). Exploring the effect of a power assisted exercise programme upon overall physical activity levels could be the focus of future studies.

CONCLUSIONS

This is the first study to explore the use of power-assisted equipment for people with complex neurological disabilities. The study offers a unique contribution to the growing field of research evidence surrounding exercise with the neurological population. The diverse sample included participants with very limited mobility who would not have met the inclusion criteria for conventional exercise programmes. All participants completed the programme and the findings indicate that the sample experienced a positive response to the intervention. High attendance and minimal reporting of adverse effects indicates that power-assisted exercise is a feasible option for people with complex neurological impairment. Power-assisted exercise enables people to experience continuous movement without direct assistance and has potential as a cost-effective option for the neurological population. Further research to explore the physiological impact and longer-term effects of power-assisted exercise upon the neurological population is required. **IJTR**

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