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Acceptability of a progressive resistance training programme for ambulatory adolescents with spastic cerebral palsy in England: a qualitative study

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ABSTRACT

Purpose: The aim of this study was to explore the acceptability of a 10-week progressive resistance training programme from the perspective of ambulatory adolescents with CP and physiotherapists.

Material and Methods: Semi-structured interviews were conducted with 32 adolescents with spastic CP, aged 10–19 years in Gross Motor Function Classification System (GMFCS) levels I–III, and 13 physiotherapists. Adolescents had completed a 10-week progressive resistance training programme and physiotherapists had delivered the programme. The Framework Method was used to analyse data.

Results: The analysis identified four themes. “It’s do-able” described the acceptability of the programme structure, including the frequency of sessions and the duration of the programme. “They were difficult but I did it” described the acceptability of the exercises. “It is completely different,” explored the experience of using equipment to progress the programme and “I wish I could do it on a permanent basis” discussed continuing to participate in resistance training.

Conclusions: Findings suggest that resistance training is largely acceptable to adolescents and physiotherapists. Acceptability was enhanced by having a weekly supervised session and being able to adapt and progress the exercises to meet the individual’s ability. However, there are challenges to implementing progressive resistance training as part of routine practice.

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> IMPLICATIONS FOR REHABILITATION

- Progressive resistance training is largely acceptable to ambulatory adolescents with cerebral palsy and physiotherapists.
- Adolescents’ ability to complete the exercises increased their confidence and motivated them to continue with the programme.
- Adolescents valued being supervised by a physiotherapist and believed they needed a physiotherapist to progress the exercises and motivate them to perform to their maximum capacity.
- Within the National Health Service (NHS), limited time and equipment may prevent implementation of resistance training for adolescents with CP in accordance with guidelines.
- A short-term resistance training programme delivered by physiotherapists in the NHS may provide the foundation for continuing participation in resistance training in a community setting.

Introduction

Children and adolescents with cerebral palsy (CP) typically experience reduced muscle strength, which may contribute to impaired motor function [1]. Muscle strengthening is one of the most commonly used interventions by physiotherapists to improve or maintain lower limb function among ambulatory adolescents with CP [2]. Despite this, the evidence that exercise programmes improve the muscle strength or function of children and adolescents with CP is weak [3,4]. Variations in the volume and intensity of training

may contribute to variation in the effect of exercise programmes on strength between studies [4].

The National Strength and Conditioning Association (NSCA) identified guidelines for designing resistance training programmes to enhance muscle strength in youth [5]. These guidelines were used to develop exercise prescription guidelines for people with CP because of a lack of evidence regarding appropriate training parameters specifically for people with CP [6]. The NSCA guidelines state that young people should use a load that is sufficiently heavy to prevent them from completing more than 10–15

repetitions of an exercise for one to two sets. The guidelines also recommend short-term resistance training programmes should last 8–20 weeks. A position stand from the American College of Sports Medicine additionally recommends progressively increasing training volume and intensity throughout the programme to improve strength [7]. Many studies that have examined the effect of strength training for children and adolescents with CP have used intensity and duration that is inadequate to improve muscle strength according to NSCA guidelines [6].

Although physiotherapists often aim to increase muscle strength in adolescents with CP, resistance training may not be successfully implemented or enhance clinical outcomes if it is not acceptable to both adolescents and physiotherapists [8]. Acceptability can be defined as “a multi-faceted construct that reflects the extent to which people delivering or receiving a healthcare intervention consider it to be appropriate, based on anticipated or experiential cognitive and emotional responses to the intervention” [8]. If adolescents do not find resistance training acceptable, they are less likely to adhere to and benefit from a programme. If physiotherapists do not find resistance training acceptable, they may not deliver it as it is intended, which could negatively influence effectiveness. Several constructs contribute to the acceptability of an intervention, such as the perceived burden of participating in the intervention, the opportunity cost of participating in the intervention, and the participant’s confidence that they can perform the behaviour required to participate in the intervention [9].

Two studies have previously explored the benefits of strength training from the perspective of young people with CP, adults with CP and parents [10,11]. Adults enjoyed participating in strength training and reported experiencing benefits including increased physical activity, muscle strength and social interaction [11]. Some adults experienced negative effects of strength training such as fatigue and discomfort [11]. Young people and parents similarly reported improvements in strength and balance, physical activities, and participation in school, leisure and social activities [10]. Young people and parents also described how personal and environmental factors such as parental assistance, time management and equipment could act as barriers or facilitators to participation in strength training [10]. While these studies provide an essential understanding of the perceived benefits of strength training to people with CP, they did not focus on exploring the acceptability of strength training from the perspective of people with CP and physiotherapists.

This study aimed to explore the acceptability of a 10-week progressive resistance training programme from the perspective of ambulatory adolescents with spastic CP and physiotherapists. The programme was developed in line with NSCA guidelines for youth resistance training [12], with training intensity and volume being progressively increased over the duration of the programme.

Methods

Design

This qualitative descriptive study was embedded in a randomised controlled trial. Qualitative descriptive studies are a useful approach to provide a comprehensive summary of an event in everyday terms, staying closer to the surface of the data than approaches based on specific methodological frameworks [13]. The randomised controlled trial, Strength Training for Adolescents with cerebral palsy (STAR trial), was a multi-centre trial comparing

a 10-week progressive resistance training programme of the ankle plantarflexors to usual care [3]. The trial was approved by Brunel University London’s College of Health and Life Sciences Research Ethics Committee and the Surrey Borders Research Ethics Committee (ref: 15/LO/0843). Trial registration number was ISRCTN90378161.

Participants

Adolescents with a diagnosis of spastic CP, aged 10–19 years, ability to walk independently with or without a mobility aid (i.e., Gross Motor Function Classification System [GMFCS] levels I–III), and an ability to activate the ankle plantarflexors, as determined by palpation, were included in the STAR trial. Adolescents who received orthopaedic surgery of the lower limbs in the past 12 months, botulinum toxin type A injections or serial casting in the past 6 months, or who had insufficient cognition to comply with assessment procedures and the training programme, were excluded. Adolescents were recruited to the trial from eight National Health Service (NHS) trusts in England, a special education needs school, a University, a primary care organisation, national organisations for people with disabilities, and by word of mouth. An NHS trust is an organisational unit within the NHS generally serving either a geographical area or a specialised function (e.g., a hospital trust, a mental health trust). Gatekeepers at the recruiting organisations shared information with adolescents who met the eligibility criteria. The research team confirmed eligibility during an initial conversation with each participant and/or parent prior to scheduling the baseline assessment. Sixty-four participants were randomly allocated to the resistance training or usual care control group after baseline assessments.

When invited to participate in the RCT, adolescents and their parent/guardian were provided with an information leaflet that stated they would be asked to take part in an interview upon completion of the programme. Additionally, seventeen physiotherapists and one physiotherapy assistant who delivered the programme were invited to take part in an interview on completion of the programme at their site and provided with an information leaflet. Written informed consent was provided by adolescents aged ≥ 16 years and physiotherapists, and by parents/guardians of adolescents < 16 years. Written informed assent was provided by participants under 16 years.

Intervention

A brief description of the progressive resistance training programme is provided here as the programme is described in detail elsewhere [3,12]. The programme was delivered by one or two physiotherapists to participants in groups of up to three across a variety of settings, i.e., therapy centres, hospitals, a University, and schools. Physiotherapists attended a one-hour training session where they were provided with information about the theoretical underpinning of the programme and were shown how to practically prescribe and progress the exercises. The trial manager attended the first supervised session and additional sessions to provide support if requested by the therapist.

Adolescents completed 10 supervised and 20 home sessions over 10 weeks. The programme was progressed from 4 sets of 12 repetitions at 12 repetition-maximum (RM) to 8 sets of 6 repetitions at 6 RM (Table 1). Participants performed one or more exercises that targeted the ankle plantarflexors to achieve the prescribed number of sets and intensity for a given week.

Table 1. Periodized progressive resistance training programme.

Weeks	Sets	Resistance	Muscle action
1 and 2	4	12 RM	ECC and CON
3 and 4	6	12 RM	ECC and CON
5 and 6	6	8 RM	ECC and CON
7 and 8	8	8 RM	ECC and CON
9 and 10	8	6 RM	ECC and CON

RM: repetition maximum; ECC: eccentric; CON: concentric.

Resistance was added to the exercise using body weight, free weights on a leg press or hack squat machine, weighted vests, ankle weights or resistance band, depending on the individual's baseline level of strength. During each session, physiotherapists prescribed at least one exercise to complete at home and provided participants with written instructions and photographs outlining the exercise(s) to be performed.

Data collection

Data were collected through semi-structured interviews. Interviews with adolescents were face-to-face and scheduled to coincide with their attendance at Brunel University London for their 10-week assessment (i.e., immediately post-intervention). However, they were offered the opportunity to take part in the interview at an alternative place of convenience for them if preferred. Interviews with physiotherapists and the physiotherapy assistant were conducted by telephone or face-to-face at a time and place convenient to them. All interviews were conducted by one researcher (GL) who is also a physiotherapist. A topic guide developed from the aims of the study was discussed with the research team, which included an experienced qualitative researcher and expert paediatric physiotherapist and was piloted prior to use. Interview topic guides are included in [appendices](#). Participants were asked to describe their experience of taking part in or delivering the programme. Prompts, when required, included their perceptions of the specific exercises, positive or challenging aspects of the programme, and potential to continue the programme. Interviews were audio-recorded and transcribed verbatim. Participant names were replaced with pseudonyms.

Analysis

Data were analysed using the Framework Method by two researchers (GL, JR). The two researchers had some prior experience of conducting qualitative research and a professional background in physiotherapy. This paper specifically reports aspects of the participants' experience relating to the acceptability of the programme.

The Framework Method involves seven stages: transcription, familiarisation, coding, developing an analytical framework, applying the framework, charting, and interpretation [14]. Two researchers (GL, JR) familiarised themselves with data by reading the transcripts, before independently completing line-by-line coding on a sample of transcripts. Both a deductive and inductive approach to line-by-line coding was taken. Specific areas relating to acceptability were identified *a priori*, i.e., the structure of the programme in terms of duration, number and duration of sessions, and acceptability of the exercises. Codes were also generated inductively through a process of "open-coding" [14]. Following this, the researchers and a third experienced qualitative researcher and experienced physiotherapist specialising in neurorehabilitation (CK) discussed and agreed on a set of codes, and grouped codes into broader, clearly defined, categories to form the analytical

framework. One researcher (GL) applied the framework to all transcripts (labelling phase) before charting the data. Finally, the two researchers discussed their interpretation of data with each other and members of the wider research team before developing broader themes (interpretation phase). Processes used throughout the analysis to enhance trustworthiness included the two researchers iteratively engaging with the data, noting and discussing ideas during the analysis, revisiting codes and recoding data, and discussing their interpretation with members of the wider research team [15]. In recognition of the interviewer's involvement in the delivery of the intervention and her professional background as a physiotherapist, GL engaged in reflexive discussions with the CK and JR who also challenged any assumptions and drew out considerations of any negative case analyses.

Results

Of the 33 adolescents who completed the programme, 32 participated in an interview. One adolescent did not return for the 10-week assessment and we were unable to schedule an interview at an alternative time. Twelve physiotherapists and one physiotherapy assistant participated in interviews. Five physiotherapists refused to participate in interviews because they had insufficient time. However, we interviewed at least one therapist from each site at which the intervention was delivered. We will hereafter refer to the physiotherapy assistant and physiotherapists as "therapists." All interviews with adolescents were completed face-to-face. Interviews with therapists were completed either face-to-face ($n=11$) or by telephone ($n=2$). The mean duration of interviews with adolescents was 15 min (range 8 min to 41 min). The mean duration of interviews with therapists was 25 min (range 10 min to 40 min).

Characteristics of adolescents are presented in [Table 2](#). Therapists (all female) were from 6 NHS trusts. Adolescents attended supervised sessions in 8 different locations across England: 5 NHS trust therapy centres/hospitals, a University, and two schools. Supervised sessions were predominantly held after school hours in the evening. Two participants attended supervised sessions during school hours. At some sites, the timing of the supervised session changed weekly based on participants' preference. Among the 32 adolescents, median attendance at supervised sessions was 80% and median percentage of home sessions completed was 77.5% ([Table 2](#)).

Summary of themes

The analysis identified four themes, which described participants' perceptions of the acceptability of the programme. The first "*It's do-able*" describes the acceptability of the programme structure, including the frequency of sessions and the duration of the programme. "*They were difficult but I did it*" describes the acceptability of the exercises. The third theme, "*It is completely different*," explores the experience of using equipment to progress the programme and the fourth, "*I wish I could do it on a permanent basis*" discusses continuing to participate in resistance training, beyond the trial. We outline each theme below. Additional supporting quotes for each theme are provided in [supplemental table](#).

"It's do-able"; acceptability of the programme structure

Having one supervised session per week was important to both therapists and adolescents. Adolescents valued the experience

Table 2. Characteristics of adolescents.

	n (%)	Mean (SD)	Median (range)
Age, yr	32	13.5 (2.6)	13 (10–19)
Female			
GMFCS level			
I	15 (46.9)		
II	12 (37.5)		
III	5 (15.6)		
Location of supervised session			
University ^a	14 (43.8)		
NHS Trust	13 (40.6)		
School	5 (15.6)		
Attendance at supervised sessions, % ^b	32	–	80 (40–100)
Completion of home sessions, % ^c	32	–	77.5 (10–115)

^a7 participants were recruited from an NHS trust but attended a University for the supervised session.

^bout of possible 10 supervised sessions.

^cout of possible 20 home sessions.

and knowledge of the physiotherapists and wanted reassurance that they were performing the exercises correctly. They also thought they needed a physiotherapist to continuously progress the exercise for them and to motivate them to perform the exercise to their maximum capacity.

“...it’s just that I think maybe the class... you have someone like watching you and making sure you’re doing it right. At home you don’t really know if you’re doing it right and you could be doing it wrong and then...”; Adam, 15 years, GMFCS level I

The therapists thought that the supervised session was important for building a relationship with the adolescent, monitoring progress and motivating the adolescent.

“I think it’s nice that they were sort of seeing, seeing us regularly, having contact.....rather than just being sent away with programmes and get on with it...”; Paula, therapist

One supervised session per week was an acceptable frequency, largely because therapists were flexible with the time that the supervised session was held. They were often held after school to increase participation in the programme. Acceptability was also enhanced by the therapists consulting adolescents and parents before choosing the day and time of the session. Adolescents liked the structure of having one supervised session at the same time each week, which helped them to develop a routine.

Although holding the supervised session after school increased participation in the programme, adolescents and therapists thought it was tiring. It was particularly tiring when adolescents were participating in physical education in school or other sports on the same day. Fatigue may have contributed to the variable attendance at the supervised session; only 18% of participants attended all sessions. Other reasons for non-attendance reported by adolescents and therapists included conflict with other after-school activities, family commitments, illness and the distance some adolescents had to travel to the session.

For these reasons, adolescents also did not think it would be possible to attend more than one supervised session per week. When adolescents did not attend the supervised session, therapists tried to advise the parents on how to progress the exercise at home but were not always confident that the programme was being followed correctly without face-to-face supervision.

“I think it absolutely needed to happen to have that check in once a week; I don’t think you could ask them to manage for any longer than that really.”; Kim, therapist

The home exercise sessions were on the whole well received, with adolescents appreciating the flexibility of being able to perform the two home sessions at a time that suited them.

“It was just sort of fitting them in between, at the end of the day or in the morning, or I’d normally do them on days where I’d got nothing on you found the days because you had free days anyway, so it was all right to squeeze it in.”; Conor, 18 years, GMFCS level II

However, there were challenges to completing the exercises at home. Some adolescents struggled to find space to complete the exercises while other household members were there. Others needed support from someone to use the equipment and some lacked motivation.

“It was good, but it was sort of like I just didn’t want to do it at home. Because I didn’t feel like it at home, I just sort of like wanted to sit down and do nothing to be honest.”; Louis, 10 years GMFCS level I

Therapists reported that compliance with home exercises was variable, and perceived that compliance depended on either the adolescent’s internal motivation, parents’ engagement with the programme, or both.

Most adolescents reported that 10 weeks was an appropriate duration for the programme. Many said they would like the programme to be longer than 10 weeks. This desire for a longer programme was linked to the improvements they believed they had made over 10 weeks. They also found the programme came to an abrupt end, which they were not prepared for.

“I personally would have liked more, liked a bit more time to be part of it. Yes. If it was my decision. [I would make it longer] I thought there wasn’t really a gradual stop to it, it was all very instantaneous.”; Frank, 10 years, GMFCS level I

In contrast, some adolescents thought that 10 weeks was just right and that the programme would become boring if it was longer.

Therapists’ views about the acceptability of a 10-week programme were more mixed than adolescents’. All worked in the NHS where they reported it was unusual to deliver a programme for as long as 10 weeks. They appreciated being able to monitor the adolescents’ performance over 10 weeks and build a relationship with the adolescent. They also viewed the continuous contact as important for keeping the adolescent motivated and progressing the exercises appropriately.

“I think the 10 weeks of consistency is quite rare in clinical practice so that was a real treat. And you would think by the very nature of the fact that they all increased their weights that there was some progression, so that was, yes, nice to be able to do that; felt like a luxury.”; Lily, therapist

Additionally, while many perceived that 10 weeks was a long time at the start of the programme, they commented that it went by very quickly in retrospect. However, some therapists perceived a decline in motivation among adolescents over 10 weeks, with adolescents needing more encouragement to participate in the programme.

In one site, several therapists shared the delivery of the programme because one therapist was not able to commit to delivering the programme in the evening, outside of working hours, for 10 weeks. While this enabled the programme to be delivered, therapists noted some potential negative impacts of changing therapist, such as limiting their ability to build a rapport with the adolescent and potential variations in how the programme was delivered between therapists.

"I think just making it really clear what you've done over the week and sort of adding a little comment so, if a child is bending their knee then make sure that that's being observed next time because otherwise you do get differences...and stuff. Yeah I think that's the main thing just having that continuity"; Olivia, therapist

"They were difficult, but I did it": acceptability of the exercises

The exercises were largely acceptable to both adolescents and therapists. Adolescents reported the exercises were challenging but possible to complete. The simplicity of the exercises and potential for therapists to adapt them, by changing positions and varying the level of support to each individual's ability, enabled the majority of adolescents to successfully perform them. Therapists' ability to adjust the amount of resistance added to the exercises ensured adolescents were constantly challenged within their capability.

"I think that on the whole they were at the right balance because of the way you could adjust the weight so you would end up doing what you were capable of doing and not more which was good, which was positive."; Matt, 16 years, GMFCS level I

"What was nice with this is actually you have the time and actually if it wasn't working you stopped it you started again, you stopped it you started again. It was very individual and prescriptive which was nice"; Gill, therapist

Adolescents' ability to complete the exercises, and rise to the challenge, increased their confidence and motivated them to continue with the programme. Repetition of the exercise in the supervised session also gave adolescents the confidence to perform the exercises independently at home.

"Yes I'm pretty comfortable doing it. The only ones that I got in the home programme were ones that I could already do. That had been checked already that I could do at home."; Maria, 18 years, GMFCS level III

Although repetitiveness and simplicity had benefits, therapists were concerned that they would become boring.

"I think their repetition allowed them to build the strength.... So calf raises was quite a nice exercise to give to children to practice by themselves at home. Quite straightforward....it is quite, I think, easy to do. I'm not sure if the participants liked them, this exercise, perhaps they could comment, "It was boring," but no-one told me that..."; Marian, therapist

While young people were primarily focused on adding more weight to the exercise, therapists reported a tension between increasing the weight and ensuring that the adolescent performed the exercise with good technique. This was a particular challenge

when different therapists delivered the programme because they had different opinions about what constituted adequate technique. Some therapists focused on ensuring the technique was excellent before increasing weight, whereas others increased weight even if the technique was not perfect.

"The only thing I'd say is really that understanding of what is a good heel raise, so what level is acceptable. I think I'm quite picky maybe so what some people might say, "Yes that was fine," I might want to go, "No that's not."; Gill, therapist

Finally, therapists reported that they were not always able to adequately adapt the exercises to enable adolescents to perform them. In particular, children who had poor selective motor control or very limited range of movement were not able to perform the exercises. Therapists noted it may be particularly challenging to target the ankle plantarflexors in this group because it required a combination of balance, co-ordination and selective motor control.

"It is completely different": experience of using equipment

Adolescents and therapists reported that the use of equipment to increase the intensity of the exercises was novel and it differentiated the programme from previous exercise programmes that they had received or delivered. Importantly, the concept of working at a high intensity and progressively increasing the intensity of the exercises to challenge adolescents was novel.

"It is completely different...just because we only do a few groups and it was not really with weights. If it is, it's really light ankle weights, like up like 2 kilograms, something like that, and we tend to do various exercises, whereas this was just the one exercise and mainly weights. Yeah, we definitely don't push them to fatigue like it was for this group." Millie, therapist

The equipment was simply a means of enabling this progression. Adolescents gained a sense of achievement from meeting the challenge. Some young people and therapists contrasted this to the experience of previous physiotherapy interventions, where the young person did not feel challenged.

"Yeah, this, the home exercise programme and the class, I could feel my calf burning. I could feel it. That's what I liked because I knew it was working. I needed to feel that, I needed that when I was younger to motivate me to do something like that because who knows, if I'd had that kind of reaction to my physio, I probably would've carried on doing it and I could be in an even better position than I am now, which is a shame to think because it's not something that's pushed me that would help so many more kids."; Shona, 19 years, GMFCS level II

The leg press and hack squat machine were particularly useful for adding resistance incrementally because weight could be added using free weights in small values. Adolescents also liked using the machines, more than the weighted vests or ankle weights. However, not all adolescents could use the machines because of their strength or other impairment such as limited range of motion. It was also not always possible to adjust the machines to the size of adolescents. This was demotivating, particularly when they were in a class with others who could use the machine.

"I think the machine, we had the leg press...it was a challenge...Yeah the kids, we didn't really use it, they'll be excited to use it and physically not able."; Paula, therapist

"Well we had quite, we had quite some issues with it. Not working and like I'm in the middle between two different sizes, and it wouldn't go high

enough but it wouldn't go low enough, so I was just struggling with that so I eventually had to go back to weights."; Alex, 12 years, GMFCS level I

Although the weighted vest was adaptable and enabled therapists to increase weight in small increments, there were also difficulties with using it. Primarily, they caused shoulder and back pain or discomfort. Additionally, support was often needed to put it on and take it off, which limited adolescents' independence in performing exercises. For some participants, it was not possible to add sufficient weight to the vest to reach the required intensity, either because it caused discomfort or the maximum amount of weight possible had been added to the vest.

"I hit the maximum amount of weights that you could have. I couldn't put any more on. I think it was because the jacket couldn't hold it and then I couldn't fit any other stuff."; Mark, 12 years, GMFCS level I

This prevented progression of the home exercises and potentially resulted in a plateau in strength gains. This experience was not unique to adolescents in GMFCS level I or older adolescents.

"I Wish I could do it on a permanent basis": continuing participation in and delivery of progressive resistance training

The majority of young people expressed a desire to continue the programme, although there were varying degrees of enthusiasm among participants. The primary motivation to continue came from the perception that the programme was beneficial and the desire to see further improvement. Many adolescents commented that they had improved and that the programme had helped them, but did not expand on exactly what had improved or how it had helped them.

"Yes, definitely [would continue the programme]. If I noticed improvement this much in ten weeks, what could I do in a year?"; Conor, 18 years, GMFCS level II

For some young people, the motivation to continue came from the perceived impact of the programme on their sporting performance outside the class. A unique perspective from one of the oldest participants was the motivation to start and continue the programme came from observing a decline in her physical capacity during adolescence, which the programme counteracted.

"Because I'd been so passive for about a year, year and a half of it, something stupid like that. So it was a really good kind of springboard for me to get back into being active rather than just... Yeah because at the beginning of the uni year, I felt... I didn't feel good in myself. Like I felt like I needed physio and that's not something that I have ever felt"; Shona, 19 years, GMFCS level II

However, while adolescents expressed a desire to continue the programme, when discussed further, it was clear that the programme was not a priority for many. Some mentioned education was a priority while others would simply prefer to participate in other activities.

"I think at the moment just because like I've got deadlines and I've got exams and things like that. It's not at the bottom, it's just there are a lot of things, with being a uni student, the assignments and things that I need to get in"; Maria, 18 years, GMFCS level III

Further, the language used by adolescents suggested that even if motivated to continue, they lacked confidence to perform the programme independently. For many, a barrier to continuing the

programme was a lack of understanding about the principles of exercise prescription, including progression, which was important for developing independence in completing the programme.

Therapists also largely believed that ongoing supervision was required. Many thought that specifically close supervision of one or two adolescents at the same time was necessary to ensure the exercises were performed and progressed appropriately.

"I think they need one to one guidance with the technique by a therapist because even with X who had a really, really good technique if I was distracted because I was thinking oh yes he's doing really well I'll just let his mum do it with him, then he was saying, 'I've fatigued I'm not doing anymore..."; Aisling, therapist

There was debate among therapists about whether a therapist had to supervise the programme or if another person could fulfil this role. Some therapists believed that their expertise was required to appropriately prescribe and progress the exercises. They did not think that parents had the appropriate knowledge to ensure the exercises were performed correctly. This mirrored the opinion of adolescents that they did not trust their parents' knowledge.

"Well, I think with a one to one there'd probably have to be either another physio or an experienced therapy support worker...I think with parents, they didn't always quite understand in terms of slow, controlled movement watching the calf, making sure it was going through that full range of movement when they're actually engaging with the exercises."; Louise, therapist

However, even if therapists thought they had a role in the ongoing supervision of a programme, they identified several barriers that would prevent them from delivering the programme in the future. The primary barrier was a lack of resources, including therapists' time, equipment and space. Some also questioned the equity of providing a relatively intensive intervention to adolescents with CP and not providing the same level of intervention to others without CP on their caseload.

"So I suppose just those really boring logistics of fitting it around the timetable and making sure that there's an equity of service because obviously if you're doing that sort of thing for one cohort of children...it's trying to make sure that the others are getting not the same because that might not be appropriate but a similar level of input."; Gill, therapist

Some therapists suggested that a possible solution was supporting adolescents to complete the programme in the community, for example in a local gym, where the appropriate equipment is available. Some also thought that participation in the community may normalise participation in resistance training as opposed to framing it as a therapeutic intervention. In this context, therapists saw their role in educating exercise professionals, as well as parents and young people, to support delivery of the programme.

"we can go out and speak to the gym person with them if they want us to, yeah, because I think sometimes like you know, gym people will be a bit oh, can you do all this stuff and use the equipment safely?"; Ava, therapist

Education of exercise professionals may address a concern raised by an older participant who, based on her previous experience, thought they lack knowledge about disability and are unable to appropriately adapt exercises for her to perform.

“...with personal trainers, I have to kind of take my talks with them kind of with a pinch of salt because it’s not something they do all the time, working with a disabled person. So I just kind of... You compromise and it is a lot of stretches or like off equipment work and it’s not necessarily what I want to do”; Shona, 19 years, GMFCS level II

Further, although adolescents generally agreed that continuing the programme in a gym was appropriate, if adequately supervised, some commented that they were not permitted to access gyms or use certain equipment because of their age.

Discussion

The aim of this study was to explore the acceptability of a 10-week progressive resistance training programme from the perspective of ambulatory adolescents with spastic CP and physiotherapists. The results indicated that the programme was broadly acceptable to adolescents and physiotherapists. Specifically, the majority of adolescents and therapists perceived that the structure of the programme was appropriate and not too burdensome, and that the exercises were possible to complete. A weekly supervised session and appropriate equipment enhanced acceptability. However, challenges to implementing the programme were identified at both a personal and environmental level such as the child’s size and degree of physical impairment, lack of suitable equipment, and insufficient staff time. These challenges may in part explain why strength training was not implemented in accordance with resistance training guidelines in several previous studies [4], which in turn may negatively impact effectiveness.

The duration of the programme and the use of equipment to progressively overload the exercises were in line with exercise training principles and guidelines for resistance training [5,7]. However, both were perceived as novel and were contrasted by adolescents and physiotherapists against previous experience of physiotherapy for young people with CP. Although there is no evidence about what constitutes the typical duration of a physiotherapy programme for adolescents with CP within the NHS, physiotherapists reported that exercise interventions were commonly delivered over 6 weeks. This is similar to the duration used in many studies of exercise for people with CP [4]. Further, although adolescents and physiotherapists were familiar with the exercises, they had not added load to the exercises, suggesting that the exercises were not typically performed at an intensity in line with guidelines for resistance training. This agrees with a survey of current practice among physiotherapists in the UK, which identified that although 74% frequently used strengthening to improve or maintain lower-limb function among ambulatory adolescents with CP, only 18% used muscle strengthening with equipment [2].

Although using equipment was essential for delivering the programme according to guidelines, the equipment was not acceptable or accessible to all adolescents. This potentially resulted in some adolescents performing an exercise at a below-recommended intensity and may have contributed to a lack of effectiveness [3]. In a previous study, children and adolescents with CP reported similar issues with using backpacks to add resistance, such as them being too tight or affecting their balance [10]. It is noteworthy that the intensity of the home exercises plateaued for some adolescents because they could not add more weight to the vest, even though the programme was targeting ankle plantar flexors only. The load provided by weighted vests is therefore likely inadequate to progressively overload exercises targeting larger muscle groups such as the quadriceps. This has implications for implementing the programme in the NHS, where

access to the gym equipment required to progressively overload exercises is rare.

A further important finding was that the ability to adapt and individualise the type of exercise and challenge presented to the adolescent was central to the acceptability of the programme. It was not possible to sufficiently adapt the exercises for all adolescents, however, which potentially contributed to wide variation in strength changes among adolescents with CP [16]. For the majority of adolescents who could complete the exercises, repetition of the same exercise was necessary to monitor and progressively increase intensity. Physiotherapists’ concern that repetition would lead to boredom, suggests they may be reluctant to adhere to guidelines for fear that adolescents would disengage with the programme. Similarly, in comparison to physiotherapy assistants, physiotherapists are more likely to spend a larger proportion of treatment time instructing on self-directed exercise, rather than supervising repetitive active movements and functional practice [17]. In contrast, most adolescents were positive about the repetition of exercises because repetition was necessary to progressively add load, which enhanced adolescents’ sense of being physically challenged. Overcoming the physical challenge and observing improvement, increased their confidence and motivation to continue the programme, as has previously been reported in relation to strength training [10].

Although the NSCA guidelines indicate 8–20 weeks is sufficient to increase muscle strength, guidelines for people with CP recommend using programmes of at least 12–16 weeks to allow people with CP time to adapt to the exercise [5,6]. Insufficient duration of the programme may partly explain the lack of effect on muscle strength observed in the trial [3]. However, given the challenges with delivering a 10-week programme noted by physiotherapists, implementing a resistance training programme over ten or more weeks may require changing the model of how physiotherapy is delivered to adolescents with CP in the NHS. Advocating for this change based on the potential for resistance training to improve function among children and adolescents with CP may be difficult given the evidence for benefits to functional outcomes is weak at present [4].

However, regardless of the effect on function, ongoing participation in resistance training is recommended for all people. The recently published UK physical activity guidelines for disabled children and young people recommend that disabled children and young people participate in manageable strength and balance-focused activities on average three times per week to accrue health benefits [18]. Thus, participation in resistance training as part of everyday life should be a goal for all adolescents with CP. Continuing participation in resistance training, beyond a 10-week physiotherapy-led programme, is essential for maintaining any improvements gained in muscle strength [7]. However, adolescents in this study largely lacked the confidence and skills to continue the programme independently, even if they wanted to. The programme did not include self-management skills such as education or goal-setting to support adolescents to transition from completing a programme under supervision to completing it independently in the community. Inclusion of such elements in the programme may alleviate some concerns raised by adolescents. Even with these skills, however, adolescents may not be able to access appropriate facilities or use equipment without support. Adolescents’ need for physical assistance to perform strength training has been previously noted [10]. In the absence of physiotherapists to support participation in exercise, family members may provide support [19,20]. However, therapists and adolescents in this study agreed parents may not be able to appropriately supervise a resistance training programme. While

participating in resistance training in a local gym under the supervision of an exercise professional is proposed as an alternative way to support ongoing participation, the findings of this study and others indicate it might not be acceptable to adolescents [19]. Although there are a growing number of exercise professionals with expertise in supporting people with disability, many exercise professionals may lack disability knowledge and have low expectations of adolescents with CP, which prevents them from providing an appropriate programme [19]. Further, equipment in gyms may not be easily adaptable to adolescents with CP and facilities may be inaccessible to people using a mobility aid or wheelchair [19]. Ongoing participation in resistance training is unlikely to be realised for many adolescents with CP if the environmental barriers to participating in physical activity are not addressed.

This study has a number of strengths and weaknesses to consider. Data collection and analysis were conducted by two researchers with a professional background in physiotherapy, and thus concerns about preconceptions may be relevant. However, debriefing and challenging theme development aimed to provide transparency and rigour to the process. Although we attempted to conduct all interviews face-to-face, two interviews with therapists were conducted by telephone in order to facilitate their participation. While telephone interviews may allow participants to feel more relaxed and disclose sensitive information, they may also compromise the researcher's ability to probe participants and interpret responses [21]. All adolescents and physiotherapists who participated in or delivered the programme during the trial were invited to participate in interviews. All but one adolescent who participated in the programme were interviewed. Thus, the findings of this study are likely not limited to adolescents who solely had a positive experience and include those who had relatively poor attendance at the supervised session. The multi-centre design ensures the results reflect the experiences of adolescents and physiotherapists from a range of geographical locations across England. Adolescents were also diverse in terms of age, GMFCS level and ethnicity. However, by selecting to participate in the trial, adolescents were likely highly motivated to participate or were well supported and encouraged by their parents or guardians. Similarly, as physiotherapists chose to deliver the programme as part of research study they are likely a unique group in terms of openness to try new approaches and possess altruistic tendencies [22].

In conclusion, this study found that resistance training is largely acceptable to adolescents and physiotherapists. However, the exercises were not acceptable to all adolescents and it was not always possible to adequately adapt the exercise to enable participation. The interviews also identified challenges with implementing progressive resistance training as part of routine practice in the NHS, which include limited time and equipment to support implementation according to resistance training guidelines. The majority of adolescents expressed a desire to continue the programme because they observed benefits in a relatively short period of time and valued the expertise provided by physiotherapists delivering the programme. Future work should explore how to bridge the gap between a short-term physiotherapy-led resistance training programme and long-term participation in resistance training in the community.

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Ethical approval

The trial was approved by Brunel University London's College of Health and Life Sciences Research Ethics Committee and the Surrey Borders Research Ethics Committee (ref: 15/LO/0843).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

Data are not available.

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