

BMJ Open Effectiveness and feasibility of We12BFit!: improving physical fitness and lifestyle physical activity in children with developmental coordination disorder in a paediatric rehabilitation setting—a small sample field study

Petra Braaksma ¹, Ilse Stuive,² Dorothee Jelsma,³ Corry K Van der Sluis,¹ Rienk Dekker,^{4,5} Marina M Schoemaker ⁵

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For numbered affiliations see end of article.

Correspondence to

Dr Marina M Schoemaker;
m.m.schoemaker@umcg.nl

ABSTRACT

Objectives To examine the effectiveness and feasibility of We12BFit!, a family-focused intervention aimed at increasing physical fitness (PF) and motivation for physical activity (PA) in 7-year-old to 12-year-old children with developmental coordination disorder (DCD).

Design A single-arm mixed methods small sample field study.

Setting Rehabilitation centres and schools for special education in The Netherlands.

Participants Twenty children with DCD diagnosis.

Interventions We12BFit! consists of We12BFit!-PF and We12BFit!-Lifestyle PA. During We12BFit!-PF, cardiorespiratory fitness (CRF), muscle strength and anaerobic power were trained in small groups (10 weeks 2*60 min/week). We12BFit!-Lifestyle PA, which addresses motivation for PA in children and parents, was added in week 6 of We12BFit!-PF and ended 12 weeks after We12BFit!-PF.

Outcome measures The 20-Metre Shuttle Run Test (20mSRT), Muscle Power Sprint Test and Hand Held Dynamometry were performed before and after We12BFit!-PF and after We12BFit!-Lifestyle PA (T0–T1–T2). Parents and coaches were interviewed and trainers participated in a focus group to assess motivation for PA, perceived effectiveness, and feasibility of the intervention.

Results Attendance rates of participants were 88% (We12BFit!-PF) and 89% (We12BFit!-Lifestyle PA). From T0 to T1, significant improvements were found in VO_{2peak} number of runs on the 20mSRT and mean anaerobic power. From T1 to T2, improvements were maintained. No changes were found after We12BFit!-Lifestyle PA in time spent on moderate to vigorous activity and metabolic equivalent of task; parents observed their child improved in qualitative aspects of activities and participation. Feasibility of We12BFit! was confirmed, although some adaptations were recommended.

Conclusions We12BFit! resulted in significant improvements and maintenance of CRF and anaerobic

Strengths and limitations of this study

- This is the first study to evaluate the effectiveness and feasibility of a combined physical fitness and lifestyle physical activity intervention for children aged 7–12 years with developmental coordination disorder.
- The study concerns a systematic and evidence-based intervention using treatment theory and stakeholder perspectives.
- A comprehensive range of outcome measures was used to assess effectiveness.
- No control group was included.
- No longitudinal effects on behaviour were measured because the study period was limited to 6 months.

power in a small group of children with DCD and seemed to improve motivation for PA. The group aspect of We12BFit!-PF, the high intensity and positive motivational climate of We12BFit!-PF may have improved children's self-efficacy. We12BFit! seems feasible to improve PF and PA in children with DCD.

Trial registration number NTR6334.

INTRODUCTION

Children with developmental coordination disorder (DCD) have lower levels of health-related physical fitness (PF) and participation in physical activity (PA) than typically developing (TD) children.^{1–5} This increases their risk of developing cardiovascular disease (CVD) later in life⁵ and may also affect their social and personal development.^{6,7}

In the literature, no common underlying physical pathology has been identified that explains the origins of the decreased

health-related PF in children with DCD.⁸ Instead, it is hypothesised that their decreased health-related PF is due to a negative cycle, in which poor motor coordination leads to lower participation in PA and deconditioning.⁹ Current treatment of children with DCD does not seem to suffice in breaking this negative cycle,^{6 10} as it mainly focuses on their coordinative problems and pays less attention to PF or PA.¹¹

To date, few studies have focused on improving PF, PA or both in children with DCD.^{12–17} Some studies focused on improving a single aspect of health-related PF and showed that children with DCD are able to exercise and improve cardiorespiratory fitness (CRF), muscle strength and anaerobic power, despite their motor coordination problems.^{12 15–18} Two other studies focused on improving PA in children with DCD, but these studies did not find significant improvements in objectively measured PA¹⁴ or in parents' reports of children's participation in activities.¹³

As no effective, integrated interventions focusing directly on PF and PA are available for children with DCD, the We12BFit! (We want to be fit!) intervention was developed.^{19 20} We12BFit! aims to improve PF and PA in 7-year-old to 12-year-old children with DCD and consists of two partly intertwined components: We12BFit!-PF and We12BFit!-Lifestyle PA. We12BFit!-PF consists of an intensive group training to improve CRF, muscle strength and anaerobic power. These components of PF were selected as targets for the intervention based on the literature about PF impairments in children with DCD^{1 2} and the results of a focus group.²⁰ According to previous research, VO_{2max} as a measure of CRF was 7%–22% lower, muscle strength 15% lower and anaerobic power 10%–30% lower in children with DCD compared with TD children. The We12BFit!-Lifestyle PA component aims to improve the child's motivation for PA. In order to become more physically active, both parents and children need to be motivated. To induce such a change in lifestyle, the transtheoretical model (TTM) of change of Prochaska was applied.²¹ According to this model, people progress through several stages of change, starting with precontemplation and ending with maintenance of the intended behaviour. For each stage, behaviour change strategies are operationalised in order to guide parents and children through the different stages. See Braaksma *et al*¹⁹ for a detailed description of the strategies for each stage. We12BFit!-Lifestyle PA relies on the use of pedometers by the child and his or her family to create insight into their activity levels. Based on these data, information is given to parents on how to improve motivation and participation in PA and lifestyle coaching is offered.

The aim of this study was to examine the effectiveness and feasibility of both components of We12BFit!. It was hypothesised that (1) CRF, muscle strength and anaerobic power will improve during We12BFit!-PF; (2) these PF components will at least stabilise after We12BFit!-PF; (3) objectively and subjectively measured participation in PA and motivation for PA will improve

after We12BFit!-Lifestyle PA and (4) both components of We12BFit! will be feasible to apply in clinical practice.

METHODS

Design

The design of We12Bfit is based on treatment theory.²² Within treatment theory, three domains of treatment can be discerned: treatment targets, mechanism of action and treatment ingredients. Treatment targets refer to those aspects of PF that will be targeted during treatment. Mechanism of action theoretically explains how the treatment targets will improve. Treatment ingredients are the observable actions that are necessary to achieve an improvement in the treatment target. Treatment targets for We12BFit! were selected based on the outcomes of a literature search and a focus group with professionals in the field of DCD.²⁰ This resulted in three treatment targets for We12Bfit!-PF: CFR, muscle strength and anaerobic power. These three targets will improve if overload is present during an intervention (mechanism of action). Overload means that increasing demands are placed on a system or tissue to achieve improvements in CRF, strength and endurance. This can be achieved by high intensity interval training (HIIT) to improve CRF, static and dynamic strength exercises to improve muscle strength and plyometric exercises to improve anaerobic power. We12BFit!-PF was offered 60 min per session twice a week for 10 weeks.

To become more physically active was chosen as a treatment target for We12BFit!-Lifestyle PA. To reach this target, a change in behaviour was necessary. The TTM of change was applied to determine the mechanism of action and the essential ingredients for change. People progress through several stages in changing their behaviour, starting with a growing recognition of the need to change and subsequently progressing to action. During We12BFit!-Lifestyle PA, consciousness was raised by wearing a pedometer (to provide insight into the amount of PA) and by a parent meeting and booklet, which provided information about why PA needs to be improved and how PA can be improved. Eight 30 min coaching sessions with either children or parents were scheduled to set PA goals and to discuss barriers to lifestyle change. We12BFit!-PA started after 6 weeks of We12BFit!-PF and continued until 12 weeks after the last PF session. The treatment design and the evaluation methods of this multicentre single-arm mixed methods study were described in detail elsewhere.^{19 20} No amendments were made to the original study protocol. However, although all parents were asked to fill in an Activity Log (to register wear time and type of activities when wearing the ActiGraph), hardly any of the parents filled in the Log. Therefore, the Log data were not analysed. This study was registered in the Netherlands Trial Registry (NTR6334) and reported in accordance with the CONSORT,²³ COREQ²⁴ and GRAMMS guidelines²⁵ (see online supplemental files 1–4).

Table 1 Timeline of We12BFit!

Action	Week													
	0	1	2	3	4	5	6	7	8	9	10			
Intake	X													
Measurements	T0													
1. We12BFit!-PF:														
Training		XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
2. We12BFit!-Lifestyle PA:														
Poster							X	X	X	X	X			
Booklet							X	X	X	X	X			
Parent meeting							X							
Fitbit							X	X	X	X	X			
Coaching									X					
Action	11	12	13	14	15	16	17	18	19	20	21	22	23	
Measurements	T1												T2	
Parent interviews	X*												X†	
1. We12BFit!-PF:														
Training														
2. We12BFit!-Lifestyle PA:														
Poster														
Booklet	X	X	X	X	X	X	X	X	X	X	X	X	X	
Parent meeting														
Fitbit	X	X	X	X	X	X	X	X	X	X	X	X	X	
Coaching	X	X	X	X		X		X				X		

*Parent interviews focusing on We12BFit!-PF, by the assigned coach (questions on effectiveness and feasibility).

†Parent interviews focusing on We12BFit!-Lifestyle PA, by students (questions on effectiveness and feasibility).
PA, physical activity; PF, physical fitness.

Participants

A convenience sample of 22 children with DCD was recruited from two Dutch rehabilitation centres and two schools for special education. Two children dropped out during the intervention, leaving 20 children for data analysis. All children were diagnosed by a paediatric rehabilitation physician following the criteria for diagnosing DCD²⁶ or met criteria A, B and C for diagnosing DCD²⁶ and had criterion D checked in school records. All participants were 7–12 years old and had expressed a wish to improve their PF or PA. The study protocol describes the involvement of the participants in setting personal goals before the intervention and the participation of parents in evaluating PA in interviews after the intervention.¹⁹

Treatment: We12BFit!

We12BFit! is divided into two different components: We12BFit!-PF and We12BFit!-Lifestyle PA (table 1). We12BFit!-PF consists of a 10-week group training, twice a week for 60 min, using HIIT based on running, strength exercises and plyometrics. During the HIIT of WE12BFit!, the mean heart rate should be at least 80% of maximal heart rate (HR_{max}) in children who achieved a heart rate of at least 190 bpm during endurance

testing.²⁷ In children who achieved a heart rate lower than 190 bpm during the 20mSRT at baseline, the mean heart rate during HIIT should be at least 150 bpm. If 80% of HR_{max} or 150 bpm was not achieved during two consecutive training sessions, the HIIT distances were increased up to a level at which the threshold was reached. The trainers were trained physical therapists and physical education teachers. The training sessions took place at the rehabilitation centres or at schools for special education.

In week 6 of the training, We12Bfit!-Lifestyle PA started with a parent group meeting, where parents also received an information booklet. At that time, children and their family received Fitbit Zip pedometers. In week 8, parents met with their coach in person to set goals. The remaining coaching sessions started after the last PF training session. The parent meeting was led by a trainer and a coach. The coaches were paediatric psychologists who worked in the field of rehabilitation or who had experience with counselling and working with children with DCD. All coaches were trained in providing We12Bfit!-Lifestyle PA. Between weeks 6 and 10 of the training sessions, children were asked to share their latest and most fun activities.

The children wrote down or drew their input on a shared poster.

Patient and public involvement

Two parents of a child with DCD were interviewed on their preferences for the treatment (frequency, location, activities) and two children with DCD pilot tested the training activities for at least 8 weeks. The parents were also interviewed about the role of the parent in motivating and activating the child. During the We12BFit! intervention, participants set their personal goals during the intake and coaching sessions. Participants were asked to contribute to a video to inform other potential participants about the intervention. We12BFit!-Lifestyle PA was evaluated in parent interviews afterwards. Participants were informed about their personal results after the intervention, and the overall research results will be presented to them in a newsletter.

Instruments

Effectiveness

Measurements to assess the effectiveness of We12BFit! took place at T0, T1 and T2 (weeks 0, 11 and 23, respectively). The effects of We12BFit!-PF were evaluated with a range of PF field tests.

The primary outcome CRF (VO_{2peak} , number of runs) was measured with the 20-Metre Shuttle Run Test (20mSRT),²⁸ a test commonly used in studies in children with DCD.¹ VO_{2peak} , measured with the 20mSRT, showed good correlations with more direct assessments of aerobic capacity.¹ The 20mSRT was administered once at T0, T1 and T2 in small groups, while a therapist encouraged the children to keep up their pace and motivation. For each child, VO_{2peak} and the number of runs for each test moment were entered into the data analysis.

Additional measures included flexion and extension strength of elbows and knees assessed with the MicroFET handheld dynamometer (HHD)²⁹ and handgrip strength assessed with the JAMAR HHD.³⁰ Both measures were chosen for their reliability for use in children and for the fact that they do not involve motor coordination. Each muscle group of the dominant and non-dominant side was assessed three times. The mean of these six measurements was calculated and entered into the data analysis.

Mean anaerobic power was assessed with the Muscle Power Sprint Test, an instrument that was initially designed for children with cerebral palsy. Its reliability has been demonstrated in children.³¹ Children will perform six 15 m runs at maximal speed, with 10 s rest between runs. The mean of these six runs was calculated as a measure of mean power. Weight and height were measured for descriptive purposes. The effectiveness of We12BFit!-Lifestyle PA was assessed using the ActiGraph accelerometer (wGT3x-BT),³² which measures activity intensity (percentage of time spent on moderate to vigorous activity (MVPA) and metabolic equivalent of task (MET)). The ActiGraph was worn for 7 days.

In addition, parents were invited twice by email for an interview on the effects of the treatment and its feasibility. In the second coaching session (week 11), all parents were interviewed by the coach, and after completion of We12BFit! (week 23) eight parents were interviewed by trained master's students of Human Movement Sciences and Applied Psychology with an interest in DCD. The interviews took place after completion of We12BFit! at home (2), at school (4) or at the rehabilitation clinic (2). All interviews were audio recorded and anonymously transcribed verbatim afterwards (average duration about 45 min). A summary of the interviews was emailed to the participants for comments or corrections; however, no corrections were necessary. See online supplemental files 2–4 for the Consolidated Criteria for Reporting Qualitative research checklist²⁴ and the Good Reporting of A Mixed Methods Study (GRAMMS) checklist.²⁵

Feasibility

Attendance rate, mean percentage of HR_{max} during HIIT (for participants with $HR_{max} > 190$ bpm achieved in the 20mSRT) and percentage of HIIT sessions over 150 bpm (for participants with $HR_{max} > 190$ bpm achieved in the 20mSRT) were assessed.

Feasibility of We12BFit!-PF was assessed using interviews with parents, observations of the training sessions, a focus group with the trainers and interviews with coaches (see online supplemental appendices B and C of the study protocol for the interview questions).¹⁹ All participants were invited by email. The focus group (duration 110 min) took place at the University Medical Center Groningen, the interviews with coaches (average duration 76 min) at their workplace. Human Movement Sciences and Paediatric Physical Therapy students observed the training sessions to monitor the exercises, detect potential issues with the execution of the training and check heart rates. The focus group leader had a background in research (PhD) and in occupational therapy, was not involved in the study and had extensive experience in leading focus groups. Coaches were interviewed by trained students of Human Movement Sciences and Applied Psychology. All interviews and the focus group were audio recorded. A summary of the interviews and focus group was emailed to the participants for comments or corrections; however, no corrections were necessary.

Data analysis

The minimum required sample size was 19 participants. Sample size calculation was based on the primary outcome measure VO_{2peak} (mL/kg/min), as obtained from the 20mSRT. Effect size d , $d = |x1 - x2| / (s(1-r)0.5)$ was calculated using mean VO_{2peak} from preliminary research ($x1$),² mean VO_{2peak} after 5% improvement ($x2$),²⁶ standard deviation (s) and at least moderate Pearson correlation ($r > 0.3$). Next, sample size was calculated based on a two-tailed t-test with a power of 80% and alpha of 0.05, resulting in a required sample size of 19 participants.

Effectiveness was evaluated between T0–T1 (We12BFit!-PF) and T1–T2 (We12BFit!-LifestylePA), using single dependent t-tests for normally distributed data and the Wilcoxon test for not normally distributed data. Significance for the tests was set at 0.05. The interview and focus group data were analysed using manifest content analysis with ATLAS.ti V.8 software. The aim of the focus group and the interviews was to evaluate We12BFit! from the perspective of professionals and parents of the participants. A qualitative manifest content analysis was undertaken to describe the aspects of evaluation (descriptive).³³ First, the researchers familiarised themselves with the data by reading the transcripts. Second, the researchers independently coded the transcripts (ie, the focus group, two parent interviews regarding We12BFit!-PF, two parent interviews regarding We12BFit!-Lifestyle PA and two coach interviews) using a basic coding tree based on the terminology of treatment theory (deductive) (see online supplemental file 5). If parents or coaches mentioned concepts that were not in the original coding tree, codes were added to the coding tree (inductive). After the initial coding, the researchers discussed their coding tree until they reached consensus. This coding tree was used to code the remaining data. When new codes came up in the remaining interviews, these were discussed by the researchers and added to the coding tree. Data saturation was reached after three interviews, as the coding tree did not change after three interviews (see also Braaksma *et al*¹⁹).

RESULTS

Enrolment and baseline characteristics

Twenty children completed the We12BFit!-PF intervention and 16 of these children also participated in We12BFit!-Lifestyle PA (figure 1, table 2).

Effectiveness: quantitative results

For We12BFit!-PF, significant improvements from T0 to T1 were found for the two primary outcome measures VO_{2peak} ($p=0.005$) and number of runs on the 20mSRT ($p=0.002$) and for the secondary measure mean anaerobic power ($p=0.010$) (table 3). After completion of We12BFit!-PF, no significant differences were found for any of the PF measures ($p>0.05$) from T1 to T2. For We12BFit!-Lifestyle PA, percentage of time spent on MVPA and METs did not improve significantly over time ($p>0.05$).

Effectiveness: qualitative results

In the interviews, 16 (T1) and 8 (T2) parents were asked if they had noticed any changes since participating in We12BFit!. Eight of the original 16 parents declined the interview, as they were too busy to participate; in the end eight mothers and one father participated. In table 4, noticed changes regarding the direct targets are provided. Table 4 also presents quotes from parents and an overview of behavioural changes mentioned by parents (manifestations). Parents indicated that their child improved

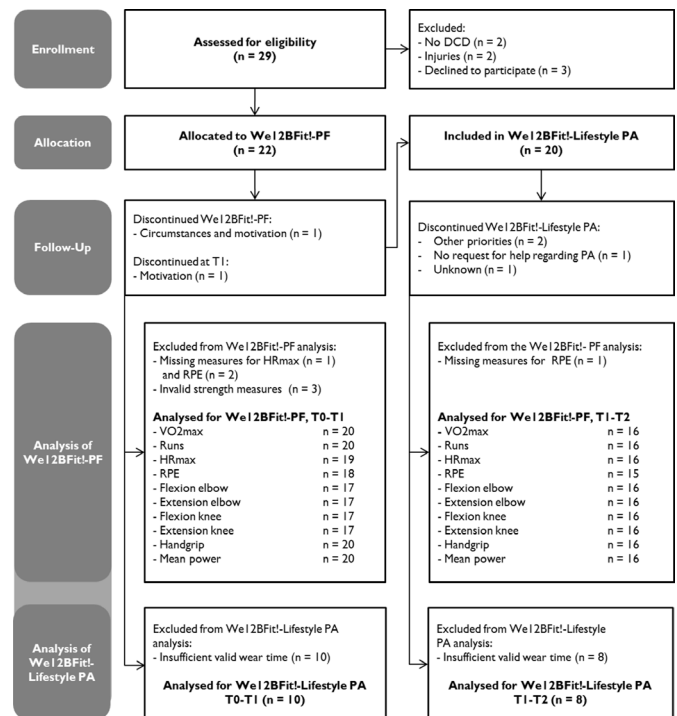


Figure 1 Flow diagram of participant enrolment. DCD, developmental coordination disorder; PA, physical activity; PF, physical fitness; RPE, rate of perceived exertion.

on the We12BFit!-PF targets endurance and muscle strength. Parents also indicated that their child initiated activities more often, that their child participated in new structured and unstructured activities and that their child performed activities more often or at a higher intensity.

In addition, changes in other aspects than the direct targets of We12BFit! were reported (online supplemental file 5). Remarkably, almost all parents indicated that their child had more confidence in social interactions and physical challenges and that their child enjoyed being more active. In addition, parents noticed improvements in motor skills and concentration at school, and children also lost weight. Most parents reported they had gained knowledge and insights, extended the strategies to stimulate their child to be active and got involved in more activities themselves. Some parents reported that they now had less concerns about their child being active than before. One parent was concerned that his child might start feeling obliged to be active.

Eight out of ten trainers participated in the focus group and four out of five coaches were interviewed.

Table 2 Descriptive baseline characteristics of the participants (n=20)

Characteristics	Mean (SD)
Age (years)	10.0 (1.6)
Weight (kg)	46.2 (19.2)
Height (cm)	146.8 (16.5)
Boys (n)/girls (n)	16/4



Table 3 Physical fitness (PF) and physical activity (PA) measurements

	T0 mean (n)	(SD) min- max	T1 mean (n)	(SD) min- max	P value test statistic	T1 mean (n)	(SD) min- max	T2 mean (n)	(SD) min- max	P value test statistic
1. We12BFitI-PF										
Cardiorespiratory fitness										
VO _{2peak} (mL/kg/min)	42.3 (n=20)	(4.3) 35.9-50.1	43.7 (n=20)	(4.3) 36.7-52.0	0.005†** Z=2.800	44.0 (n=19)	(4.1) 37.6-52.0	42.9 (n=19)	(3.7) 36.6-49.3	0.089 t(18)=1.797
Runs (n runs)	17.9 (n=20)	(9.5) 5-37	22.3 (n=20)	(9.3) 10-45	0.003†** Z=2.925	22.8 (n=19)	(9.0) 11-46	22.4 (n=19)	(8.7) 9-46	0.266† Z=0.567
HR _{max}	191.4 (n=20)	(10.1) 175-221	184.4 (n=20)	(22.5) 115-220	0.147† Z=1.450	184.1 (n=19)	(23.0) 115-220	191.9 (n=19)	(10.8) 175-221	0.064† Z=1.854
RPE (OMNI)	6.6 (n=20)	(2.9) 2-10	7.7 (n=20)	(2.1) 3-10	0.376† Z=0.884	7.7 (n=19)	(2.1) 3-10	7.2 (n=19)	(1.9) 4-10	0.542 t(17)=0.622
Muscle strength										
Flexion elbow (N)	102.6 (n=17)	(28.1) 66.9-160.9	110.3 (n=17)	(25.6) 62.3-153.5	0.115 t(16)=1.403	106.1 (n=19)	(24.5) 62.3-153.5	105.1 (n=19)	(29.9) 57.8-172.7	0.828 t(18)=0.221
Flexion knee (N)	112.4 (n=17)	(38.6) 67.3-217.2	124.8 (n=17)	(35.3) 50.1-189.5	0.084† Z=1.728	120.9 (n=19)	(34.1) 50.1-189.5	123.4 (n=19)	(35.9) 59.2-205.8	0.702 t(18)=0.389
Extension elbow (N)	88.8 (n=17)	(28.5) 53.3-158.4	83.4 (n=17)	(20.0) 44.0-123.5	0.193† Z=1.302	80.8 (n=19)	(19.9) 44-123,5	85.9 (n=19)	(25.6) 44.9-140.1	0.256 t(18)=1.174
Extension knee (N)	152.8 (n=17)	(34.2) 108.5-213.3	156.0 (n=17)	(39.0) 88.9-248.1	0.619† Z=0.497	150.1 (n=19)	(38.4) 88.9-248.1	150.9 (n=19)	(30.1) 98.2-193.5	0.904† Z=0.121
Handgrip (kg)	14.7 (n=20)	(5.4) 5.3-24.5	14.9 (n=20)	(5.5) 4.8-26	0.769 t(19)=0.297	14.6 (n=19)	(5.5) 4.8-26	16.1 (n=19)	(6.7) 5.7-29.3	0.063† Z=1.53
Anaerobic power										
Mean power (Watt)	163.3 (n=20)	(72.8) 61.3-346.3	197.8 (n=20)	(89.3) 57.6-410.6	0.010*† Z=2.576	198.6 (n=19)	(91.7) 57.6-410.7	215.4 (n=19)	(115.3) 66.1-533.4	0.573† Z=0.563
2. We12BFitI-Lifestyle PA										
PA										
MVPA (%)	5.529 (n=12)	(2.100) 2.31-9.56	5.668 (n=12)	(2.135) 2.45-10.22	0.803 t(11)=0.256	5.533 n=9	(2.319) 2.45-10.22	6.561 n=9	(2.708) 3.21-10.8	0.314† Z=1.007
MET	1.899 (n=12)	(0.281) 1.45-2.46	1.877 (n=12)	(0.243) 1.49-2.40	0.706 t(11)=0.387	1.856 n=9	(0.265) 1.49-2.40	1.919 n=9	(0.306) 1.54-2.35	0.515† Z=0.652

*p<0.05; ** p<0.01.

†Based on Wilcoxon test.

HR_{max}, maximal heart rate; max, maximum value; MET, Metabolic Equivalent of Task; min, minimum value; MVPA (%), percentage of time spent on Moderate to Vigorous Physical Activity; n, number of participants; N, Newton; RPE, rate of perceived exertion.

Table 4 Reported effects of We12BFit!

Change in CHILD

Examples of Quotes	Manifestations
Target: endurance	
P: 'His endurance improved a lot. Maybe even a bit too much because I almost can't keep up with him anymore'.	Keeping up with others; being able to sustain activities longer; less fatigue.
T/C: 'They are able to participate better and longer. That is what the children say and their parents as well'.	
Target: muscle strength	
P: 'His muscle strength has improved, that was very important'.	Being stronger; having a higher muscle tone.
T/C: –	
Target: anaerobic power	
P: –	
T/C: –	
Target: motivation for PA, reflected in:	
A. Child <i>initiates</i> (more) activities	
P: 'And he will just say: 'let's go to park for a walk, let's go cycling or swimming''. 'The biggest change is that now he will go and play outside spontaneously more often'.	Playing outside and cycling on their own initiative; choosing the stairs; suggesting to participate in family activities (walking in the park, cycling, swimming); spontaneously taking a detour on the way home from school; choosing active games.
T/C: 'I heard from parents that they (the children) now also started doing things on their own initiative. One of those children for instance suddenly liked to run in circles around the house because he really liked running'.	
B. (Participation in) activities (new activities/higher intensity)	
P: 'He would always choose the easier games but now he takes the risk and plays tag more often'. 'Well, now he goes to school by bike every day, before, that was unthinkable'.	Playing soccer; doing fitness with/without parents; horseback riding; playing table tennis; active play with siblings; playing outside; cycling; walking the dog; doing chores in the garden; walking the stairs; playing active Wii computer games; participating in other rehabilitation programmes; playing in the school playground.
T/C: 'He even started running with his dad'. 'I know that because they all started participating in sports which they really like...'	

Change in PARENT

Quotes	Manifestations
Target: motivation for PA, reflected in:	
A. Activities	
P+T/C:	Sports (swimming, running, fitness (with/without child)); taking part in running events; family walks; walking the dog.
B. Strategies used to increase child's activity level	
P: 'He is easily motivated by compliments. So when I tell him: 'You did so well' you know, then he'll be going again'.	Buying materials for outside play; getting siblings involved; being active as a parent; joining child in being active (being active together); explaining to child that sweating is normal; buying sports gear; looking for activities that suit the child; finding adapted sports opportunities; telling child to play outside; making being active a habit; getting child involved in daily activities of the parent, such as walking the dog; going to school by bike (by default); being active as a family; showing child the benefits of being active; encouraging child; limiting screen time; being realistic at moments when being active is not feasible; complimenting child; giving child more independence; increasing activity goals gradually; showing child what he achieved with We12BFit!; rewarding activity with screen time; focusing on what child is able to do; asking child to motivate parent if he is less active again; letting child try activities; finding a balance in challenging the child; continue using pedometer; 'just do it'; making being active more fun.
T/C: 'Being active together is one thing that I heard often, but I think they already did that before. I think that is something that was extended now (...) I heard that they would do more with brothers, sisters, or cousins'.	

The content of this table is derived from the qualitative manifest content analysis procedure as described in the Methods section.

*To protect the identity of the participants, pronouns in all quotes were changed to 'he/him/his' instead of distinguishing sex.

C, coach of We12BFit!-Lifestyle PA; P, parent; T, trainer of We12BFit!-PF.

Two trainers did not participate due to illness, and one coach found other employment during the intervention. During the focus group and interviews, the trainers and coaches were also asked if they had noticed any changes in the children and their parents since participating in We12BFit! (table 4). The changes reported by the trainers and coaches largely confirmed those mentioned by the parents. With regard to changes in the children, the coaches additionally mentioned that parents reported improvements in sleep and in keeping balance between being active and relaxing. The trainers and coaches valued the peer contacts because they noticed that the children became aware that other children with DCD also experience difficulties and that they were not alone in this situation. Moreover, they noted that the children learnt to push their boundaries. Contrary to the parents, the trainers and coaches did not mention changes in muscle strength, motor skills or concentration at school, which may be due to the fact that the trainers and coaches only saw the children during the intervention and could not observe or measure changes during activities of daily living or at school.

Feasibility: quantitative results

Ninety-five per cent of the eligible participants completed We12BFit!-PF and 73% completed We12BFit!-Lifestyle PA (figure 1). The attendance rate of the We12BFit!-PF training sessions was 89% (18 out of 20 sessions). The mean percentage of HR_{max} during HIIT was 81% (for participants with $HR_{max} > 190$ bpm achieved at 20mSRT, n=14). The percentage of HIIT sessions over 150 bpm was 64% (for participants with $HR_{max} < 190$ bpm achieved at 20mSRT, n=6). The attendance rate of the We12BFit!-Lifestyle PA coaching sessions was 88% (seven out of eight sessions).

Feasibility: qualitative results

Both positive and negative feedback, as well as suggestions on how to improve We12BFit!, was provided by parents, trainers and coaches during interviews and a focus group (online supplemental file 5). Parents considered the We12BFit!-PF training sessions helpful, structured, motivating, and stressed the benefits of group sessions. Although the children enjoyed the sessions, they wished for more variation in the exercises. The trainers provided suggestions for improving the intensity and attractiveness of the exercises and pointed out the lack of time for things other than the exercises (eg, preparing materials and interacting with parents and children). They also pointed out the disadvantages of parents not being present at the training sessions that were provided at schools during school hours. This meant not witnessing the physical capability and improvement of their child throughout the training sessions and not seeing how other children with DCD performed in the training.

Parents endorsed the purpose of the Fitbit as being fun, motivating, increasing awareness, helping to set goals and reinforcing family involvement. Disadvantages listed by

parents were mainly practical/technical and were related to children with DCD scoring lower than others on the Fitbit. Children used the Fitbit in a competitive way by comparing how they scored compared with other family members. Coaches focused on the children and parents who did not use the Fitbit. According to the coaches, most of these children were not sufficiently active and might have benefited from using the Fitbit.

Parents valued the interactive content of the parent meeting. The coaches were positive about the input of the parents and also considered meeting's content to be valuable. Both parents and coaches suggested increasing the opportunities for interaction by adding meetings or extending the duration of the meeting. The coaches suggested adding information about DCD because parents asked several questions about DCD during the meeting.

The booklet was generally considered useful. Some parents thought it was too complicated, whereas coaches considered it easy to read and suggested adding optional information. Both parents and coaches suggested adding information for the children (the booklet was originally written for parents).

Parents appreciated the interaction with the coach and generally considered the sessions to be helpful in achieving the goals they set. The coaches endorsed the importance of coaching. Opinions differed on the suitability of using video or phone calls; some coaches thought it was convenient, whereas others felt it hampered the conversation. They added that there were more no-shows for video or phone call appointments than for face-to-face meetings. However, they did consider the video and phone calls to be suitable for the transfer from being active in the rehabilitation centre or school to being active in the home environment. Having bonded with the child and the parents prior to coaching was considered a prerequisite for successful coaching.

The student observers reported only minor adverse events, such as incidental bruises, abrasions, muscle strain and muscle soreness. They reported that it seemed to benefit the children's motivation if they could choose activities freely and if games were added during the training sessions. In addition, the student observers indicated that it was hard for the trainers to have all the children perform their individual strength exercises at the same time, that the anaerobic exercises were not always performed in an explosive way and that there was not always time for cooling down.

DISCUSSION

The current study had four hypotheses: (1) CRF, muscle strength and anaerobic power will improve during We12BFit!-PF; (2) PF components will stabilise after We12BFit!-PF; (3) participation in PA and motivation for PA will improve after We12BFit!-Lifestyle PA and (4) both components of We12BFit! will be feasible for use in clinical practice. Regarding hypothesis 1,

significant improvements were found for VO_{2peak} , number of runs on the 20mSRT and mean anaerobic power after We12Bfit!-PF training. The level of these improvements remained stable over time (T2) (hypothesis 2). Hypothesis 3 was not confirmed as no changes were found after We12Bfit!-Lifestyle PA on the time spent on MVPA and METs. However, parents indicated that motivation for PA increased, as the children initiated and engaged in more activities than prior to the intervention. Overall, the We12Bfit! was found feasible; children were able to perform the exercises and enjoyed the sessions. In the next paragraphs, the results will be discussed in more detail.

We12Bfit!-PF: effects on PF

The results of We12Bfit!-PF underline that, despite their motor difficulties, children with DCD have the ability to be active at an intensity, frequency and duration that is sufficient for improving CRF and anaerobic power. Moreover, after the We12Bfit! training sessions stopped, they were active at a level that was sufficient for maintaining the improvements in CRF and anaerobic power for 3 months.

To our knowledge, no studies are available that demonstrate maintenance of improvements in CRF and anaerobic power. However, the increases in CRF and anaerobic power are consistent with the improvements reported by Tsai *et al.*¹⁷ and Smits-Engelsman *et al.*¹⁸ after directly targeting these outcomes. It is unlikely that the improvements can be attributed to spontaneous development during the study period, as previous research showed that CRF and anaerobic power of both children with motor coordination problems and TD children declined over time if they did not partake in an intervention to stimulate CRF or anaerobic power.^{10 29 30} Importantly, children with motor coordination problems who had lower CRF and anaerobic power showed an even steeper decline than TD children.^{10 34 35} A drawback of measuring CRF with field tests such as the 20mSRT is that children with DCD may drop out earlier during the test due to feelings of incompetence or lack of motivation.¹ In that case, the results will not reflect the true potential of the children. To prevent this from happening in the current study, a therapist joined the children during the pre-test and posttest to encourage them to keep up their pace.

CRF is an important indicator of the risk of cardiovascular diseases; improvements in CRF are related to a decrease in cardiovascular risk factors, and this decrease is greatest in people with an a priori low CRF.^{36 37} This implies that if the children with DCD in the current study would maintain the increased level of activity for even longer than the 3 months monitored after the intervention, a decrease in risk of cardiovascular disease would likely take place. Future studies could extend the monitoring of children after interventions over a longer period of time to gain knowledge on the extent of stabilisation of the levels of activity. Importantly, it should be noted that the improvements are potentially partly due to improvements in motor coordination gained during the

intervention.^{38 39} Although CRF is primarily targeted for its relation to health, it has an additional function, in that it enables children to engage in intensive activities for an extended duration. Likewise, anaerobic power is an important skill-related component of PF that enables children to be active in short intermittent bursts of activity of varying intensity, for example, during playing tag, hide and seek, or ball games.

Despite improvements in CRF and anaerobic power, flexion and extension strength of elbows and knees did not improve significantly after We12Bfit!-PF. One explanation for this might be that although the strength exercises aimed to improve elbow and knee strength, they put more strain on the core muscles instead. Unfortunately, this could not be verified in this study because a measure of core strength was not included. Another explanation relates to difficulties of ensuring sufficient overload for each individual participant while performing exercises in a group. All children had to do the strength exercises at their own level simultaneously. This proved difficult to coordinate for the trainers. In addition, the baseline elbow and knee strength of the participants was relatively high compared with previous research,² potentially leaving less room for improvement. Handgrip strength was not targeted directly in We12Bfit!-PF, but the measure was included because it is seen as an indicator of overall strength.⁴⁰ Therefore, the absence of improvement in handgrip strength is in line with the non-significant findings on flexion and extension strength of elbows and knees.

We12Bfit!-Lifestyle PA: effects on motivation for PA and intensity of PA of children

The maintenance of PF in the period after We12Bfit!-PF is in line with the increase in motivation for PA. Motivation for PA, as reported by parents, was reflected by their child initiating activities and employing new activities or performing activities at a higher intensity. However, these findings were not supported by an increase in intensity of activities measured with ActiGraph accelerometers. As the power calculations were based on the primary outcome CRF and only eight participants reached sufficient accelerometer wear time, the study was underpowered to detect significant changes in intensity of activity.

Motivation for PA of parents also improved and manifested itself in parents engaging in more activities and employing a wide range of previously underused strategies to encourage their child to be active.

We12Bfit!: indirect effects

In addition to improvements in the direct targets CRF, anaerobic power and motivation for PA, a number of valuable indirect effects of We12Bfit! were also listed by parents, trainers and coaches. Improvements in motor skills, increased confidence in social interaction and physical challenges, and greater enjoyment of activities stood out. The reported improvements in confidence likely reflect improvements in self-efficacy of the

children, which is defined as ‘belief in one’s capabilities to organise and execute the courses of action required to manage prospective situations’. (p.2)⁴¹ Self-efficacy is reported to be lower in children with DCD than in TD children and is an important predictor of PA⁴² and maintenance of behaviour change.⁴³ Parents attributed the improvements in confidence mainly to We12BFit!-PF. The explanations they provided for this largely correspond to three sources for improving self-efficacy listed by Bandura⁴¹: (1) enactive mastery experience, reflected by experiencing success during We12BFit!-PF; (2) vicarious experience, reflected by the children seeing other children with similar problems being active as well; and (3) verbal persuasion, reflected by the trainers encouraging the children to explore their boundaries. Therefore, the group aspect of We12BFit!-PF and the high intensity training combined with the positive motivational climate of We12BFit!-PF may have reinforced the target of We12BFit!-Lifestyle PA: motivation for PA. This illustrates the potential added value of a combined PF and PA intervention.

Feasibility

The We12BFit! training and coaching sessions had high attendance rates. It is often difficult to engage parents in these types of interventions, particularly at schools. Therefore, this is a notable result in general and for the coaching sessions in particular.⁴² Analysis of feasibility of We12BFit!-PF showed that the HIIT exercises resulted in the required intensity; the children enjoyed the sessions; the children were able to perform the exercises at high intensity; and, finally, only minor adverse events were reported. It was suggested that the HIIT training could be improved by providing more variety in the exercises to make them more enjoyable. The absence of an effect on the muscle strength parameters indicates that the strength exercises need to focus more specifically on the targeted muscle groups and should be adjusted for group training. Furthermore, the anaerobic exercises may be improved by adding game elements that challenge the children to perform the exercises at a higher intensity. Time for preparation and interaction between trainers, children and parents was identified as an important condition for satisfactorily giving the training sessions. The presence of parents at the training sessions was considered to be of added value as it improved their involvement.

In conclusion, We12BFit!-Lifestyle PA was generally considered feasible. Future adjustments can further increase feasibility. Parents appreciated being involved in the intervention, but parents and coaches also wished for more opportunities for interaction. Face-to-face contact prior to the video or phone calls to establish a connection between coach and participant was identified as an important condition for adherence to the coaching sessions. Intertwining We12BFit!-Lifestyle PA more with We12BFit!-PF will increase motivation for PA.

Strengths, limitations, and recommendations for future research

The strength of this study lies in the systematic development of the intervention using treatment theory and combining evidence-based information with practical expertise gathered from a focus group.^{19,20} Consequently, We12BFit! aims to be a comprehensive and tailored intervention that involves both parents and children and uses group interactions and the reinforcing effect of We12BFit!-PF on We12BFit!-Lifestyle PA to achieve the set targets. A strength resulting from the systematic development of We12BFit! is the comprehensive evaluation method. Effects on direct targets were evaluated using mixed methods and potential indirect effects were mapped using qualitative methods. Moreover, separate behaviour change strategies were evaluated during the interviews after We12BFit!-Lifestyle PA, which allowed us to give specific directions for improvement. These recommendations can be used in future studies. A final strength of this study is that it concerns a group intervention. There is increasing evidence for the effectiveness of group interventions,^{8,37,44–46} which is also recognised in the clinical practice guidelines for DCD, where small group interventions are recommended.¹¹ The cost-effectiveness of group interventions is an important asset.

Despite the strengths of this study, there are some limitations related to the size of the sample and scope of the methods. First, a control group was not included because the intervention concerns a newly developed treatment method. In addition, recruitment of participants required great effort from the research team. Nevertheless, more participants than needed were included according to the power calculation (20 instead of the required 19 participants). However, the results of fewer children were available for some measures due to missing data, leaving those measures probably underpowered. Moreover, more boys than girls were included, which may have affected outcomes, specifically where balance was needed to execute exercises. Girls with DCD are known to have better balance than boys with DCD due to immaturity or inattention. Second, the interviews were conducted with parents and not with the children themselves. Consequently, only the perception of parents regarding the effectiveness of the intervention was presented. Whether children noticed the same changes after the intervention remain unknown. In addition, although both parents were invited to the interviews, in all but one case only mothers attended the interviews. However, although mothers and fathers may perceive their child’s behaviour differently, it has been reported that mothers are reasonably accurate in evaluating their child’s development.⁴⁷ Finally, self-efficacy and stage of change were only assessed using interviews. The inclusion of standardised instruments for measuring self-efficacy and stage of change in children and parents would have strengthened the study.

Future interventions should build on the recommendations from the feasibility analysis and focus on effectively targeting muscle strength in joint collaboration

with children, parents and professionals. Subsequently, therapists may consider integrating direct targeting of motor coordination in We12BFit!. It is paramount to determine the required parameters, such as type of activity, frequency, intensity and duration, for each target. The evaluation methods can be extended with a control condition (eg, extended baseline), a larger sample size and interviews with children. Evaluation of motor skills and standardised assessment of self-efficacy may be added to elucidate their potential effect on PF outcomes.

CONCLUSION

We12BFit! resulted in significant improvements in and maintenance of CRF and anaerobic power in a small group of children with DCD and also seemed to improve the motivation for PA. The effects of We12BFit! exceeded its direct targets and showed the potential added value of a combined PF and PA intervention. High intensity group training in a positive motivational climate may result in improved self-efficacy and may consequently strengthen the effects of behavioural interventions to improve motivation for PA. We12BFit! was shown to be effective and feasible. Further improvements regarding the strength exercises and enjoyment of the programme are recommended.

Author affiliations

¹Department of Rehabilitation Medicine, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

²Center for Rehabilitation, University Medical Center Groningen, University of Groningen, Groningen, The Netherlands

³Developmental and Clinical Neuropsychology, University of Groningen, Groningen, The Netherlands

⁴Department of Rehabilitation Medicine, University Medical Center Groningen, Groningen, The Netherlands

⁵Center for Sports Medicine, University Medical Center Groningen, Groningen, The Netherlands

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ORCID iDs

Petra Braaksma <http://orcid.org/0000-0002-6608-7239>

Marina M Schoemaker <http://orcid.org/0000-0002-3437-9325>

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