Identification of a core set of exercise tests for children and adolescents with cerebral palsy: a Delphi survey of researchers and clinicians

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ABBREVIATIONS
MWT Minute walk test
SRT Shuttle run test

AIM Evidence-based recommendations regarding which exercise tests to use in children and adolescents with cerebral palsy (CP) are lacking. This makes it very difficult for therapists and researchers to choose the appropriate exercise-related outcome measures for this group. This study aimed to identify a core set of exercise tests for children and adolescents with CP.
METHOD Fifteen experts (10 physical therapists/researchers and five exercise physiologists; three from the Netherlands, two from the USA, one from the UK, five from Canada, and four from Australia) participated in a Delphi survey which took four stages to achieve a consensus. Based on the information that was collected during the survey, a core set of measures was identified for levels I to IV of the Gross Motor Function Classification System (GMFCS).
RESULTS For children with CP classified at GMFCS levels I and II, tests were identified for two motor skills (walking and cycling). For the subgroup of children with CP classified at GMFCS level III, the tests that were identified related to walking, cycling, and arm cranking. For children with CP classified at GMFCS level IV, the tests included in the core set were related to cycling and arm cranking.
INTERPRETATION The core set will help physical therapists, exercise physiologists, and other health professionals who work with children and adolescents with CP to decide which test(s) to use in clinical practice or research. This will facilitate comparability of results across studies and clinical programmes.

Children and adolescents with spastic cerebral palsy (CP) often have poor physical fitness, which may compromise their daily physical functioning.[1–4] These poor fitness levels have been well documented by means of exercise tests. Moreover, exercise testing has been used as a primary outcome measure of therapy and exercise programmes in children and adolescents with CP.[5–8]

Indications for exercise testing are broad and have as a general goal the evaluation of exercise performance, although the test selected depends on the goal(s) of the intervention. A number of generic and CP-specific exercise tests have been used in fitness- and exercise-related studies in children and adolescents with CP. Exercise tests can be divided into three general fitness categories: (1) submaximal exercise tests, which are defined as tests that are used to predict maximal aerobic capacity ($V\dot{O}_{2max}$) using a submaximal exercise protocol (e.g. the test does not require the participant's maximal effort),[9,10] involve exercising to a certain end point, and the participant is

not taken to the point of fatigue; (2) maximal exercise tests, which are defined as tests to determine the maximal amount of the participant's oxygen consumption ($V\dot{O}_{2max}$) that can be consumed per unit of time using a progressive exercise test to exhaustion;[10] and (3) anaerobic exercise tests, which are defined as tests that measure the anaerobic power and/or capacity of anaerobic energy pathways (adenosine triphosphate, creatine phosphate, or anaerobic glycolysis). Usually these tests last between 5 seconds and 30 seconds and require maximal effort from the participant.[10] These tests relate to short-term high-energy production during which the predominant fuels are produced without the need for oxygen. Tests for anaerobic performance aim to assess relatively short-duration, high-intensity exercise bouts.

Exercise testing over time can provide a quantitative assessment of the improvement or decline in the condition of children and adolescents with CP and has the potential to be an important measurement tool in clinical practice as well as in research work.[11] However, there are no clear recommendations regarding which exercise tests to use in individuals with CP. This makes it very difficult for therapists and researchers to choose the exercise-related outcome measures that are closely related to the goal(s) of the intervention. The development of a core set of evidence-based, standardized, exercise-related outcome measures for children with CP would help physical therapists and researchers to make better decisions on which test to use for each individual child. This streamlining of measures would improve the commonality of exercise tests across studies, thereby facilitating the comparison of study results or clinical programmes.

Clinicians use both clinical expertise and the best available external evidence to guide decision making, as neither on its own is sufficient. Therefore, it is essential to involve physical therapists and exercise physiologists, as well as researchers from these fields in the development of the core set of exercise tests. Not only does this ensure that the interests of relevant stakeholders are considered, but it may also increase the likelihood of the results influencing practice. Therefore, a Delphi procedure among experts in the treatment of individuals with CP was performed to identify a core set of field and laboratory exercise tests for children and adolescents with CP.

What this paper adds

- The core set adds to the knowledge base for best practice regarding exercise testing in children and adolescents with CP.
- The core set helps clinicians and researchers to choose the appropriate exercise tests for children and adolescents with CP.
- This core set facilitates comparability of results across future studies and clinical programmes.

METHOD

Design

This study used the well-established Delphi survey method.[12] The Delphi is a way of structuring group communication between experts, where individual participants give feedback that contributes to an emerging consensus. Delphi surveys eliminate potential sources of conflict experienced in committees and panels because they are anonymous and provide the opportunity to revise individual views in response to group trends. We selected this Delphi survey approach because it has been shown to be effective when (1) consensus is sought in an area where none previously existed; (2) the research problem does not lend itself to precise analytical approaches but can be illuminated by subjective collective judgements; (3) when more research participants are needed than can effectively interact face-to-face; and (4) when frequent meetings of all participants are not feasible.[13] For the purpose of the Delphi procedure, children and adolescents were grouped according to Gross Motor Function Classification System[14] (GMFCS) levels I to IV.

To support the content validity of the process, we aimed to include a group of 15 experts that consisted of research experts, exercise physiologists, and clinical experts (10 physical therapists/researchers and five exercise physiologists). The participants were from the Netherlands (n=3), the USA (n=2), the UK (n=1), Canada (n=5), and Australia (n=4). The research experts and exercise physiologists had to have published one or more articles related to exercise testing or training in this population. They were asked to identify clinical experts with at least 5 years' experience of working with individuals with CP. In total, 15 appropriate experts from different countries were identified and invited to participate in the Delphi procedure, which took four stages for the participants to achieve a consensus.

For the first stage of the Delphi survey, the first author (OV) performed a comprehensive literature search to identify fitness-related outcome measures that were used in exercise-related studies for children with CP. Based on this search in four databases (PubMed, EMBASE, SPORTDiscus, and PsycINFO), a list of outcome measures was identified and divided into three fitness categories: (1) submaximal exercise tests; (2) maximal exercise tests; and (3) anaerobic exercise tests. The identified outcome measures were listed and sorted by GMFCS levels for each domain. Since the aim of this first stage was to obtain a list of exercise-related outcome measures that was as complete as possible, additional proposals of outcome measures for each GMFCS level were specifically requested from the panel of experts by e-mail. These additional outcome measures could be exercise tests that were being used in clinical practice or ones that the participants had read about in an article or in a student's thesis that was related to children or adolescents with CP. No restriction was placed on the additional outcome measures that could be added to the list.

In stage 2 of the Delphi survey, participants were shown the updated list of exercise-related outcome measures, which was sent to them by e-mail. Based on the additional information from the group survey of stage 1, the outcome measures were also listed within each of the GMFCS levels. Because the clinical expertise needs to be integrated with clinical evidence, information obtained from the peer-reviewed and grey literature (e.g. student projects, unpublished manuscripts, conference proceedings, etc.) about the psychometric properties of these measures with children with CP was added. If a test was

not studied in adolescents with CP, psychometric data were noted to be unavailable. The participants were also asked in this stage to provide additional information from the grey literature regarding psychometric properties of any of the listed exercise tests.

All the participants rated each outcome measure on a 10-point scale for four different topics (safety, suitability, user friendliness, and overall rating) for each GMFCS level. Each participant was asked to indicate whether they felt these tests were valuable to use in children with CP in their (professional) setting.

A core set of exercise tests was identified by the steering group (OV, MK, and TT) in stage 3 of the Delphi survey. This core set was based on expert opinion (some tests were eliminated from the list), ratings (median scores were provided), and the psychometric properties of the exercise tests collected during stage 2. This core set was presented to all participants. Each expert was shown the median ratings from stage 2 for each measure listed within each GMFCS level. In this stage all participants were asked whether they agreed or disagreed with each measure in the suggested core set for each GMFCS level. If a participant disagreed with the suggested core set, they were asked to provide their comments and reasons for disagreement.

Based on the decisions and the comments made by the participants, a final revised core set was presented in stage 4. Participants were asked if they agreed or disagreed with the suggested core set for each GMFCS level.

Statistical analysis

Descriptive statistics were used to summarize the experts' ratings of the exercise tests during each of the Delphi stages. The comments that were collected during stage 3 were presented in stage 4 to all the experts.

RESULTS

Results of Delphi stage 1

In stage 1 of the Delphi survey, 21 tests were identified from the literature and six additional tests were suggested by the participating group. For the complete list of tests, see Table I.

While the Energy Expenditure Index and the Physiological Cost Index were also identified by one or more participants as possibilities for the exercise test, these indexes are not considered as 'true' exercise tests since they can be calculated using different submaximal exercise tests. Therefore, they were not included in the list for the next stage of the Delphi survey.

Results of Delphi stage 2

In this stage all the participants rated the complete list of outcome measures, based on the provided definitions that were identified and categorized for each fitness domain by the investigators. The outcome measures were listed within each

Table I: Overview of tests that were identified during the first stage of the Dephi survey

Exercise test	Mode of testing	GMFCS levels I and II	GMFCS level III	GMFCS level IV
Submaximal				
1-MWT[15,16]	Walking	+	+	+
2-MWT[a]	Walking	+	+	–
3-MWT[40]	Walking	+	+	–
5-MWT[a,41,42]	Walking	+	+	–
6-MWT[17,18]	Walking	+	+	–
8-MWT[43]	Walking	+	+	–
600yd walk/run test[44]	Walking	+	+	–
30-s walk test[44]	Walking	+	+	–
Half-mile walk/run test[45]	Walking	+	–	–
Arm-cranking ergometer protocol[24]	Arm cranking	+	+	–
5-min treadmill economy test[46]	Walking	+	–	–
EEI-HR overground walk test[13]	Walking	+	–	–
6-min wheelchair riding test[a]	Riding	–	+	+
Maximal				
Bruce protocol[47]	Walking	+	–	–
10m SRT (SRT-I and SRT- II)[19]	Walking	+	–	–
Treadmill test[19]	Walking	+	–	–
Treadmill test[48]	Walking	+	–	–
Treadmill test[38]	Walking	+	–	–
McMaster all-out protocol cycle test[4]	Cycling/arm cranking	+	+	+
Ergometer test (cycle or cranking)[49]	Cycling/arm cranking	+	–	–
Modified Balke treadmill test[a]	Walking	+	–	–
7.5m SRT (SRT-II protocol)[a,20]	Walking	–	+	–
Modified 20m SRT (10m course is used)[a]	Walking	–	+	–
Anaerobic				
10×5m sprint test[21]	Walking	+	–	–
Muscle power sprint test[21]	Walking	+	–	–
30-s Wingate cycle test[2,4]	Cycling/arm cranking	+	+	+
20-s full-out cycle test[50]	Cycling	+	+	–

[a]Exercise test was added by the experts during the first stage. GMFCS, Gross Motor Function Classification System; MWT, minute walk test; EEI-HR, Energy Expenditure Index - heart rate version; SRT, shuttle run test.

Table II: Overview of tests that were presented during stage 3 of the Delphi survey

Exercise test	Mode of testing	GMFCS levels I & II (median score)	GMFCS level III (median score)	GMFCS level IV (median score)
Submaximal				
5-MWT[41,42]	Walking	7	8	–
6-MWT[17,18]	Walking	9	8	–
8-MWT[43]	Walking	7.5	7.5	–
Arm-cranking ergometer protocol[24]	Arm cranking	–	7.5	–
6-min wheelchair riding test	Riding	–	6.5	6
Maximal				
10m SRT (SRT-I and SRT-II)[19]	Walking	9	–	–
McMaster all-out protocol cycle test[4]	Cycling/arm cranking	8	7	6
Ergometer test (cycle or cranking)[49]	Cycling/arm cranking	8	6.5	–
7.5m SRT (SRT-II protocol)[20]	Walking	–	9	–
Anaerobic				
Muscle power sprint test[21]	Walking	8	–	–
30-s Wingate cycle test[2,4]	Cycling/arm cranking	8	5.5	5

GMFCS, Gross Motor Function Classification System; MWT, minute walk test; SRT, shuttle run test.

of the GMFCS levels (levels I and II were combined because the responses were the same for the two levels).

The submaximal exercise test for which reliability and concurrent validity data were found in CP was the 1-minute walk test (MWT; intraclass correlation [ICC]=0.94 for GMFCS levels I, II, III, and IV; significant correlation between Gross Motor Function Measure score and the distance covered during the 1min walk).[15,16] Reliability was found for the 6-MWT (ICC=0.93, 0.91, and 0.99 for GMFCS levels I, II, and III respectively).[17,18]

For maximal exercise tests, the 10-meter shuttle run tests (SRT-I; for children classified at GMFCS level I [starting speed 5km per h] and SRT-II for children classified at GMFCS level II [starting speed 2km per h]; ICC>0.97)[19] and the McMaster all-out cycle test (r_s >0.72–0.92)[4] were the only two tests with published (test–retest) reliability data in CP. One participant provided additional unpublished psychometric data regarding a maximal exercise test (7.5m shuttle walk/run test) for children classified at GMFCS level III.[20] This test has been shown to be reliable (ICC=0.99) in a group of 12 children aged 7 to 18 years. The 10m SRT is the only test with published validity data (r=0.96 with treadmill test) in a subgroup of children with CP in GMFCS levels I and II.

Anaerobic exercise tests that have demonstrated (test–retest) reliability for children classified in GMFCS levels I and II are the 10×5m sprint test (ICC=0.97),[21] the muscle power sprint test (ICC=0.99),[21] and the 30-second Wingate cycle test (r_S=0.90–0.94 for peak power; r_S=0.92–0.95 for mean power).[4] Moreover, the 10×5m sprint test and the muscle power sprint test also have demonstrated construct validity (significant difference in peak and mean power for GMFCS level). For children at GMFCS levels III and IV, the 30-second Wingate cycle test was the only test with established reliability (r_S=0.90–0.94 for peak power; r_S=0.92–0.95 for mean power).[4]

Results of the final Delphi stages

Based on the median scores from the ratings and the available psychometric properties of the exercise tests, a core set of measures were identified for the various GMFCS levels. This core set included certain tests whose psychometric properties in individuals with CP were not available but were deemed important by the experts. Most tests were eliminated based on expert opinion. The median scores of the ratings by the experts for the selected tests during stage 3 of the Delphi survey are presented in Table II.

Since most children classified at GMFCS levels I and II are able to walk and cycle, tests were identified for both of these motor skills for these children. Children classified at GMFCS level III are able to walk and cycle and sometimes propel a manual wheelchair for short or long distances. Therefore, for this subgroup the tests that were identified related to walking, cycling, and arm cranking (which is a skill more closely related to wheelchair propelling than either cycling or walking). For children classified at GMFCS level IV, the core set included tests that were related to cycling and arm cranking.

Four experts did not agree with two of the exercise test categories that were suggested for the core set presented during stage 3. These categories were maximal exercise testing (GMFCS levels I and II) and submaximal exercise testing (GMFCS levels III and IV). Their comments, which are addressed in detail in the discussion, were related to the exclusion of treadmill testing (maximal exercise testing) in the core set and issues associated with submaximal exercise testing. All of the experts agreed with the suggested revised core sets from stage 4 that are presented in Table III.

DISCUSSION

The primary aim of the current Delphi study, using physical therapists, exercise physiologists, and researchers as experts, was to develop core sets of exercise tests for use in clinical practice and research trials involving children and adolescents with CP. The heterogeneity in panel composition and the experience and specialty of the experts had a positive effect on group judgement,[22,23] which made it possible to compare views on this topic for all three professions. After four Delphi stages, the international group of experts established core sets

Table III: Core set of exercise tests

Exercise test	Mode of testing	GMFCS levels I & II	GMFCS level III	GMFCS level IV
Submaximal				
6-MWT[17,18]	Walking (field test)	+	+	–
Arm-cranking ergometer protocol[24]	Arm cranking (lab test)	–	+	–
Maximal				
10m SRT (SRT-I and SRT-II)[19]	Walking (field test)	+	–	–
McMaster all-out protocol cycle test[4]	Cycling (lab test)	+	+	+
	Arm cranking (lab test)	–	+	+
7.5m SRT (SRT-II protocol)[20]	Walking (field test)	–	+	–
Anaerobic				
Muscle power sprint test[21]	Walking (field test)	+	–	–
30-s Wingate cycle test[4]	Cycling (lab test)	+	+	–
	Arm cranking (lab test)	–	+	+

GMFCS, Gross Motor Function Classification System; MWT, minute walk test; SRT, shuttle run test.

of exercise tests for children with CP classified at GMFCS levels I to IV.

The establishment of these core sets is an important step forward for clinical practice as well as for research in this population. It will help clinicians and researchers to use the best available test for their purposes, and the streamlining of measures will aid comparison among exercise studies and clinical programmes. Furthermore, the present study identified gaps in our current 'psychometric' evidence (only limited validity and reliability data are available) regarding currently used exercise tests in the paediatric population with CP. This will alert researchers as to which knowledge gaps need to be addressed in future measurement studies. For example, information of psychometric properties such as responsiveness is lacking.

Submaximal exercise tests

The 6-MWT[17,18] (for GMFCS levels I, II, and III) and an arm-cranking ergometer protocol (for GMFCS level III)[24] are the two submaximal exercise tests that have been included in the core sets. The 6-MWT is a simple test that is inexpensive and easy to administer. Walking for a given time seems to correspond to functional activities used in daily activities. The use of a standard time rather than a predetermined distance provides a better test of endurance. Moreover, the 6-MWT allows the individuals to set their own pace. Unlike the original 6-MWT protocol from the American Thoracic Society,[25] a practice trial was not performed in the studies that included participants with CP in which the 6-MWT is described.[17,18] However, based on the findings of Thompson et al.,[18] a practice test, especially for children classified as GMFCS level I, might improve consistency in the distance covered.

We believe that other limitations of simply measuring the distance covered during a timed walk test include the lack of monitoring of physiological variables while the individual is completing the test and the lack of specific performance criteria to ensure that maximal effort is not performed. A researcher/physical therapist may wish to know why the distance covered by the child with CP changed from one test to another (e.g. over time or after an intervention). In other words, was it because the child was more or less prepared psychologically to complete a 6-minute task, or because the child was able to move with more or less ease and, thus, had lower energy expenditure? A measure of energy expenditure could be useful to help differentiate between such 'psychological' and 'physical' factors. Although for research studies variables such as mechanical power or metabolic energy (e.g. oxygen consumption) could be used, in the clinic this is not usually feasible. Therefore, it is recommended that heart rate should be consistently monitored both at rest and during the walk when using the 6-MWT, as has been done with typically developing children.[26,27] When measuring heart rate, distractions and other factors unrelated to energy expenditure should be kept to a minimum to help ensure that the heart rate values are related to energy expenditure and not to these other factors. At present there is no test to measure 'psychological' preparedness for tests such as the 6-MWT; that is to address the 'voluntary' component of the test. Future work may wish to look at the relationship between familiarization with the test and self-efficacy related to test performance.

Although the 6-minute wheelchair riding test was suggested in Delphi stage 1, it was not included in the final core set for children classified at GMFCS level III and IV because no psychometric data were available. Moreover, children classified at GMFCS levels III and IV could have such low self-propelling skills/ability in a manual wheelchair that their performance would be a reflection of their gross motor capacity rather than any reflection of their submaximal fitness level. Further research is required to test the psychometric properties of this submaximal test for children who use wheelchairs.

Despite the fact that no psychometric properties are available, the arm-cranking protocol (for GMFCS level III) was included based on expert opinion. However, this test might not be feasible for all children classified as GMFCS level III because of upper limb impairment. Moreover, the necessary equipment is expensive and may require modification for use in children and adolescents with CP. Further research is needed to decide for whom this test might be appropriate and whether this test is reliable and valid in this group of children.

Maximal exercise tests

The 10m SRT (SRT-I and SRT-II),[19] the McMaster all-out protocol cycle test (for all GMFCS levels),[4,25] the McMaster all-out protocol arm-cranking test (GMFCS levels III and IV),[4] and the 7.5m SRT (SRT-II protocol; GMFCS level III)[20] are the four maximal exercise tests that have been included in these core sets for this fitness category.

Shuttle run tests are based on an individual's maximal aerobic speed. The 7.5m and 10m tests have multiple stages, enabling GMFCS levels I, II, and III to be tested. There are several benefits to using an SRT. First, it requires little equipment and more than one individual can be tested at a time. Second, all three shuttle run protocols are unique because they pace the individual with the use of audio signals on a prerecorded CD with different starting speeds and a speed increase every minute. Some individuals may find it difficult to pace themselves with the signals and need assistance of a 'pacer' during the test. Finally, testing criteria (peak heart rate >180 beats/min) need to be followed to ensure maximal effort.[28]

Several 'general' clinical treadmill tests are also available, for example the (modified) Balke protocol.[29,30] They are considered to be criterion standards in terms of measuring cardiorespiratory fitness, and have been deemed suitable for children who are unfit or who have health conditions that affect their physical activity.[31] An additional benefit of (modified) treadmill tests is that they allow for an increase in workload without necessarily an increase in speed. However, this requires a high treadmill inclination, which can be a drawback for these tests, especially in children with spasticity in the legs, as one of the experts noted.

Aerobic fitness ($V\dot{O}_{2max}$ or $V\dot{O}_{2peak}$) can also be directly measured during progressive exercise testing via a (stationary or portable) respiratory gas-exchange system, depending on whether the individual is stationary or moving. However, based on the lack of psychometric property data related to the (modified) Balke protocol for children with CP, these treadmill protocols were not included in this core set for children with CP. The 10m SRT protocol (starting speed and speed increase every minute) can be used for treadmill tests, as has been demonstrated in a previously published study.[19]

For both of the McMaster all-out protocols (cycle and arm ergometry),[4] it is important to realize that psychometric properties are based on a small sample of children (eight ambulatory and four non-ambulatory children) with CP. In addition, none of the maximal exercise tests for children with CP has been validated using an additional 'supramaximal' exercise stage. Because the presence of a plateau in both adult and paediatric exercise testing has been disputed, supramaximal protocols, such as the one-session protocol described by Rossiter et al.,[32] can be used to evaluate whether the added step to the protocol can yield higher $V\dot{O}_2$ values. When the supramaximal step does not result in increased $V\dot{O}_2$ values, $V\dot{O}_{2peak}$ is considered to be a valid indicator of $V\dot{O}_{2max}$. Clearly more research is needed in this area.

Anaerobic exercise tests

The muscle power sprint test[21] (for GMFCS levels I and II) and the 30-second Wingate cycling test[4] (for GMFCS levels I, II, and III) and 30-second Wingate arm-cranking test (for GMFCS levels III and IV)[4] are the two tests (three protocols) that have been selected to measure the anaerobic performance.

The Wingate anaerobic test is the most thoroughly investigated and applied test for assessing maximal anaerobic performance in children who are healthy, as well as in children with CP and other chronic diseases.[2,33] External leg or arm power can be assessed on an ergometer by measuring the crank velocity (revolutions per min) for a given braking force or torque. Therefore, cycling or arm ergometry allows precise measurement of anaerobic performance independent of body mass as the imposed resistive load. The measurement of anaerobic performance is protocol dependent (in contrast to maximal aerobic fitness measurement, which is essentially protocol independent). However, clinicians and researchers need to realize that, in contrast to the muscle power sprint test, the equipment necessary to perform the Wingate anaerobic test is expensive and may require modification for the use in children and adolescents with CP.

Anaerobic testing has some intrinsic methodological limitations. Just as for submaximal exercise testing, both tests (muscle power sprint test and 30-s Wingate anaerobic test) depend on the individual's motivation. Currently, there are no objective physiological criteria that can be used to establish a 'true' maximal anaerobic performance of the child; thus, the researcher or the clinician must rely on the willing cooperation of the individual. Among the factors that may affect the interpretation of anaerobic performance power tests during growth, one should consider the nature and extent of the pretest warm-up; the duration of the test; the resistive load applied in ergometer tests; and the use of a rolling versus a static start.[34]

RECOMMENDATIONS FOR CLINICAL PRACTICE

The indications for exercise testing in children and adolescents with CP are broad and have, as a general goal, the evaluation of exercise performance and the mechanisms that limit performance in the individual. The questions that need answers may vary on the basis of the child's clinical issues.[35]

In general, symptom-limited maximal exercise testing is safe for children, even for those whose diagnoses place them in a high-risk group.[36] Moreover, studies using these protocols with children and adolescents with CP reported no adverse health or safety effects.[4,19,24,37–39] Thus, one can conclude that in general, with the proper safety precautions as described by Paridon et al.,[35] maximal exercise testing for children and adolescents with CP is suitable and safe.

To determine the exercise performance-limiting factors to exercise capacity, maximal exercise testing is the preferred method. Submaximal exercise tests (i.e. 6-MWT and arm-cranking ergometer protocol) may be more appropriate for assessing exercise tolerance in children and adolescents with CP for whom maximal exercise testing may be too stressful.

When conducting exercise tests, the following points should be considered: (1) each test should have one main objective (albeit very difficult to accomplish with different energy systems); (2) specificity of testing is important: the modality of the testing tool needs to be similar to the type of activity or exercise of interest; (3) the test should not require too much technical competence on the part of the child; (4) care should be taken to make sure that the child understands exactly what is required of him or her; and (5) the test procedure should be standardized in terms of administration, organization, and environmental conditions.

Recommendations for future research

As discussed above, many gaps exist in our knowledge regarding psychometric properties of exercise tests for children with CP. In constructing tests it is important to make sure that they really measure the factors that need to be tested, and are therefore objective rather than subjective. In doing so, all tests should be specific (designed to assess a certain aspect of the child's fitness), valid (the degree to which the test actually measures what it claims to measure such that the evaluator has confidence in the tests meaning), reliable (meaning differences in test values mostly are due to real differences between people or within a person over time; consistency of repeated measurements taken by the same or different testers over time), responsive (sensitive to clinically meaningful change), and objective (produce a consistent result irrespective of the evaluator). All tests included in the core set require additional psychometric evaluation.

Limitations

The potential limitations of this study are the known weaknesses of the Delphi technique,[12] which include the subjective process used for defining the expert panel and the ability to remain impartial in light of others' views when rating items on multiple rounds. The Delphi technique is also limited by whether the anonymous nature influences accountability.[13] However, those who participated appeared to have been highly involved in the surveys.

CONCLUSION

Identifying exercise tests for children and adolescents with CP is critical to building the knowledge base for best practice. The core set resulting from this Delphi survey is based on the consensus views of internationally renowned researchers and clinicians. The core set will help physical therapists, exercise physiologists, and other health professionals working with children and adolescents with CP to decide which test(s) to use in clinical practice or research. This will facilitate comparability of results across studies and clinical programmes.

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