Functional progressive resistance training improves muscle strength but not walking ability in children with cerebral palsy

Synopsis


Question: Does functional progressive resistance exercise (PRE) improve walking ability and participation in school-aged children with cerebral palsy (CP)? Design: Randomised, controlled trial with concealed allocation and blinded outcome assessment. Setting: Three special schools for children with physical disability in the Netherlands. Participants: Ambulatory children (Gross Motor Function Classification System 1–3) with spastic unilateral or bilateral cerebral palsy aged 6–13 years. Botulinum toxin injections in the previous three months or orthopaedic surgery in the previous six months were exclusion criteria. Randomisation of 51 participants allocated 26 to the functional PRE group and 25 to a usual care group. Interventions: The intervention group participated in a 12-week functional PRE program, three times a week for 60 minutes in groups of 4 or 5. The program comprised four exercises: one using a leg press machine and three functional exercises (sit-to-stand, lateral step-up, half knee-rise) using body weight and a weighted vest to provide resistance. Participants completed 3 sets of 8 repetitions for each exercise. Intensity was increased progressively based on repeated estimation of 8 RM (repetition maximum). The control group received conventional physiotherapy 1–3 sessions a week. Outcome measures: The primary outcomes were walking ability (timed 10 m walk, 1-minute fast walk test, timed stair test) and participation (intensity scores of 17 items of Children's Assessment of Participation and Enjoyment questionnaire recalculated on a 0–100 scale) measured at baseline, after 6 and 12 weeks training, and 6 weeks after the intervention. Secondary outcome measures were anaerobic muscle power, muscle strength, spasticity and range of movement (ROM). Results: 49 participants completed the study. At the end of the intervention period, there was no difference between the groups for comfortable (−0.04, 95% CI −0.18 to 0.1 m/s) or fast walking speed (0.04, 95% CI −0.04 to 0.12 m/s), timed stair test (0.8, 95% CI −2.6 to 4.3 s) or participation (−1, 95% CI −11 to 9). Muscle strength improved significantly more in the intervention group than the control group immediately after the intervention by 1.3 N/kg (95% CI 0.6 to 2.5) for total isometric muscle strength and by 14% BW (95% CI 2 to 26) for 6 RM leg press. Knee flexion range had decreased in the intervention group by 15° (95% CI −29 to −1) compared to the control group 6 weeks after training stopped. The groups did not significantly differ on anaerobic muscle power, spasticity or other ROM outcomes. Conclusion: A 12-week functional PRE program improved muscle strength, but did not improve functional walking activity in school-aged ambulatory children with CP.

Commentary

This rigorously conducted trial in moderate to high functioning children with CP compared an adequate dose of training (36 hours over 12 weeks) with a focus on PRE of lower limb muscle groups compared to usual care (which in the Netherlands is 12–36 hours of regular physiotherapy). It is adequately powered and elegantly provides test-retest reliability on all key measures. The study 'gained what it trained'; improvements in lower limb muscle strength which did not transfer to improved walking ability.

Why should we expect PRE in the gym to translate to improved walking ability in children who are GMFCS I and II? As the authors correctly conclude a lack of context specific training (ie, training walking ability) and a high proportion of children who were GMFCS I (51%) with sufficient strength for walking capacity explains the null result. The high level of physiotherapy administered in the usual care group (much higher than in Australia or North America) could also explain why both groups improved on gait parameters. The authors propose functional training of strength needs to be in context (Thorpe et al 2005) to improve walking ability, and training of higher level ambulation is an important next step.

The take home message is we need to train functional tasks in a context-specific manner. Children with CP have difficulties with co-ordination and motor planning. Providing resistance in non-functional tasks (repetitive leg presses) will not enhance motor learning or translate to improvements of functional performance. We need to consider the context in which we train and measure ambulatory performance using measures of habitual physical activity (Clanchy et al 2011). We should consider the density of training and whether the number of repetitions is sufficient to drive muscle plasticity. Current research suggests the dose and density of most neurorehabilitation frequently may not be sufficient to drive neuroplasticity (Nielsen and Cohen 2008). This needs to be considered in future trials aimed at improving ambulatory performance.

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References

A 12-week exercise program performed during the second trimester does not prevent gestational diabetes in healthy pregnant women

Synopsis


Question: Does a 12-week exercise program prevent gestational diabetes and improve insulin resistance in healthy pregnant women with normal body mass index (BMI)?

Design: Randomised, controlled trial with concealed allocation and blinded outcome assessment.

Setting: Two University hospitals in Norway.

Participants: White adult women with a single fetus. High-risk pregnancies or diseases that would interfere with participation were exclusion criteria. Randomisation of 855 participants allocated 429 to the exercise group and 426 to a control group.

Interventions: Both groups received written advice on pelvic floor muscle exercises, diet, and lumbo-pelvic pain. In addition, the intervention group participated in a standardised group exercise program led by a physiotherapist, once a week for 12 weeks, between 20 and 36 weeks gestation. The program included 30–35 minutes low impact aerobics, 20–25 minutes of strength exercises using body weight as resistance and 5–10 minutes of stretching, breathing, and relaxation exercises. They were also encouraged to follow a 45-minute home exercise program at least twice a week. The control group received standard antenatal care and the customary information given by their midwife or general practitioner.

Outcome measures: The primary outcomes were the prevalence of gestational diabetes, insulin resistance estimated by the homeostasis model assessment method (HOMA-IR), and fasting insulin and oral glucose tolerance tests at baseline and at the end of the training period. Fasting and 2-hour glucose levels were measured in serum by the routine methods. Gestational diabetes was diagnosed as fasting glucose level 2-hour value ≥ 7.8 mmol/L. Secondary outcome measures were weight, BMI, and pregnancy complications and outcomes.

Results: 702 participants completed the study. At the end of the 12-week program, there was no difference in the prevalence of gestational diabetes (25 (7%) of intervention group compared with 18 (6%) of control group), HOMA-IR (−0.15, 95% CI −0.33 to 0.03), or oral glucose tolerance tests at 2 hours (−0.13 mmol/L, 95% CI −0.28 to 0.03) between the groups. Fasting insulin was significantly lower in the intervention group by 1.0 international units/mL (95% CI −0.1 to −1.9). The groups did not differ significantly on any of the secondary outcomes. Adherence to the exercise protocol in the intervention group was 55%.

Conclusion: A 12-week exercise program undertaken during the second trimester of pregnancy did not reduce the prevalence of gestational diabetes in pregnant women with BMI in the normal range.

Commentary

Diabetes causes 5% of deaths worldwide, mainly in low-to-middle income countries and affects over 220 million people. About 60% of women with gestational diabetes mellitus (GDM) are at high-risk of developing Type 2 diabetes within 20 years (Boerschmann et al 2010). Current guidelines (Artal and O'Toole 2003) recommend regular exercise for pregnant women, including those who are sedentary. However, the effect of exercise on the development of GDM has been studied little, and the results of published studies are conflicting (Callaway et al 2010).

Stafne et al (2012) have presented a paper of excellent methodological quality, reported according to CONSORT, and dealing with the controversial question of exercise during pregnancy. In this trial, the incidence of GDM was similar in both groups and levels of insulin resistance (HOMA-IR) also showed no difference between groups, regardless of adjustment for factors such as baseline fasting insulin levels. Of note, only 55% of women in the exercise group adhered to the study protocol and 10% of women in the control group exercised at least three days per week. An exploratory analysis, in which adherent women in the exercise group were compared with women in the control group, showed no difference in incidence of GDM, but fasting insulin was lower in the adherent women. Given that the trial was not powered to compare adherent and non adherent women, results of the exploratory analysis should be interpreted with caution.

The lack of adherence to the exercise protocol among the study participants confirms a pressing priority in this area is effective promotion of exercise in pregnant women. It is unclear whether the effect on GDM alone is large enough for pregnant women to feel it justifies the time, effort, and cost of an exercise program. Other trials should determine whether any specific type of exercise before pregnancy prevents GDM. Despite the uncertainty about whether exercise during pregnancy prevents GDM, exercise provides other benefits such as reducing depressive symptoms (Robledo-Colonia 2012) suggesting we should continue prescription of exercise during pregnancy. A potentially successful strategy to encourage pregnant women to exercise might be to introduce regular leisure-time physical activity as a routine part of obstetric care (Ramírez-Velez et al 2011).

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References

Interval training confers greater gains than continuous training in people with heart failure

Synopsis


Question: Is aerobic interval training (AIT) more effective than moderate continuous training (MCT) at enhancing aerobic fitness and myocardial remodelling in patients with stable heart failure? Design: Randomised controlled trial in which participants were allocated to AIT, MCT, or a control group. Setting: Hospital in Trondheim, Norway. Participants: Adults with stable heart failure post myocardial infarction with left ventricular ejection fraction (EF) < 40% on optimal medical management. Exclusion criteria comprised: unstable angina pectoris, uncompensated heart failure, myocardial infarction within four weeks, complex ventricular arrhythmias, no use of D-blockers and ACE inhibitors or, any other limitation to exercise. Randomisation of 27 patients allocated nine to each group. Interventions: The AIT and MCT groups completed two supervised exercise training sessions and one home training session each week for 12 weeks. Those in AIT completed uphill treadmill walking that comprised a warm-up and cool down interspersed with 4 × 4 minute exercise intervals completed at 90–95% of peak heart rate. Intervals were separated by three minutes of walking at 50–70% of peak heart rate (total exercise time = 38 minutes). The MCT participants walked continuously for 47 minutes at 70–75% of peak heart rate. Weekly home training comprised outdoor hill walking. The control group completed 47 minutes of supervised treadmill walking at 70% of peak heart rate once every three weeks. Outcome measures: The primary outcomes related to exercise capacity (eg, peak rate of oxygen uptake; VO$_{peak}$); secondary outcomes comprised measures of echocardiography and endothelial function. Results: Outcomes were available from 26 participants. The VO$_{peak}$ achieved on completion of training was greater in the AIT group compared with the MCT group (mean difference 4.1; 95% CI 2.4 to 5.8 ml/kg/min) and the control group (5.8, 95% CI 3.8 to 7.8 ml/kg/min). Compared with the other groups, AIT also conferred greater gains in measures of systolic and diastolic function and endothelial function. Conclusion: In adults with stable heart failure, AIT conferred greater gains than MCT in improving aerobic capacity and measures reflecting left ventricular and endothelial function. [Mean difference and 95% CIs calculated by the CAP Editor]

Commentary

A key objective of clinical exercise prescription is optimising physiological adaptations without placing the patient at risk of exercise-induced events. In patients with heart failure, who are at the higher end of the risk spectrum, exercise has historically been prescribed at moderate intensities approximating 60% of measured peak VO$_{peak}$ (70% of HR$_{peak}$) (Pina et al 2003). This intensity is well tolerated, with no exercise-related deaths reported in a systematic review of published exercise training involving over 100 000 patient hours of exercise (Smart 2011).

Wisloff et al (2007) evaluated a novel, high intensity aerobic interval training (AIT) approach and found this produced significant benefits over moderate, continuous aerobic exercise. These findings raise the question: has the traditional approach been too conservative?

Before exercise practitioners rush to adopt high intensity exercise prescription in clinical groups, such as heart failure, several salient points related to the study should be considered: first, the investigators were a highly trained and specialised group which included cardiologists; second, the study was performed in carefully screened and selected patients who were clinically stable and on optimal medical therapy; and third, all participants were at least 12 months post myocardial infarction. Accordingly, their risk of adverse events is markedly less than for many patients referred to clinical programs. Importantly, the study documents only 200 hours of experience with AIT, a ‘drop in the ocean’ compared with that of moderate continuous aerobic exercise, so assumptions about safety are premature. Also noteworthy is that perceived exertion levels during AIT averaged 17 (‘very hard’). Ongoing adherence to such effort requires high personal motivation, a trait less common in the broader patient population than study volunteers.

The study by Wisloff et al (2007) challenges convention. However, practitioners should always apply due prudence when translating research into clinical practice.

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References

Abdominal muscle feedforward activation in patients with chronic low back pain is largely unaffected by 8 weeks of core stability training

Synopsis


Question: Does timing of abdominal muscle activation in response to rapid shoulder flexion change after 8 weeks with low-load core stability exercises (CSE), high-load sling exercises (SE), or general exercises (GE) in chronic nonspecific low back pain (LBP) patients? Design: A randomised, controlled trial with concealed allocation.

Setting: Patients were recruited from general practitioners, physiotherapists, or by advertising at a regional hospital in Norway. Participants: Men and women, aged 18–60 years, with chronic nonspecific LBP for 3 months or more, and pain score of 2 or more on a 0–10 numeric rating scale were included. Key exclusion criteria included radiating pain below the knee or neurological signs from nerve root compression, and former back surgery. Randomisation of 109 participants allocated 36 to CSE, 36 to SE, and 37 to GE. Interventions: Patients in the three groups attended treatment once a week for 8 weeks, supervised by a physiotherapist. All were encouraged to stay active and received an information booklet with general information on LBP. The CSE were individualised according to protocols focusing on isolated activation of transversus abdominis during an abdominal drawing-in maneuver in supine hook-lying position with ultrasound feedback. Written instructions to carry out the drawing-in exercise (10 × 10 seconds 2–3 times per day) at home were also provided. The SE maintained the lumbar spine stable in neutral position throughout a range of leg/arm positions and movements, using elastic bands attached to the pelvis to help the patient maintain a neutral spine position. The SE was performed for 40 minutes in a physiotherapy clinic. The GE group received generalised trunk strengthening and stretching exercises supervised by a physiotherapist at a fitness centre. Outcome measures: Primary outcome was change in onset of the deep abdominal muscles in response to rapid shoulder flexion. Results: 102 participants completed the study. No or small changes were found in onset after treatment. Baseline adjusted between-group differences showed a 15 milliseconds (95% CI 1 to 28) and a 19 millisecond (95% CI 5 to 33) improvement with SE relative to CSE and GE, respectively, but on one side only. There was no association between changes in pain and onset over the intervention period (R² ≤ 0.02). Conclusion: Abdominal muscle onset was largely unaffected by 8 weeks of exercises in chronic LBP patients with changes in onset of less than 20 milliseconds between groups.

Commentary

This RCT utilises a large cohort to examine mechanical onsets of the deep abdominal muscles and response to different exercises. The findings show limited changes in the timing of the core onsets and no association with pain or disability. Interestingly 99% of the 109 cohort subjects had feedforward (FF) onsets of the contralateral abdominal muscles. The current dogma is that a small percentage of the LBP cohort should have had FF responses. Therefore, this may question how any exercise regimen may ‘improve’ the onset of the LBP cohort if they already have what could be within a normal range. This could be the basis of the continued discussion on the significance and validity of the FF corset hypothesis and the method of detecting onsets (Massé-Alarie H et al 2012)

Another observation is that the assessment of mechanical movement ‘onsets’ may not correlate with activation (EMG) onsets because movement can be achieved via relaxation. We have previously shown that the FF response of (ipsilateral) transversus abdominis can be inhibitory; this is also highly directional specific and controlled by planned rotational torques (Morris et al 2012, Allison et al 2008a,b). Therefore these underlying rotation mechanisms may in part explain the observed side to side differences in change of the mechanical onsets as well as the greater improvements with the sling exercises.

This RCT contributes to evidence that the association between the deep muscle FF responses and spinal pain is not simple. It adds to the growing diversity of opinion of the hypothesised mechanisms of motor control in LBP. This is an important reminder that there should be a separation between the research question asking how or why the treatment works, and if the treatment works, and how or why the treatment works. Too many therapists and researchers rely on one to justify the other.

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References