

## OVERVIEW OF CEREBRAL PALSY AND PHYSICAL THERAPY RELEVANCE

Cerebral Palsy (CP) is a chronic condition which affects the movement and posture of children and adults.<sup>1</sup> Their impairments impact a range of gross motor functions including balance, walking, and motor control.<sup>1</sup> Evidence shows how the impairments of people with CP lead to an increased risk for sedentary behavior and decreased physical activity.<sup>1-7</sup> Staggeringly, Verschuren et al. found that “children and adults with CP spend 76% to 99% of their waking hours being sedentary, fewer than 18% engaged in light physical activities, and 2% to 7% in moderate to vigorous activities.”<sup>6</sup> Not only is this population proven to be less physically active than their peers in the general population,<sup>1-3,6,7</sup> it has been shown that these patterns lead to an increased risk for secondary health issues.<sup>1-3,7</sup> Fowler et al. discusses these secondary conditions of CP related to decreased physical activity as including “chronic pain, fatigue, and osteoporosis.”<sup>3</sup> Not only do Fowler et al. mention the various dynamics of CP that limit participation in physical activity, they also discuss how these limitations inhibit the ability develop cardiorespiratory fitness because of the high exercise intensity demands necessary for such fitness.<sup>3</sup> Ryan et al. concludes that most people with CP do not meet physical activity guidelines and spend more time sedentary than their able-bodied peers.<sup>7</sup> For reference, Verschuren et al. outlines current aerobic exercise guidelines for people with CP as needing to engage in aerobic exercise three times per week at an intensity of at least 60% of peak heart rate, or at least 40% of heart-rate reserve, or between 46% and 90% of VO<sub>2</sub> peak for a minimum of 20 minutes per session in order to improve cardiorespiratory fitness.<sup>6</sup> Furthermore, these concepts are

supported by the trends of children with CP having lower cardiorespiratory fitness according to research.<sup>3,6</sup>

Within the scope of physical therapy practice, it is essential to target this issue of decreased physical activity in the patient population of children with CP. Physical therapists are intimately involved in the lives of children with CP in many ways, and this issue should not be overlooked in relation to their care. Now that trends have been identified, it is the responsibility of the physical therapist to consider interventions to address this issue. Therefore, there is a need to consider the gap between knowledge of the issue and lack of an interventional program response. This requires a consideration of resulting consequences, a consideration of nuances contributing factors, and finally an informed interventional program as a response.

#### OVERWEIGHT/OBESITY AS AN ISSUE AND RATIONALE FOR PROGRAM NEED

A decrease in physical activity also leads to overweight and obesity, which is widely seen as a common trend among children with CP.<sup>4,5</sup> Whitney et al. describe how “children with spastic CP are at a very high risk for early and accelerated development of obesity and obesity-related chronic diseases.”<sup>4</sup> Furthermore, Abeysekara et al. demonstrate how ambulatory CP populations have a higher prevalence of overweight as compared to the general population.<sup>5</sup> This can lead to secondary complications that result from overweight and obesity including “insulin resistance, glucose intolerance, dyslipidemia, cardiovascular disease (CVD), type II diabetes and hypertension.”<sup>5</sup> Verschuren et al. mention the significant risks for children with CP to develop “metabolic and cardiovascular diseases” due to this decrease in fitness levels.<sup>6</sup> Ryan et al. also

conclude this same potential for increase in cardiometabolic risk factors secondary to sedentary lifestyle in people with CP.<sup>7</sup>

Therefore, there is a high need for community-based programs and interventions to address overweight and obesity in children with CP due to their decreased physical activity status. A program to address increasing physical activity status in this patient population would help to address not only their fitness levels and overweight or obesity, but also the associated secondary problems and health risks. Improving the health outcomes of this population is possible through a targeted community health promotion program that could be administered by a physical therapist.

#### SOCIAL ECOLOGICAL MODEL BARRIERS TO PHYSICAL ACTIVITY

Ryan et al. make the point that children are more likely to engage in exercise if it is something that they enjoy, they see the health benefits of the activity, and it involves social interaction.<sup>8</sup> Therefore, a program to target decreased physical activity must consider these dynamics in order to be successful. Furthermore, a consideration of the Social Ecological Model (SEM) of health behavior can help to inform a community program to address overweight and obesity in populations of children with CP.<sup>9</sup> Sallis et al. explain how there are multiple levels that influence health behaviors, including “intrapersonal, interpersonal, organizational, community, and public policy levels.”<sup>9</sup> Skinner et al. describe how the constructs of the Health Belief Model (HBM), including “perceived susceptibility, perceived severity, perceived benefits and barriers to engaging in a behavior, cues to action, and self-efficacy” all contribute to a patient’s action relating to health behaviors.<sup>10</sup>

Specifically related to childhood obesity, SEM layers such as presence of food and physical activity facilities, parent's perception of food and physical activity environments, neighborhood characteristics, household characteristics, parent characteristics, and child characteristics are all proven to contribute to a child's weight status.<sup>11</sup>

Specifically related to children with CP, Verschuren et al. describe multiple facilitators and barriers to physical activity in this specific patient population.<sup>12</sup> They conclude that both personal and environmental factors play a role in the likelihood of a child with CP participating in physical activity.<sup>12</sup> Within the framework of both the SEM and HBM, the perceived health benefit of physical activity is shown to be a widespread intrapersonal level factor affecting participation in exercise in children with CP.<sup>9,10,12</sup> Barriers on this same level include physical characteristics being viewed as a barrier to participation in particular activities that might not allow for accommodations.<sup>12</sup> Furthermore, fear of risk of injury as well as insecurity related to being accepted by peers are noted as personal level barriers to physical activity.<sup>12</sup> On a community level, Verschuren et al. cite a lack of opportunities as well as a lack of awareness of possibilities as barriers to physical activity in children with CP.<sup>12</sup> Other practical barriers were noted including lack of access to transportation, lack of time, financial restrictions, and time of training being inconvenient.<sup>12</sup>

## CONCLUSION

A community-based health program that targets health behaviors and addresses SEM level barriers is a realistic way to address the issue of decreased physical activity

and resulting overweight and obesity in children with CP. Intervention ideas include an aerobic exercise program or an aquatic therapy program that is administered through an after-school program. Evidence supporting these interventions is summarized in an evidence table below.

Author/Title/Year	Subjects (number, inclusion/exclusion criteria)	Outcome Measures	Measurement Time(s)	Description of Intervention(s)	Results	Conclusions
1. (intervention) 1) Verschuren et al. / Exercise training program in children and adolescents with cerebral palsy: a randomized controlled trial / 2007 <sup>13</sup>	86 children with CP Inclusion criteria: age 7-20 years, diagnosed with spastic CP, Gross Motor Function Classification System (GMFCS) Level I or II Exclusion criteria: history of orthopedic surgery, neurosurgery, or botulinum toxin injections within 6 months prior to study, cardiac or respiratory conditions negatively affected by exercise <sup>13</sup>	10-meter Shuttle Run Test, Muscle Power Sprint Test, 10x5-meter Spring Test, Body Mass Index, Self-Perception Profile for Children, Gross Motor Function Measure Dimensions D and E, Children's Assessment of Participation and Enjoyment, TNO-AZL Questionnaire for Children's Health-Related Quality of Life <sup>13</sup>	At baseline, after 4 months, directly after the 8 months of intervention period, 12 months after baseline <sup>13</sup>	2 times per week training session including 45-minute circuit focused on aerobic and anaerobic exercises <sup>13</sup>	Significant training effects for improving aerobic capacity (P<.001), anaerobic capacity (P=.004), agility (P<.001), muscle strength (P<.001), athletic competence (P=.005), formal activity participation (P<.001), overall activity participation (P=.002), physical activity participation (P=.005), and skill-based activity	A long-term functional exercise program with aerobic and anaerobic components can significantly improve the physical fitness of individuals with CP on multiple training levels <sup>13</sup>

					participation (P<.001) <sup>13</sup>	
2. ( <i>intervention</i> 2) Lai et al. / Pediatric Aquatic Therapy on Motor Function and Enjoyment in Children Diagnosed With Cerebral Palsy of Various Motor Severities / 2015 <sup>14</sup>	24 children with CP Inclusion criteria: diagnosis of spastic cerebral palsy, age 4-12 years, GMFCS Level I-IV, ability to follow instructions Exclusion criteria: receiving botulinum toxin injections or surgery no earlier than 6 months before project start, psychiatric disorder or communication disorder such as autism or mental retardation, poorly controlled epilepsy, skin problems such as open wounds, active infection <sup>14</sup>	Modified Ashworth Scale score, 66-item Gross Motor Function Measure score, Physical Activity Enjoyment Scale score, Vineland Adaptive Behavior Scale, Cerebral Palsy Quality-of-Life- parent proxy scale <sup>14</sup>	Baseline, posttreatment test performed within 1 week after the final intervention <sup>1</sup> <sup>4</sup>	Pediatric aquatic therapy program based on the Halliwick concept of combining play, fun, self- help skills, and impairment- related goals consisting of 5- 10 minutes of warm up and stretching, 40 minutes of pool exercises, and 5-10 minutes of exercises to cool down in pool with water temperature between 33-36 degrees Celsius <sup>14</sup>	Significant and large training effect on improving 66- item Gross Motor Function Measure score (P=.007) and improvements in Physical Activity Enjoyment Scale scores <sup>14</sup>	An aquatic therapy program with pool exercises based on the Halliwick concept can improve gross motor function and perceptions of physical activity enjoyment in children with CP <sup>14</sup>
3. ( <i>behavior theory/model</i> )	33 youth with CP and their parents	Semi- structured	Semi- structured	Ten focus group	Personal and environmental	Important factors that

<p>Verschuren et al. / Identification of Facilitators and Barriers to Physical Activity in Children and Adolescents with Cerebral Palsy / 2012<sup>12</sup></p>	<p>Inclusion criteria: ability to walk without a device, ability to understand and respond to interview questions Exclusion criteria: not noted in article<sup>12</sup></p>	<p>interview questions, response-driven discussion<sup>12</sup></p>	<p>interview questions assessed during part one of focus group interview, response-driven discussion assessed during part two of focus group interview<sup>12</sup></p>	<p>interviews (5 for children and 5 for parents)<sup>12</sup></p>	<p>facilitators and barriers to participation in physical activity exist for children with CP; seven themes include physical abilities of the child, child-related psychological factors, parental factors, opportunities for sport and physical activity, practical feasibility, social environment, and facility/program factors<sup>12</sup></p>	<p>influence participation in physical activity for children with CP include personal and environmental factors that cross multiple SEM levels<sup>12</sup></p>
<p>4. Slaman et al. / Can a Lifestyle Intervention Improve Physical</p>	<p>42 adolescents and young adults with CP Inclusion criteria: age 16-24 years, diagnosed with</p>	<p>Peak oxygen consumption from Progressive Ramp Protocol during</p>	<p>Prior to randomization (Pretest at week 1), directly after completing</p>	<p>6 month long active lifestyle and sports participation intervention including 3</p>	<p>Significant effects of the intervention including significant increases in</p>	<p>A long-term multi-faceted lifestyle intervention program consisting of</p>

<p>Fitness in Adolescents and Young Adults With Spastic Cerebral Palsy? A Randomized Controlled Trial / 2014<sup>15</sup></p>	<p>spastic unilateral or bilateral CP, GMFCS level I-IV Exclusion criteria: disabilities other than CP affecting physical activity or cardiopulmonary fitness, contraindication to maximal exercise, exceeding the mean physical activity level +2 standard deviations of a CP population, insufficient understanding of the project caused by severe cognitive impairment or insufficient language comprehension<sup>15</sup></p>	<p>cardiopulmonary exercise testing, height, body mass, waist circumference, skinfold thickness, High-density lipoprotein cholesterol, total serum cholesterol, the ratio between total serum cholesterol and high-density lipoprotein, Hand-held dynamometer measure of muscle strength<sup>15</sup></p>	<p>fitness training portion at 3 months (Posttest 1 at week 14), directly after completing entire intervention at 6 months (Posttest 2 at week 26), 6 months after finishing the intervention (Follow-up test at week 52)<sup>15</sup></p>	<p>months of physical fitness training (consisting of 12 weekly supervised sessions and 12 home sessions lasting one hour and including aerobic endurance, aerobic interval, and strength training with gradually progressing duration and intensity), counseling on daily physical activity based on motivational interviewing (consisting of 6 monthly sessions each lasting 30 minutes), and sports advice</p>	<p>cardiopulmonary fitness (P&lt;.01) and decrease in weight circumference (P=.04), decrease in skin folds at follow-up (P=.04), decreases in systolic blood pressure at follow-up (P=.03), and decreases in total cholesterol at follow-up (P=.01)<sup>15</sup></p>	<p>physical activity as well as counseling can significantly improve the long-term cardiopulmonary fitness and body composition of individuals with CP<sup>15</sup></p>
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				of sports counseling and sport-specific training (consisting of 2-4 sessions over a period of 6 months each lasting 30 minutes to identify sports history, preferences, possibilities, barriers, and facilitators) <sup>15</sup>		
5. Van den Berg-Emons et al. / Physical training of school children with spastic cerebral palsy: effects on daily activity, fat mass and fitness / 1998 <sup>16</sup>	20 children with CP Inclusion criteria: age 7-13 years, normal intelligence and mild mental retardation, students at the Children's Rehabilitation Centre Franciscusoord in Valkenburg Exclusion criteria: not noted in article <sup>16</sup>	Heart rate, body weight, height, thickness of skinfolds, fat mass, levels of daily physical activity as the ratio of total energy expenditure to sleeping metabolic rate or resting metabolic rate, peak aerobic power and	Before the training programme started, after 2 months of training, after 9 months of training for both training periods <sup>16</sup>	2 training periods of 9 months over the course of 2 years consisting of exercise sessions 4 times per week lasting 45 minutes with predominantly aerobic training exercises <sup>16</sup>	Significant difference in change in fat mass as compared to control (P<.05), increased level of daily physical activity, increased peak aerobic power, increased isokinetic muscle strength <sup>16</sup>	A long-term training program consisting of predominantly aerobic exercise can improve physical fitness and decrease fat mass in children with CP <sup>16</sup>

		anaerobic power, isokinetic strength of knee extensors and flexors <sup>16</sup>				
6. Dorval et al. / Impact of aquatic programmes on adolescents with cerebral palsy / 1996 <sup>17</sup>	20 adolescents with CP Inclusion criteria: age 10-17 years, diagnosed with CP, capable of following simple verbal orders, reside within geographical area of Quebec City Exclusion criteria: not noted in article <sup>17</sup>	General Information Questionnaire, Leisure Activities Inventory, Rosenberg's Self-Esteem Scale, Functional Independence Measure for Children <sup>17</sup>	Baseline two weeks before the beginning of the aquatic programme, post-test at the end of the aquatic programme, follow-up period nine months later <sup>17</sup>	Aquatic group sessions (5 participants in each group) in hydrotherapeutic pool (9 meter x 5 meter pool with water temperature between 32-35 degrees Celsius) consisting of one session lasting 55 minutes per week for 10 weeks; sessions included warm-up, individual exercises, group activities, and relaxation <sup>17</sup>	Significant improvements in self-esteem scores (P=.04) and functional independence scores (P=.01) <sup>17</sup>	A group aquatic intervention program can lead to positive impacts on the general well-being of children with CP related to self-esteem and functional independence <sup>17</sup>

<p>7. Fragala-Pinkham et al. / Aquatic aerobic exercise for children with cerebral palsy: a pilot intervention study / 2014<sup>18</sup></p>	<p>8 children with CP Inclusion criteria: diagnosis of CP, able to walk independently with or without an assistive device, age 6-18 years, medically able to participate in an exercise program, able to follow directions and adhere to the exercise program, no anticipated changes in medications or rehabilitation services during the study, willingness to enter the water with no specific swimming ability required Exclusion criteria: recent history of</p>	<p>Gross Motor Function Measure Dimensions D and E, 6-minute Walk Test, Brockport modified curl-up, Brockport isometric push-up and lateral step-ups, Shuttle Run Test, Pediatric Berg Balance Scale<sup>18</sup></p>	<p>Twice at baseline before the intervention was initiated, once at the end of the 14-week intervention, once one month after the intervention ended<sup>18</sup></p>	<p>14-week aquatic exercise program consisting of 2 times per week pool sessions lasting 60-minutes in a therapeutic pool (8 foot x 12 foot pool with water temperature generally 32 degrees Celsius); sessions included 2-5 minutes warm-up, 40-45 minutes of aerobic exercise, 5-10 minutes of strength training, and a 5-10 minute cool down and stretch<sup>18</sup></p>	<p>Significant improvements in gross motor function (P&lt;.001) and walking endurance (P&lt;.001) that were maintained at follow-up<sup>18</sup></p>	<p>An aquatic exercise program consisting of aerobic and strength training can increase the long-term physical fitness of children with CP through improvement in gross motor function and walking endurance<sup>18</sup></p>
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	botulinum toxin injections within 3 months of the initiation of the study, orthopedic surgery within 6 months of the initiation of the study, open wounds, swallowing precautions <sup>18</sup>					
8. Darrah et al. / Evaluation of a community fitness program for adolescents with cerebral palsy / 1999 <sup>19</sup>	23 people with CP Inclusion criteria: age 11-20 years, diagnosis of CP, able to walk for three minutes with or without assistive devices, able to understand instructions for the use of weight-lifting equipment Exclusion criteria: severe physical or cognitive involvement <sup>19</sup>	Energy Expenditure Index, Hand-held dynamometer measure of muscle strength, Sit-and-Reach Test, Behind-the-Back Reach test, Intermalleolar Distance, Heart Rate for a standardized submaximal exercise, Self-Perception Profile for Adolescents,	Three pre-tests, one post-test, one follow-up <sup>19</sup>	Conditioning program 3 times per week for 10 weeks including group sessions consisting of 10 minutes of warm-up, 10-30 minutes of aerobic exercise with duration progressing over 10 weeks, 30 minutes of weight training in the weight room, and 20 minutes of flexibility cool-	Significant increases in muscle strength values (P<.01), significant positive effect on perceptions of physical appearance (P=.006) <sup>19</sup>	A community-based group exercise program consisting of aerobic exercise, weight lifting, and flexibility exercises can increase muscle strength and improve perceptions of physical appearance in children with CP <sup>19</sup>

		Self-Perception Profile for Children <sup>19</sup>		down exercises <sup>19</sup>		
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