The Effect of a Fundamental Movement Skill Intervention on the Physical Literacy Levels of Children with Congenital Heart Disease – A CHAMPS† Cohort Study

†CHAMPS – Children's Healthy-Heart Activity Monitoring Program in Saskatchewan

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Abstract

Physical literacy is a multidimensional concept that includes physical competence, knowledge, confidence, and motivation and their influence on physical activity engagement across the lifespan. High levels of physical literacy is a determinant of physical activity participation. Preliminary evidence suggests that children with congenital heart disease (CHD) may have low physical literacy. Therefore, the effect of a 12-week intervention on the physical literacy of children with CHD was assessed. Physical literacy was measured pre- and post-intervention in 14 participants with CHD, aged 9-16 years, using the Physical Literacy Assessment for Youth (PLAY) tools. The intervention involved six bi-weekly sessions that consisted of a fundamental movement skill practice designed to enhance gross motor function and confidence. PLAYfun assessed physical competence. PLAYself assessed the child's perception of their physical literacy and PLAYparent was completed by parents to assess their perception of their child's physical literacy. We found a significant increase in overall physical competence (PLAYfun, $p<.001$), along with the domains of running ($p=.001$), locomotor ($p=.002$), upper body object control ($p<.001$), and balance ($p=.006$). No significant changes were found in PLAYself or PLAYparent indicating no changes to their self and parental perceptions of physical literacy. This study demonstrated that a 12-week fundamental movement skill intervention can improve the physical literacy of children with CHD. Children with CHD are at an increased risk of sequelae secondary to their reported physical inactivity, physical literacy development may augment physical activity engagement and provide health benefits to this at-risk population.

Keywords: physical literacy, pediatric congenital heart disease, physical competency, confidence, physical activity

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Introduction

Congenital heart disease (CHD) is one of the most common birth anomalies in the world affecting approximately 1 in 100 children (Irvine et al., 2015; Van Der Linde et al., 2011). With increasing survival rates, long-term health conditions associated with CHD have recently been identified (Ray & Henry, 2011). CHD increases a child's risk of other cardiovascular diseases, osteoporosis, and obesity as they age, independent of their existing heart condition (Halliday et al., 2013); potentially decreasing their quality of life. Physical activity has been shown to improve the quality of life for children with CHD (Giannakoulas & Dimopoulos, 2010) and is known to decrease the risk of chronic conditions such as cardiovascular disease in both healthy and clinical populations.

Physical activity is paramount for the optimal physical, emotional, and psychosocial development of children with CHD (Takken et al., 2012). However, misconceptions about safe physical activity levels (Lunt et al., 2003; Moons et al., 2006) as well as parental and educator hesitation (Takken et al., 2012) may contribute to lower physical activity levels in children with CHD. Currently, literature on physical activity levels in children with CHD is mixed with some studies reporting children with CHD engage in less physical activity than their typically developing peers activity (Lunt et al., 2003) and others reporting similar levels of physical activity (Stone et al., 2015; Voss et al., 2017). The discrepancy in findings may be related to the severity of CHD in participating children, the level of comfort physicians have in encouraging physical activity, or different methods used to assess physical activity. However, regardless if children with CHD are as active as healthy peers, it should be noted that only 20% of healthy children 8 to 12 years of age (Belanger et al., 2018) and 9% of children 5 to 17 years of age (Barnes et al., 2016) are meeting the Canadian guidelines of 60 minutes of moderate to vigorous physical activity (MVPA) per day. Therefore, even if children with CHD are participating in similar amounts of physical activity as their healthy peers, they are still unlikely to be achieving the recommended amount of physical activity and thus are limited in the magnitude of the positive health benefits that would typically be conferred. Therefore, finding a way to increase physical activity is crucial for children with CHD to reduce short- and long-term health risks. The development of physical literacy is regarded as a key component and foundation of lifelong physical activity participation (Canadian Sport for Life, 2016).

Physical literacy combines previous knowledge from sport/exercise psychology and physical competence development to target both physical (physical competence) and psychological (confidence and motivation) aspects of physical activity participation to improve an individual's engagement in physical activity (Bremer et al., 2020). Physical literacy is the "motivation, confidence, physical competence, knowledge, and understanding to value and take responsibility for engagement in physical activities for life" (International Physical Literacy Association, 2016). Therefore, physical literacy allows individuals to gain the skills necessary to engage in physical activity for life. Children who are more physically literate are more physically active, and in turn more likely to meet the physical activity guidelines (Longmuir et al., 2015b). Additionally, children who meet the physical activity guidelines have higher physical competence, motivation, and confidence compared to those who do not meet the guidelines (Belanger et al., 2018). As evident in healthy children, physical literacy and its components (e.g., physical competence) may be key contributors to physical activity participation in children with CHD.

To the author's knowledge, only three studies have assessed the physical literacy of children with CHD. These studies have focused on the physical competence component of physical literacy. Physical competence has been defined as a person's ability to execute fine and gross motor skills to complete daily tasks (Barnett et al., 2016). For physical literacy, physical competence relates to a person's capability to competently perform motor skills (Barnett et al., 2016). Physical competence is positively correlated to physical activity engagement and children with high physical competence engage in significantly greater MVPA than children with low physical competence (Adank et al., 2018). Using the Canadian Assessment of Physical Literacy (CAPL) tool, investigators reported that children 8 to 12 years of age with CHD had significantly lower physical competence when compared to healthy peers (Longmuir et al., 2015a). Holm et al. (2007) found that children 7 to 12 years of age with CHD had a six times higher risk of impaired physical competence when compared to healthy controls. Finally, a 10-week intervention in children 8 years of age with CHD found no improvements in physical literacy after the intervention (Blais et al., 2020). This could have been due to the small sample size (*n*=8) or that the purpose was to assess the feasibility of a community-based intervention for children with CHD rather than improve physical literacy (Blais et al., 2020).

Current evidence suggests that children with CHD may lack the physical competence to complete different movement tasks compared to their healthy peers, which may be a factor in their decreased levels of physical activity. Developing physical literacy will not only improve children with CHD's physical competence but may also give them the motivation, confidence, and knowledge to be physically active for life, thus reducing potential short- and long-term health risks in this at-risk population. Therefore, we assessed the effect of a 12-week fundamental movement skill intervention on the physical literacy of children with CHD. We hypothesized that children with CHD would have an increase in their physical literacy after the 12-week intervention.

Methods

Study Design and Participants

This study utilized a pre-post design, with a 12-week physical literacy intervention. Fourteen children and adolescents 9-16 years of age (9 males, 5 females) were recruited from a hospital in Saskatoon and screened for participation by a pediatric cardiologist. Exclusion criteria included: cardiac surgery in the last six months, inability to perform physical activity, and inability to follow verbal commands related to study procedures. Participants had a variety of congenital heart defects including both simple and complex diagnosis. CHD conditions included: teratology of Fallot (*n*=4), transposition of great arteries (*n*=4), pulmonary valve stenosis (*n*=2), ventricular septal defect (*n*=2), double inlet left ventricle (*n*=1), and coarctation (*n*=1). The study received ethical approval from the University of Saskatchewan Biomedical Research Ethics Board (Internal ID: Bio 15-148) and written informed parental consent and participant assent was obtained prior to study initiation.

Physical Literacy Intervention

The intervention consisted of six bi-weekly 1-hour group sessions. The sessions were designed to provide opportunities for skill acquisition and development as well as to improve self-confidence performing each skill. The bi-weekly schedule was determined to meet the needs of our participants as some individuals lived far away from the intervention location; therefore, having more frequent sessions was not feasible. Each session began with a locomotor warm-up, followed by a skill acquisition opportunity that included developmentally appropriate instruction. The skills that were taught were: session 1 - sending and receiving; session 2 - foot dribble and kicking; session 3 - balance and stability; session 4 - overhand throw and strike with stick; session 5 - overhand throw and one-handed catch; and session 6 - upper body sending and receiving skills (similar to sessions 4 and 5). Skills were first practiced on their own and then were integrated into fun activities and games that could be repeated outside of the intervention sessions. Participants were encouraged to practice their skills with their families and friends after each session. Participants were considered to be adherent to the physical literacy program if they attended a minimum of 4 of the 6 sessions.

Anthropometrics, Chronological and Biological Age

Each participant's height (cm), sitting height (cm), and weight (kg) were measured pre- and post-intervention. Height was recorded to the nearest millimeter using a wall mounted stadiometer (Holtain Ltd., Crosswell UK) and body mass to the nearest 0.5 kg using a digital physician's scale (Toledo Scale Company of Canada, Windsor, ON). All measures were performed twice; if the difference was >0.4 cm or kg, a third measure was recorded. The mean or median was then reported depending on whether two or three measures were recorded (Stewart & Marfell-Jones, 2011). The chronological age of each participant was recorded to the nearest 0.1 year by subtracting the decimal year of the participant's date of birth from the decimal year of the day of testing. Biological age was then estimated using the Prediction of Age at Peak Height Velocity equation (Mirwald et al., 2002).

Physical Activity

Physical activity was measured pre- and post-intervention, using accelerometers (Actigraph wGT3X-BT). Children wore the accelerometer on their hip for seven consecutive days, during waking hours only. Participants had to have at least 3 days of ≥10 hours of valid wear time at both baseline and post intervention to be included in the analysis. Accelerometer data was used to determine each child's percentage of day spent sedentary, minutes of daily light physical activity, minutes of moderate physical activity, minutes of vigorous physical activity, minutes of MVPA, and daily step counts using Evenson et al. (2008) cut points at an epoch of 10 seconds. These accelerometer parameters were specifically chosen as they allowed for comparison with a population study of physical activity levels of children with CHD (Voss et al., 2017).

Additionally, the Physical Activity Questionnaire for Children (PAQ-C: 8 to 14 years of age) and for Adolescents (PAQ-A: 14 to 18 years of age) were used to assess the participants' physical activity levels a week before their pre- and post-testing date (Kowalski et al., 2004). An overall score is given ranging from 1 to 5. A score of 1 means a child participated in a low amount of physical activity, while a score of 5 means the child participated in a high amount of physical activity. Since both tools operate on the same 5-point likert scale and were created to allow for a continuous evaluation of physical activity from the elementary to high school setting, results will be shown as an average PAQ score.

Physical Literacy Assessments

The impact of the intervention was assessed using the PLAY tools (Canadian Sport for Life, 2013a). This battery of tools designed by Canadian Sport for Life assesses physical competence, confidence, and comprehension. The specific tools used for this study were the PLAYfun, PLAYself, and PLAYparent assessments. Each of these tools were administered pre- and post-intervention.

PLAYfun is designed for the use of researchers and physical educators to assess participant's physical literacy and tests physical competence and confidence of 18 fundamental movement skills. The PLAYfun assessment was completed by a single trained researcher in a gymnasium and each participant was assigned a score between 0 and 100 for each skill based on the grading criterion (Canadian Sport for Life, 2013a). An overall physical competence score was then calculated by dividing the sum of the 18 skills by 18, which gives an overall PLAYfun score from 0-100; with zero being the lowest possible score and 100 being the highest. Each domain (i.e. locomotor and object control upper body) also had the sum of their corresponding skills taken to provide a total score for each domain (values range from 200-500 depending on the number of skills included in the domain). Confidence and comprehension were assessed simultaneously during the skill assessment. If the participant was perceived by the researcher to lack confidence when they performed the skill, it was recorded on the PLAYfun scoresheet. Additionally, if a child needed more guidance to complete a skill (i.e. prompt, mimic, description, or demonstration) a flag was placed as indication of a lack of comprehension in performing a particular skill. The total number of the times a child lacked the confidence and/or comprehension to complete a skill was recorded for each domain. For the purpose of this study, videos were taken of each participant performing each skill and were used to allow the assessor to slow down and/or repeat the skill to enhance accuracy of scoring.

PLAYself and PLAYparent questionnaires were completed by each participant and their parent/guardian, respectively. PLAYself assesses the child's confidence to be physically active in different environments, the child's self-description of their physical abilities, and valuing of literacies (i.e. writing, math, and movement). PLAYparent assesses how the parent views their child's confidence and comprehension, their ability in different environments, and their physical competence. Assessment of the PLAYparent and PLAYself were done in a lab space with the child and parent in separate rooms. The same parent was requested to answer the questionnaire at both time points. Instructions were provided to answer every question to the best of their ability and any questions that arose were answered by a single researcher. The tools can be accessed at http://physicalliteracy.ca/play-tools/.

Statistical Analysis

Results are presented as means and standard deviation (SD). Paired sample *t*-tests were used to assess differences in participant characteristics pre- and post-intervention. The percent change for each PLAY tool score was calculated from the baseline and post-intervention values. The average of each individual's percent change was calculated to see the change in values. Additionally, a paired sample *t*-test was utilized to look for statistical differences between pre- and post-tests for the domains of each assessment method. Analyses were performed using SPSS version 25 and the significance level was set at $p<0.05$.

Results

Complete data for all study measures was collected from 12 participants (9-16 years of age). Two participants (1 female) completed only PLAYself and PLAYparent while 12 participants (4 female) completed the PLAYfun, PLAYself, and PLAYparent assessments pre- and post-intervention. All participants met the adherence criteria of attending a minimum of 4 of the 6 sessions.

Participant Characteristics

Participant characteristics are presented in Table 1. One male did not have his sitting height recorded; therefore, we were not able to calculate his biological age (n=13). Height and weight increased significantly over the 12-week intervention period ($p<0.05$). The PAQ scores and accelerometer data showed no change. Two of the participants' accelerometer data were removed because they did not reach the requirement of three valid wear days.

Table 1: Participant Characteristics at Baseline and Post the 12-week Intervention

Sex	9 Male, 5 Female	
Chronological Age (years)(*n*=14)	12.8 ±2.0	
Biological Age (APHV) (*n*=13)	12.8±1.3	
	Pre-Intervention	**Post-Intervention**
Height (cm)	153.2±13.2	154.9±12.9*
Weight (kg)	46.3±14.8	47.4±14.9*
PAQ Score	2.2±0.5	2.5±0.8
Percentage of Day Spent Sedentary (%)	85±7	85±6
Daily Light physical activity (min)	206.1±66.3	187.1±77.1
Daily Moderate physical activity (min)	29.2±16.2	25.3±13.8
Daily Vigorous physical activity (min)	12.5±10.6	12.2±10.5
MVPA (minutes/day)	41.7±26.1	37.7±23.6

Daily Step Count	7535±2812	6422±2459

Note. Data is displayed as mean±SD. Abbreviations: APHV = Prediction of Age at Peak Height Velocity, MVPA = Moderate-to-Vigorous Physical Activity, PAQ = Physical Activity Questionnaire Score from either the PAQ-C or PAC-A. *Denotes a significant difference between pre and post scores ($p < 0.05$)

PLAYfun

PLAYfun results are presented in Table 2. At post intervention a significant increase was found in the average test scores for the domains of running, locomotor, object control upper, balance, and the total physical competence score ($p<0.05$). Children with CHD improved in all domains with percent change ranging from 25% for object control lower, to 92% for the locomotor domain. Additionally, children with CHD had no significant changes in the researcher assessed comprehension and perceived confidence after the intervention (Figure 1).

Table 2: Average Pre- and Post- Intervention Scores for each Domain in the PLAYfun Assessment

Domain	Pre-Test Average Score	Post-Test Average Score	*p*-value	Average Percent Change
Running (300)	118.3±40.8	174.5±29.6*	.001	70%
Locomotor (500)	140.8±57.8	228.5±58.4*	.002	92%
Object Control Upper (400)	203.6±42.9	264.5±38.3*	<.001	33%
Object Control Lower (200)	82.0±26.5	96.6±30.8	.168	25%
Balance (400)	210.7±78.9	260.4±73.1*	.006	31%
Total (100)	42.3±8.6	56.9±7.8*	<.001	37%

Note. Data is displayed as mean±SD. The maximum possible score for each domain is in brackets. *Denotes a significant difference between pre and post scores.

PLAYself

PLAYself average scores are presented in Table 3. There were no significant differences between pre- and post-intervention scores. The percent change for PLAYself values ranged from -5% in the self-description to 10% in the math domain ($p>0.05$, Table 3).

Table 3: Average Pre- and Post-Intervention Scores for each Domain in PLAYself Assessment

Domain	Pre-Test Average Score	Post-Test Average Score	*p*-value	Average Percent Change
Environment (600)	408.9±106.8	414.3±91.8	.811	5%
Self-Description (1200)	814.9±218.3	746.4±161.3	.174	-5%
Literacy (300)	226.6±55.7	224.4±33.0	.883	5%
Math (300)	219.4±55.7	229.0±38.8	.410	10%
Movement (300)	248.0±40.5	247.9±69.9	.994	1%
Total (100)	71.3±14.3	69.4±11.4	.477	-1%

Note. Data is displayed as mean±SD. The maximum possible score for each domain is in brackets. *Denotes a significant difference between pre and post scores.

PLAYparent

PLAYparent average scores are shown in Table 4. No changes were seen after the intervention. The percent change ranged from 6% to 13% ($p>0.05$, Table 4).

Table 4: Average Pre- and Post-Intervention Scores for each Domain in PLAYparent Assessment

Domain	Pre-Test Average Score	Post-Test Average Score	*p*-value	Average Percent Change
Cognitive (12)	7.9±2.0	8.4±2.4	.355	8%
Locomotor (12)	9.0±2.5	9.6±2.3	.280	13%
Object Control (6)	5.0±1.5	5.0±1.2	1.000	6%
Environment (8)	4.9±2.1	4.7±2.2	.834	10%
Total (99.94)	70.1±17.1	72.9±18.0	.478	6%
Cognitive (12)	7.9±2.0	8.4±2.4	.355	8%

Note. Data is displayed as mean±SD. The maximum possible score for each domain is in brackets. *Denotes a significant difference between pre and post scores.

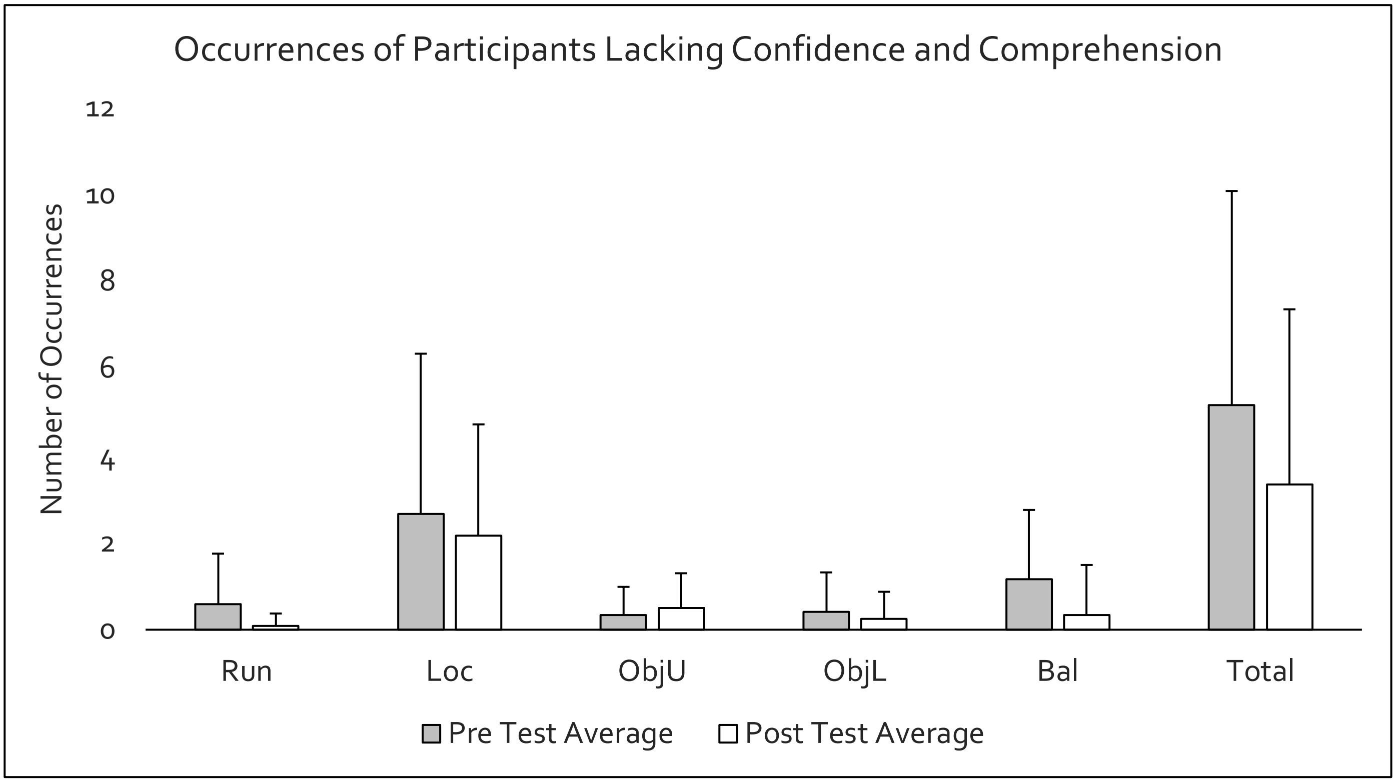

Figure 1: The Total Number of Times the Participants Lacked Confidence or Needed Comprehension Cues, during PLAYfun Assessment

Note. Abbreviations: Run = Running, Loc = Locomotor, ObjU = Object Control Upper, ObjL = Object Control Lower, Bal = Balance. Note: Based on this tool's scoring system, the observed decrease displays a positive change in children's confidence and comprehension.

Discussion

The novel finding of this study is that children with CHD's participation in a 12-week fundamental movement skill intervention significantly increased their scores in the PLAYfun domains of running, locomotor, upper body object control, balance, and the total physical competence score. There was no significant difference in the researcher's assessment of the children's confidence and comprehension. No changes were found in any of PLAYparent and PLAYself domains. These results suggest that our intervention, aimed at developing gross motor function and confidence, was effective in improving children with CHD's physical competence, which is important component of physical literacy and the predilection to be physically active.

The increase in physical literacy scores can be attributed to the intervention's ability to teach the participants the proper movement skills and language used when describing the skills. The positive finding supports the assertion that the study's intervention was effective in improving components of physical literacy in children with CHD. The largest increase was observed in the locomotor domain, which is not surprising considering the intervention started with a locomotor warm-up before each session and research suggests locomotor skills may be easier to improve than other skills (Morgan et al., 2013). In addition, pre-intervention, movement comprehension lacked the most in the locomotor domain; most likely because children did not know the differences between crossover, skip, gallop, hop, and jump. Therefore, as expected after teaching the differences between these locomotor skills the children were able to execute them with a higher degree of success. This increase in skill knowledge and competence is important as it has previously been found to result in an increase in physical activity participation (Belanger et al., 2018). The only domain that did not significantly change was the object control lower domain. This may be related to the timing of skill introduction in the intervention, object control lower was taught in the first intervention session and not reintroduced after that. This highlights the importance of consistent and repeated exposure to the different movement patterns. Finally, anytime a participant was absent for an intervention session, they did not receive the instruction on the skills that were taught during that session, impacting their potential improvement in physical competence. Three participants attended 4 sessions, five participants completed 5 sessions, and six participants completed all 6 sessions.

The improvements observed in physical competence could also be related to gains in confidence which may have increased their motivation to practice skills and engage in physical activity outside of the intervention. However, our accelerometer and PAQ data revealed no change in physical activity levels post-intervention suggesting the majority of improvement in physical competence was most likely the result of the time spent in the intervention. Additionally, PLAYself and PLAYparent showed no changes in environment or locomotor domains suggesting children were not engaging in any new forms of physical activity post-intervention. However, it important to note that children may not have been involved in the intervention long enough for them or their parents to notice differences in behavior outside of the intervention.

When comparing physical competence between different studies caution should be taken when different tools are utilized to measure physical literacy. For example, it should be noted that the PLAYfun and CAPL assess physical competence differently making a direct comparison difficult; therefore, we calculated a percentage of total possible points to comment on these studies, but the absolute scores cannot be compared. The physical competence of our participants, using a percentage of total possible score, (total PLAYfun score) was lower than the physical competence of a large representative sample of healthy Canadian children aged 8 – 12 measured using CAPL (Tremblay et al., 2018). When comparing our physical competence score, again as assessed by the percentage of total possible score, to the physical competence of typically developing children who completed a physical literacy intervention within their physical education classes, as assessed by CAPL, the healthy children scored higher at baseline and post-intervention (Coyne et al., 2019). This could mean the children in the current study have lower physical competence than their healthy peers or the differences may be due to how the CAPL and PLAY tools measure physical competence. However, in a pilot study using CAPL, Longmuir et al. (2015) found that children with CHD scored significantly lower in the physical competence domain of CAPL when compared to healthy controls. Taken together these results suggest that children with CHD may have lower physical literacy compared to their typically developing peers. A limitation of physical literacy research in general is the use of different tools to assess physical literacy in children making comparisons between cohorts difficult.

The current study findings are consistent with findings from previous studies that utilized the PLAY tools. Hennessey et al. (2018) found significant improvements in the PLAYfun domains of running, locomotor, and balance after a 10-week intervention. They also found no observable changes in PLAYself scores, which is consistent with our findings (Hennessy et al., 2018). It should be noted their intervention only focused on improving the children's physical competence of 8 skills in the running, locomotor, and balance domain. These skills are in the same domains that significantly increased in the current study and children in the current cohort scores were on average 5 points higher than those reported by Hennessy et al. (2018). This demonstrates that the intervention implemented in the current study could have increased the physical competence of children with CHD to a similar degree as healthy individuals; however, since physical literacy often increases with age (Cairney et al., 2018; Caldwell et al., 2020) it could also because the current cohort's average age (12±2 years) is higher than Hennessy et al. (2018) (9±1 years). Finally, even though the current intervention displayed improvement in the participants' physical literacy score by 15 points; they are only classified as being in the competent category (PLAYfun score 51-75) post-intervention, which indicates that our cohort is not proficient (PLAYfun score 76-100) in their movement competency.

PLAYself displayed no significant changes from pre- to post-intervention. Other studies have also reported an increase in physical competence with no change in PLAYself scores (Hennessy et al., 2018; Kriellaars et al., 2019). Additionally, none of domains within the PLAYself changed post intervention. The self-description domain of PLAYself determines the child's self-efficacy and it's connection to their engagement in physical activity (Canadian Sport for Life, 2013b). The lack of a change in the self-description domain could be due to children with CHD's higher health anxiety (Awaad & Darahim, 2015; Oliver et al., 2018) or because they have a greater fear of attaining a physical injury while being active (Oliver et al., 2018). Another reason we did not see a change could be due to the interventions inability to improve the perceived self-confidence of the participants. Increasing the length of the intervention, practicing the same skills for longer periods of time, and allowing the participants to get more comfortable with the skills could increase their self-perceived confidence. There was also no change in the range of environments (i.e., water, ice, playground) the children felt confident participating in, according to the PLAYself and PLAYparent; as the intervention took place solely in a gymnasium setting this is not overly surprisingly. Finally, the movement domain demonstrated that the participant's value of movement with friends, family, and at school did not change after the intervention; this is further verified by the lack of change in the PAQ scores or MVPA. This demonstrates that it is likely that the children did not value physical activity more after the intervention. Despite this, getting children to value physical activity more is a critical aspect of physical literacy development and in turn in increasing physical activity engagement (Cairney et al., 2019; Edwards et al., 2017). One-way future interventions could potentially improve children's value of movement could be educating them and their parents on the importance of physical activity for children with CHD's health. Additionally, when planning an intervention, the researcher could talk to the participants about new skills they would like to learn or want to improve their competency and confidence in. This would increase the children's ownership in the intervention and suggest motor skills they might be motivated to engage in by themselves, with friends, and with family.

Parental perception of their child's physical literacy also displayed no change after the intervention. Baseline PLAYparent values were high; therefore, it could be suggested that the parents were already confident in their children's physical competence before the intervention and may explain the lack of a change post-intervention. This could be explained by some of the participants previous involvement in the Children's Healthy-Heart Activity Monitoring Program in Saskatchewan (CHAMPS) summer camp, where some of the children in the current study were exposed to different physical activities, so it could be that their parents were less hesitant since they were comfortable with the program and its' leaders.

When examining physical activity levels pre- and post-intervention, neither the PAQ score nor the accelerometer data changed after the intervention. Additionally, the percentage of the day spent sedentary did not change post intervention. In comparison to a large sample of children with CHD, accelerometer measured physical activity levels in the current cohort are similar to other children with CHD; however, it appears the children in the current study spent a greater proportion of their time sedentary (Voss et al., 2017). Both studies have a similar average age, and both used Evenson et al. (2008) cut points to determine MVPA and sedentary time. Additionally, even though there was an increase in physical literacy in our study, there was no significant change physical activity parameters. One potential reason is the short duration of the intervention. The increase in the participants' physical literacy did not increase physical activity participation in this study. This requires further exploration in the current population.

One limitation of the current study is the small sample size. There were only 14 participants in this study thus giving us limited generalizability our findings. However, it is the first study, to the authors', knowledge to assess the effect of an intervention on the physical literacy of children with CHD and provides promising results for future research. Lastly, this project was an undergraduate thesis project and due to feasibility, there was no control group; therefore, the improvement in physical competence could be due to normal growth and development. However, with the short 12-week time span of the intervention it is more likely a result of the intervention than an increase to do normal growth and development, since physical literacy does not develop rapidly as children age. As mentioned previously, some of children in this cohort were previously involved in a summer camp pilot study which exposed them to new physical activity opportunities, like rock climbing and yoga. While none of those opportunities were designed to improve physical literacy, it could have inflated their baseline PLAYself and PLAYparent data because the children and parents may have already been comfortable with the program due to their summer camp participation.

In terms of future directions, it would be advantageous to design a study where children with CHD are compared to healthy controls using the PLAY tools. This would allow for examination of potential physical literacy differences between children with CHD and matched healthy children. Additionally, a qualitative research approach could help in understanding child and parent experiences with the intervention. This could allow us to understand if children engaged in different forms of physical activity after the intervention and get a deeper insight into parent perspectives.

In conclusion, we found that the physical literacy of children with CHD can be improved with a 12-week movement skill intervention. Even an intervention that is short in duration can be effective in increasing the physical competence of the participants. We observed significant increases in the participants' physical competence in the running, locomotor, object control upper, and balance domains as well as their total physical competence. We found no difference in self or parental perceived physical literacy. This is consistent with previous studies, which have also found an improvement in physical competence without a change in self-perception or confidence in healthy populations. The totality of this study demonstrates that physical literacy can be significantly improved when children are taught the proper movement patterns and vocabulary.

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Declaration of Interest

The authors report no conflict of interest.

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