ARTICLE

Is Physical Activity–Related Self-Efficacy Associated with Moderate to Vigorous Physical Activity and Sedentary Behaviour among Ambulatory Children with Cerebral Palsy?

Felipe Ganz, MSc, PT (student);[*] *Virginia Wright, PhD, PT;*[†‡] *Patricia J. Manns, PhD, PT;*[*§] *Lesley Pritchard, PhD, PT*[*§]

ABSTRACT

Purpose: To determine how physical activity–related self-efficacy is associated with physical activity and sedentary behaviour time among ambulatory children with cerebral palsy (CP). ***Method:*** Children with CP, Gross Motor Function Classification System (GMFCS) Levels I-III (N = 26; aged 9–18 y), completed the task self-efficacy component of a self-efficacy scale and wore Actigraph GT3X+ accelerometers for 5 days. Correlations (Pearson and Spearman's rank-order; $\alpha = 0.050$) were conducted to evaluate the relationships among age, GMFCS level, self-efficacy, and both daily moderate-to-vigorous physical activity (MVPA) and sedentary time. Linear regression models were used to determine the relationships among the independent variables and MVPA and sedentary time. ***Results:*** Self-efficacy was positively associated with MVPA time ($r = 0.428$, $p = 0.015$) and negatively correlated with sedentary time ($r = -0.332$, $p = 0.049$). In our linear regression models, gross motor function ($\beta = -0.462$, $p = 0.006$), age ($\beta = -0.344$, $p = 0.033$), and self-efficacy ($\beta = 0.281$, $p = 0.080$) were associated with MVPA time ($R^2 = 0.508$), while GMFCS level ($\beta = 0.439$, $p = 0.003$) and age ($\beta = 0.605$, $p < 0.001$) were associated with sedentary time ($R^2 = 0.584$). ***Conclusions:*** This research suggests that self-efficacy, age, and gross motor function are associated with MVPA in children with CP. Additional research is needed to confirm these findings and further explore the influence of self-efficacy on sedentary behaviour.

Key Words: cerebral palsy; gross motor function; physical activity; sedentary behaviour; self-efficacy.

RÉSUMÉ

Objectif : déterminer l'association entre l'autoefficacité liée à l'activité physique et la durée de l'activité et du comportement sédentaire chez les enfants ambulatoires ayant la paralysie cérébrale (PC). ***Méthodologie :*** des enfants ayant la PC âgés de 9 à 18 ans ($N = 26$) présentant les niveaux I à III du système de classification de la fonction motrice globale (GMFCS) ont effectué l'élément d'autoefficacité de l'échelle d'autoévaluation et ont porté des accéléromètres Actigraph GT3X+ pendant cinq jours. Les chercheurs ont établi des corrélations (hiérarchie de Pearson et Spearman; $\alpha = 0{,}050$) pour évaluer les relations entre l'âge, le niveau de GMFCS, l'autoefficacité et à la fois l'activité physique modérée à vigoureuse (APMV) et à la durée de la sédentarité. Ils ont utilisé les modèles de régression linéaire pour déterminer la relation entre, d'une part, les variables indépendantes et, d'autre part, l'APMV et la sédentarité. ***Résultats :*** l'autoefficacité était associée de manière positive au temps d'APMV ($r = 0{,}428$, $p = 0{,}015$) et de manière négative avec la durée de sédentarité ($r = -0{,}332$, $p = 0{,}049$). Dans les modèles de régression linéaire des chercheurs, la fonction motrice globale ($\beta = -0{,}462$, $p = 0{,}006$), l'âge ($\beta = -0{,}344$, $p = 0{,}033$) et l'autoefficacité ($\beta = 0{,}281$, $p = 0{,}080$) étaient associés à la durée de l'APMV ($R^2 = 0{,}508$), mais le niveau du GMFCS ($\beta = 0{,}439$, $p = 0{,}003$) et l'âge ($\beta = 0{,}605$, $p < 0{,}001$) étaient corrélés avec la durée de sédentarité ($R^2 = 0{,}584$). ***Conclusions :*** selon la présente recherche, l'autoefficacité, l'âge et la fonction motrice globale sont liées à l'APMV chez les enfants ayant la PC. D'autres recherches devront être réalisées pour confirmer ces observations et explorer plus à fond l'influence de l'autoefficacité sur le comportement sédentaire.

Mots-clés : activité physique; autoefficacité; comportement sédentaire; fonction motrice globale; paralysie cérébrale

From the: *Faculty of Rehabilitation Medicine, University of Alberta, Edmonton, Alberta, Canada; †Holland Bloorview Kids Rehabilitation Hospital, Toronto, Ontario, Canada; ‡University of Toronto, Toronto, Ontario, Canada; §Department of Physical Therapy, University of Alberta, Edmonton, Alberta, Canada.

Correspondence to: Lesley Pritchard, Department of Physical Therapy, Faculty of Rehabilitation Medicine, 2-50 Corbett Hall, University of Alberta, Edmonton, AB T6G 2G4, Canada; lesley.wiart@ualberta.ca.

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Children with cerebral palsy (CP) experience motor impairments that can affect their functional mobility and physical activity levels;[1] they are more sedentary than children without disabilities,[2] and engage in vigorous intensity physical activity for a smaller proportion (range, min-max, 2%–7%) of their day.[3] Since cardiovascular disease is a leading cause of early mortality among adults with CP,[4] researchers and clinicians are increasingly recognizing that interventions focused on increasing physical activity and decreasing sedentary behaviour are important aspects of physical therapy.[3,5] Among adults without disabilities, the adverse effects of increased sedentary time are independent of those from decreased moderate-to-vigorous physical activity (MVPA); they have unique contributions to health.[6] Even adults without disabilities who meet physical activity guidelines can experience increased cardiovascular disease risk factors if they spend large amounts of time sedentary.[7,8]

Gross motor function levels of children with CP are associated with daily physical activity.[9] For example, children who walk without mobility devices spend less time sedentary than those who use mobility devices.[10,11] Among children and youth with CP, age is also associated with physical activity; time spent being sedentary starts to increase around the age of three and continues through adolescence.[10–13] While self-efficacy, defined as "one's beliefs regarding their capability to produce performances that will lead to anticipated outcomes,"[14(p. 371)] is a widely known precursor of behavioural change,[15] research has not examined its relationship to physical activity and sedentary behaviour in children with CP.

Theoretically, self-efficacy should be an important consideration for long-term behavioural change since social cognitive theory[16] and theories of behavioural change[17] suggest that individuals with higher self-efficacy are more likely to be successful at altering their behaviour and maintaining change in the long term.[18] Self-efficacy is a strong predictor of physical activity behaviour in children who are typically developing,[19] and therefore it is important to determine whether an association exists among children with CP. Knowing the factors associated with increased physical activity and decreased sedentary behaviour could inform approaches to physical activity interventions in pediatric physical therapy.

The aim of this study was to determine how physical activity–related self-efficacy is associated with physical activity and sedentary behaviour time among children with CP classified as Gross Motor Functional Classification System (GMFCS) levels I to III.

METHODS

This was a cross-sectional study that combined the data from an ongoing multi-centre randomized control trial[20] with data collected from participants recruited specifically for this study. The data from the ongoing study were collected at two rehabilitation hospitals (located in Edmonton and Toronto). The University of Alberta Research Ethics Board provided Ethics approval (Pro00084363). All parents or legal guardians gave informed consent, and children provided informed assent.

Participants

Children were eligible for inclusion if they: (1) were aged 9–18 years, (2) were able to read and speak English, and (3) had a diagnosis of CP (GMFCS levels I –III). Thus, all the participants in the ongoing randomized trial who met the age criterion were eligible. We invited additional participants through a local CP organization and through Edmonton's Glenrose Rehabilitation Hospital, Physical Medicine Clinic. Our sample size estimate of 30 participants was based on the commonly used guideline of a minimum of 10 participants per independent variable.

Data collection

For the prospective data collection, we recorded height, weight, age, sex, and GMFCS level, and participants completed the task self-efficacy component of the self-efficacy scale.[19] In addition, we used accelerometry to measure physical activity across the spectrum, including sedentary time. Additional information about the assessment tools is provided below.

Gross motor function

We used the Gross Motor Function Classification System – Expanded and Revised version (GMFCS-ER),[21,22] to classify gross motor function, the international standard for classifying gross motor functioning in children and youth with CP.[23] Children in GMFCS levels I and II walk independently without devices and there is evidence that they engage in more physical activity and less sedentary behaviour than children in GMFCS level III.[10] Children classified as GMFCS level III use mobility aids such as walkers and canes for independent mobility.

Self-efficacy

We used the task self-efficacy component of the self-efficacy scale,[24] adapted for use with children and adolescents by Foley and colleagues,[19] to assess the perceived competence of successful engagement in incremental physical activity.[19,24] Internal consistency for the original version of the scale was excellent (α = 0.98–0.99).[25] Children rate their confidence (range, min-max, 0%–100%) in their ability to participate in physical activity at three intensity levels (light, moderate, and hard).[19] Each level includes three items related to the duration of physical activity. For example, the first two questions in the light physical activity section are (1) How confident are you that you can complete 10 minutes of physical activity at a light intensity level three times over the next week? and (2) How confident are you that you can complete 30 minutes of physical activity at a light intensity level three times over the next week? We calculated the total score by adding the scores for each item and then dividing the total by the number of items; higher total scores represent greater task self-efficacy.

Physical activity

This study included accelerometry to measure MVPA and sedentary time. We used an ActiGraph accelerometer GT3X+ (ActiGraph, LLC, Pensacola, FL), a triaxial accelerometer that measures body acceleration in three axes (vertical, mediolateral, and anteroposterior) and combines this information into vector magnitude.[26] The GT3X+ accelerometer has evidence of good concurrent validity with oxygen consumption and good to excellent test–retest reliability in children with CP classified as GMFCS levels I to III.[27,28] It converts voltage signals into a series of activity counts, the summation of the measured accelerations during a certain period of time (epoch). Although epochs typically range from 1 to 60 seconds, recommendations include using short epochs in children since they often use sporadic bursts of energy.[29]

Participants wore the accelerometer on their right hip for 5 days, except during water activities and sleeping. Parents recorded wear and non-wear time in a logbook.[2,13] We downloaded and processed activity data using ActiLife, version 6.0 (ActiGraph, LLC, Pensacola, FL). The minimum required period of valid wear time was 3 days – 2 weekdays and 1 weekend day, for a minimum of 8 hours per day.[27] Before analysis, we removed the non-wear time, which was defined as any interval of at least 60 consecutive minutes of zero counts per minute (cpm), with allowance for up to 2 minutes of some limited movement (< 100 cpm); determined by the ActiLife software. Prior to removal and exclusion of these data from the analyses, we validated non-wear time against the logbook to ensure that they did not include periods of sedentary time.[10]

We digitized the accelerometry data with a rate of 30 Hz and integrated over 3-second epoch intervals[2] and used Evenson cut-points to classify sedentary and MVPA intensity.[28,30] Sedentary behaviour was defined as ≤ 100 cpm, light physical activity as 101–2,295 cpm, and MVPA as ≥ 2,296 cpm. The Evenson cut-points have demonstrated the highest classification accuracy for measuring sedentary behaviour and MVPA in children with CP, GMFCS levels I-III, when compared to other cut-points.[28] In addition, the Evenson cut points have been validated by comparing physical activity levels to oxygen consumption, providing further evidence of validity in this population.[30]

Analysis

We analyzed the data using IBM SPSS Statistics, version 25.0 (IBM Corporation, Armonk, NY) and calculated descriptive statistics for all variables.

The construction of each regression model considered the following process.[31] Pearson's (continuous variables) and Spearman's rank-order correlation coefficients (ordinal level variables) were calculated to determine the relationships among the three independent variables (gross motor function, age, and self-efficacy) and the two dependent variables (mean daily proportion of MVPA time and mean daily proportion of sedentary time) (0.05). Then we built two linear regression models to examine the associations between the independent and dependent variables. We grouped children classified as GMFCS levels I and II together for the purpose of this analysis.[9,10] Independent variables with correlations of $p < 0.20$ were selected for inclusion in the models. To do so, all independent variables with $p \leq 0.05$ were initially included in the model and then we entered each independent variable with $p > 0.05$ into the model individually to examine their effects on the beta-coefficients. If the beta coefficients changed by 10% or more with the addition of these variables, they were classified as confounding variables and retained in the model.[32]

We evaluated assumptions of linearity and homoscedasticity with p-plots of the relationships between the actual regression standardized residuals and the regression standardized predicted value. Additionally, we examined linearity with scatterplots of each independent and dependent variable and assessed normal probability plots and histograms of the regression standardized residuals for normality. To assess multicollinearity, we calculated the variance inflation factor and checked the correlation of all the independent variables. We hypothesized that self-efficacy would be positively associated with physical activity and negatively associated with sedentary time.

RESULTS

A total of 26 children and adolescents with CP participated (mean age of 13.9 [SD 2.1] y; range, min-max, 9–17 y) and were classified at GMFCS level I (5; 19.2%), level II (6; 23.1%) and level III (15; 57.7%). The accelerometry data from all the participants met our requirements for valid wear time, and 25 participants returned their activity logbooks. We used logbooks to identify deviations from typical accelerometer wear patterns during the day (e.g., removal for swimming). There were no deviations noted and therefore no adjustments to the accelerometer data were made based on the logbooks. Descriptive information about the participants is included in Table 1.

Relationships between independent and dependent variables

We observed that age and GMFCS were positively associated with the percentage of daily time spent being sedentary ($r = 0.626$ and $r = 0.422$ respectively, both $p < 0.05$), and negatively associated with daily MVPA ($r = –0.408$ and $r = –0.540$ respectively, both $p < 0.05$). Self-efficacy was negatively associated with the daily percentage of sedentary time ($r = –0.332$; $p = 0.049$) and positively associated with the daily MVPA ($r = 0.428$; $p = 0.015$). These relationships are included in Table 2.

Table 1 Participants' Characteristics

Characteristic	Mean (SD)*		
	GMFCS I and II (n = 11)	GMFCS III (n = 15)	Total (N = 26)
Age, y	13.91 (3.0)	13.93 (1.4)	13.92 (2.1)
Sex, *n*			
Female	6	9	15
Male	5	6	11
Height, cm; $n = 24$†	147.3 (16.8)	143.7 (10.0)	144.5 (11.7)
Weight, kg; $n = 24$†	43.8 (8.7)	42.2 (13.4)	43.8 (11.9)
Wear time, min	781.4 (76.6)	769.2 (111.9)	774.4 (96.9)
MVPA			
Min x d	39.4 (22.5)	14.3 (12.0)	24.9 (21.0)
% per d‡	5.0	1.9	3.2
Sedentary time			
Min per d, $\bar{x}$ (SD)	621.0 (59.7)	666.7 (116.0)	647.4 (97.4)
% per d‡	79.4	86.6	83.6
self-efficacy scale, $\bar{x}$ (SD)	75.5 (18.5)	64.6 (21.3)	69.2 (20.5)

* Unless otherwise specified.
† Change in *n* due to missing data.
‡ Time spent per day as % of total wear time.

GMFCS = Gross Motor Function Classification System; MVPA = moderate to vigorous physical activity.

Table 2 Pearson and Spearman's Rank-Order Correlations

Variable	Time spent, %			
	MVPA		Sedentary	
	r (95% CI)	*p*-value	*r* (95% CI)	*p*-value
Age	–0.408 (–0.793, –0.024)	0.019	0.626 (0.297, 0.954)	0.001
GMFCS	–0.540 (–0.892, –0.180)	0.004	0.422 (0.09, 0.840)	0.032
Self-efficacy	0.428 (0.057, 0.809)	0.015	–0.332 (–0.729, –0.065)	0.049

MVPA = moderate to vigorous physical activity; GMFCS = Gross Motor Function Classification System.

Linear regression model for moderate to vigorous physical activity time

In the initial univariable analyses, age, gross motor function, and self-efficacy were associated with MVPA (Table 3). Only age and gross motor function were significant in the multivariable model; self-efficacy was not significant ($\beta = 0.28$; $p = 0.08$). However, since self-efficacy was our main variable of interest, and our small sample size may have contributed to the insignificant result, we retained self-efficacy in the model. In addition, adding self-efficacy to the model changed the β coefficients of age and gross motor function by more than 10%. This model explained 50.0% of the variance in the daily percentage of MVPA ($R^2 = 0.50$; $F_{(3, 22)} = 7.58$; $p < 0.001$).

Linear regression model for sedentary time

In the univariable analysis, age and gross motor function were associated with sedentary time (see Table 3). Self-efficacy was excluded from the model based on the initial univariable analysis ($p > 0.20$). The final model explained 58.4% of the variance in the daily percentage of sedentary time ($R^2 = 0.58$; $F_{(2, 23)} = 16.13$; $p < 0.001$).

DISCUSSION

The aim of this study was to determine the factors that influenced MVPA and sedentary behaviour time among children with CP. Not surprisingly, the factors that significantly contributed to variance in these activity behaviours were age and gross motor function. Even though self-efficacy did not significantly contribute to explaining the variance in the linear regression models, we observed that greater self-efficacy was associated with more time spent in physical activity. The presence of this relationship suggests that studies should investigate the role of self-efficacy to explain physical activity behaviours in these children.

Table 3 Multivariable Regression Results

Regression model, % time spent per day						
	MVPA			Sedentary		
Variable	B	SE	β (95% CI)	B	SE	β (95% CI)
Univariable						
Age, y	–0.474	0.216	–0.408* (–0.920, –0.027)	2.041	0.520	0.626* (0.297, 0.954)
GMFCS	–2.666	0.857	–0.536* (–4.433, –0.897)	6.543	2.523	0.468* (0.09, 0.840)
Self-efficacy	0.053	0.023	0.428* (0.006, 0.100)	–0.115	0.067	–0.332 (–0.729, –0.065)
Multivariable						
Constant	9.911	3.273	(3.122, 16.699)	46.592	6.730	(32.669, 60.515)
Age, y	–0.399	0.176	–0.344* (–0.763, –0.035)	1.973	0.439	0.605* (1.064, 2.882)
GMFCS	2.298	0.760	–0.462* (–3.874, –0.722)	6.144	1.883	0.439* (2.249, 10.039)
Self-efficacy	0.035	0.019	0.281 (–0.005, 0.074)	—	—	—
R^2	—	—	0.508	—	—	0.584

* $p < 0.05$.

MVPA = moderate to vigorous physical activity; GMFCS = Gross Motor Function Classification System; B = unstandardized beta; β = standardized beta.

Clinically, a number of strategies for enhancing self-efficacy could potentially include vicarious experience (e.g., learning by watching other children performing the same activity), verbal persuasion (e.g., encouragement), or mastery experience (e.g., facilitating the achievement of small tasks so a child can experience success). Verbal persuasion and mastery experience have been demonstrated to reduce sedentary time in adults with stroke, for example.[33] Therapists may also increase self-efficacy by working on foundational skills and practice before transitioning into community based physical activity as is advocated in physical literacy approaches.[34]

Using a physical literacy framework may provide opportunities to facilitate the development of self-efficacy related to physical activity. *Physical literacy* is defined as "an engagement cycle wherein the relationships among motor competence, social, affective and motivational processes, and knowledge are viewed as reciprocal and reinforcing."[35(p. 373)] Motor competence has been associated with increased physical activity in children who are typically developing,[36] and there is potential for physical literacy-based interventions to improve social, cognitive and psychological functioning.[37] Refining and practising foundational motor skills could be viewed as precursors to attaining advanced sport-specific skills that could potentially increase physical activity.[38]

Future research could focus on investigating the effects of applying physical literacy concepts to children with CP and further evaluating the role of self-efficacy in their physical activity behaviours. In addition, children with CP, GMFCS levels IV and V are often excluded from studies on sedentary behaviour and physical activity; thus, future efforts to include them in this body of research is warranted.

While this study considered sedentary time as sedentary behaviour, it would be important to consider sedentary behaviour patterns in future research. Sedentary behaviour patterns can include *sedentary breaks*, which are defined as a time when participants interrupt sedentary time with any intensity of physical activity;[39] and *sedentary bouts*, described as uninterrupted periods of sedentary behaviour.[40] In adults without disabilities,[41] increased number of breaks have been associated with improved cardiometabolic biomarkers, independent of total sedentary time. Therefore, future research in pediatrics should consider broadening the measurement of physical activity to include sedentary behaviour patterns in addition to sedentary time.

In addition, barrier self-efficacy (belief in one's ability to overcome barriers to physical activity such as time, feeling unwell, and negative body image) should also be considered a potential contributor to the physical activity of children with CP and it is likely important for long-term behavioural change.[19] Research could also explore environmental factors that have been identified in the literature including parental support,[42] family culture, and attitudes.[43] In addition to these environmental factors, further investigation of the role that physical therapists can play in developing physical literacy and its effects on sport participation, may be beneficial.[44] To the best of our knowledge, there is a lack of research on the association of these factors with physical activity among children with CP. Information on the roles that these factors play in supporting physical activity participation would guide intervention strategies used in pediatric rehabilitation.

There are four main limitations of this study. First, the lack of statistical significance of self-efficacy in the sedentary behaviour regression model may have been due to the nature of the tool we used to measure it. The self-efficacy scale we used was designed to assess self-efficacy related to MVPA, rather than sedentary behaviour.[19] Second, we did not evaluate sedentary behaviour related to physical activity patterns such as bouts and breaks.[39] Third, we could not achieve the target sample size of 30 participants; thus, the study may have been underpowered, precluding our ability to cross-validate the model and potentially explaining the lack of statistical significance of self-efficacy in the sedentary behaviour model. Finally, the physical activity intensity classified by the cut-points we used may be underestimated since the energy cost of movement in children with CP differs according to specific GMFCS levels;[45] and some researchers have proposed alternate cut-points.[46]

CONCLUSION

This research highlights the importance of considering self-efficacy in the physical activity of children with CP. This research suggests that an association between self-efficacy and moderate to vigorous physical activity exists among children with cerebral palsy. Future research should continue to investigate the influence of self-efficacy on the sedentary behaviour of children with CP.

KEY MESSAGES

What is already known on this topic

While there is evidence that relationships exist among age, gross motor function, and MVPA time and sedentary time, little is known about how self-efficacy contributes to the physical activity levels of children with CP.

What this study adds

This cross-sectional study provides preliminary evidence of a relationship between self-efficacy and the physical activity behaviours of children with CP. Therefore, strategies to assess and develop self-efficacy related to physical activity could potentially be included in physical therapy intervention programmes.

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