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# An International Classification of Functioning, Disability and Health Perspective on Physical Activity Participation Among Children with Cerebral Palsy

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***An International Classification of Functioning, Disability and Health Perspective on Physical Activity Participation Among Children with Cerebral Palsy***

An Honors Thesis submitted in partial fulfillment of the requirements for Honors in *Health Sciences and Kinesiology.*

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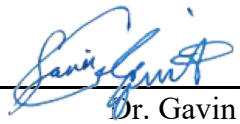
ABSTRACT

Children with cerebral palsy do not commonly meet the minimum recommended physical activity guidelines published by the U.S. Department of Health and Human Services. Children with cerebral palsy face many functional limitations which can in turn affect participation and activity; therefore, this study aimed to identify the predictors of participation and activity among children with cerebral palsy. The study examined associations among poverty levels, neighborhood support, accommodating services, and familial financial burdens as factors influencing participation. Data were taken from the National Survey of Children's Health. A chi-square test for the association was executed along with a logistic regression.

Thesis Mentors: 
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## INTRODUCTION

Cerebral palsy (CP) is the most common childhood-onset physical disability affecting 3.1 children out of every 1,000 births (Whitney et al. 2019). It is a neuromuscular disorder that occurs when damage to the cerebrospinal nervous system presents at birth or in the immediate years following birth (Shariat et al., 2014). CP is caused by damage to the white matter of the brain, restriction of oxygen to the brain, irregular development of the brain and bleeding within the brain (Stavsky et al., 2017). The damage to the developing brain causes movement and postural development disorders. CP can also manifest disturbances of sensation, perception, cognition, communication, behavior, epilepsy, and secondary musculoskeletal problems (Rosenbaum et al., 2007). Other symptoms of CP can include walking on the toes, walking in a crouched or scissored gait, swallowing and speech difficulty, tremors, involuntary movements, and difficulty with fine motor skills (National Institutes of Health [NIH], 2013). These symptoms can affect motor deficits by causing delays in achieving motor skill milestones, favoring one side of the body, difficulty eating, learning, walking, and speaking (NIH, 2013). Muscle movements are created by the central nervous system in the cerebral cortex of the brain's outer layer. Cerebral palsy is a result of a motor injury to the cerebral cortex which causes motor deficits within a child diagnosed with cerebral palsy.

CP most frequently affects muscle tone, movement, and motor function (Yang et al., 2020). Muscle movement and function in CP are restricted because of the damaged neural pathways, impacting the transmission of signals sent from the brain to the muscle. Muscle tone is the amount of tension within a muscle at rest and is the response to an

outside force including a change in direction or a stretch (Astarita, 2017). There are two types of muscle tonal abnormalities affecting children with CP, hypertonia and hypotonia. Hypertonia presents levels of higher muscle tone, which can lead to rigidness within the muscles. Children with CP affected by hypertonia tend to have difficulty with muscle contraction, balancing, and walking due to muscle stiffness (National Institute of Neurological Disorders and Stroke, n.d.). Muscles affected by hypertonia can develop joint contracture and possess a decreased range of motion which puts a child with CP at risk for falls and loss of muscular flexibility and strength (National Institute of Neurological Disorders and Stroke, n.d.). Hypotonia is characterized by low muscle tone which causes a decline in the strength and firmness of the muscles (Straathof et al., 2021). Children with CP affected by hypotonia tend to have poor posture, flaccid extremities, increased flexibility in joints, decreased muscular strength, and experience delays in achieving gross motor skills such as rolling, sitting, crawling, or walking (The Royal Children's Hospital Occupational Therapy Department, 2018). Hypotonic muscles also result in reduced mobility and balance which is associated with fall risks (National Institute of Neurological Disorders and Stroke, n.d.). These symptoms of hypertonia and hypotonia are a barrier to participation due to the child's inability to perform basic gross motor skills such as standing, walking, running, or jumping which are included in most sports and physical activities (Ryan et al., 2017).

The capability to maintain normal muscle tone in a resting position is crucial for maintaining normal posture, joint support and stability, and the prevention of a sudden change in the joint position (Latash & Vladimir 2016). Posture impacts the efficiency of body functions and helps to minimize potential muscle strain or injury during physical

activity (Kim et al., 2015). Balance is limited in the population of children diagnosed with CP which is necessary to complete basic skills such as walking, running, or standing which limits participation (Ryan et al., 2017) as these coordinated movements are necessary for most activities within physical activity and sports.

Collectively, the symptoms associated with CP result in limited motor function. These limitations are categorized into five levels by the Gross Motor Function Classification System (GMFCS) (Palisano et al., 1997). The five levels assess the child's ability to do daily movements such as walking and sitting with a mobilization device (Cerebral Palsy Alliance, 1997). Children with CP on level I can walk without limitations, level II can walk with limitations, level III can walk using a hand-held mobility device, level IV can use self-mobility with limitations or powered mobility, and level V are transported in a manual wheelchair.

Physical therapy can be an important component in increasing physical activity and sport participation among children with CP. The objective of physical therapy for this population is to maximize functional control over the body and overall gross motor function (Das & Ganesh 2019). Participation in sports and sport related therapy for children with CP provides more individual gratification and induces more consistent therapy attendance (Carroll et al., 2006). Though it is common for children with cerebral palsy to become tired of attending life-long physical therapy, the gratification from sports related therapy motivates a child to continue attendance (Carroll et al., 2006). These children are prone to uncommitting from therapy programs due to boredom with monotonous treatment plans, lack of time commitment, or the expenses. Sports and sport related therapy are a satisfactory alternative that helps to provide the population of

individuals with cerebral palsy consistent, lifelong physical therapy attendance (Carroll et al., 2006).

Participation in sports and physical activity is important for the entire human population, especially those diagnosed with cerebral palsy. Participation is the act of taking part in something. Participation in sports or physical activity is the experience of physically demanding activities which result in energy expenditure and involvement within a community. Physical activity is defined as a bodily movement produced by skeletal muscle in which energy is expended (Caspersen et al., 1985). Physical activity guidelines for children and adolescents ages 6 through 17 years are 60 minutes or more of moderate-to-vigorous physical activity daily as stated by the U.S. Department of Health and Human Services (Physical Activity Guidelines for Americans, 2nd edition, p 48). Individuals with CP benefit from regular participation in physical activity as much as individuals without physical handicaps. It is beneficial for the overall well-being of a child diagnosed with cerebral palsy to participate in activities, sports, and physical activity. Benefits include improved health and function, individual independence, and increased satisfaction of life (Carroll et al., 2006). The elements of physical fitness that exercise may improve include muscle strength, muscle endurance and cardiorespiratory fitness (Ryan et al., 2017). Physical activity and exercise have become more recognized interventions for children with CP to improve levels of muscle strength, aerobic capacity, and muscle function (Kelly & Darrah 2005).

An activity can be defined as the condition in which one is active, and something is getting done. Participation in activities prompts the necessary socialization with peers which helps to develop physical, emotional, and social-psychological skills for children

with CP (Hassani et al., 2016). Children with CP tend to have difficulty socializing with peers which can impact overall participation in daily activities and community sports. Additionally, participation in sport and sport related therapy contributes to the socialization of children with CP with peers and increase the likeliness of participation in physical activity. The participation of children with some type of disorder in sports and recreational activities has been a factor for the promotion of quality of life (Feitosa et al., 2017).

CP is a health condition framed by the International Classification of Functioning, Disability, and Health (ICF) within five main categories: body functions, activities and participation, environmental factors, personal factors, and body structures. The ICF is the World Health Organization (WHO) framework for measuring health and disability at both individual and population levels and is endorsed as the international standard to describe and measure health and disability (WHO, 2001).

The body function category includes factors that may influence participation in physical activity and sport among children with CP, such as mobility of joints, muscle tone, and control of movements. The body structures category that results in the physical manifestations of the condition and in turn relate to function, such as the structure of the child's brain, trunk, and lower/upper extremities. Activities and participation category includes activities of daily living which can also result in participation in physical activity within social settings or the community such as walking, moving around, sport and club participation after school, and recreation and leisure. Environmental factors category includes areas that may influence participation in physical activity and sport such as community and familial support, relationships, and attitudes, human-made changes to the

environment, and services, systems and policies for physical activity and sport for children with disabilities such as CP within the community. The personal factors category includes factors influencing participation in physical activity and sport, such as the motivation, age, weight, socioeconomic status, living status, and independence of a child (Çankaya & Seyhan, 2016). For the current study, influence of socioeconomic status and poverty levels on participation was an important personal factor that was examined in data analysis. The results of this study are framed by the categories of the ICF which contributes to the international perspective on personal and environment factors influencing participation in physical activity and sport within adolescents diagnosed with CP.

The ICF presents a framework to examine factors that may influence participation in physical activity and sport among children with CP. Therefore, we examined data from a nationally representative sample of children with CP to determine the relationship between participation in sport, participation in physical activity, participation in other organized activities and community-based programs, and factors associated with the neighborhood environment while controlling for demographic variables such as age, socioeconomic status, gender, and race.

The primary focus of the study was framed by the environmental factors category of the ICF which includes environmental factors influencing participation in physical activity and sport within adolescents diagnosed with CP. Environmental factors specific to adolescents diagnosed with CP are community and familial support, relationships, and attitudes, and services, systems, and polices (Schiariti & Mâsse 2014). In a previous study, it was found that environmental factors that influence participation in physical

activity are social support, access to adaptive equipment and recreation facilities, suitability of playgrounds and access to sport or physical activity within the community (Bloemen et al., 2014). Access to a suitable playground or recreation center was found to be a notable factor influencing participation in physical activity in this previous study (Bloemen et al., 2014). Ortiz-Castillo (2012) found that 72% of adolescents with physical disabilities believed that support from someone facilitated their participation in physical activity. Finally, in a study done by Matheri and Frantz in 2009, it was found that 41% of the adolescents with disability found it difficult to exercise on an uneven playground or recreation facility (Matheri & Frantz, 2009). In previous literature, the listed environmental factors have been found to influence participation in physical activity for children with CP.

An additional focus within this study was framed by the personal factor category of the ICF which pertains to gender, race, and poverty levels and socioeconomic status of the families of children with CP. Adaptive equipment, sports and recreation facilities may require funds a caregiver is not able to produce which is a barrier to participation. In a previous study, 60% of families experienced the inability to pay and limited funds for necessary adaptive equipment for participation (Feehan et al., 2012). Lower federal poverty levels (FPL) within caregivers may negatively influence access to necessary opportunities that facilitate participation. The current study examined the effect of the number of neighborhood amenities, poverty levels and living in supportive neighborhoods on participation in sport and physical activity among children with CP.

## METHODS AND MATERIALS

### Overview and Purpose

This study examined data from the 2016-2017 National Survey of Children's Health (NSCH). The Child and Adolescent Health Measurement Initiative (CAHMI) contributed to the study design creation and sponsorship of the NSCH (CAHMI, 2017c). The purpose of the CAHMI is to examine data retrieved from both state and national levels on the health (mental and physical) of children between the ages of 0-17 in the United States. The NSCH was previously conducted three times between 2003 and 2012 by the National Center for Health Statistics at the Centers for Disease Control before introducing the updated version in 2016. Since 2016, the NSCH has been collected annually by the Census Bureau and combined with the National Survey of Children's Health with Special Health Care Needs. The purpose of this study was to examine factors influencing participation in physical activity within adolescents with CP. Physical activity guidelines for children and adolescents ages 6 through 17 years are 60 minutes or more of moderate-to-vigorous physical activity daily as stated by the U.S. Department of Health and Human Services (Physical Activity Guidelines for Americans, 2nd edition, p 48).

### Study Design

This research utilized data from the NSCH study from 2016 and 2017 which was a cross-sectional, observational study that analyzed data from a population of children with CP at a specific point in time. The survey was administered both online and through mailings between August 2017 to February 2018 and then again between June 2018 to January 2019. From the 2017 and 2018 NSCH, a combination of 52,129 surveys were submitted. Out of the 52,129 surveys, 151 were completed by the caregivers of children and adolescents diagnosed with CP.

Participants

The sample included 151 surveys completed by parents or caregivers of a child with CP who participated in the NSCH. Modified survey data was used to mirror the demographic structure of non-institutionalized children between the ages of 0-17. To increase sampling efficiency, administrative data were used to determine which addresses were more likely to be households with children aged 0-17 years (CAHMI, 2017a). The NSCH uses a valid household pre-survey screen for participant selection. This screen asked the caregivers to answer a questionnaire (child-level) on a child in their household selected at random (CAHMI, 2017b). Households received a mailed invitation asking an adult in the household who is familiar with the child's health and health care (usually a parent) to complete a short screener questionnaire (via web or paper). The screener asked participants to identify all children ages 0-17 living in the household. Participants could also request a paper copy of the screener and topical questionnaire if they did not wish to complete it online. If no children lived in the household, it was the end of the survey submitted online or by mail (CAHMI, 2018b). If there was a child between the ages of 0-17 living in the household, participants filled out an initial Screener with age and sex of all children in household. Additional information on the 4 youngest children includes race/ethnicity, English proficiency, and the presence of special health care needs. Responses were submitted back to the screener. One child from each household was randomly selected to be the subject of the main Topical Questionnaire. Participants then filled out the age-appropriate topical questionnaire submitted online or as a hard copy by mail. Age categories were 0-5 years, 6-11 years, and 12-17 years. Once the age-appropriate topical questionnaire was submitted, the survey concluded.

The survey oversampled children with special health care needs (CSHCN) and children 0-5 years of age which means that in households with 2 or more children, CSHCN and children 0-5 years old had a higher probability of being selected as compared to other children in the household. A total of 71,811 surveys were completed for 2016 and 2017 combined. 50,212 surveys were completed in 2016 and 21,599 in 2017. The Overall Weighted Response Rate was 40.7% for 2016 and 37.4% for 2017. Survey data was weighted (adjusted for the combined dataset) to represent the population of noninstitutionalized children ages 0-17 who live in housing units nationally and in each state. Out of the surveys submitted, 139,923 households screened for age-eligible children (approximately 2744 per state), 50,212 child-level questionnaires completed (approximately 985 per state), and 11,392 questionnaires completed on CSHCN (approximately 223 per state).

Of the 11,392 questionnaires completed by parent with a CSHCN, 151 were parents of caregivers of children aged 6-17 with CP. Children under the age of 6 were excluded from our study because they did not offer answers to the study variables analyzed in the current study. This study was conducted with approval from a university Institutional Review Board under exempt status since all the data was available to the public.

Outcome Measure

Researchers used study variables directly from the 2017-2018 NSCH Indicator and Outcome Variables SAS Codebook (CAHMI 2018 a). Survey questions specific to activities of daily living and participation in social environments were selected for analysis. The selected questions examined the effects of conditions on daily activities and participation in sports and other extracurricular activities. The “effect of the condition on daily activities” variable was acquired from two questions. The first question was,

"During the past 12 months, how often have this child's health conditions or problems affected his or her ability to do things other children his or her age do?". The second question was, "To what extent does this child's health conditions, or problems affect his or her ability to do things?". Researchers combined the answers to these questions to one variable with four levels: 1) do not have conditions, 2) daily activities never affected, 3) daily activities moderately affected some of the time, and 4) daily activities consistently affected, often a great deal. Participants were first asked, "During the past 12 months, has this child had frequent or chronic difficulty with: Using his or her hands? Coordination or moving around?" and parents recorded dichotomized responses (yes/no). Researchers investigated answers to various questions specific to extracurricular activity for variables related to participation in social environments. The study also included questions regarding specific activities the child participated in the past 12 months (Table 1). Finally, participants were asked "During the past week, on how many days did this child exercise, play a sport, or participate in physical activity for at least 60 minutes?" and including the following options: 0, 1-3, 4-6 or every day.

Covariates

To prevent uncertainty between the dependent and independent variables, demographics, including the reported child's age, sex, and race, were included in the analysis's statistical models. Only children aged 6-17 were included in this study. To avert sparse array within the data, ethnicity was grouped into four categories: "non-Hispanic white", "non-Hispanic black", "Hispanic", and "Others". To determine if children with CP participated in after-school sports or clubs, caregivers were asked "During the past 12 months, did this child participate in 1) a sports team or did he or she

take sports lessons after school or on weekends? 2) any clubs or organizations after school or on weekends? 3) any other organized activities or lessons, such as music, dance, language, or other arts? 4) any type of community service or volunteer work at school, church, or in the community? And 5) any paid work, including regular jobs as well as babysitting, cutting grass, or other occasional work? Caregivers could select 0 days, 1-3 days, 4-6 days, or every day" (CAHMI, 2017b). To establish whether children with CP lived in supportive neighborhoods, caregivers were asked "To what extent do you agree with these statements about your neighborhood or community? 1) people in this neighborhood help each other out 2) we watch out for each other's children in this neighborhood 3) this child is safe in our neighborhood 4) when we encounter difficulties, we know where to go for help in our community and 5) this child is safe at school." Caregivers could answer "definitely agree, somewhat agree, or somewhat or definitely agree" (CAHMI, 2017b). To determine whether children with CP lived in safe neighborhoods, caregivers were asked "In your neighborhood, is/are there 1) litter or garbage on the street or sidewalk? 2) poorly kept or run-down housing 3) vandalism such as broken windows or graffiti?" caregivers could answer "definitely agree, somewhat agree, or somewhat or definitely agree" (CAHMI, 2017b). To determine whether children with CP attended safe schools, caregivers were asked "This child is bullied, picked on, or excluded by other children?" caregivers could answer "definitely agree, somewhat agree, or somewhat or definitely agree" (CAHMI, 2017b). To ascertain whether or not children with CP had access to amenities in their neighborhoods, caregivers were asked about the number of amenities in neighborhood "1) sidewalks or walking paths?", "2) a park or a

playground?", "3) a recreation center, community center or boys' and girls' club?", "4) a library or bookmobile?" caregivers could answer "0, 1, 2, 3, or 4" (CAHMI, 2017b).

Statistical Methods

Prior to analysis, children outside the 6-17 age group were eliminated from the data which were cleaned by combining the four ethnicity categories. After the data was cleaned, SAS was used for statistical analysis (version 9.4; SAS Institute, Cary, NC, USA). Descriptive statistics and frequencies were calculated for all categorical dependent and independent variables. Means and standard deviations were calculated for the numerical variable age. Binary logistic regression models were utilized for the "participation in social environments" and "participation in physical activity or sport" dichotomous dependent variables. Additionally, multi-logistic models were utilized to investigate the relation between the dependent variable "participation in physical activity and sport" and the independent variables of "poverty levels, accommodating services, neighborhood support, and financial burdens." Demographic variables including age, sex, and race for these models were controlled. This study did not include household poverty as a covariate due to a lack of convergence. Statistical significance was set at 0.05.

A multiple imputation method to handle the missing data was used by researchers. Multiple imputations can account for the statistical uncertainty not captured by a single imputation (Azur et. al, 2011). Researchers utilized multivariate imputation by chained equations (MICE), which is commonly referred to as the fully conditional specification (FCS). Researchers completed the imputation thirty times for each response variable using the PROC MI procedure. The PROC logistic procedure was used after imputation to evaluate the effects the independent variables had on the dependent variables. Only

one inference per procedure was formed since results were combined using PROC MIANALYZE.

## RESULTS

For this study, survey data for 151 children with cerebral palsy were included in analysis. Only 15.7% indicated daily participation in physical activity, while 84.3% did not participate in daily physical activity. Approximately 24.7% participated in 0 days, 46.6% participated in 1-3 days, 13.0% participated in 4-6 days, 15.7% participated in physical activity for 60 minutes every day. All participants were between the ages of 6 and 17, with 3.3% age 6, 7.3% age 7, 9.3% age 8, 5.3% age 9, 12.6% age 10, 6.6% age 11, 8.0% age 12, 6.0% age 13, 6.0% age14, 8.0% age 15, 12.6% age 16, and 15.2% age 17. Of the children participating, 60.3% reported living in supportive neighborhoods and 39.7% reported not living in supportive neighborhoods. Based on the four categories published by DHHS guidelines for poverty levels of households, 39.1% were below the federal poverty line.

In response to questions compiled on neighborhood support, cohesion, and social capital, 57.8% of participants reported living in supportive neighborhoods and 42.2% reported not living in supportive neighborhoods. In response to questions on school safety, 70.9% of parents definitely agreed, 24.8% of parents somewhat agreed, and 4.23% of parents somewhat or definitely disagreed that their child attended safe schools. In response to neighborhood amenities, 16.9% of participants reported having 0 neighborhood amenities, 9.5% reported having 1 neighborhood amenity, 16.9% 2 amenities, and 18.2% reported having 3 neighborhood amenities, and 38.5% reported having 4 neighborhood amenities available for their children.

Table 1 outlines the associations between the participation variables of participating in clubs, organized activities, community service, and paid work with meeting the physical activity guidelines. Demographic variables including age, sex, and race for these models were controlled. No predictor variables had a significant effect on the meeting the physical activity guideline. The effect of children participating in community service approached statistical significance (0.08). The probability of a child engaging in physical activity on all days of the week rather than on some days of children who participate in community service compared to children who do not are higher (odds are 22% higher). exp(0.2)=1.22.

Table 1
*Logistic Regression Model for Associations between the Participation Variables for Participating in Physical Activity*

| Parameter | β | SE | 95% CI | t | P value |
|---|---|---|---|---|---|
| Intercept | -5.79 | 116.74 | (-234.6, 223) | -0.1 | 0.96 |
| Age | -0.13 | 0.08 | (-0.3, 0.03) | -1.6 | 0.1 |
| Poverty* | | | | | |
| 0-199% FPL | 0.13 | 0.52 | (-0.9, 1.2) | 0.2 | 0.81 |
| 200%-299% FPL | 0.43 | 0.49 | (-0.5, 1.4) | 0.9 | 0.37 |
| 300%-399% FPL | -1.2 | 0.84 | (-2.8, 0.4) | -1.4 | 0.15 |
| Sex † | | | | | |
| Female | -0.06 | 0.27 | (-0.6, 0.5) | -0.2 | 0.82 |
| Race § | | | | | |
| White, non-Hispanic | 0.66 | 0.55 | (-0.4, 1.7) | 1.2 | 0.23 |
| Black, non-Hispanic | -0.34 | 0.47 | (-1.3, 0.6) | -0.7 | 0.47 |
| Asian, non-Hispanic | -0.79 | 0.89 | (-2.5, 1) | -0.9 | 0.38 |
| Sport participation outside school¶ (K7Q30) | 0.2 | 0.29 | (-0.4, 0.8) | 0.7 | 0.5 |
| Clubs participation after school¶ (K7Q31) | -0.14 | 0.32 | (-0.8, 0.5) | -0.5 | 0.66 |
| Other organized activities¶ (K7Q32) | 0.29 | 0.29 | (-0.3, 0.9) | 1 | 0.32 |
| Community Service¶ (K7Q37) | 0.51 | 0.29 | (-0.1, 1.1) | 1.7 | 0.08 |
| Paid Work¶ (K7Q38) | -5.74 | 116.74 | (-234.5, 223.1) | -0.1 | 0.96 |

*Reference category is >=400% FLP
†Reference category is Male
§Reference category is Others
¶ Reference category is No

Table 2 outlines the associations between the participation variables of participating in clubs, organized activities, community service, and paid work with participation in sport. Poverty level and sex of a child were significant predictors of participation in sport. The probability of a child participating in sports was 40% (exp(-0.5) = 0.60) lower in females compared to males ($p$ = 0.03). The effect of children participating in clubs after school has a p value close to significance level (0.09). Children within 0-199% Federal Poverty Level (FLP) category had a 70% (exp(-1.2)=0.30) lower probability of participating in sports or lessons outside school compared to children within the 400% FLP or above category.

Table 2

*Logistic Regression Model for Associations between the Participation Variables for Participating in After-School Clubs or Sports*

| Parameter | β | SE | 95% CI | t | P value |
|---|---|---|---|---|---|
| Intercept | 0.56 | 0.97 | (-1.3, 2.5) | 0.6 | 0.56 |
| Age | -0.04 | 0.06 | (-0.2, 0.1) | -0.6 | 0.55 |
| Poverty* | | | | | |
| 0-199% FPL | -1.2 | 0.47 | (-2.1, -0.3) | -2.6 | 0.01 |
| 200%-299% FPL | 0.43 | 0.39 | (-0.3, 1.2) | 1.1 | 0.27 |
| 300%-399% FPL | 0.44 | 0.46 | (-0.5, 1.3) | 1 | 0.33 |
| Sex † Female | -0.5 | 0.23 | (-1, -0.1) | -2.2 | 0.03 |
| Race § | | | | | |
| White, non-Hispanic | -0.04 | 0.51 | (-1, 1) | -0.1 | 0.94 |
| Black, non-Hispanic | -0.54 | 0.38 | (-1.3, 0.2) | -1.4 | 0.15 |
| Asian, non-Hispanic | 1.6 | 0.64 | (0.3, 2.9) | 2.5 | 0.01 |
| Clubs participation after school¶ (K7Q31) | 0.45 | 0.27 | (-0.1, 1) | 1.7 | 0.09 |
| Other organized activities¶ (K7Q32) | 0.09 | 0.26 | (-0.4, 0.6) | 0.3 | 0.73 |
| Community Service¶ (K7Q37) | 0.29 | 0.25 | (-0.2, 0.8) | 1.2 | 0.25 |
| Paid Work¶ (K7Q38) | 0.49 | 0.34 | (-0.2, 1.2) | 1.4 | 0.15 |

*Reference category is >=400% FLP
†Reference category is Male
§Reference category is Others
¶ Reference category is No

Table 3 outlines associations among neighborhood environmental variables and meeting the physical activity guidelines. White children were 4.48 times higher (exp(1.5) = 4.48) than children in the others race category (P value=0.03) to meet the physical activity guidelines. There was also a was a notable association between amenities within the neighborhood and physical activity. The probability of a child meeting the physical activity guideline was 2.91 (exp(1.07) = 2.91) times higher in children that live in a neighborhood with 2 amenities compared to none (p value=0.04), 4.17 times higher (exp (1.43) = 4.17) in children living in neighborhoods with 3 amenities (p value=0.01) and 85% lower (exp(-1.8) = 0.165) in children that live in a neighborhood with 4 amenities (p value=0.01).

Table 3
*Logistic Regression Model for Associations*
*Neighborhood Environmental Variables and Meeting Physical Activity Guidelines*

| Parameter | β | SE | 95% CI | t | P value |
|---|---|---|---|---|---|
| Intercept | -4.34 | 167.64 | (-332.9, 324.2) | -0.03 | 0.98 |
| Age | -0.12 | 0.08 | (-0.3, 0.03) | -1.5 | 0.12 |
| Poverty* | | | | | |
| 0-199% FPL | -0.6 | 0.57 | (-1.7, 0.5) | -1.1 | 0.29 |
| 200%-299% FPL | 1.2 | 0.62 | (-0.02, 2.4) | 1.9 | 0.053 |
| 300%-399% FPL | -1.2 | 0.91 | (-3, 0.6) | -1.3 | 0.19 |
| Sex † | | | | | |
| Female | 0.09 | 0.31 | (-0.5, 0.7) | 0.3 | 0.76 |
| Race § | | | | | |
| White, non-Hispanic | 1.5 | 0.69 | (0.1, 2.9) | 2.2 | 0.03 |
| Black, non-Hispanic | -0.72 | 0.53 | (-1.8, 0.3) | -1.4 | 0.18 |
| Asian, non-Hispanic | -0.95 | 0.98 | (-2.9, 1) | -1 | 0.33 |
| Supportive Neighborhood¶ | -0.08 | 0.36 | (-0.8, 0.6) | -0.2 | 0.82 |
| Safe neighborhood** | | | | | |
| Definitely agree | 3.68 | 167.64 | (-324.9, 332.3) | 0.02 | 0.98 |
| Somewhat agree | 3.82 | 167.64 | (-324.7, 332.4) | 0.02 | 0.98 |
| School Safety** | | | | | |
| Definitely agree | 0.56 | 0.59 | (-0.6, 1.7) | 1 | 0.34 |
| Somewhat agree | 0.18 | 0.64 | (-1.1, 1.4) | 0.3 | 0.78 |
| No. of amenities in Neighborhood†† | | | | | |
| 1 | -0.18 | 0.72 | (-1.6, 1.2) | -0.3 | 0.8 |
| 2 | 1.07 | 0.53 | (0.02, 2.1) | 2 | 0.04 |
| 3 | 1.43 | 0.57 | (0.3, 2.6) | 2.5 | 0.01 |
| All 4 | -1.8 | 0.69 | (-3.2, -0.4) | -2.6 | 0.01 |

*Reference category is >=400% FLP
†Reference category is Male
§Reference category is Others
¶ Reference category is Not living in a supportive neighborhood
** Reference category is Somewhat or definitely disagree
††Reference category is Neighborhood does not contain any amenities

Table 4 outlines associations among neighborhood environmental variables and participation in sport. The probability of participating in sports was 69% (exp(-1.17) = 0.31) lower in children within the constructs of the 0-199% FLP category as compared to those in the 400% FLP category or above (P value=0.01). Sex was also significantly associated (p value=0.049) where female children have a 35% lower probability in participating in sports (exp(-0.43) = 0.65) compared to males (P value=0.049). The probability of a child participating in sports was 5.75 times higher (exp(1.75) = 5.75) in children in the Asian race category as compared to the children within the constructs of the other race category (P value=0.01)

Table 4
*Logistic Regression Model for Associations Neighborhood Environmental for Participating in After-School Clubs or Sports*

| Parameter | β | SE | 95% CI | t | P-value |
|---|---|---|---|---|---|
| Intercept | -0.97 | 0.92 | (-2.8, 0.8) | -1.1 | 0.29 |
| Age | 0.02 | 0.06 | (-0.1, 0.1) | 0.3 | 0.75 |
| Poverty* | | | | | |
| 0-199% FPL | -1.17 | 0.45 | (-2.1, -0.3) | -2.6 | 0.01 |
| 200%-299% FPL | 0.5 | 0.41 | (-0.3, 1.3) | 1.2 | 0.22 |
| 300%-399% FPL | 0.19 | 0.46 | (-0.7, 1.1) | 0.4 | 0.68 |
| Sex † Female | -0.43 | 0.22 | (-0.9, 0) | -2 | 0.049 |
| Race § | | | | | |
| White, non-Hispanic | -0.36 | 0.56 | (-1.5, 0.7) | -0.6 | 0.52 |
| Black, non-Hispanic | -0.5 | 0.38 | (-1.2, 0.2) | -1.3 | 0.19 |
| Asian, non-Hispanic | 1.75 | 0.63 | (0.5, 3) | 2.8 | 0.01 |
| Supportive Neighborhood¶ | 0.24 | 0.27 | (-0.3, 0.8) | 0.9 | 0.37 |
| Safe neighborhood** | | | | | |
| Definitely agree | 0.004 | 0.52 | (-1, 1) | 0.01 | 0.99 |
| Somewhat agree | 0.09 | 0.53 | (-0.9, 1.1) | 0.2 | 0.86 |
| School Safety** | | | | | |
| Definitely agree | 0.04 | 0.42 | (-0.8, 0.9) | 0.1 | 0.93 |
| Somewhat agree | -0.28 | 0.48 | (-1.2, 0.6) | -0.6 | 0.55 |
| No. of amenities in Neighborhood†† | | | | | |
| 1 | -0.31 | 0.58 | (-1.5, 0.8) | -0.5 | 0.59 |
| 2 | -0.42 | 0.48 | (-1.4, 0.5) | -0.9 | 0.39 |
| 3 | -0.06 | 0.48 | (-1, 0.9) | -0.1 | 0.89 |
| All 4 amenities | 0.55 | 0.36 | (-0.2, 1.3) | 1.5 | 0.13 |

*Reference category is >=400% FLP
†Reference category is male
§Reference category is Others
¶ Reference category is Not living in a supportive neighborhood
** Reference category is Somewhat or definitely disagree
††Reference category is Neighborhood does not contain any amenities

## DISCUSSION

The current study aims to provide insight on how personal and environmental factors framed by the ICF affect participation in physical activity and sport within the population of children with CP. The analysis assumed to identify an association with gender, race, poverty levels, neighborhood support, number of neighborhood amenities, and sport and club participation outside school as factors influencing participation in physical activity and sport. This insight will provide necessary information on the specific factors that facilitate participation and which factors are a barrier to participation in sport and physical activity within the population of children with CP.

Caregivers can use this information to increase participation in physical activity and sport for children with CP and raise awareness within their communities. It is important for communities to become educated regarding the needs of children with CP to become more inclusive and facilitate the recommended participation in physical activity for children with CP. For caregivers in the lower FLP category, community awareness is crucial to gain access to opportunities they are not able to afford outside the community. According to the results from Table 2, children of families within 0-199% FLP category had a 70% lower probability of participating in sports or lessons outside school compared to children within the 400% FLP or above category. The results found in Table 4 concur with Table 2. Table 4 shows the probability of children with CP participating in sports was 69% lower in children within the constructs of the 0-199% FLP category as compared to those in the 400% FLP category or above. Of children with CP that live in supportive neighborhoods (57.8%), 39% live in poverty according to published guidelines. Of children with CP that does not live-in supportive neighborhoods (42.2%), 21.2% live in poverty.

Support from a neighborhood or community can be a facilitator for participation in physical activity for a child with CP but it can also be a barrier when there is a lack thereof. Another study found that participation in physical activity within the population of children with CP was primarily in social and community settings (Palisano et al., 2009). A supportive neighborhood that provides equal opportunities for all children with CP to participate in community activities facilitates more participation in physical activity. It was found in data analyses that gender and racial inequities were additional factors influencing participation in physical activity within adolescents with CP. Shown in Table 2, the probability of a child participating in sports was 40% lower in females compared to males. Additionally, the results found in Table 4 show female children have a 35% lower probability in participating in sports compared to males. In Table 4, the probability of a child participating in sports was 5.75 times higher in children in the Asian race category as compared to the children within the constructs of the others race category. As seen in Table 3, white children were 4.48 times higher than children in the others race category to meet the physical activity guidelines. The current study found that children with CP participated in "exercise, play sport or physical activity" for 60 minutes or more on 0 days of the week was 24.7%, 1-3 days was 46.6%, 4-6 days was 13% and everyday was 15.8% respectively. It is important for a community to be diligent in providing equal opportunities for participation in sport and physical activity within the population of children with CP regardless of gender or race.

The most notable association of participation in physical activity among children with CP was found based on the number of amenities within the residential neighborhood. A neighborhood amenity includes any space that provides recreational or

social activities to residents (Merriam-Webster 2021). This study examined the presence of neighborhood amenities such as sidewalks or walking paths, parks or playgrounds, a recreation center, community center or a boys' and girls' club. Of the participants within this study, 16.9% live in neighborhoods with 0 amenities, 9.5% live in neighborhoods with 1 amenity, 16.9% 2 amenities, 18.2% 3 amenities, and 38.5% 4 amenities respectively. Based on the results found in Table 3, the probability of a child participating in physical activity every day of the week rather than some days are 2.91 times higher in children that live in a neighborhood with 2 amenities compared to none, 4.17 times higher in children living in neighborhoods with 3 amenities and 85% higher in children that live in a neighborhood with 4 amenities. The study Watson et al (2016), showed that children who live in neighborhoods without amenities were less likely to be physically active. While this study did not solely examine participants with CP, it shows a significant association of physical activity participation and the presence of neighborhood amenities.

It can be observed in Table 4 that there was a noticeable association between access to a recreation center, community center, or boys' and girls' club and participation in physical activity. This shows that there is an association between children with CP participating in physical activity and the availability of accessible and accommodating opportunities for children with CP within a community. A previous study found that children who lived in a neighborhood with a recreation center reported participation in physical activity on more days (Cooper & Murphey, 2014). Though racial and gender inequities are present, the results of this study show a supportive neighborhood with

accommodating facilities and neighborhood amenities facilitate participation in physical activity within the population of children with CP.

Limitations and Strengths

Along with all other studies, this study has limitations that include missing data and the use of data that may no longer relevant because of more recent published data sets. Missing data can be extrapolated using the missing completely at random, missing at random (MAR), and missing at not random techniques. This study assumed the data held to the MAR technique which was used for the multiple imputation method. There is a possibility that updated survey data could provide different results than the data used for this study. An additional limitation of this study was self-reported data. Self-reported data can be a limitation depending on the education level of the respondent and how they comprehend the questions within the survey as misinterpretation of the question is possible. Respondents may also report data in a more favorable way to prevent stigmatization or how they think the researcher wants them to answer. Finally, this was a secondary data analysis which is limiting compared to using primary data. Secondary analysis can have many limiting factors including out of date data, data may not be authentic or genuine, and oftentimes does not specifically address the research question.

While using secondary data is a limitation of this study it is also a strength since it required little to no monetary or time cost. Other strengths of this study include the utilization of a well-designed, reliable, national study that contained a large sample size. A large sample size helps to decrease the chance of a violation of the MAR assumption. The survey was administered This study was strengthened through use of the data from

CAHMI (2016) which utilized robust sampling and survey methods from a nationally representative sample of children in the United States.

Implications

Children with CP classified on the five different GMFCS levels vary in their abilities to participate in physical activity and sport. Children with CP on level I can participate in physical activity and sport with fewer modifications required than a child who may be on level V of the GMFCS. It was found that children with CP on level I of the GMFCS had the highest percentage of participation in physical activities with peers in their community since they possess the ability to walk without restrictions (Palisano et al., 2009). It is critical to distinguish between the capabilities of children within the different levels of GMFCS to provide appropriate modifications facilitating participation in physical activity and sport for children with CP on all levels of the GMFCS. There were also findings that children with CP on levels IV and V of the GMFCS participated in activities outside of the home which supports the statement previously stated that neighborhood support can facilitate participation (Palisano et al., 2009). It is recommended that future research be conducted in distinguishing facilitators and barriers to participation in physical activity between children with CP on the different GMFCS levels. It is important for clinicians, rehabilitation professionals, and movement science specialists to be knowledgeable in the different requirements a child with CP may need depending on their GMFCS categorization to facilitate participation in physical activity and sport.

Clinicians, rehabilitation professionals, and movement science specialists can use this study's results to gear their services toward the promotion of regular participation in

physical activity for children diagnosed with CP who are not regularly participating or experiencing newfound barriers. These professionals can use the ICF as a guideline for each client to provide accurate, individualized activities for children with CP to partake in outside of their services which will advance the child from a therapeutical standpoint and facilitate regular participation in physical activity outside the clinic. The body function category of the ICF used in this study refers to factors influencing participation in physical activity and sport, such as mobility of joints, muscle tone, and control of movements. Professionals can focus on increasing mobility within joints, breaking up pre-existing tone in the muscles, and movement control techniques. These areas of focus during treatment can help a child with CP have more functional muscles and more sufficient muscle control allowing them to participate in physical activities and sports they were not able to prior. Clinicians, rehabilitation professionals, and movement science specialists can use the results from this study to improve their knowledge on facilitators and barriers to physical activity participation within the population of children with CP. By improving their knowledge on these factors, they can refer these children to appropriate facilities based on their demographics, specific needs according to the ICF, and classification within the GMFCS. Clinicians, rehabilitation professionals, and movement science specialists can also use the results of this study to focus treatment plans on the barriers children with CP experience within the body function category of the ICF that limit participation in physical activity. Utilizing comprehensive patient care plans, eases the burdens on caregivers by providing straightforward information for supporting the needs of children with CP. These plans also help administrators in the

referred facilities and/or programs to better promote participation in physical activity or sport for children with CP.

The environmental factors category of the ICF includes areas that may influence participation in physical activity and sport such as community and familial support, relationships, and attitudes, human-made changes to the environment and services, systems, and policies for physical activity and sport for children with disabilities such as CP within the community. Social support and access to opportunities to participate in physical activity or sport were found to be the most influencing factor to participation in this study. Depending on which area the client in need is lacking, clinicians, rehabilitation professionals, and movement science specialists can use the framework of the ICF to identify factors limiting participation for their client and then can provide access to opportunities to participate in physical activity or sport or refer the family to an outlet of social support based on their client's particular needs. If clinicians, rehabilitation professionals, and movement science specialists use the framework of the ICF to focus on these implications within treatment plans and provide appropriate information explained previously to caregivers, participation in physical activity and sport for children with CP can be increased.

REFERENCES

Astarita, C. (2017, December 11). *What is the difference between muscle tone and strength?* Breakthrough intensive physical therapy. https://www.breakthroughptli.com/the-difference-between-muscle-tone-and-strength/#:~:text=Muscle%20TONE%20is%20defined%20as,stretch%20or%20change%20in%20direction.

Azur, M. J., Stuart, E. A., Frangakis, C., & Leaf, P. J. (2011). Multiple imputation by chained equations: What is it and how does it work? *International Journal of Methods in Psychiatric Research*, *20*(1), 40–49. https://doi.org/10.1002/mpr.329

Bloemen, M., Backx, F., Takken, T., Wittink, H., Benner, J., Mollema, J., & Groot, J. (2014). Factors associated with physical activity in children and adolescents with a physical disability: A systematic review. *Developmental Medicine & Child, 57*(2), 137-148. https://doi.org/10.1111/dmcn.12624

Çankaya, Ö. & Seyhan, K. (2016). ICF-CY-based physiotherapy management in children with cerebral palsy. *Cerebral palsy: Current steps*. https://doi.org/10.5772/64255

Carroll, K. L., Leiser, J., & Paisley, T. S. (2006). Cerebral palsy: Physical activity and sport. *Current Sports Medicine Reports*, *5*(6), 319–322. https://doi.org/10.1007/s11932-006-0060-x

Caspersen, C., Powell, K., & Christenson, G. (1985) Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public Health Reports Journal, 100*(2),126–131.

Cerebral Palsy Alliance. (1997). *Gross motor function classification system (GMFCS)*. Retrieved April 01, 2021, from https://cerebralpalsy.org.au/our-research/about-

cerebral-palsy/what-is-cerebral-palsy/severity-of-cerebral-palsy/gross-motor-function-classification-system/

National Institutes of Health. (2013). *Cerebral palsy: Hope through research.* National institute of neurological disorders and stroke. https://www.ninds.nih.gov/Disorders/Patient-Caregiver-Education/Hope-Through-Research/Cerebral-Palsy-Hope-Through-Research#top

Child and Adolescent Health Measurement Initiative (CAHMI), Data Resource Center for Child and Adolescent Health. (2018a). *2016 National Survey of Children's Health (NSCH).* Child and Family Health Measures and Subgroups, SAS Codebook, Version 1.0. Retrieved [03/24/21] from www.childhealthdata.org

Child and Adolescent Health Measurement Initiative (2017a). *2016 National Survey of Children's Health (2017), Sampling and Survey Administration*. Data Resource Center, supported by Cooperative Agreement 1-U59-MC06980-01 from the U.S. Department of Health and Human Services, Health Resources and Services Administration (HRSA), Maternal and Child Health Bureau (MCHB). Available at www.childhealthdata.org. Revised 04/26/17.

Child and Adolescent Health Measurement Initiative (2018b). *Fast Facts: 2016-2017 National Survey of Children's Health.* Data Resource Center for Child and Adolescent Health, supported by Cooperative Agreement U59MC27866 from the U.S. Department of Health and Human Services, Health Resources and Services Administration's Maternal and Child Health Bureau (HRSA MCHB). Available at www.childhealthdata.org. Revised 9/26/2018.

Child and Adolescent Health Measurement Initiative (2017b). *2016 National Survey of Children's Health (NSCH): Guide to Topics & Questions Asked*. Retrieved [03/24/21] from www.childhealthdata.org

Child and Adolescent Health Measurement Initiative, (2017c). *2016 National Survey of Children's Health (NSCH) (SAS) [Constructed Data Set]*. Data Resource Center for Child and Adolescent Health supported by Cooperative Agreement U59MC27866 from the U.S. Department of Health and Human Services, Health Resources and Services Administration (HRSA), Maternal and Child Health Bureau (MCHB). Retrieved [03/24/21] from www.childhealthdata.org.

Cooper, M., & Murphey, D. (2014, October). *Neighborhood characteristics and children's physical activity.* City trends. https://www.childtrends.org/wp-content/uploads/2015/08/2014-54NeighborhoodExercise.pdf

Das, S. P., & Ganesh, G. S. (2019). Evidence-based approach to physical therapy in cerebral palsy. *Indian Journal of Orthopaedics, 53*(1), 20–34. https://doi.org/10.4103/ortho.IJOrtho_241_17

Feehan, K., O'Neil, M. E., Abdalla, D., Fragala-Pinkham, M., Kondrad, M., Berhane, Z., & Turchi, R. (2012). Factors influencing physical activity in children and youth with special health care needs: A pilot study. *International Journal of Pediatrics,* 4. https://doi.org/10.1155/2012/583249

Feitosa, L.C., Muzzolon, S., Rodrigues, D., Crippa, A., & Zonta, M. B. (2017). The effect of adapted sports in quality of life and biopsychosocial profile of children and adolescents with cerebral palsy. *Revista Paulista de Pediatria : Orgao Oficial da*

*Sociedade de Pediatria de Sao Paulo*, *35*(4), 429–435. https://doi.org/10.1590/1984-0462/;2017;35;4;00001

Hassani Mehraban, A., Hasani, M., & Amini, M. (2016). The comparison of participation in school-aged cerebral palsy children and normal peers: A preliminary study. *Iranian Journal of Pediatrics, 26*(3), e5303. https://doi.org/10.5812/ijp.5303

International Classification of Functioning, Disability, and Health. ICF. (2001). Geneva: WHO.

Kelly, M. & Darrah, J. (2005). Aquatic exercise for children with cerebral palsy. *Developmental Medicine and Child Neurology, 47*(12), 838-842. https://doi.org/10.1111/j.1469-8749.2005.tb01091.x

Kim, D., Cho, M., Park, Y., & Yang, Y. (2015). Effect of an exercise program for posture correction on musculoskeletal pain. *Journal of Physical Therapy Science, 27*(6), 1791–1794. https://doi.org/10.1589/jpts.27.1791

Latash, M. L., & Zatsiorsky V.M. (2016). Muscle tone. *Biomechanics and Motor Control*, 85-98. https://doi.org/10.1016/B978-0-12-800384-8.00005-3

National Institute of Neurological Disorders and Stroke. (n.d.) *Hypertonia information page.* Retrieved from https://www.ninds.nih.gov/Disorders/All-Disorders/Hypertonia-Information-Page

Matheri, J. M., & Frantz, J. M. (2009). Physical activity levels among young people with physical disabilities in selected high schools in Kenya and their perceived barriers and facilitators to participation. *Journal of Community and Health Sciences, 4*(1), 21–6. http://hdl.handle.net/10566/120

Merriam-Webster. (n.d.). Amenity. In *Merriam-Webster.com dictionary.* Retrieved April 17, 2021, from https://www.merriam-webster.com/dictionary/amenity

Ortiz-Castillo, E. M. (2011). *Physical activity patterns and factors influencing physical activity participation among adolescents with physical disabilities in urban communities.* (Publication No. 3493243) [Doctoral dissertation, Ohio State University]. ProQuest Dissertations and Theses Global.

Palisano, R., Kang, L., Chiarello, L., Orlin, M., Oeffinger, D., & Maggs, J. (2009). Social and community participation of children and youth with cerebral palsy is associated with age and gross motor function classification. *Physical Therapy & Rehabilitation Journal, 89*(12), 1304-1314. https://doi.org/10.2522/ptj.20090162

Palisano, R., Rosenbaum, P., Walter, S., Russell, D., Wood, E., & Galuppi, B. (1997). Development and reliability of a system to classify gross motor function in children with cerebral palsy. *Developmental Medicine & Child Neurology, 39*(4), 214–223. https://doi.org/10.1111/j.1469-8749.1997.tb07414.x

Rosenbaum, P., Paneth, N., Leviton, A., Goldstein, M., Bax, M., Damiano, D., Dan, B., & Jacobsson, B. (2007). A report: The definition and classification of cerebral palsy april 2006. *Developmental Medicine and Child Neurology, 109*, 8–14.

Ryan, J. M., Cassidy, E. E., Noorduyn, S.G., & O'Connell, N.E. (2017). Exercise interventions for cerebral palsy. *The Cochrane Database of Systematic Reviews*, *6*(6), CD011660. https://doi.org/10.1002/14651858.CD011660.pub2

Schaible, B., Colquitt, G., Caciula, M. C., Carnes, A., Li, L., & Moreau, N. (2018). Comparing impact on the family and insurance coverage in children with cerebral

palsy and children with another special healthcare need. *Child: Care, Health and Development*, *44*(3), 370–377. doi: 10.1111/cch.12547

Schiariti, V., & Mâsse, L.C. (2014). Identifying relevant areas of functioning in children and youth with cerebral palsy using the ICF-CY coding system: From whose perspective? *European Journal of Paediatric Neurology*, *18*(5), 609–617. https://doi.org/10.1016/j.ejpn.2014.04.009

Shariat, A., Shariat, A., Abedi, A., & Tamrin, S.B.M. (2014). Physical activity as a prescription for the children with cerebral palsy. *Russian Open Medical Journal*, *3*(1), 1–4. https://doi.org/10.15275/rusomj.2014.0108

Stavsky, M., Mor, O., Mastrolia, S.A., Greenbaum, S., Than, N.G., & Erez, O. (2017). Cerebral palsy-Trends in epidemiology and recent development in prenatal mechanisms of disease, treatment, and prevention. *Frontiers in Pediatrics*, *5*(21). https://doi.org/10.3389/fped.2017.00021

Straathof, E.J.M., Heineman, K.R., Hamer, E.G., & Hadders-Algra, M. (2021). Patterns of atypical muscle tone in the general infant population - Prevalence and associations with perinatal risk and neurodevelopmental status. *Early Human Development*, *152*. https://doi.org/10.1016/j.earlhumdev.2020.105276

The Royal Children's Hospital Occupational Therapy Department (2018). Low muscle tone. *The Royal Children's Hospital Melbourne*. Retrieved April 01,2021, from https://www.rch.org.au/kidsinfo/fact_sheets/Low_muscle_tone/

U.S. Department of Health and Human Services. (2018). Physical activity guidelines for americans, 2nd edition. Retrieved from https://health.gov/paguidelines/second-edition/pdf/Physical_Activity_Guidelines_2nd_edition.pdf

Watson, K.B., Harris, C.D., Carlson, S.A., Dorn, J.M., & Fulton, J.E. (2016). Disparities in adolescents' residence in neighborhoods supportive of physical activity. *Morbidity and Mortality Weekly Report*, *65*(23), 598–601. https://doi.org/10.15585/mmwr.mm6523a2

Whitney, D. G., Kamdar, N. S., Ng, S., Hurvitz, E. A., & Peterson, M. D. (2019). Prevalence of high-burden medical conditions and health care resource utilization and costs among adults with cerebral palsy. *Clinical Epidemiology*, *11*, 469–481. https://doi.org/10.2147/CLEP.S205839

WHO (2001) International classification of functioning, disability and health. *World Health Organization, Geneva.*

Yang, K.T., Yin, C.H., Hung, Y.M., Huang, S.J., Lee, C.C., & Kuo, T.J. (2020). Continuity of care is associated with medical costs and inpatient days in children with cerebral palsy. *International Journal of Environmental Research and Public Health*, *17*(8). https://doi.org/10.3390/ijerph17082913