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Walking Stride Rate Patterns in Children and Youth

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Abstract

Purpose—To describe walking activity patterns in youth who are typically developing (TD) using a novel analysis of stride data and compare to youth with cerebral palsy (CP) and arthrogryposis (AR).

Method—Stride rate curves were developed from 5 days of StepWatch data for 428 youth ages 2 to 16 years who were TD.

Results—Patterns of stride rates changed with age in the TD group ($P = .03$ to $< .001$). Inactivity varied with age ($P < .001$); peak stride rate decreased with age ($P < .001$). Curves were stable over a 2-week time frame ($P = .38$ to $.95$). Youth with CP and AR have lower stride rate patterns ($P = .04$ to $.001$).

Conclusion—This is the first documentation of pediatric stride-rate patterns within the context of daily life. Including peak stride rates and levels of walking activity, this single visual format has potential clinical and research applications.

Keywords

activities of daily living; adolescent; age factors; arthrogryposis; cerebral palsy; child; locomotor activity; walking

INTRODUCTION

Strategies to evaluate and enhance day-to-day physical activity have included pedometer- and accelerometer-based step or stride counting devices.¹ Interpretation of pedometer- and accelerometer-based walking activity data is currently based on the levels of individual numeric variables of counts, steps or strides/day, percent time active, and/or some metric of intensity of walking activity.² Assessments of walking and physical activity through singular descriptive values or levels of activity do not capture the combined temporal descriptors within daily life that aid in understanding the day-to-day limitations created by the disabilities or health states being evaluated.^{3–5}

Currently, *patterns* of physical activity expressed as amounts of vigorous physical activity (vs moderate physical activity) appear to have a stronger and more consistent association to

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decreased obesity. More importantly, this relationship appears independent of levels of sedentary activity.⁶⁻⁹ Investigators of the relationship of pedometer-based physical and sedentary activity described in the literature to date have reported time spent in levels of physical activity or inactivity (moderate, vigorous, or sedentary) with “patterns” examined through linear or latent model regressions.^{10,11}

On the basis of the data from 22 studies, Tudor-Locke and colleagues reported a summary daily “expected” habitual step curve for ages 6 to 18 years.¹² These median steps/day data were presented separately by gender and for each chronological year, with the authors noting gender and environmental influences on habitual pedometer-based walking activity in children and youth.¹² Patterns of adult walking cadence were recently described in bands of steps/minute from accelerometer data gathered in the 2005-2006 US National Health and Nutrition Examination Survey (NHANES).¹³ Participants wore a waist-mounted accelerometer that recorded steps taken with each leg. Walking cadences greater than 100 steps/min were rare in this US population-based sample, but they did reach 60 steps/min for approximately 30 minutes/day. Levels of walking activity have been well documented in the literature, yet “patterns” of stride rate walking activity or cadence have not been described in children and youth.

The StepWatch Activity Monitor (SW), also known as Step Activity Monitor or SAM, is an ankle-worn two-dimensional accelerometer that functions like a pedometer, with excellent documented accuracy with respect to manual stride counts (step taken by 1 lower extremity) across varying speeds in children and adults with and without obesity.¹⁴⁻¹⁷ The day-to-day walking activity of children with obesity, muscular dystrophy, cerebral palsy (CP), and arthrogryposis (AR) has been documented with summary variables (ie, average strides/day, percent time walking) of SW stride data.¹⁸⁻²¹ SW data in ambulatory adolescents with CP have suggested significantly lower average strides/day and percent of time walking as motor impairments increase.¹⁸ This article describes the walking stride rate patterns of youth who are typically developing (TD) through a novel analysis of stride rate data collected with the SW. Stability of the derived stride rate curves developed over a 2-week period is examined with stride rate patterns of youth who are TD compared to youth with CP and AR.

METHODS

This descriptive cross-sectional comparison cohort study is a secondary analysis of data collected during an institutional review board–approved study of walking activity in youth who are TD with the SW device.²² Participants included a convenience sample of 428 youth who were TD (ages 2-15 years). A minimum of 60 youth (30 + girls) were included in each of 7 age groups 2 years apart (Table). Mean group stride trajectory or curve stability (test-retest) was examined through secondary analysis of SW data from 20 youth that were TD (10 boys, age groups 5 to 7 and 9 to 11 years) from the initial pediatric SW study in 2006.²³ Youth with CP who were ambulatory (n = 81), ages 10-13 years, and classified at Gross Motor Function Classification System (GMFCS) levels I to III from a study of physical activity, health status, and quality of life,^{24,25} and youth with amyoplasia and distal AR (n = 13, 9 with amyoplasia) were compared to age-matched TD cohorts.¹⁹ The youth with AR were all independently ambulatory in the community without assistive devices. All participants were recruited through focused mailings from 3 regional pediatric specialty care hospitals with written informed consent obtained prior to data collection. The participants were predominately Caucasians with the percent of parents having a college degree ranging from 32 to 100 (Table).

Participants were instructed to wear the SW device during all of their waking hours except when swimming or bathing for 7 consecutive days while wearing their current orthotics and/

or using assistive devices for mobility as needed. A 2-dimensional accelerometer, the SW is designed and validated to assess when the heel of 1 leg leaves the ground (1 stride) during walking activity within day-to-day life.¹⁷ Height and weight as well as observation of walking with the device on was used to individually program the SW to each participant's walking stride pattern. Visually observed strides were counted and compared to the SW stride counts with the average calibration accuracy (device counts divided by manual count of observed strides) found to be excellent ranging from 97.7% to 101.4% across all study cohorts (Table). Noncompliance was defined as days with more than 3 hours of inadequate monitoring (ie, upside down) or no stride counts during waking hours (6:00 AM-10:00 PM), which were unexplained (ie, swimming/bathing). Five days of data (4 week days and 1 weekend day) were analyzed.

Data for the trajectory or curve stability (test-retest) analysis were from the original StepWatch study of youth who were TD²³ and followed the same protocol, except they were instructed to wear the SW for 14 consecutive days. Five days of week 1 (4 weekdays/1 weekend day) were compared to the same 5 days in the week 2. The mean group trajectory or curve ($n = 20$) and 95% confidence band for week 1 was graphed with week 2 for visual and statistical analysis. Data were collected only during the months of March through May.

ANALYSIS METHODS

For each participant, the SW recorded the walking activity as strides during 1-minute epochs (strides/min) during the 24-hour day. Data for each day were tabulated and minutes spent at each stride rate, ranging from zero strides/min to the peak strides/min, were counted. The average minutes spent at each stride rate (strides per minute) were calculated across all 5 days (4 weekdays and 1 weekend day) to generate a representative stride activity trajectory or curve. The “minutes spent at each stride rate” data were not normally distributed and skewed heavily to the right since participants spent less and less time at higher stride rates and a large amount of time each day not walking. One strategy to make nonnormal data resemble normal data and to facilitate visual interpretation is by using a transformation. Logarithmic transformation is a common technique for changing the visual presentation or graphing of the data in statistics.²⁶ It shrinks the scale of the data, with larger shrinkage for larger values and smaller shrinkage for small values. The transformation squeezes the scale for lower stride rates while magnifying the scale for higher stride rates. This is important for this analysis because higher stride rates are typically of most interest in terms of function and often represent a large percentage of the number of strides achieved, yet almost always have a shorter amount of time during which they are achieved. Thus, we employed a log transformation of the average minutes as the “y” axis against stride rate on the “x” axis. The group mean curve and 95% confidence interval for time spent (y-axis) at each stride rate (x-axis) were generated using point-wise means and SDs. Instead of simply connecting the discrete data points (time spent) for each stride rate, we generated smooth curves using a lowess estimator.²⁷ This technique basically smoothes out the bumps in the plotted raw data and retains the overall trend and shape to allow better visual analysis.

We further compared the mean stride rate trajectories (log-scale) across the TD age groups (2 to 3 year age group as reference group) and gender using the Hotelling T^2 , assuming the trajectories or plotted curves follow a multivariate normal distribution. Because the Hotelling T^2 test requires trajectories of the same length (ie, time spent at every stride rate), comparison was restricted to a range of stride rates with complete data. For this analysis, data from 0 to 60 strides/min range were examined for the TD sample with 0 to 40 and 0 to 60 strides/min ranges for the CP and AR analyses, respectively. We also examined mean stride rate trajectories between youth with CP and AR and an age-matched TD cohort. The levels of walking stride inactivity (child not walking or zero strides/min, start of curve on

the vertical axis) and peak stride rates (end of curve on horizontal axis) were compared across TD age groups and between youth with CP and AR as compared to age-matched TD cohorts using analysis of variance. The stability (test-retest) analysis of the mean group trajectories or curves was examined with the Hotelling T^2 test.

To interpret the profile curves, the vertical position (y -axis) of a curve at any point indicates how much time the individual spent, on average, at the stride rate corresponding to the horizontal position (x -axis) of the curve at that point. Figure 1 displays the profile curve developed for the 2 to 3 year age group of the cross-sectional TD cohort ($n = 60$, 30 boys). The relative level where the curve starts on the y -axis describes the average amount of time in minutes per day subjects were not walking or were inactive. For the 2- and 3-year-old group, average inactivity (nonwalking or zero strides/min) was 16.78 hours during a 24-hour day (Figure 1, dot A). Time spent at a given stride rate represents the number of minutes recorded at that exact rate. To calculate time spent in a particular stride rate range requires summing the time at each point within that range. On average, a typically developing 2- to 3-year-old child from this sample, spent 5 minutes daily walking at the intensity of 31 strides/min (Figure 1, dot B). The ambulatory curve profiles are plotted on a natural log scale with corresponding values in minutes to the left of the log scale on the y -axis. Where a curve ends on the horizontal axis defines the highest stride rate reached during the entire monitoring period. The highest (peak) stride rate of 101 strides/min was reached by only 1 child (thus no variance) in the 2- and 3-year-old group (Figure 1, dot C). When comparing an individual activity profile to a reference or normative population profile, mean curves outside of the 95% confidence interval (CI) would be considered statistically different.

Statistical and graphical analyses as well as all data manipulations were conducted with the public domain R statistical software version 2.10.1 (R Development Core Team, 2009). Existing functions within R software supported the plotting and smoothing of the walking stride rate trajectories for walking activity curve development.

RESULTS

The walking stride rate curves from the youth who were TD (mean group stride rate trajectories and 95% CI) by age groups are presented in Figure 2 with minutes non-walking (zero strides/min) and peak stride rate summary data reported in the Table. The time spent inactive each day (level of curve on vertical axis) appears to represent a U shaped nonlinear relationship ($P < .001$) from 2 to 15 years of age. Visually, the mean group trajectory curves change with the 2- to 7-year-old children having similar stride rate trajectories and 8- to 15-year-old youth demonstrating a greater amount of time in the 40 to 60 strides/min range. Mean group trajectories of stride rates up to 60 stride/min for all age groups (Figure 2) were significantly different than the referent 2- to 3-year-old group ($P = .03$ to $< .001$). The mean peak strides/min rates significantly decrease from 80.6 strides/min for 2- and 3-year-old children to 64.2 strides/min for the 14- and 15-year-old group ($P < .001$, Figure 2, Table). There is increasing variability (wider CIs) at the peak stride rates with age as well as fewer participants reaching the highest stride rates. Analysis of mean group trajectory curves by gender of the combined groups or within groups noted no significant differences ($P = .08$ to $.78$). Combining age groups revealed no significant difference between boys and girls for minutes/day inactive or mean peak stride rate attained ($P = .09$ and $.1$, respectively). Relative short-term stability (test-retest over 14 days) of the curves derived from the summation of 5 days of monitoring is displayed in Figure 3 and suggests no significant difference by visual and statistical analysis ($P = .38$ to $.95$).

Figures 4 to 7 display the walking stride rate curves developed for the combined 81 youth with CP (dotted lines), by GMFCS levels and 121 gender- and age-matched youth with TD

(solid lines/gray area 95% CI). Nonwalking time per day (zero strides/min) for the combined sample of youth with CP was significantly higher at 1104.3 (110.6) minutes/day vs 976.6 (91.1) (Table, Figure 4, $P < .001$) than the TD comparison cohort with peak stride rate attained significantly lower (65 [11] vs 68 [7.3] $P < .001$). The stride rate trajectory curve is significantly lower for youth with CP than youth who were TD between stride rates of 0 to 40 ($P < .001$). Youth with CP at GMFCS level I walked significantly less on average than the TD cohort (0 strides/min, $P < .001$, see Figure 5). Peak stride rates were similar for youth with CP and the TD cohort (median = 67 stride/min, range 44-90, $P = .56$). Mean group trajectories of stride rates up to 55 stride/min were not significantly different ($P = .09$, $T^2 = 141.65$, $F = 1.41$, $df = 69$). Upon visual inspection of mean group trajectories, they demonstrate greater variability than the youth that were TD in minutes per stride rates between 20 and 60. Youth functioning at GMFCS level II (Figure 6) walked significantly less (inactivity or 0 strides/min, $P < .001$) and had significantly lower group mean trajectories of stride rates up to 50 strides/min than did the TD cohort ($P < .001$, $T^2 = 222.37$, $F = 2.67$, $df = 79$) with similar peak stride/min rates (median = 65, range 55-79, $P = .14$). The curve for youth with CP at GMFCS level II is flatter in the mid ranges of stride rates and lower by visual inspection. Compared to the TD cohort, youth at GMFCS level III (Figure 7) demonstrated significantly higher levels of inactivity (0 strides/min, $P < .001$) with lower peak stride rates (median = 60, range 13-81, $P < .001$) and mean group trajectories of stride rates up to 50 strides/min ($P < .001$, $T^2 = 552.36$, $F = 8.53$, $df = 69$). This is consistent with mean group stride rate trajectories outside the 95% confidence band for the TD cohort by visual analysis between 10 and 50 strides/min and a peak strides/min of 70. Visual analysis alone of Figures 2 to 4 may appear to suggest there was no difference between youth with CP and the TD cohort at 0 strides/min rate (level of curve at y -axis). This is due to the scaling with log transformation with significantly higher levels of inactivity found with regression analysis for each GMFCS level as compared to the TD cohort.

Children and youth with AR ($n = 13$, ages 6-15 years) were compared to 306 age-matched youth who were TD in Figure 8. The average time spent inactive (nonwalking or zero strides) is significantly higher (1063.6 [100.7] min/day) than the comparison TD cohort (969.7 [94.2], $P < .001$, see Table). Mean peak stride rate attained (right end of curve) for youth with AR of 70.9 [6.9] stride/min was not significantly different than the TD cohort (69.0 [7.5], $P = .36$). Mean group trajectories curve is also significantly lower for youth with AR than youth that are TD between 0 and 60 strides/min range ($P = .04$).

DISCUSSION

This work presents walking stride rate patterns generated for a convenience sample of youth that were TD across the ages of 2 to 15 years with summation of minutes spent across stride rates based on 5 days of monitoring with the SW. Walking inactivity (zero strides/min) data suggest that the 62 preschool participants (4 to 5 years) on average spent more time walking each day than older elementary school aged children (6 to 9 years). This is in contrast to Cardon and Ilse DeBourdeaudhuij's²⁸ findings, which reported low daily step counts with a waist worn pedometer (Yamax Digiwalker SW-200) in 129, 4- to 5-year-old children as compared to published step data from older school age children in Belgium. These differences may be a function of attachment site, type of device, and/or potential undercounting of the quick stepping of young children.

Level and shape of the patterns (mean group trajectory curves) for the TD cohort appear to change significantly with increasing age and the peak stride rates attained decreased significantly with age. These changes may be a function of increasing leg length, personal and/or environmental factors in this cohort. No significant gender difference by age group or

within age groups was found, which also contrasts with the published single variable pedometer data that document girls walking less than boys.^{3,5,28,29} This literature is based on secondary analysis of combined data sets with convenience samples that included from 334 to 1954 participants. The difference in these gender outcomes maybe due to the attachment of waist-mounted devices possibly disrupted more during toileting by girls than boys compared to the ankle-worn SW, which would not be affected during clothing rearrangement. The stability (test-retest) of the mean group stride rate trajectory curves developed through novel analysis of SW data over 14 days appears acceptable and supports the use of the curves for further psychometric testing of discriminative and evaluative validity.

Data presented in this article suggest that children with CP and AR have mean group trajectories or patterns of stride rates that are significantly lower than the TD cohort by visual and statistical analysis with significantly higher levels of inactivity (nonwalking or zero strides/min) on average each day. These findings may suggest that walking activity limitations for youth with CP and AR within the context of daily life may be related to limitations in the ability of an individual and/or group to increase stride rate and/or time at a stride rate to meet the demands of day-to-day life. This lack of variability in walking rate within daily life is consistent with clinical observations in these populations. In light of recent discussions surrounding how aspects of variability are related to the normal development of motor skills, Edelman theory of neuronal group selection suggests that this lack of variation maybe due to a limited repertoire of neuronal networks or impaired selection.³⁰ This work is consistent with the premise that variability (of stride rates) is considered necessary for normal development and movement, while lack of variability is characteristic of developmental delay and/or neurological disorders.³¹

Children with CP appear to have patterns or trajectories of day-to-day walking stride rate activity that differ from that of an age-matched TD comparison cohort and that these patterns also vary by GMFCS levels. All youth with CP on average spent significantly less time walking (0 strides/min) than the TD cohort regardless of GMFCS level. The youth with CP who were highest functioning (level I) were not significantly different than the comparison cohort for patterns (mean group trajectory) of time spent across stride rates or in peak stride rates attained. This is consistent with clinical observations that youth classified at level I, are generally able to keep up with their peers who are typically developing when walking. Youth at levels II and III demonstrated significantly lower patterns of stride rates that are consistent with the relative functional limitations seen clinically in walking levels, rates, and peak speeds for each GMFCS level. As expected, the lowest patterns of stride rates (mean group trajectories) were documented for youth who use assisted devices to walk (youth with CP at level III) with a statistically significant lower peak stride rates attained as compared to the TD cohort.

Examining stepping cadence patterns from the NHANES 2005-2006 data set, Tudor-Locke and colleagues recently proposed 60 steps/min (30 SW stride/min) as the minimum for “slow walking” and 100 steps/min (50 SW strides/min) as the lower level for “brisk walking” for adults with the waist-mounted Actigraph.¹³ They reported that 100 steps/min was rare in the adults’ 20 years of age or older, yet they appear to spend approximately 30 min/day in cadences of 60 + step/min or 2500 steps/day. Our data documented that typically developing 2- to 3-year-old children spend 5.46 min/day at 30 strides/min (slow walking by adult definitions) and 1.97 min/day at a rate of 50 stride/min or “brisk walking.” In contrast, adolescents aged 14 to 15 years spend on average 4.62 minutes at 30 stride/min and 2.64 minutes each day on average at 50 stride/min. Consistent with clinical observations, the combined sample of 10- to 14-year-old youth with CP spends on average only 2.48 minutes at 30 stride/min and 59 seconds at 50 stride/min. Youth with AR from our convenience

sample were a bit more active than the youth with CP walking on average 3.65 min/day at the low level of slow walking (30 stride/min) and reaching “brisk walking” for 1.39 minutes. As Tudor-Locke *et al*/noted,⁵ further research is necessary to examine association of these cadence or stride rate patterns to various indicators of health and physical function (ie, obesity, cardiovascular disease) and for individuals with physical limitations the relationship to day-to-day mobility and participation.

A number of factors may influence these stride rate patterns in these convenience samples of youth who are TD and youth with CP and AR. Presently, it is unknown what the influence of ethnic/genetic makeup, body mass, cardiorespiratory capacity, home, neighborhood, child care policies, school environment, and time spent in required sedentary activities is on these stride patterns.^{32,33} The shape of these stride rate curves or patterns may vary by day of the week, season of the year, and/or throughout adolescence into adulthood.

How does this apply to outcome measurement in effectiveness research and/or clinical management? Stride activity with the SW is a measure of what a child is really “doing” in the context of personal factors as well as day-to-day environment (eg, *performance* of the activity of walking).³⁴ In contrast, 3-dimensional gait analysis (3DGA) or a 6-minute walk test (6MWT) measures a child's ability to perform in a structured environment when asked to do so (eg, *capability* of walking). The relationship of 3DGA and/or 6MWT output to SW data has not been explored. To gauge the influence of interventions, day-to-day walking stride rate patterns will need to be explored along with the numerous personal and/or environmental factors and in relation to participation in day-to-day life.

Changes in walking patterns or trajectories of stride rates may be helpful in documenting functional walking mobility over time. If a child can walk on average more each day and at higher stride rates for longer period of times, this may generalize to activities requiring speed and endurance (ie, playing soccer). In such a scenario, the overall total average stride count may remain relatively the same while the pattern of average stride rate changes (as compared to baseline), with a lower starting point on the *y*-axis, a higher trajectory of mean stride rates across the *x*-axis and end further along the *x*-axis documenting a higher peak stride rate (Figure 1). Thus, if only the variable of “average strides/day” was examined for change over time versus stride rate patterns potentially important functional daily change would have been missed.

This novel method of SW stride rate analysis has the potential to describe walking activity patterns within the context of day-to-day life relative to level of inactivity, time spent across stride rates (pattern) and peak rates attained. Such analysis may be quickly and easily contrasted to a nonimpaired cohort's walking stride rate curves and 95% CIs by visual analysis. Clinically, pre- and postintervention patterns (trajectory curves) may be visually and/or statistically compared along with other measures of physical activity and participation in day-to-day life. Further work is needed to expand this analysis method to large population-based samples of youth who are TD to potentially develop a reference cohort across ages and/or genders. The SW software will need to include the processing capability required to create these profile curves for it to be accessible for clinical application.

Walking stride rate patterns appear to change significantly with age in youth who are TD, with no significant differences in these stride rate patterns by gender with the SW. These stride rate trajectories or curves appear to have acceptable stability within 14 days for trajectories derived from 5 days of monitoring in children ages 5 to 11 years. Stride rate pattern analysis with the SW appears sensitive to the day-to-day walking limitations of children with physical impairments as compared to youth who are TD. This single format

visual “snapshot” analysis of walking stride rate patterns may complement and expand the interpretation of outcome measures related to walking activity during day-to-day life. The future development of walking stride rate curves (similar to anthropometric growth curves) is supported by this preliminary work.

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Fig. 1.

An example of stride rate curve or pattern interpretation with curves developed from 60 children who were typically developing, aged 2 to 3 years. Walking activity stride rate curves (mean group trajectory of minutes spent at increasing stride rates) represented by dark lines and 95% confidence interval (vertical lines) across stride rate levels. A = level of inactivity or nonwalking time per 24-hour period, B = average min/day spent at 30 strides/min, and C = minutes at peak (highest) strides/min rate attained by an individual in the age group.

Fig. 2. Walking stride rate curves or patterns (mean group trajectories and 95% confidence intervals) by 7 age groups for children aged 2 to 15 years (n = 428) with a combined plot of mean group trajectories.

Fig. 3. Walking stride rate curves or patterns (mean group trajectory of minutes spent at increasing stride rates and 95% confidence interval) from the same 5 days of monitoring of week 1 (solid line) compared to week 2 (dotted line) of 20 youth who were typically developing (age groups 5 to 7 and 9 to 11 years, 10 boys).²³

Fig. 4. Walking stride rate curves or patterns (mean group trajectory of minutes spent at increasing stride rates and 95% confidence interval) for youth with cerebral palsy (CP, $n = 81$) at Gross Motor Function Classification System (GMFCS) levels I to III compared to 121 youth that were typically developing aged 10 to 13 years.

Fig. 5.

Walking stride rate curves or patterns (mean group trajectory of minutes spent at increasing stride rates and 95% confidence interval) for youth with cerebral palsy (CP, $n = 31$) at Gross Motor Function Classification System (GMFCS) level I compared to 121 youth that were typically developing aged 10 to 13 years.

Fig. 6. Walking stride rate curves or patterns (mean group trajectory of minutes spent at increasing stride rates and 95% confidence interval) for youth with cerebral palsy (CP, $n = 30$) at Gross Motor Function Classification System level II compared to 121 youth who were typically developing aged 10 to 13 years.

Fig. 7.

Walking stride rate curves or patterns (mean group trajectory of minutes spent at increasing stride rates and 95% confidence interval) for youth with cerebral palsy (CP, $n = 30$) at Gross Motor Function Classification System (GMFCS) level III compared to 121 youth who were typically developing aged 10 to 13 years.

Fig. 8. Walking stride rate curves or patterns (mean group trajectory of minutes spent at increasing stride rates and 95% confidence interval) for youth with arthrogryposis (AR, $n = 13$) compared to 306 youth who were typically developing, all ages 6 to 15 years.

TABLE

Participant Characteristics for Cross-Sectional and Stability Analysis Cohorts of Youth Who Were Typically Developing (TD) and Youth With Cerebral Palsy (CP) and Arthrogryposis (AR)

TD Age Group (n)	% Female	Average Age yrs (SD)	% Caucasian	% College Degree	% Calibration Accuracy (Range)	Mean Inactive Time Minutes/day (SD) ^a	Mean Peak Stride/min ^a Rate attained (SD)
2-3 yrs (60)	50	3.0 (.6)	73.3	38.3	99.2 (90-104)	1009.4 (66.2)	80.6 (9.1)
4-5 yrs (62)	50	5.0 (.6)	77.4	50.0	100.0 (91-104)	958.4 (69.2)	77.6 (7.3)
6-7 yrs (62)	48	7.1 (.6)	78.7	60.7	101.4 (91-105)	929.3 (78.0)	74.3 (7.2)
8-9 yrs (63)	49	9.0 (.6)	84.1	41.3	99.7 (90-105)	950.9 (74.8)	70.5 (6.2)
10-11 yrs (61)	49	11.0 (.6)	83.3	50.0	100.2 (94-102)	961.4 (95.3)	68.6 (7.2)
12-13 yrs (60)	50	13.0 (.5)	81.7	38.3	99.9 (92-105)	991.9 (84.5)	67.1 (7.4)
14-15 yrs (60)	50	15.1 (.6)	76.7	46.7	100.4 (92-106)	1017.4 (110.9)	64.2 (5.4)
Total (428)	49.5	8.9 (4.0)	79.3	46.5	100.1 (93-102)	—	—
TD- Test-retest Analysis ²³							
5-7 yrs (10)	50	7.8	80	100	98.6 (100-93)	—	—
9-11 yrs (10)	50	10.6	80	100	97.7 (100-92)	—	—
CP & AR/TD cohort							
CP 10-13 yrs (81) ¹⁸	48	11.8 (1.3)	77.8	32.1	99.5 (90-107)	1104.3 (110.6) ^a	65 (11) ^b
GMFCS Level I (31)	55	12.0 (1.3)	74.2	32.3	99.8 (93-105)	1053.2 (89.8)	67 (10)
GMFCS Level II (30)	50	11.6 (1.4)	80.0	36.7	99.9 (93-104)	1073.7 (82.9)	65 (12)
GMFCS Level III (20)	35	11.8 (1.2)	80.0	25.0	98.4 (90-107)	1229.1 (78.5)	60 (11)
TD (10-13 yrs (121)	49.6	12.0 (1.2)	82.5	44.2	100 (92-112)	976.6 (91.1)	68 (7.3)
AR 6-15 yrs (13) ¹⁹	38.5	10.2 (3.1)	84.6	46.2	100.4 (95-102)	1063.6 (100.7) ^a	70.92 (6.9) ^c
TD 6-15 yrs (306)	49.3	10.9 (2.9)	80.9	47.4	100.3 (90-112)	969.7 (94.2)	68.96 (7.5)

Abbreviations: ANOVA, analysis of variance; GMFCS, Gross Motor Function Classification System.

^a $p < .001$.

^b $p < .02$.

^c $p = .36$.