The Pediatric Temporal-spatial Deviation Index (TDI) was developed as a single score with spastic CP and would correlate to GDI scores in children with CP.

Temporal-spatial gait parameters were assessed using an instrumented mat for 75 typically developing children and 17 children with cerebral palsy (CP). Barefoot walking was tested at a self-selected speed along a 6-meter path. Marker trajectories were recorded with 3D gait kinematics for GDI calculation. PCA was performed to decouple the highly interrelated gait parameters into a set of independent components. The first six principal components retained >98% of the original data.

Kaiser-Meyer-Olkin test of sampling adequacy was used to assess 26 collected candidate parameters with measuring indices for GDI calculation. Candidate and final Pediatric TDI features included: normalized velocity, cadence, left and right normalized step length, normalized step length asymmetry, left and right step length coefficient of variation (CoV), normalized averaged step width, and single limb support asymmetry.

The raw Pediatric TDI was formulated with natural log to emphasize deviation about the typically developing mean. The Pediatric TDI correlated with average GDI (r=0.610, p=0.009), and demonstrated sensitivity (0.778) and specificity (0.875) to gait function, assessed with GDI.

**Background**

Identification of pediatric gait abnormalities using easily-administered gait evaluation can promote more effective treatment and provide quantified assessment of treatment outcomes. Emerging inertial sensors may easily measure temporal-spatial parameters in the clinic and could serve as useful tools for clinical assessment of gait.

**Aims**

To develop an easily-administered metric to quantify gait impairment in children and to assess its use in children with cerebral palsy (CP).

**Hypothesis**

The Pediatric Temporal-spatial Deviation Index (TDI) was developed as a single score index of gait deviation with an average score of 100 for typically developing children. We hypothesized that Pediatric TDI values would be significantly lower in children with spastic CP and would correlate to GDI scores in children with CP.

**Methods**

**Participants and data collection**

Temporal-spatial gait parameters were assessed using an instrumented mat for 75 typically developing children and 17 children with spastic CP aged 7 to 11 years, Gross Motor Function Classification System (GMFCS) levels III.

**Gait analysis**

- Gait temporal-spatial parameters were assessed using a GAITRite instrumented mat (CIR Systems, Inc., Sparta, NJ).
- For each child, three to four “best effort” trials with a total of at least 12 footfalls were analyzed.

**3D Gait Kinematics for GDI calculation**

- Bestfit walking was tested at a self-selected speed along a 6-meter path. Marker trajectories were recorded with an 8-camera optoelectronic system for 3D motion analysis (Motion Analysis, Santa Rosa, CA), sampling rate 100Hz.

**Construction of Index**

The Pediatric TDI was developed using principal component analysis (PCA). Under-sampling, and cross-validation were used to address the larger typically developing compared to CP sample size.

**Feature Selection**

- Kaiser-Meyer-Olkin test of sampling adequacy was used to assess 26 collected candidate parameters with measuring indices for GDI calculation.
- Final 9 features included: normalized velocity, cadence, left and right normalized step length, normalized step length asymmetry, left and right step length coefficient of variation (CoV), normalized averaged step width, and single limb support asymmetry.

**Balancing data and PCA**

- A balanced fold was generated in each cross-validation step by combining a single leave-one-out fold from the CP group with a single fold from the K-folded typically developing group using the weighting parameter wCP = 2. Total folds K=11; total number of cross-validation folds was 105.
- PCA was performed to decouple the highly interrelated gait parameters into a set of independent components.

**Index Generation**

- The six principal components describe a gait component vector z for each sample.
- The raw Pediatric TDI was formulated with natural log to emphasize deviation about the typically developing mean.
- Raw Pediatric TDI was mapped to a z-score such that the typically developing population averages at 100 and SD±10.
- The z score and final Pediatric TDI of each participant α were defined respectively as

\[ z_{\text{TDI}} = \frac{\text{Pediatric TDI} - 100}{10} \]

The Pediatric TDI had a stronger Pearson’s correlation with TDI than any individual gait parameter except for normalized step width.

**Results**

**Discussion & Impact**

The Pediatric TDI is an easily-administered, revealing gait metric that correlates with average GDI and demonstrated sensitivity (0.778) and specificity (0.875) to gait function, assessed with GDI. Detection of gait abnormalities in the clinic can expedite diagnosis and treatment.

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