# Baseline assessment of pulse wave velocity and carotid distensibility in adolescents with cerebral palsy: A pilot study

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## ABSTRACT

Impairments in mobility place youth with cerebral palsy (CP) at a higher risk of physical inactivity, a major risk factor for cardiovascular disease. The consequences of reduced levels of physical activity (PA) on vascular health in adolescents with CP have not been evaluated. Baseline arterial stiffness was assessed using pulse wave velocity (PWV) and distensibility in nine 10 to 18 year old patients with CP (7 males; age 13 ± 2.4 yrs) and compared to nine 10 to 16 year old controls (7 males; age 11.3 ± 3.1 yrs). GMFCS levels I to III were included, with each subject being ambulatory or ambulatory with assistive devices. Data for the control population were previously collected in our laboratory (Proudfoot, 2010). Baseline measurements of whole body PWV were taken using electrocardiography and photoplethysmography. PWV was calculated using the distance (sternal notch to the dorsalis pedis artery) and time delay between ventricular depolarization and the foot of the dorsalis pedis waveform. Carotid distensibility, a direct measure of central artery stiffness, was assessed using a combination of B-mode ultrasound imaging and applanation tonometry. Brachial artery blood pressures were determined using an automated sphygmomanometer. There were no significant differences in whole body PWV between the CP (4.2 ± 0.3 m/s) and control (4.0 ± 0.7 m/s) groups (p=0.560). However, carotid distensibility was significantly lower in the CP group (0.0069 ± 0.0019 $mmHg^{-1}$) than the control group (0.0101 ± 0.0033 $mmHg^{-1}$) (p<0.05). These findings indicate that youth with CP have increased central artery stiffness at rest. This decline in vascular health at a young age may increase risk of cardiovascular disease into adulthood. Future research will further evaluate conduit artery structure and function in adolescents with CP. By identifying potential compromises to vascular health in this clinical population, appropriate interventions and precautionary measures can be taken at the earliest possible stage.

## BACKGROUND

- CP describes a group of disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain[1].
- Adolescents with CP are at a higher risk of having sedentary lifestyles in comparison to age and sex matched controls[2].
- One therapeutic goal for youth with CP is to improve the ability to walk / perform other functional activities in an attempt to increase and maintain habitual levels of PA[3].
- The expanded and revised gross motor function classification system (GMFCS-ER) is used to classify the functional abilities of youth 12 to 18 years of age
  - 5-level system based on self-initiated movement, levels based on functional limitations, the need for mobility devices and quality of movement[4].

| GMFCS Level | Description | # of participants in current study |
|---|---|---|
| Level I | Walks without limitations | 5 |
| Level II | Walks with limitations | 3 |
| Level III | Walks using a hand-held mobility device | 1 |
| Level IV | Self-Mobility with limitations; may use powered mobility | 0 |
| Level V | Transported in a manual wheelchair | 0 |

**Figure 1: GMFCS General Headings, adapted from GMFCS - E & R © Palisano, R. et al, 2007.**
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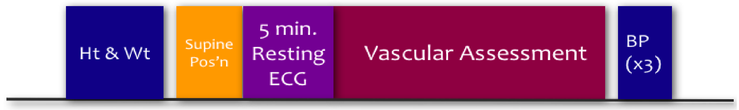
## RATIONALE

- Declines in functional abilities and motor skills prove detrimental to levels of habitual PA performed by individuals with CP, which may have negative long-term implications on cardiovascular (CV) health.
- Accelerometer measurement of PA has been shown that youth (9-15 yrs) with lower levels of PA are at a significantly higher risk for developing cardiovascular disease (CVD) compared to the more active participants[2].
- It is well established that CV risk factors are identifiable in childhood and are predictive of future CV risk[5].
- The prevention of premature vascular aging and exposure to CV risk factors may be most effective when initiated in childhood or adolescence[6].

- **PURPOSE: to determine whether individuals with CP experience declines in vascular structure and function at rest in comparison to their healthy controls.**

## METHODS

- 9 participants with CP and 9 controls completed the protocol:

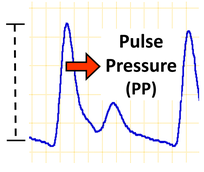


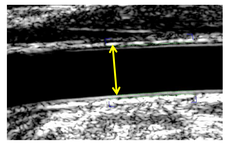

**Measurements**

- Heart Rate (HR): ECG recorded continuously
- Brachial Blood Pressure (BP): Automated sphygmomanometer
- Carotid artery images: B-mode ultrasound (10 MHz)
- Carotid artery BP: hand-held tonometer, calibrated to brachial B
- Vascular Function: Measures of arterial stiffness:
  - i) Carotid distensibility
  - ii) Whole body PWV: ECG to dorsalis pedis (DP) artery
- Vascular Structure: Carotid intima-media thickness (IMT) measurements were determined from the carotid artery images using a semi-automated edge detection software program

**Carotid Distensibility:**

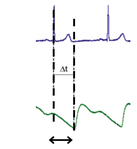
$$\frac{\Delta CSA}{(PP)\ (CSAmin)}$$

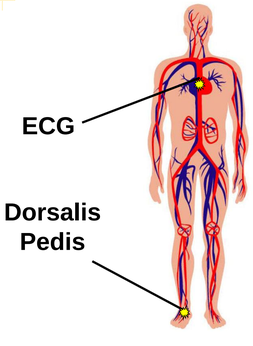


**Whole-body PWV:**

$$\frac{\text{Distance between sites (m)}}{\text{Pulse Transit Time (s)}}$$




## RESULTS

**Table 1. Participant Characteristics**

| | CONTROL (N=9) | CP (N=9) |
|---|---|---|
| Age (yrs) | 11.3 ± 3.1 | 13.1 ± 2.3 |
| Height (m) | 1.5 ± 0.2 | 1.4 ± 0.1 |
| Weight (kg) | 41.9 ± 18.2 | 44.3 ± 12.4 |
| BMI ($kg/m^2$) | 17.8 ± 3.2 | 19.7 ± 3.3 |
| BMI Percentile | 52 ± 25 | 55 ± 25 |
| Resting HR (bpm) | 74 ± 8 | 73 ± 10 |
| Resting Systolic BP (mmHg) | 105 ± 6 | 111 ± 11 |
| Resting Diastolic BP (mmHg) | 54 ± 4 | 62 ± 7 * |
| Resting MAP (mmHg) | 70 ± 4 | 82 ± 7 ** |

Note: Values are represented as means ± SD. HR, Heart rate; BMI, Body mass index; BP, Blood pressure; MAP, Mean arterial pressure. * indicates p≤0.05 ** p<0.001. N=7 for Ht, Wt, BMI and BMI Percentile values.

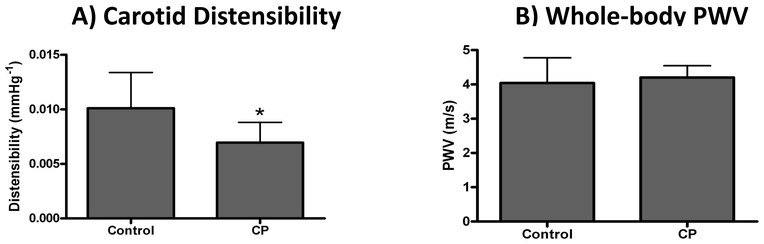



**Figure 2: Comparisons of indices of vascular health between the control group and CP group (N=9).**
Values are means ± SD. *p<0.05.

## CONCLUSIONS

- There were no significant differences in whole-body PWV and carotid IMT between the control and CP group.
- Carotid distensibility and mean diameter were significantly lower in the CP group.
- Significant increases in MAP and DBP were seen in the CP group versus the control group.
- The CP group therefore has declines in vascular function, increased pressure and decreased lumen diameter, at rest, in comparison to their healthy controls.
- This information may assist with monitoring CV risk for this group of adolescents with potentially lower levels of habitual PA and adverse effects on vascular health.
- Future research should examine exercise interventions and their effects on vascular health in addition to the effort made in the development of strategies to improve the levels of PA youth with CP.

## REFERENCES

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## ACKNOWLEDGEMENTS

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We would like to thank the participants and their families.