STUDY TITLE: Postural Control Intervention With the Robotic Trunk-Support-Trainer (TruST) in Children with Cerebral Palsy: A Randomized Controlled Trial

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STATISTICAL DESIGN AND POWER

Statistical Design: The overall design of this study is a prospective Randomized Clinical Trial with two treatment groups.

Randomization Procedure: We will use a computer-generated blocked randomization stratified by GMFCS and age with concealed prospective allocation to the two treatment groups. We will follow *intention-to-treat principles*. Randomization will occur after the baseline assessments for each cohort have been completed, since knowledge of each child's age and GMFCS are needed before randomization.

Blinding: We will blind all people involved with the study to the extent possible.

- Dr. Santamaria will not be blind to treatment allocation because he will be responsible for supervising/delivering the postural training with TruST and the static trunk support with other two PhD candidates. The allocation of the people delivering the intervention will be counterbalance in each of the sample blocks. All personnel will be trained to optimize standardization, safety, and fidelity of the protocol. Dr. Santamaria has clinical expertise in pediatric rehabilitation, and has been the first author and physical therapist delivering the motor learning-based intervention in our previous proof-of-concept and feasibility study.
- All kinematic data analyses will be coded using file names changed by Dr. Santamaria and Karen Chin (research coordinator) to random code names. In this way, a doctoral student blinded to group assignment will analyze kinematic data: postural star-sitting test (area of stable sitting control), modified functional reaching test, and kinematic postural and reaching outcomes.
- Blinded evaluators, who are external to our research project, will perform all functional assessments, except for the postural star-sitting and modified functional reach tests. The Box and Blocks (B&B) will be videotaped and scored off-site by a blinded analyst with expertise in Datavyu software.

Statistical Analysis Plans

Aim 1: To investigate the efficacy of robotic-TruST and static-trunk interventions to improve *seated postural control* in children with bilateral CP.

> Our hypothesis is that children with CP level GMFCS III-IV receiving postural training with TruST and static support will improve sitting control. However, children receiving the TruST-intervention will attain a greater level of postural control during independent sitting.

Expected Outcome: We predict that both groups will demonstrate improvement in postural sitting control at activity-based (postural star-sitting test and functional reach test) and performance (kinematic postural tasks: static, active and proactive) levels, as evidenced by a significant interaction between treatment group and time session. Furthermore, we hypothesize that children receiving the TruST-intervention will show more robust postural improvements than children receiving static trunk support.

Analysis Plan: The effect of intervention on primary outcomes (i.e., postural measurements) and exploratory outcomes (e.g., trunk muscle dynamometry) will be analyzed with two-factor mixed analysis of variance (ANOVA) with group a between-subjects factor and test session a within-subjects factor. The test of the group by time interaction will be of primary interest and, if significant, will be followed with simple contrast tests. The Holm-Bonferroni procedure will be used to hold familywise Type I error rate to $\alpha = .01$ for the family of contrasts. Due to random assignment, we do not expect to find any meaningful baseline imbalances on observed covariates. Nevertheless, we will check standardized mean differences and variance ratios across groups at baseline and control for any imbalances (if any are found) in subsequent analyses. We will also add in covariates to the analysis, as discussed in the Research Strategy – GMFCS, GMFM (dimension B: sitting) and age.

Aim 2: To investigate the efficacy of robotic-TruST and static-trunk interventions to improve *upper extremity function* in children with bilateral CP.

> Our hypothesis is that children with CP level GMFCS III-IV receiving both TruST and static trunk interventions will improve reaching and dexterity. However, children receiving the TruST-intervention will improve upper extremity function more than those receiving training with static support.

Expected Outcome: We predict that the 2 groups will show upper extremity function in reaching-related variables during box & blocks (dexterity and video-coding analysis), as evidenced by a significant interaction between treatment group and time session. Furthermore, we hypothesize that children receiving the TruST intervention will show robust upper extremity improvements that can consequently improve motor function and ADLs.

Analysis Plan: As in Aim 1, a two-factor mixed ANOVA will be used to examine differences between groups at upper extremity tasks (B&B), reaching performance (kinematics and video-coding) and gross motor function (GMFM), in addition to our functional and participation outcomes (HABILHAND-Kids, Canadian Occupational Performance Outcome (COPM) and Participation and Environment Measure and Youth (PEM-CY)). We will also add in covariates to the analysis, as discussed in the Research Strategy – GMFCS, MACS and age.

Procedures for Handling Missing Data: All four children in our pilot study completed the pre- and post-intervention assessments. However, in the event that a number of children miss test sessions for unpredicted reasons (e.g. illness), we will implement Generalized Estimating Equations (GEE) to analyze events-in-trials following a repeated-measures procedure with subjects as clusters, test session as the within-subject variable (baseline, 1week post-training and 3mos follow-up assessments) and treatment groups (experimental and control) as the between-subject variable. A linear model will be selected, and the covariance structure will be specified as correlation matrix based on the quasi-likelihood under independence criterion (QIC) goodness of fit coefficient.

Sample size estimation: This study will primarily examine improvements in postural sitting control and upper extremity function in children with bilateral CP (GMFCS III-IV). Because of the novelty of our proposed robotic-TruST intervention and scarce literature in goal-oriented postural training with static trunk support, we rely on a combination of pilot data and previous literature to estimate reasonable effect size ranges for sample size calculation. *G-Power* (version 3.1.9.4. Dusseldorf University) and SPSS (version 25, IBM) were used to compute statistics and estimate the sample size of our study. Our primary outcome for this analysis is upper body balance during seated reaching (Pilot average = 30°, SD: 22°, n = 11) with an effect size (partial η^2: 0.10). Applying a mixed ANOVA with one between-subjects and one within-subjects factor with α = 0.01 (two-tailed), we estimate that 68 subjects (34 subjects per group) will be needed to achieve .8 power. We will recruit 20% more children than needed for the primary analyses, to account for group heterogeneity and possible dropouts; which adds a total of 82 subjects (41 subjects per group).