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Faculteit Revalidatiewetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

Evaluating sitting balance on the back of a horse in children with neurological disorders: reliability and responsiveness of a new assessment tool, the HippoTrunC

Allisha Aerts
Valerie Spreeuwers

Scriptie ingediend tot het behalen van de graad van master in de revalidatiewetenschappen en de kinesitherapie, afstudeerrichting revalidatiewetenschappen en kinesitherapie bij neurologische aandoeningen

PROMOTOR :
Prof. dr. Evi VERBECQUE

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CONTEXT

This research was conducted in fulfillment of the requirements for the degree of Master in Rehabilitation Sciences and Physiotherapy. One of the research lines within pediatric rehabilitation focuses on the investigation of postural control in children with neurological disorders. This master thesis is part of the larger study, in which the responsiveness, reliability and validity of the HippoTrunC, a measurement scale designed to examine postural control in children with neurological disorders on the back of a horse, is investigated. The study was initiated by Katrijne Severi, a physiotherapist at school and care institution 'Sint-Gerardus', Diepenbeek, who provides the hippotherapy. To assess the children's progress after receiving hippotherapy, she needed an outcome measure that was able to detect changes in sitting balance while the child was sitting on the back of the horse. However, no such measure was available. The project was funded by "Het Innovatiefonds – VZW Stijn". All data was collected at Sint-Gerardus. A central format was employed.

Among all neuromotor disorders affecting children, cerebral palsy (CP) is the most common (Facciolo et al., 2023), affecting 17 million people worldwide (Graham et al., 2016). It is characterized by musculoskeletal changes, including muscle weakness, spasticity, decreased muscle strength, and limitations in the range of motion of joints. (Russo et al., 2019; Findlay et al., 2016; Viruega et al., 2019; Yun et al., 2023). These motor disorders impact the development of typical motor functions and the acquisition of skills necessary to maintain balance and posture, which can result in delayed walking or the development of pathological gait patterns (Hunt et al., 2022; Jones et al., 2007).

Originally, the aim of this study was to build upon the work of former master's students Marie-Julie Bulen and Lore Boers to evaluate the responsiveness and reliability of the HippoTrunC. After delving deeper into the item level of the scale, a peculiar trend was observed in the performance data. Consequently, it was decided to refine the scoring criteria further before testing the psychometric properties of the scale.

Development of the research question was performed by the students in collaboration with the master thesis's promotor. The data were collected by Katrijne Severi and Els Schruers, physiotherapists from the Sint-Gerardus school. In the assessment of the 39 participants, scoring was independently conducted by the students in order to prevent the risk of data contamination for inter-rater reliability determination.

1 ABSTRACT

Background: Children with neurological disorders struggle with sitting balance. Although hippotherapy improves postural control, its immediate effect on sitting balance on horseback is unclear because a proper measurement scale did not exist yet. This study aims to evaluate the psychometric properties of the HippoTrunC, a novel scale for measuring sitting balance on horseback.

Method: Thirty-nine children with various neurological conditions, mean age (SD) 11.44 (3.11), were included in the study, covering all GMFCS levels. The HippoTrunC, consisting of 10 items evaluated with a 5-point scale (total score 6-50), was administered three times. Corrected scores were observed. Test-retest reliability was evaluated over one to two weeks using a two-way mixed model. Intra-rater and inter-rater reliability were measured with a two-way mixed model and one-way random model, respectively. The Trunk Control Measurement Scale (TCMS) was used as an anchor for responsiveness, first measured in November and again five months later. Differences in HippoTrunC were compared to TCMS changes (>0 and ≤0) over time, using Cohen's d.

Results: Corrected scores showed good intra-rater reliability (ICC= [0.670-0.997]), inter-rater reliability (weighted kappa= [0.516-0.820]), (ICC= [0.715-0.958]), and test-retest reliability (ICC= 0.691). No significant differences were found in HippoTrunC scores based on TCMS changes (Cohen's d= [0.168-0.374]).

Conclusion: The HippoTrunC is highly reliable but shows poor responsiveness when the TCMS is used as an anchor. Further research with a larger sample size or another anchor, for example the GAS is needed to improve generalizability and validate additional psychometric properties.

Keywords: 'hippotherapy', 'sitting balance', 'neurological disorders'.

2 INTRODUCTION

Sitting balance, known as the ability to balance the body's center of gravity above the support surface while in a seated position (Thijs et al.,2021) plays a crucial role in performing everyday tasks. Furthermore, controlling posture while sitting is essential for the execution of various tasks, such as self-care (Bertenthal & Von Hofsten, 1998), combing your hair, using the bathroom, or getting dressed (Cabanas-Valdés et al., 2021). Individuals who are unable to maintain a proper seated position while performing simple tasks may experience adverse effects in their routine activities during daily living (Lacoste et al., 2009). The role of postural control is crucial, particularly in maintaining balance during various movements and disturbances. Moreover, effective postural control involves the ability to manage the body's position in space to ensure stability and orientation, which is essential during dynamic activities such as horse riding. This dynamic environment can help stimulate and enhance postural control mechanisms. Pelvic control plays a significant role in maintaining overall body balance, as the alignment and movement of the pelvis affect the trunk's stability and coordination (Khallaf, 2020; Hessing, 2024). Hippotherapy is one of the various therapies in pediatric rehabilitation where pelvic control is trained. The technique is of particular interest to children with various neurological conditions, including cerebral palsy. The use of horses as therapeutic partners has gained attention due to the potential benefits for the improvement of postural control and balance (Hsieh et al.,2016). In recent years, several studies have investigated the effectiveness of hippotherapy, focusing on various outcome measures (Kang et al., 2012). Hippotherapy showed beneficial effects on the postural control and balance of children with CP (Zadnikar & Kastrin, 2011).

One of the challenges in this research field is the development of reliable and sensitive measurement tools to assess changes in postural control and balance in children while seated on the back of a horse. It is important to ascertain whether the maintenance of postural control in a seated position improves after exposure to hippotherapy and the application of external disturbances. Therefore, it is important to create a scale which offers valuable insights into alterations of sitting balance within a clinical context. In this regard, the "Hippotherapy Trunk Control Scale" (HippoTrunC), developed in 2021 by Katrijne Severi in collaboration with previous master's students Kaat Hombroux and Aude Van Dessel in 2021, shows promise. This scale was specifically designed to evaluate sitting balance in children with

neurological disorders during hippotherapy sessions. The development of the scale resulted from the integration of three pre-existing measurement instruments: the Gross Motor Function Measure (GMFM), the Sitting Assessment Scale (SAS), and SATCo (Adair et al., 2012; Butler et al., 2010).

The two preceding master's theses have laid the foundation for understanding the reliability and responsivity of the HippoTrunC scale in this target population. In their respective studies, they gained valuable insights into the applicability of this scale and the potential effects of hippotherapy on sitting balance. However, there are still some opportunities for further research. Compared to the Trunk control measurement scale (TCMS), the last version of the HippoTrunC scale exclusively identifies variations among children who demonstrate low scores on the TCMS. Therefore, it seems that the HippoTrunC is more suitable for children with a weaker performance, as it is more sensitive for children with higher GMFCS levels (Bulen & Boers, 2023). When examining scores per item in relation to the GMFCS level, it was observed that higher functioning children sometimes scored lower than those with a higher GMFCS level. This contradicts expectations, as postural control in a sitting position tends to decrease as GMFCS classification rises (Mendoza et al., 2015). Based on these findings, adjustments of the individual items of the HippoTrunC are necessary to enhance the discriminative ability of the scale and its associated sensitivity to change. To see if these adaptations make a difference, psychometric properties of the scale such reliability and responsiveness need to be evaluated.

The aim of this study is to modify the HippoTrunC in such a way that there is a clear item hierarchy, enabling discrimination at the item level. Following these modifications, it is crucial to assess whether this new scale is also reliable within the same rater, between raters, and across different measurement occasions. It is necessary to ascertain whether this adapted scale is sensitive to detecting changes in seated balance on the horse compared to a reliable and responsive anchor measuring seated balance off the horse, such as the TCMS.

3 METHOD

3.1 Study design

To investigate the responsiveness and different forms of reliability for the recently modified HippoTrunC, an observational, prospective, longitudinal study was performed. This study investigated the intra-rater, inter-rater and test-retest reliability of the measurement scale. Data collection commenced at baseline in November 2023, followed by a one-to-two-week interval to evaluate test-retest reliability. After a period of five months, a third and final assessment was conducted to determine the responsiveness.

3.2 Participants

A group of 39 children from the “Sint-Gerardus'' school and healthcare facility located in Diepenbeek, Belgium, were included in this study. Inclusion criteria for the study involved children aged between 3 and 18 years with a neurological disorder who performed at least one hippotherapy session before the study commenced. Children needed to have the ability to communicate in a verbal or non-verbal way. Participants were categorized for analyses based on their GMFCS level. Children with conditions other than CP were also classified based on GMFCS. All levels of the Gross Motor Function Classification System (GMFCS) were considered for inclusion. Exclusion criteria included an inability to comprehend, or to follow short, straightforward instructions.

Informed consent was obtained from both potential participants and their parents or guardians before their involvement in the study. This research project received approval from the University of Hasselt Medical Ethics Committee (B1152021000028).

3.3 Outcome measures

3.3.1 Primary outcome measures

HippoTrunC

The HippoTrunC is a measurement scale which is designed to evaluate the head stabilization, trunk control and sitting balance on the back of a horse. The measurement scale consists of ten items, each requiring scoring on a scale from one to five points. A score of one indicates the subject's inability to execute the item or the necessity for maximal support to perform the task, while a score of five indicates that the subject fluently and independently executes the task without any need for compensation.

All item scores are summed (maximum: 50 points) to determine the 'subtotal score'. Based on the amount of support given, the subtotal score is corrected, i.e. the corrected score. For certain types of assistance, downgrade scores are applied. When a subject is wearing a plaster corset, the total score is downgraded with two points. One point is subtracted from the total score when the subject is wearing an elasticated corset or uses stirrups while performing the test. Subjects who need to be accompanied by a therapist sitting behind them on the back of the horse for physical support also receive a downgrade score of one point. If a therapist sits behind the subject without providing support, but solely out of the child's fear to fall, no points are subtracted. Each downgrade score is subtracted from the total score in the end, with a maximum subtraction of four points. As such the corrected score ranges between 6 and 50 points.

The HippoTrunC was originally composed based on three already existing measurement tools: the Gross Motor Function Measure (GMFM), the Sitting Assessment Scale (SAS) and SATCo (Adair et al., 2012; Butler et al., 2010). These measurement tools are found to be reliable and valid tools to assess sitting balance. The preceding master's theses on the HippoTrunC showed that the scale is a reliable measurement tool, and that it is able to detect large changes in subjects' personal goals. However, the scale was only able to detect these differences in children who scored weakly on the TCMS (Bulen & Boers, 2023). A boxplot of the different item scores as a function of the GMFCS level was made to investigate the score distribution at item level across GMFCS levels I-V, which can be found in ***Appendix 1***. Boxplots of the total score pre-intervention and post-intervention were also made to look at the general trend regarding GMFC level, as shown in Figure ***2 and Appendix 1 Figure 1.10*** respectively. Even

though the corrected total score resulted in some differentiation between GMFCS levels, the item performances did not (Figure 1). Based on the motor level, a decrease in total score with increasing GMFCS level was expected. However, analyses of the data showed that children classified at GMFCS levels III and V exhibited superior performance compared to anticipated outcomes. Meaning that their performance on specific items surpassed that of their peers classified at GMFCS levels I or II, a phenomenon counterintuitive given the prevailing expectation of diminished performance among the latter cohort (Figure 1). A plausible explanation for this phenomenon may lie in inadequate consideration of the level of support provided to participants during the testing process. Considering these findings, it can be concluded that the scoring criteria of the items should be revised to allocate a more accurate score, thus ensuring similar changes as measured using the TCMS.

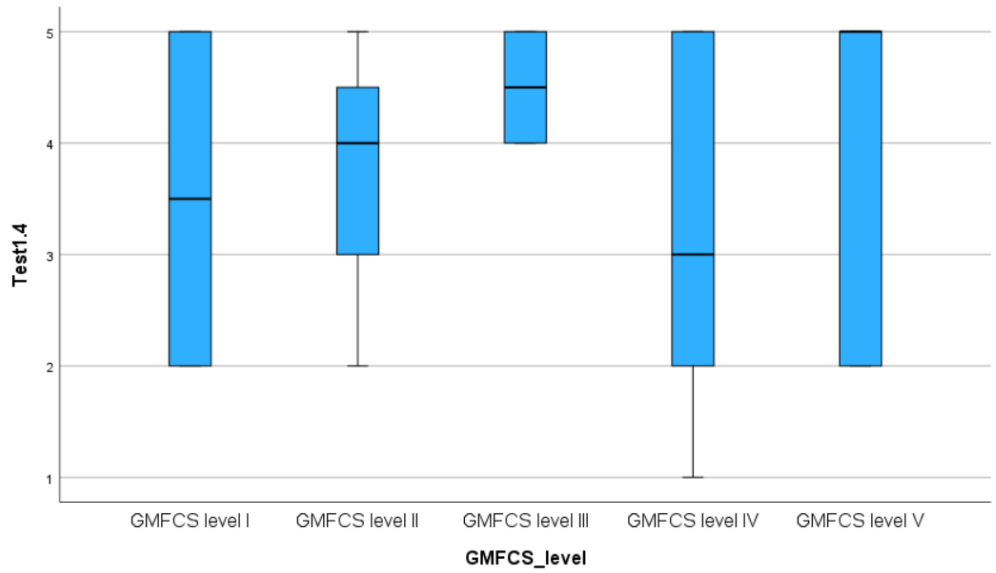


Figure 1. Boxplot item 4 HippoTrunC 2022-2023

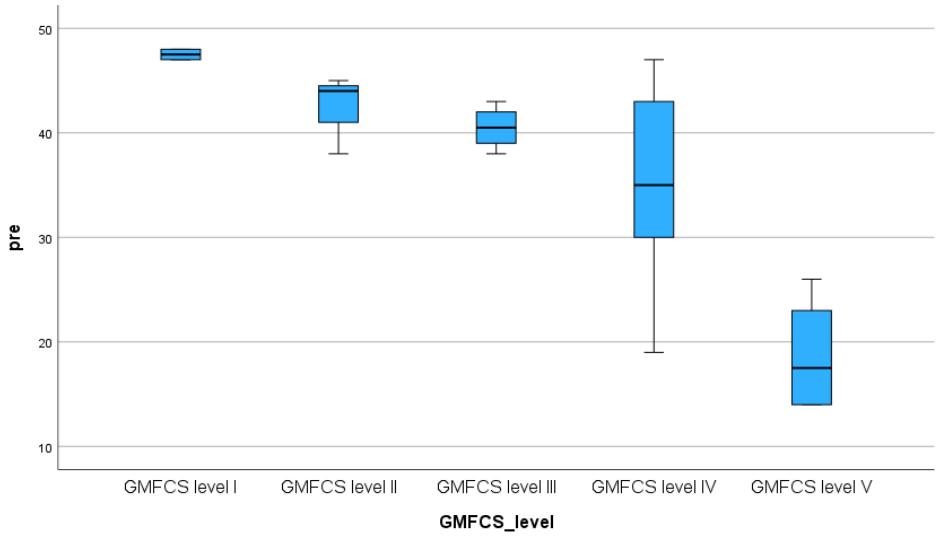


Figure 2. Boxplot pre-intervention scores HippoTrunC 2022-2023

Appendix Table 1, 2 and 3 present an overview of the adaptations and constitution of the HippoTrunC, together with the new version of the HippoTrunC

3.3.2 Secondary outcome measures

The anchor-based method aimed to ascertain the correspondence between alterations registered through the HippoTrunC and those reported by the treating therapist. By using this method, the observed changes were linked to the seated trunk control (TCMS serving as an anchor), providing a validation of the amount of change measured with the HippoTrunC compared to established measures.

Trunk control measurement scale (TCMS)

The TCMS evaluates both static and dynamic trunk control. It assesses static sitting balance, dynamic reaching and selective motor control. Additionally, it identifies any compensatory actions during the execution of the tasks, which then offers insights into the quality of performance (López-Ruiz et al., 2023). The TCMS consists of fifteen items, with scoring based on an ordinal scale ranging from two to four points. The total score of the test equals 58 points, distributed as follows: 20 points for static balance, 28 points for selective movement control, and 10 points for dynamic reaching ability. The total score ranges between 0 and 58, with higher scores representing better performances. The scale has good reliability and validity in children with CP between 8 and 15 years old (Pham et al., 2016).

3.4 Procedure

Since the tests are being scored based on videos, the testing and scoring are divided across multiple steps over time, summarized in ***Figure 3***.

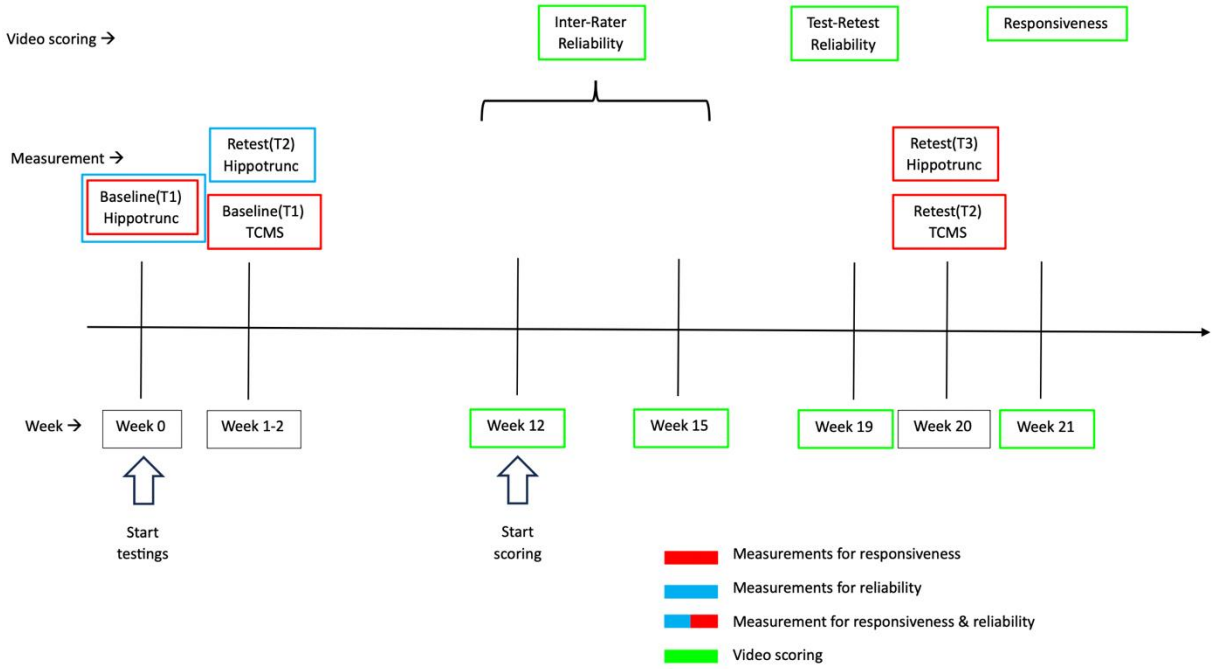


Figure 3. Visual representation of the testing and scoring procedure

3.4.1 Evaluation

Before implementing adjustments to the scoring criteria, several tests were initially scored by the raters using the latest version of the HippoTrunC, aiming to pinpoint specific areas of concern. Based on these evaluations, annotations were made regarding areas for improvement, which were subsequently integrated into the reformulation of the scoring criteria. The scoring criteria underwent refinement and modification in collaboration with domain experts K.S and E.S over a span of three months, commencing in November 2023. The final and definitive adjustment to the scale was executed in January 2024. A detailed description of the adjustments is shown in ***Appendix Table 1 and 2.***

A total of 39 children were scored, with 11 children performing their first test in November 2023, their test- and scoring- procedure is detailed in ***Figure 3.*** Test administrations took place

during the hippotherapy sessions at 'Sint-Gerardus' in Diepenbeek. The remaining 28 participants had been tested between October 2022 and March 2023, following the same test sequence as depicted in ***Figure 3*** (Bulen & Boers, 2023). Each test administration was recorded by a setup comprising four GoPro cameras, each positioned at a distinct angle (HERO8). ***Appendix Figure 1*** provides an overview of the camera setup. For this study, footage from these test administrations was scored by two independent assessors (A.A and V.S) using the updated version of the HippoTrunC. The assessors did not communicate during the scoring process to prevent data contamination. Following the completion of scoring for all videos, a consensus meeting between the two assessors was convened to discuss various observations regarding the scoring process. The administration of the HippoTrunC and TCMS tests were conducted by clinical experts K.S and E.S.

3.4.2 Assessment for reliability and responsiveness

One week after the HippoTrunC's baseline measurement, participants were reevaluated to examine test-retest reliability. The third test administration of the HippoTrunC took place five months after the baseline test, as illustrated in ***Figure 3.*** Responsiveness of the HippoTrunC was determined based on this measurement. The TCMS assessment was first administered one week after the initial HippoTrunC test. The second administration of the TCMS was conducted when the third HippoTrunC assessment took place. To assess the HippoTrunC's ability to detect changes, the variations in participants' scores were compared with the changes in TCMS scores.

3.4.2.1 Reliability

Reliability refers to the extent to which a measurement tool consistently produces the same results when used multiple times under the same conditions (Jhangiani et al., 2015). In this study, three different forms of reliability were measured, intra-rater reliability, inter-rater reliability, and test-retest reliability. Intra-rater reliability is described as the degree of agreement between two or more measurements which were conducted by the same assessor (Aarts & De Koning, 2018). Inter-rater reliability can be defined as the ability to measure the consistency among different observers (Jhangiani et al., 2015). Test-retest reliability assesses the consistency of scores over time when measuring a presumed consistent construct.

The scoring was conducted by two researchers, each independently carrying out the assessments. First, 39 children were assessed simultaneously and compared between the two raters to determine inter-rater reliability. Four weeks after the initial scoring of the video recordings in February, the same footage of eight children was reassessed by the researchers to determine intra-rater reliability. The one-month interval is based on COSMIN guidelines to prevent recall bias (Mokkink et al., 2010). To determine the test-retest reliability of the scale, participants were scored a second time, one week after the initial assessment. Again, for this component, researchers scored their tests simultaneously. The process is visualized in ***Figure 3.***

3.4.2.2 Responsiveness

The term responsiveness denotes the ability of a measurement instrument to assess genuine changes. A measurement instrument is deemed sufficiently responsive when it can demonstrate clinically relevant outcomes (Beurskens et al., 2006). In November, the anchor was administered alongside the HippoTrunC, as shown in ***Figure 3*** and then again five months later. The change in the anchor served as the basis for determining whether the change in the HippoTrunC was correlated with it. According to Lopez-Ruiz et al., 2023, a Minimal Clinically Important Difference (MCID) of 5.15 points was established for the TCMS.

3.5 Data-analysis and statistical analysis

3.5.1 Global view relationship item score and GMFCS level

To examine how the different item scores relate to the GMFCS level, boxplots were created to visually represent the relationship.

3.5.2 Reliability

Various statistical techniques were utilized using Statistical Package for the Social Sciences (SPSS) Statistics version 29.0.0.0 (241). For each type of reliability, the differences between test moments and raters, the degree of agreement at the total score level (ICC), and at the item level (weighted kappa) were analyzed. The choice of ICC models varied based on the type of reliability: a one-way random effects model was applied for inter-rater reliability, while a two-way mixed model with absolute agreement was used for intra/test-retest reliability. In both scenarios, single measures were analyzed. Additionally, Cronbach's alpha,

the mean ICC, the 95% CI, and the p-values were interpreted. The interpretation of ICC is as follows: values less than 0.5, between 0.5 and 0.75, between 0.75 and 0.9, and greater than 0.90 indicate poor, moderate, good, and excellent reliability, respectively (Koo & Li, 2016). At the item level, regardless of the type of reliability, weighted kappa (quadratic weights) was chosen. Kappa values are interpreted as follows: ≤0 as no agreement, 0.01-0.20 as slight agreement, 0.21-0.40 as fair, 0.41-0.60 as moderate, 0.61-0.80 as substantial, and 0.81-1.00 as almost perfect (McHugh, 2012; Vanbelle, 2014).

3.5.3 Responsiveness

Initially, baseline and follow-up measurements (five months later) were conducted using the TCMS as the anchor to document the degree of change. Five months after the start of therapy, the therapist evaluated the change. According to Lopez-Ruiz et al. (2023), an MCID of 5.15 points was established within a 95% confidence interval for the TCMS. In this study, it was not feasible to apply this, as only two children out of the entire sample achieved a difference in score of 5.15 (MCID). This resulted in a significant group disparity, making it challenging to use the TCMS as an anchor in this way. Therefore, the groups were divided based on an improvement of 1 or more points (group 1), or the same or a lower score compared to the pre-measurement (group 2). This approach ensured a more equitable distribution of the groups. Next, an independent sample t-test was applied to determine the difference between the HippoTrunC change for each TCMS category. The mean changes in HippoTrunC scores from baseline to follow-up were calculated and analyzed for significant differences, and these data were graphically presented. Based on these results, Cohen's d was chosen for further analysis. Levene's test was used to assess the equality of variances across the different groups, and it was found that the variances were equally distributed. Consequently, Cohen's d was used for further interpretation of the results. Additionally, the change in HippoTrunc score within each TCMS category was analyzed with a paired sample T-test.

4 RESULTS

4.1 Characteristics of the participants

Forty-five children were invited to participate, three of whom explicitly stated they did not want to participate in this study. Three others did not respond to the email invitations and/or reminder phone calls. This resulted in 39 children who enrolled in the study. Among these 39, three children did not participate in test 2 of the HippoTrunC. Consequently, data from 36 children was used for calculating test-retest reliability. Only 31 out of 39 children participated in the TCMS baseline measurement. Additionally, four children dropped out during the third HippoTrunC measurement, while only 23 children took part in the second test administration of the TCMS, resulting in 23 children left to determine responsiveness. The video recordings of eight children were used for determining intra-rater reliability.

Reasons for dropouts included socio-emotional issues, problems in the home environment, absence due to school holidays, or illness. Twenty-seven participants had a diagnosis of CP, while the remainder had various neurological conditions such as Cri du chat or spina bifida. All diagnoses are listed in ***Table 1***. The GMFCS levels varied between I and V: three children were classified at GMFCS level I, six at level II, six at level III, 17 at level IV, and seven at level V. The mean (SD) age of the participants was 11.44 (3.11) years. Of all participants, 10 were female and 29 were male.

Table 1 provides a description of the participants, including information on their age, sex, diagnosis, and degree of disability.

Table 1

Characteristics of the participants

	Age (years)	Sex	Diagnosis	Degree of disability (GMFCS)				
				I	II	III	IV	V
1	14	M	CP bilateral	X				
2	15	F	CP bilateral					X
3	10	F	CP bilateral			X		
4	10	M	CP bilateral				X	
5	18	M	CP bilateral	X				
6	5	M	Spina bifida				X	
7	16	F	CP bilateral			X		
8	16	M	Undiagnosed				X	
9	9	M	CP bilateral					X
10	18	M	CP bilateral					X
11	9	F	Sturge Weber syndrome					X
12	18	F	CP bilateral				X	
13	11	M	DMD			X		
14	7	M	Rasmussen's encephalitis		X			
15	18	M	CP bilateral					X
16	14	M	CP bilateral				X	
17	6	M	Pons glioma			X		
18	16	M	CP bilateral				X	
19	13	M	Cri du chat			X		
20	6	M	CP unilateral		X			
21	14	M	CP bilateral				X	
22	5	M	Supratentorial hydrocephalus				X	
23	19	F	Goltz-syndrome	X				
24	14	M	CP bilateral				X	
25	9	F	CP bilateral				X	
26	11	M	CP bilateral				X	
27	8	F	CP bilateral					X
28	13	M	DMD		X			
29	10	M	CP spastic quadriplegia				X	
30	9	F	Partial resection astrocytome fossa posterior		X			
31	4	M	CP spastic bilateral				X	
32	4	F	CP quadriplegic				X	
33	15	M	CP diplegia			X		
34	6	M	CP spastic quadripareses					X
35	3	M	Pontocerebellar dysplasia				X	
36	15	M	CP diplegia				X	
37	12	M	CP spastic di-quadriplegia				X	
38	17	M	CP spastic hemiplegia		X			
39	3	F	CP bilateral		X			

Abbreviations. F = Female; M = male; GMFCS = Gross Motor Function Classification Scale; CP = Cerebral Palsy; DMD = Duchenne muscular dystrophy

4.2 Visual analysis item scores

For subtotal and corrected total scores, there is a more linear distribution according to GMFCS level compared to ***Appendix Figure 1.11***. There is a consistent decrease in scores with increasing GMFCS levels across most items and the total score, suggesting that higher GMFCS levels (greater disability) are associated with lower performance scores (Figure 4-5). Variability is higher in intermediate GMFCS levels (III and IV), possibly indicating a wider range of abilities within these groups. Scores for GMFCS levels I and II tend to be higher and less variable, while scores for level V are generally lower and more variable. The scores in item four generally decrease with increasing GMFCS levels, as shown in ***Figure 6.*** The distribution is greatest at GMFCS level IV, while the distribution in item 5 is the smallest. Details of each item are presented in ***Appendix 2.***

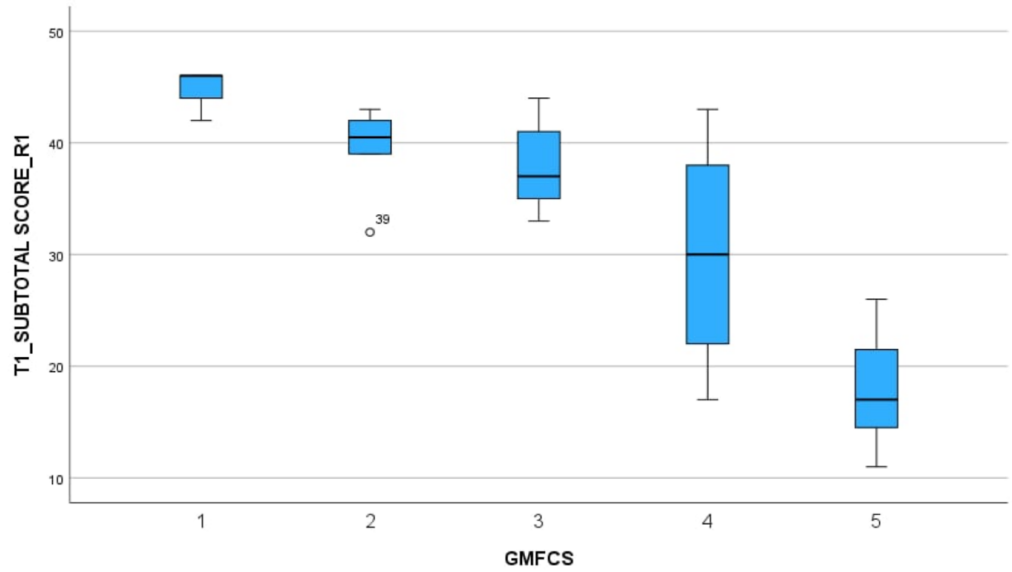


Figure 4. Boxplot HippoTrunC subtotal score rater 1

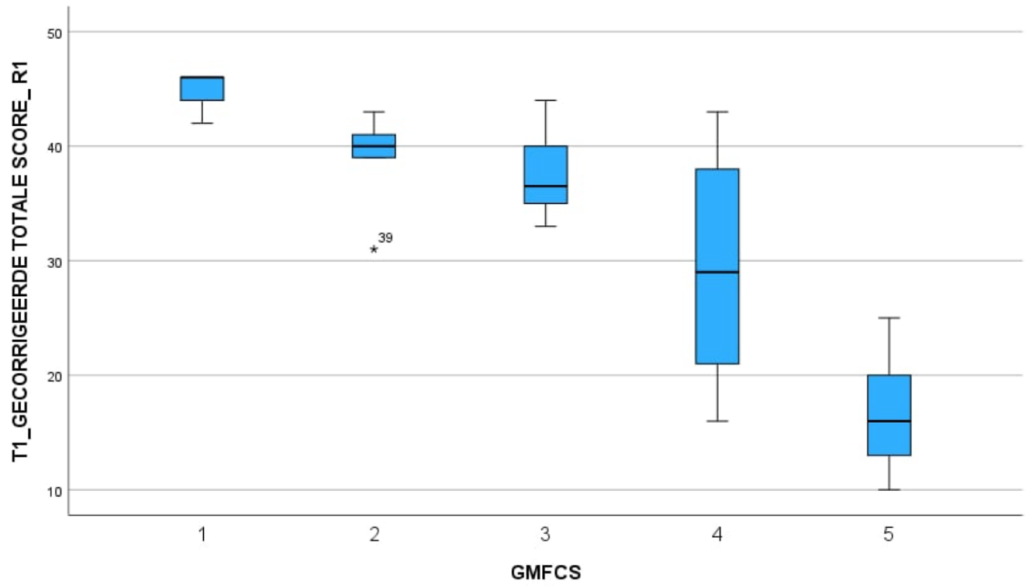


Figure 5. Boxplot HippoTrunC corrected score rater 1

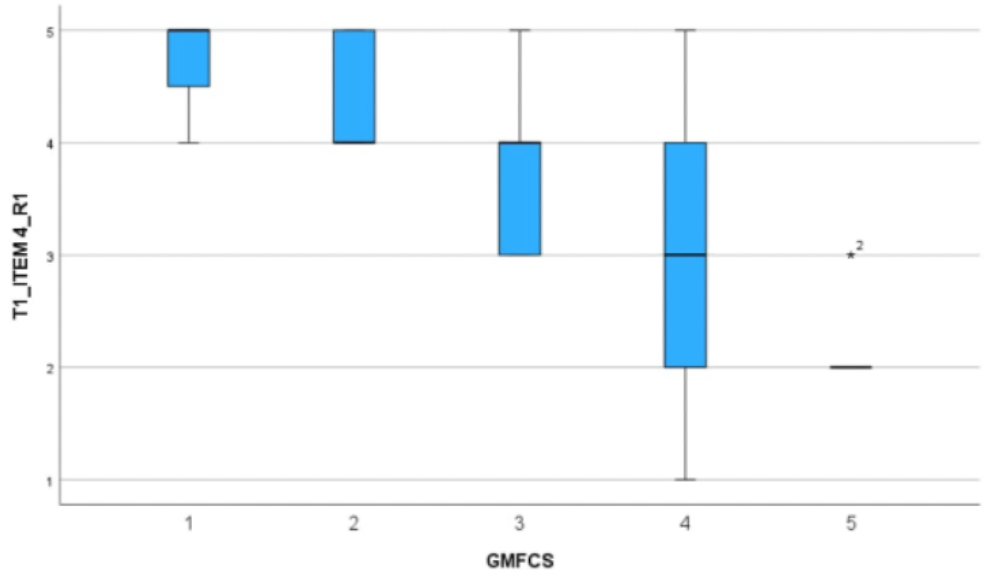


Figure 6. Boxplot HippoTrunC item 4

4.3 Reliability

4.2.1 Intra-rater reliability

Table 2 provides an overview of the Cronbach's alpha scores, mean intraclass correlation coefficient (ICC) values and the corresponding confidence intervals for the corrected score. The Cronbach's alpha values for both raters (R1, R2) consistently remained high across different assessment time points. The mean ICC values were significant, indicating strong agreement within each rater over time. For rater 1, lowest and highest values were (Cronbach's alpha = 0.958; mean ICC = 0.919; 95% CI = [0.679;0.983]) and (Cronbach's alpha = 0.990; mean ICC = 0.997; 95% CI = [0.893;0.995]) respectively. For rater 2 lowest and highest values were (Cronbach's alpha = 0.980; mean ICC = 0.965; 95% CI = [0.838;0.993]) and (Cronbach's alpha = 0.990; mean ICC = 0.974; 95% CI = [0.855;0.995]) respectively.

Table 2

Intra-rater reliability at different time points for the corrected scores

Time	Rater	Cronbach's Alpha	ICC Single Measure	95% confidence interval	
				Lower bound	Upper bound
1	1	0.958	0.919	0.679	0.983
2	1	0.990	0.997	0.893	0.995
3	1	0.988	0.941	0.302	0.990
1	2	0.980	0.965	0.838	0.993
2	2	0.980	0.967	0.861	0.993
3	2	0.990	0.974	0.855	0.995
1,2,3	1	0.972	0.943	0.875	0.975
1,2,3	2	0.984	0.967	0.922	0.986

Note. Time 1 = Baseline measurement. Time 2 = Measurement at baseline + 1-2 weeks. Time 3 = Baseline + 5 months. For each measurement, the video recording of 8 children were independently assessed twice by the same rater with a month in between to avoid recall.

4.2.2 Inter-rater reliability

At time point one, the agreement between raters for the subtotal scores was moderate (Cronbach's alpha = 0.834; mean ICC = 0.689; 95% CI = [0.496;0.829]). For the corrected scores, values were slightly higher (Cronbach's alpha = 0.845; mean ICC = 0.715; 95% CI = [0.520;0.839]).

At time point two, the subtotal scores exhibited excellent internal consistency (Cronbach's alpha = 0.966; mean ICC = 0.905; 95% CI = [0.827;0.949]). The corrected scores were comparable to the subtotal scores (Cronbach's alpha= 0.965) with identical ICC values and confidence intervals.

Both the subtotal and corrected scores demonstrated very high internal consistency in time point three (Cronbach's alpha = 0.986; mean ICC = 0.957; 95% CI = [0.921.;0.977]) and (Cronbach's alpha = 0.986; mean ICC = 0.958; 95% CI = [0.922;0.978]), respectively. ***Table 3*** provides an overview of Cronbach's Alpha and Intra-Class Correlation scores regarding inter-rater reliability. At item level, values varied from moderate (item 6) to excellent (item 7). Detailed results are presented in ***Table 4.***

Table 3

Inter-rater reliability of the subtotal and corrected total score

Time	Score Type	Cronbach's Alpha	ICC Single Measure	95% confidence interval	
				Lower bound	Upper bound
1	Subtotal	0.834	0.689	0.496	0.829
1	Corrected	0.845	0.715	0.520	0.839
2	Subtotal	0.966	0.905	0.827	0.949
2	Corrected	0.965	0.904	0.826	0.949
3	Subtotal	0.986	0.957	0.921	0.977
3	Corrected	0.986	0.958	0.922	0.978

Note. Time 1 = Baseline measurement., time 2 = Measurement at baseline + 1 to 2 weeks, time 3 = Baseline + 5 months. Subtotal = sum of all item scores without downgrade points for correction

Table 4

Overview of agreement between raters at item level

Item		Weighted Kappa	95% confidence interval	
			Lower bound	Upper bound
1	Head control: static	0.643	0.498	0.789
2	Sitting balance (A): static	0.726	0.596	0.855
3	Sitting balance (A): forward reaching	0.757	0.675	0.839
4	Sitting balance (A): lateral reaching	0.816	0.764	0.869
5	Sitting balance: active	0.775	0.719	0.831
6	Head control: active	0.516	0.386	0.645
7	Sitting balance (A): acceleration	0.820	0.777	0.863
8	Sitting balance (A): slalom	0.788	0.732	0.843
9	Sitting balance (R): slalom	0.794	0.724	0.863
10	Sitting balance (R): start-stop	0.811	0.758	0.863

Abbreviation. A = active, R = reactive. Note. A quadratic weighted model was used.

4.2.3 Test-retest reliability

Rater 1 values indicated good internal consistency for the subtotal score (Cronbach's alpha = 0.802; mean ICC = 0.670; 95% CI = [0.455;0.812]), signifying substantial agreement. Rater 1 results for the corrected score showed slightly higher values (Cronbach's alpha = 0.816; mean ICC = 0.691; 95% CI = [0.485;0.825]), consistently indicating substantial agreement (Table 5).

Table 5

Test-retest reliability of the subtotal and corrected total score

Rater	Score Type	Cronbach's Alpha	ICC single measure	95% confidence interval	
				Lower bound	Upper bound
1	Subtotal	0.802	0.670	0.455	0.812
1	Corrected	0.816	0.691	0.485	0.825

Note. Subtotal = sum of all item scores without downgrade points for correction

Bland-Altman plots

Figure 7 depicts the uncorrected total score, where two data points fall outside the 95% CI, which is 5.56% of all data. In the corrected total score, we observe three falling outside the confidence interval (8.33%) as seen in ***Figure 8***. This indicates that the variance between results is greater than expected. Most points are close to the mean (dotted line), suggesting they do not significantly deviate from the mean.

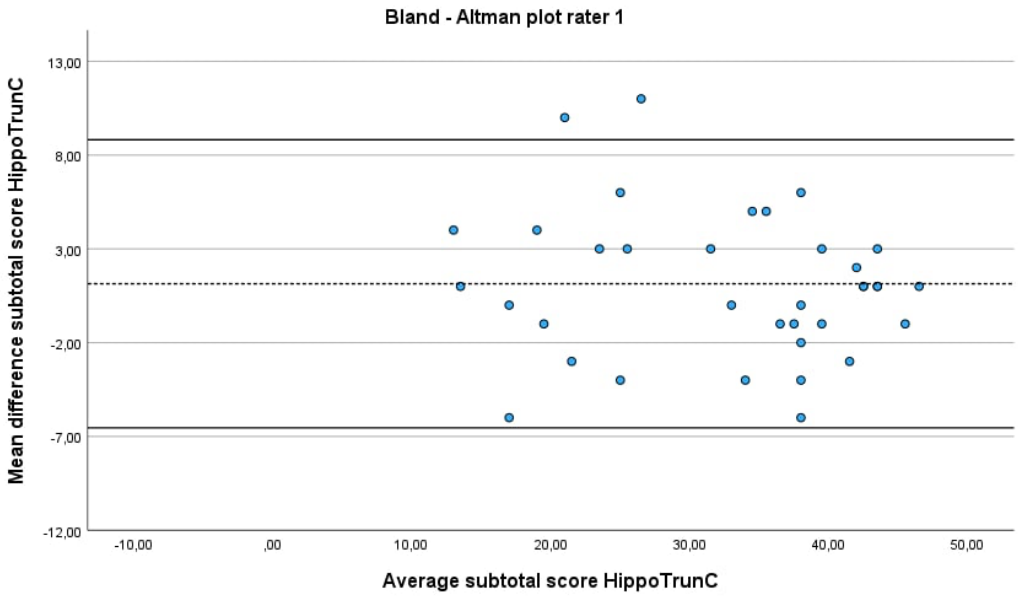


Figure 7. Test-retest reliability for subtotal score rater 1

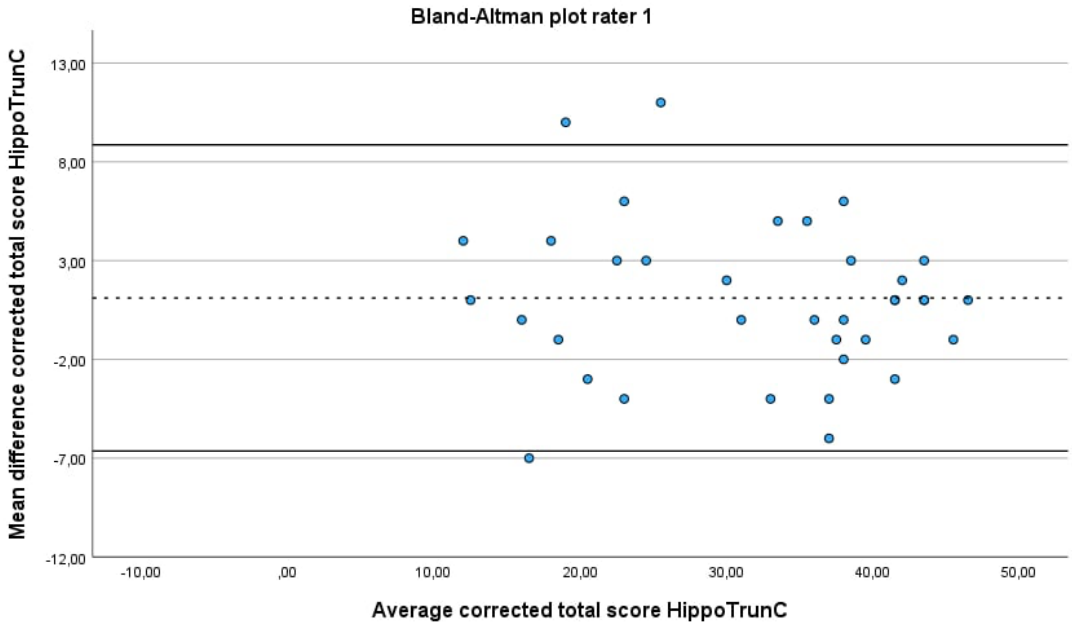
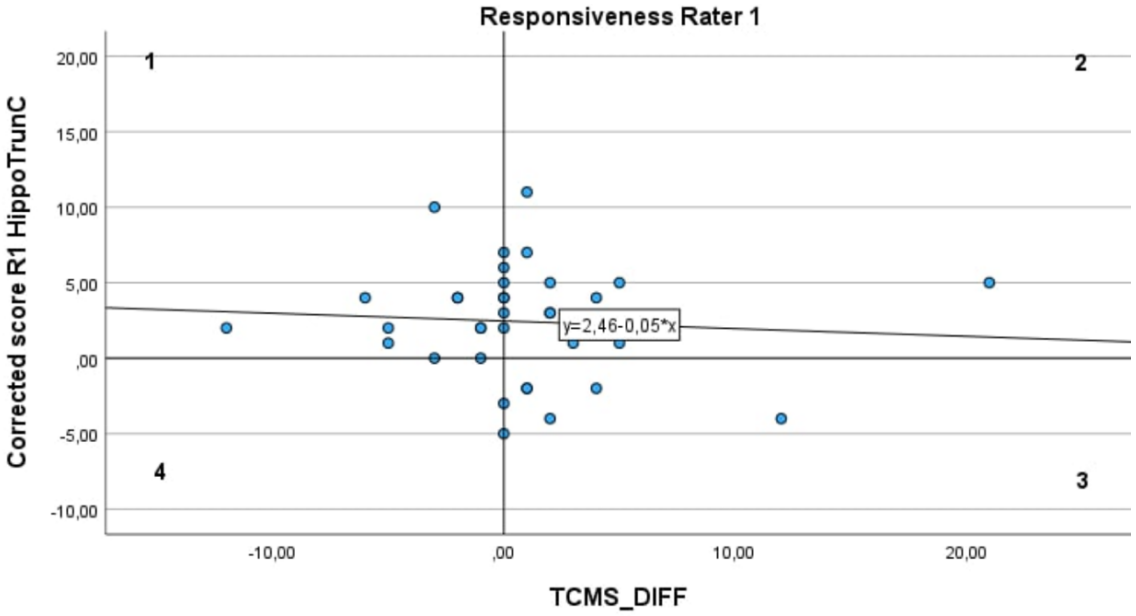


Figure 8. Test-retest reliability for corrected score rater 1

4.3 Responsiveness

Figure 9 depicts the relationship between the improvement on the HippoTrunC and the improvement on the TCMS. Although a part of the children improves on both the HippoTrunC and the TCMS, the percentage that improves on both scales is small (28.57%). This is indicated by the number of scores located in the second quadrant. The correlation coefficient for this trend is -0.0707, indicating an inverse and very weak relationship between the HippoTrunC and TCMS scores**.** This is further demonstrated by the percentage in quadrant one (45.7%), which is the highest of all quadrants. The other quadrants, three and four, have percentages of 14.29% and 11.43%, respectively. A similar trend is seen for the subtotal scores of rater 1 and for both scores of rater 2 as seen in ***Appendix figures 2-4***. When looking at Cohen's d between the TCMS categories as presented in ***Table 6***, all differences were small to moderate, indicating that the children did not show better scores over time according to the HippoTrunC. These results should be interpreted with caution, because the groups were divided according to whether there was a difference in TCMS score of one or more points, and no difference or a weaker TCMS score post intervention. None of the differences in TCMS score were considered significant according to the MCID of 5.15 points. ***Table 7*** presents the values within the TCMS categories, also indicating small to moderate differences.



Note: The scatterplot shows four quadrants: 1 (top left), 2 (top right), 3 (bottom right), and 4 (bottom left).

Quadrant 1: negative change in TCMS and a positive change in HippoTrunc
Quadrant 2: positive changes in both TCMS and HippoTrunc
Quadrant 3: positive change in TCMS and a negative change in HippoTrunc
Quadrant 4: negative changes in both TCMS and HippTrunc

Figure 9. Responsiveness for corrected score rater 1

Table 6

Responsiveness: differences between changes in HippoTrunC (subtotal or corrected) between the TCMS categories for each rater

Rater	Score type	Cohen's d	95% confidence interval	
			Lower bound	Upper bound
1	Subtotal	0.195	-0.477	0.865
1	Corrected	0.168	-0.504	0.837
2	Subtotal	0.374	-0.318	1.060
2	Corrected	0.365	-0.326	1.051

Note. Used time points are time 1 and 3, subtotal = sum of all item scores without downgrade points for correction

Table 7

Responsiveness: differences in pre- and post HippoTrunC performances (subtotal or corrected) within the TCMS categories for each rater

TCMS category	Rater	Score type	Cohen's d	95% confidence interval	
				Lower bound	Upper bound
Difference pre-post (≤ 0)	1	Subtotal	0.054	-0.374	0.482
	1	Corrected	0.050	-0.379	0.477
	2	Subtotal	-0.016	-0.444	0.412
	2	Corrected	-0.016	-0.444	0.412
Difference pre-post (> 0)	1	Subtotal	0.466	-0.076	0.993
	1	Corrected	0.479	-0.065	1.007
	2	Subtotal	0.284	-0.237	0.796
	2	Corrected	0.283	-0.239	0.794

5 DISCUSSION

The primary objective of this study was to adapt the HippoTrunC in such a way that the scores obtained at item level match expectations according to the GMFCS level of the participant. Additionally, it was needed to assess the responsiveness and reliability of this adjusted form of the HippoTrunC. This investigation holds significance due to the potential application of this measurement scale in clinical settings and to be used in intervention studies aimed at enhancing sitting balance. The findings of this study indicate that the item scores on the HippoTrunC increase as the GMFCS level decreases. It is also found that the HippoTrunC serves as a reliable outcome measure for assessing sitting balance on the back of a horse in children with various neurological conditions. The scale showed high intra-rater, inter-rater and test-retest reliability values for both the summed subtotal score and the corrected total score. Responsiveness values were not significant, suggesting substantial variability within the samples or inconsistent effects over time.

Interpretation of main results related to the research question

This study found a consistent decrease in scores with increasing GMFCS levels across most items and the total score, suggesting that higher GMFCS levels are associated with lower performance scores. Variability is higher in intermediate GMFCS levels (III and IV), possibly indicating a wider range of abilities within these groups. Scores for GMFCS levels I and II tend to be higher and less variable, while scores for level V are generally lower and more variable. The scores for item four tend to decline as GMFCS levels increase, with the widest distribution observed at GMFCS level IV, whereas the distribution for item five is the narrowest. This can be due to the large number of participants in GMFCS level IV, relative to the other GMFC levels. When comparing the boxplots at item level of the adjusted HippoTrunC with those from the previous version, it can be observed that the scores per item are now more evenly distributed as expected according to GMFCS level. Children with lower GMFCS levels generally score better than those with higher GMFCS levels, whereas previously there was an illogical distribution, with children at lower GMFCS levels often scoring higher than those with better functional abilities. However, these results should be interpreted with caution since they only represent the observation of scores during the initial measurement, the results from the second and third measurement points were not included in this analysis. Further analyses of all different measurement points and integration of these scores are

necessary to draw a more definitive conclusion regarding this assumption. At this time, it cannot be stated with certainty that these assumptions are representative of reality, nor that this trend will continue over time.

The results of this current study indicate that the HippoTrunC exhibits a high degree of consistency and reliability in its measurements. This not only confirms the internal coherence of the scale but also its effectiveness in reliably and consistently measuring a cohesive construct. Analyses conducted at various time points indicate that the scale can consistently deliver reliable measurements over time. These scores are comparable to those of the SATco, SAS, and GMFM, demonstrating that the HippoTrunC potentially has a similar level of reliability to these well-known and commonly used scales. These scores partially align with previous studies. The values of both intra-rater and inter-rater reliability are excellent, also shown in previous studies with ICC values ranging from 0.994 to 0.998 (Bulen & Boers, 2023). Test-retest reliability in this study demonstrates moderate values, in contrast to previous studies where it exhibited excellent values, with an ICC of 0.976 (Bulen & Boers, 2023). When examining the Bland-Altman plots, it can be observed that the percentage of scores falling outside the 95% confidence interval (CI) exceeds 5%, indicating that the variance among the results is greater than expected. For the subtotal scores, the agreement appears to be slightly better than for the corrected score, although other analyses suggest better consistency based on the corrected score. This discrepancy might be due to the impact of the downgrades on lower subtotal scores, which may cause these scores to fall outside the confidence interval more frequently. It must be noted that test-retest reliability is prone to the varying performances of participants at different times. It is crucial to account for this variation and attempt to minimize it by creating consistent conditions during both tests, such as using the same person guiding the horse. When employing a smaller sample size, scores are more likely to fall outside the 95% confidence interval compared to using a larger dataset. Thus, increasing the sample size can enhance the reliability of the results and reduce variance. When examining other measurement scales that assess sitting balance, the following results are noted. The SATco demonstrates excellent reliability, with intra-rater ICC values ranging from 0.91 to 0.97 and inter-rater ICC values between 0.87 and 0.96. It is a valid measure for trunk control and responsive to changes over time, particularly in children with cerebral palsy (Flores et al., 2020; Tedla & Reddy, 2021). The SAS has good to excellent reliability, with intra-

rater ICC values above 0.80 and inter-rater ICC values above 0.75. It is validated for assessing both static and dynamic sitting balance and is responsive to changes following therapeutic interventions such as physical therapy (Karabulut & Akbaş, 2024). The GMFM has shown excellent reliability with intra-rater and inter-rater ICC values above 0.90. This scale is validated for assessing changes in gross motor function in children with cerebral palsy and is highly responsive to changes over time (Karabulut & Akbaş, 2024; Josenby et al., 2009).

The responsiveness of the HippoTrunC was previously analyzed by tracking participants who scored higher than the MCID of six points ($p = 0.003$). No significant improvement in the HippoTrunC score was seen when the TCMS change score exceeded six points (Bulen & Boers,2023). This study shows that the HippoTrunC did not show significant improvements after interventions, neither between TCMS categories nor within TCMS categories, with values ranging from -0.016 to 0.479. This may suggest that the scale is not sufficiently sensitive to detect small but clinically significant improvements, or that the TCMS may not possess adequate sensitivity as an anchor in this context. It is important to investigate this in the future, as responsiveness is crucial because it measures how well an instrument can detect clinically significant changes over time, which is essential for assessing the effectiveness of interventions. While test-retest reliability ensures consistency of results under unchanged conditions, responsiveness ensures that the instrument can capture meaningful changes, making it vital for evaluating patient progress and treatment outcomes. An earlier study on responsiveness demonstrates a moderate correlation ($p= 0.54$) between TCMS and hippotherapy training in children and adolescents with CP (Pham et al., 2016). In this study, it was observed that none of the participants had a significantly different score on the TCMS according to the MCID. This leads to the hypothesis that the TCMS might be too strict for comparison with the HippoTrunC. Another measurement scale may be needed as an anchor to determine the responsiveness of the HippoTrunC. An alternative hypothesis for this phenomenon could be rater bias during the administration of the TCMS. Since the treating therapists themselves conducted the TCMS scoring, the values may include a subjective factor rather than being completely objective.

There is significant uncertainty regarding the direction and magnitude of responsiveness effects of the HippoTrunC, suggesting substantial variability within the samples or inconsistent effects over time, possibly due to subjective interpretation of certain scoring criteria. Other widely used measurement scales are often confronted with similar issues. For example the TCMS, which evaluates seated trunk control, shows variability between novice and expert raters. This variability is reflected in the differences in ICC for the total and subscales of TCMS scores [(Josenby et al., 2009; López-Ruiz, Estrada-Barranco, Giménez-Mestre, et al., 2023) The psychometric properties of various sitting balance measures show that differences in interpretation and methodology can lead to significant variability in the assessment of sitting balance in children with cerebral palsy (Bañas & Gorgon, 2014) These examples highlight the importance of training and standardizing scoring criteria to minimize variability and ensure more consistent and reliable measurements across different raters and time points.

Based on these findings, several hypotheses can be formulated. The first hypothesis is regarding responsiveness and rater influence. Differences in rater interpretation may lead to disparate outcomes in responsiveness, as observed in the variability of scores between different measurements. Establishing a clear manual for the use and interpretation of the HippoTrunC may help reduce this variability and enhance consistency between raters. Implementing a training program on how to use the scale at the beginning of the scoring process can help provide raters with a solid foundation on how to properly use the scale. Second hypothesis regards applicability across different GMFCS levels. The effectiveness of the HippoTrunC for children at different GMFCS levels needs further investigation. The effects of therapy could be examined in more detail by studying the change in the different groups separately, as employed in the study by Carey et al. (2016). The use of qualitative scales, such as the goal attainment scale (GAS), can be implemented to measure improvements in a way that quantitative scales cannot capture. Hypothesis number three concerns the influence of training on inter-rater reliability. The increasing inter-rater reliability as the study progresses may be attributed to the improved competence and familiarity of the raters with the scoring process. As raters gain more experience in applying the assessment criteria of the HippoTrunC, they become more confident and consistent in their scoring. This may suggest that some of the initial variability in scores between different raters is not only due to

subjective interpretations but also to a lack of confidence or experience with the assessment scale. It must be taken into account that this kind of scale requires observation of movement behavior which cannot be judged as objectively as a distance or time. Implementing regular training sessions for raters at the outset and throughout the duration of the study can help increase this reliability from the beginning and ensure consistency in measurements across different raters.

Strengths and limitations of the study

A primary strength of the study is the detailed analysis conducted at the outset of the process. This analysis revealed areas where adjustments were necessary to ensure that participants would score as expected according to their GMFCS level. Additionally, the adaptation of the scale was precisely executed, followed by a step-by-step process to refine the scoring criteria for each item. In collaboration with clinical experts K.S. and E.S., all scoring criteria were reformulated and reviewed six times to reach the final result.

Another strength of this study is its sample size of 39 children with various neurological disorders. Furthermore, data analysis was performed by two independent raters, each scoring separately to prevent data contamination.

The HippoTrunC proves to be a highly convenient scale to utilize. It requires only ten to fifteen minutes for administration and requires minimal materials. Moreover, because the test is filmed from four different angles, each video can be viewed extensively to analyze the test performance in detail, facilitating accurate scoring. However, a drawback of using video footage is the occasional ambiguity regarding the level of support provided to participants. Additionally, it may not always be clear from the angles used whether the therapist's hands are positioned around the child for safety or are actually touching for correction. Variations in factors such as turn size during slaloming or horse speed were observed due to differences in the utilization of trained guides during test administration. The test also requires the involvement of at least two to three individuals for proper execution: one to guide the horse, one to set up the poles or clothespins, and potentially another for the duo seat.

Certain items, such as items 5, 7, 8, and 9, present opportunities for subjective interpretation regarding therapist intervention, as there is no defined criterion for what constitutes an intervention. This led to differing interpretations among raters in this study, resulting in varied scoring. By potentially adding a zero score to the options, the actual capacity of a child can be

better reflected when they refuse to perform a task. The current system, in which the lowest possible score is one, may not accurately represent the child's performance or ability.

Furthermore, item 10 may be influenced by a learning effect after multiple test administrations, as children may begin to anticipate the horse's abrupt stop, which could affect their performance. Some participants needed instructions to be repeated more than twice due to motivation or attention challenges.

Methodological limitations such as uneven distribution of participants based on GMFCS level, age, and gender may impact data interpretation. With more boys participating than girls and the majority of participants having a classification of GMFCS level IV, generalization of the results should be handled with caution.

Implications for future directions and clinical practice

The HippoTrunC has the capability to measure the static and dynamic balance of children with neurological disorders while sitting on the back of a horse. It assesses the children's ability to control their head and trunk balance in a static position, as well as when the horse is in motion. The scale is stable to consistently examine scores over time. However, it is still prone to subjective interpretation of certain item scores. A clear definition of all scoring criteria in the manual is necessary to provide future raters with a consistent scoring method. Additionally, training can be offered to future users of the scale to ensure they have proper knowledge to use the scale correctly. Training for the horse handlers is necessary to standardize the speed maintained and the size of the turns during the slalom.

Additionally, more thorough validity assessments of the scale are needed in the future. Currently, analyses of the adjusted scale only confirmed the hypothesis that with an increasing GMFCS level, the scores of the HippoTrunC decrease. For further research, it is desirable for the sample to be larger and to have a more equal distribution of various participant characteristics, such as gender, age, GMFCS level, and types of neurological disorders. It would be beneficial for the scale to be translated into a more widely recognized language, such as English, to enable its use by researchers and clinicians across different countries. Research across different countries is crucial to explore cross-cultural validation and to obtain a more reliable understanding of the scale's usability and psychometric properties.

6 CONCLUSION

Results of this study indicate that the HippoTrunC scores decrease consistently with increasing GMFCS levels, indicating greater disability correlates with lower performance. Variability is higher in GMFCS levels III and IV, suggesting a wider range of abilities. Levels I and II have higher, less variable scores, while level V shows lower, more variable scores.

The HippoTrunC exhibits a high degree of consistency and reliability in its measurements. Analyses conducted across various time points underscore the scale's ability to consistently provide reliable measurements over time. There are no significant effects concerning responsiveness. This suggests substantial variability within the samples or inconsistent effects over time, possibly as a result of the subjective interpretation of certain scoring criteria. Further research is necessary to enhance responsiveness and investigate additional psychometric properties, such as validity. Before examining these, it is essential to first address two key prerequisites: the development of a clear manual to facilitate the use and interpretation of the HippoTrunC, and the expansion of the sample size to strengthen the study's findings and generalizability. Further research on these aspects is necessary to enhance the overall effectiveness and responsivity of the HippoTrunC.

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APPENDIX

Appendix Table 1

Adjustments HippoTrunC

HippoTrunC		
Naam, voornaam: Geslacht: Geboortedatum: GMFCS level: ja/neen		Testdatum: Naam paard: Video-analyse toestemming:
Hulpmiddelen		**Downgradescore**
	Duozit: ja (-1) ~~– nee (0)~~ Duozit in kader van angst/ onzekerheid (0)	
	Stijgbeugels: ja (-1) – nee (0)	
	Korset: elastisch(-1) – gips(-2)	
	Andere:	
	TOTAAL	
Algemeen ● Elke instructie mag 2x uitgelegd worden aan de zorggebruiker, vanaf dat moment wordt de zorggebruiker getest. ● Voor de test op een bewegend paard wordt afgenomen, worden er twee rondes in de piste toegestaan zodat het kind kan aanpassen aan het bewegend paard. ● Met "*recht" wordt in de testbatterij de maximale oprichting bedoeld, die mogelijk is per individu. ● De zorggebruikers mogen aangespoord worden recht te zitten en dit zoveel als nodig		

Appendix Table 2

Adjusted scoringcriteria next to the previous version of the HippoTrunC

	Score	**HippoTrunC 2022-2023**	**HippoTrunC 2023-2024**
Item 1. Hoofdcontrole statisch	**1**	Onmogelijk om het hoofd recht* te houden	Onmogelijk om het hoofd recht te houden. Geen zelf geïnitieerde beweging mogelijk
	2	Houdt hoofd zelfstandig recht* voor <10 sec	Houdt het hoofd zelfstandig recht voor < 10 seconden
	3	Houdt hoofd zelfstandig recht* ≥ 10 sec en <30 sec	Houdt het hoofd zelfstandig recht ≥ 10 en < 30 seconden
	4	Houdt hoofd zelfstandig recht* voor ≥ 30 sec en <60 sec	Houdt hoofd zelfstandig recht voor ≥ 30 en < 60 seconden
	5	Houdt hoofd zelfstandig recht* voor ≥ 60 sec	Houdt hoofd zelfstandig recht* voor ≥ 60 seconden
	1	Onmogelijk om romp adequaat op te richten (teveel extensie of flexie), maximale	Houdt de romp recht en heeft maximale ondersteuning van de therapeut nodig om in de

Item 2. Zitbalans statisch		ondersteuning van therapeut nodig.	uitgangspositie te blijven zitten
	2	Houdt romp zelfstandig recht* >0 en ≤ 10 sec en/of grote voorachterwaartse of zijwaartse bewegingen romp en/of matige ondersteuning van therapeut nodig	Houdt de romp recht met gedeeltelijke ondersteuning van de therapeut voor < 10 seconden
	3	Houdt romp zelfstandig recht* >10 en ≤ 30 sec en/of matige voorachterwaartse of zijwaartse bewegingen romp zichtbaar en/of lichte ondersteuning therapeut nodig	Houdt romp recht met gedeeltelijke ondersteuning van de therapeut voor ≥ 10 en < 30 seconden OF Houdt romp zelfstandig recht voor ≥ 10 en < 30 seconden, bij evenwichtsverlies moeten de handen geplaatst worden
	4	Houdt romp zelfstandig recht* >30 en ≤ 60 sec, en/of lichte inadequate voorachterwaartse of zijwaartse bewegingen romp zichtbaar	Houdt romp zelfstandig recht met compensaties voor ≥ 30 en < 60 seconden. Mogelijke compensaties zijn: verhoogde rompflexie, iinadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...
	5	Houdt romp zelfstandig recht* voor >60 sec, geen inadequate voorachterwaartse of zijwaartse bewegingen romp zichtbaar	Houdt romp zelfstandig recht voor > 60 seconden, zonder compensaties
Item 3. Zitbalans actief (voorwaarts reiken)	**1**	Onmogelijk om arm te strekken en voorwaarts te reiken.	Reiken richting wasknijper (<20cm) enkel mogelijk met maximale ondersteuning van de therapeut
	2	Mogelijk om de arm te strekken, maar geen voorwaartse beweging romp mogelijk zonder het verliezen van de balans, tenzij met maximale ondersteuning therapeut	Reiken tot aan de wasknijper (≧20cm) enkel mogelijk met maximale ondersteuning van de therapeut
	3	Mogelijk om arm te strekken	Mogelijkheid om zelfstandig

		en zelfstandig voorwaarts te reiken (<20cm) en/of met licht tot matige ondersteuning therapeut (20cm).	voorwaarts te reiken (<20cm), bij evenwichtsverlies moeten de handen geplaatst worden. OF mogelijkheid om voorwaarts te reiken met gedeeltelijke ondersteuning van de therapeut (≧20cm)
	4	Mogelijk om zelfstandig arm te strekken en voorwaarts te reiken (20cm), maar moet op het einde van de bewegingsbaan de handen plaatsen om balans te behouden en/of ondersteuning nodig van therapeut om terug te keren tot de beginpositie.	Mogelijkheid om zelfstandig voorwaarts te reiken tot aan de wasknijper (≧20 cm), mits compensaties.Mogelijke compensaties zijn: trage uitvoering, inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...
	5	Mogelijk om zelfstandig arm te strekken, voorwaarts te reiken (20cm) en terug te keren naar beginpositie zonder het gebruik van de handen en met behoud van balans	Mogelijkheid om vloeiend voorwaarts te reiken (≧20 cm) en terug te keren naar de beginpositie zonder compensaties
Item 4. Zitbalans actief (zijwaarts reiken)	**1**	Onmogelijk om arm richting de stok te strekken en zijwaarts te reiken	Reiken richting de stok (<10cm) enkel mogelijk met maximale ondersteuning van de therapeut
	2	Mogelijk om de arm richting de stok te strekken, maar geen zijwaartse beweging romp mogelijk zonder het verliezen van de balans, tenzij met maximale ondersteuning therapeut	Reiken richting de stok (≧10cm) enkel mogelijk met maximale ondersteuning van de therapeut
	3	Mogelijk om arm richting de stok te strekken en zelfstandig zijwaarts te reiken (<10cm) en/of met licht tot matige ondersteuning therapeut (10cm)	Mogelijkheid om zelfstandig zijwaarts te reiken (<10cm) met of zonder evenwichtsverlies. Bij evenwichtsverlies vertoont het kind ofwel zelf compensaties of is er hulp van de therapeut nodig OF Mogelijkheid om zijwaarts te reiken met gedeeltelijke ondersteuning van de therapeut (≧10cm)
	4	Mogelijk om arm richting	Mogelijkheid om zelfstandig

		de stok te strekken en zelfstandig zijwaarts te reiken (10cm), maar verliest op het einde van de bewegingsbaan de balans en heeft hiervoor ondersteuning nodig van de therapeut om terug te keren tot de beginpositie	zijwaarts te reiken (≧10cm), mits compensaties. Mogelijke compensaties zijn: trage uitvoering inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...
	5	Mogelijk om arm richting de stok te strekken, zijwaarts te reiken (10cm) en terug te keren naar beginpositie zonder de hulp van de therapeut.	Mogelijkheid om vloeiend voorwaarts te reiken (≧10 cm) en terug te keren naar de beginpositie zonder compensaties
Item 5. Zitbalans actief (normaal tempo)	**1**	Onmogelijk om romp adequaat op te richten (teveel extensie of flexie), maximale ondersteuning therapeut nodig.	Onmogelijk om de romp adequaat op te richten. Maximale ondersteuning van de therapeut is nodig
	2	Houdt romp zelfstandig recht* gedurende enkele stappen, en/of met grote voorachterwaartse of zijwaartse bewegingen en/of matige ondersteuning van therapeut nodig	Houdt de romp recht, gedurende de volledige lengte, door middel van > 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut
	3	Houdt romp zelfstandig recht* gedurende de helft van de lengte (5m) en/of met matige voorachterwaartse of zijwaartse bewegingen romp en/of lichte ondersteuning therapeut nodig.	Houdt de romp recht, gedurende de volledige lengte door middel van ≤ 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut
	4	Houdt romp zelfstandig recht* gedurende de volledige lengte (10m) met licht inadequate voorachterwaartse of zijwaartse bewegingen romp.	Houdt de romp zelfstandig recht mits compensaties. Mogelijke compensaties zijn: inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...
	5	Houdt romp zelfstandig recht* gedurende de volledige lengte	Houdt de romp zelfstandig recht zonder compensaties

		(10m), geen inadequate voorachterwaartse of zijwaartse bewegingen romp zichtbaar	
Item 6. Hoofdcontrole actief	**1**	Onmogelijk om het hoofd recht* te houden	Onmogelijk om het hoofd recht te houden
	2	Houdt het hoofd zelfstandig recht* gedurende enkele passen	Houdt het hoofd recht gedurende enkele stappen
	3	Houdt het hoofd zelfstandig recht* gedurende de helft van de lengte	Houdt het hoofd recht gedurende de helft van de lengte
	4	Houdt het hoofd zelfstandig recht* gedurende 3/4^{e} van de volledige lengte	Houdt het hoofd recht gedurende volledige lengte mits compensaties om het hoofd recht te houden
	5	Houdt hoofd zelfstandig recht* gedurende de volledige lengte (16m)	Houdt het hoofd recht gedurende de volledige lengte, zonder compensaties
Item 7: Zitbalans actief (versneld tempo)	**1**	Onmogelijk om romp adequaat op te richten (teveel extensie of flexie), maximale ondersteuning therapeut nodig	Onmogelijk om de romp adequaat op te richten. Maximale ondersteuning van de therapeut is nodig
	2	Houdt romp zelfstandig recht* gedurende enkele stappen, en/of met grote voorachterwaartse of zijwaartse bewegingen en/of matige ondersteuning van therapeut nodig	Houdt de romp recht, gedurende de volledige lengte, door middel van > 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut
	3	Houdt romp zelfstandig recht* gedurende de helft van de lengte (5m), en/of met matige voorachterwaartse of zijwaartse bewegingen van de romp en/of lichte ondersteuning therapeut nodig	Houdt de romp recht, gedurende de volledige lengte door middel van ≤ 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut
	4	Houdt romp zelfstandig recht* gedurende de volledige lengte (10m) met licht inadequate voorachterwaartse of zijwaartse bewegingen van de romp	Houdt de romp zelfstandig recht mits compensaties. Mogelijke compensaties zijn: inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de

			romp of ledematen,...
	5	Houdt romp zelfstandig recht* gedurende de volledige lengte (10m), geen inadequate voorachterwaartse of zijwaartse bewegingen van de romp zichtbaar	Houdt de romp zelfstandig recht zonder compensaties
Item 8: Zitbalans reactief (slalom)	**1**	Onmogelijk om romp adequaat op te richten (teveel extensie of flexie), maximale ondersteuning therapeut nodig	Onmogelijk om de romp adequaat op te richten. Maximale ondersteuning van de therapeut is nodig
	2	Houdt romp zelfstandig recht* gedurende enkele stappen, en/of reageert met grote voorachterwaartse of zijwaartse bewegingen van de romp op de verstoringen van het paard en/of matige ondersteuning nodig van de therapeut.	Houdt de romp recht, gedurende de volledige lengte, door middel van > 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut
	3	Kan zich meerdere keren over de volledige lengte (10m) zelfstandig oprichten, en/of reageert met matige voorachterwaartse of zijwaartse bewegingen van de romp op de verstoringen van het paard en/of lichte ondersteuning nodig van de therapeut	Houdt de romp recht, gedurende de volledige lengte door middel van ≤ 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut
	4	Houdt romp zelfstandig recht* gedurende de volledige lengte (10m) en reageert met licht inadequate voorachterwaartse of zijwaartse bewegingen van de romp op de verstoringen van het paard	Houdt de romp zelfstandig recht gedurende de volledige lengte mits compensaties. Mogelijke compensaties zijn: inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...
	5	Houdt romp zelfstandig recht* gedurende de volledige lengte (10m), anticipeert correct op de beweging van het paard	Houdt de romp zelfstandig recht gedurende de volledige lengte, zonder compensaties
	1	Onmogelijk om romp	Onmogelijk om de romp adequaat

Item 9: Zitbalans reactief (slalom 2)		adequaat op te richten (teveel extensie of flexie), maximale ondersteuning therapeut nodig.	op te richten. Maximale ondersteuning van de therapeut is nodig
	2	Houdt romp zelfstandig recht* gedurende enkele stappen, en/of reageert met grote voorachterwaartse of zijwaartse bewegingen van de romp op de verstoringen van het paard en/of matige ondersteuning nodig van de therapeut	Houdt de romp recht, gedurende de volledige lengte, door middel van > 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut
	3	Kan zich meerdere keren over de volledige lengte (10m) zelfstandig oprichten, en/of reageert met matige voorachterwaartse of zijwaartse bewegingen van de romp op de verstoringen van het paard en/of lichte ondersteuning nodig van de therapeut.	Houdt de romp recht, gedurende de volledige lengte door middel van ≤ 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut
	4	Houdt romp zelfstandig recht* gedurende de volledige lengte (10m), met licht inadequate voorachterwaartse of zijwaartse bewegingen van de romp op de verstoringen van het paard.	Houdt de romp zelfstandig recht gedurende de volledige lengte mits compensaties. Mogelijke compensaties zijn: inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...
	5	Houdt romp zelfstandig recht* gedurende de volledige lengte (10m), anticipeert correct op de beweging van het paard	Houdt de romp zelfstandig recht gedurende de volledige lengte, zonder compensaties
Item 10. Zitbalans reactief (start-stop)	**1**	Onmogelijk om de romp adequaat op te richten (teveel extensie of flexie), maximale ondersteuning therapeut nodig.	Maximale ondersteuning van de therapeut is vereist bij zowel de start- en stop beweging
	2	Houdt romp zelfstandig recht* gedurende een deel van de volledige lengte, reageert met grote voorachterwaartse of	Gedeeltelijke hulp van de therapeut is vereist bij zowel start- en stop beweging

		zijwaartse bewegingen op het starten en stoppen van het paard en/of matige ondersteuning nodig van therapeut.	
	3	Houdt romp zelfstandig recht* gedurende een deel van de volledige lengte, reageert met matige voorachterwaartse of zijwaartse bewegingen van de romp op het starten en stoppen van het paard en/of lichte ondersteuning nodig van de therapeut	Gedeeltelijke hulp van de therapeut is vereist bij start- OF stop beweging
	4	Houdt romp zelfstandig recht* gedurende de volledige lengte (10m), reageert met lichte inadequate voorachterwaartse of zijwaartse bewegingen romp op het starten en stoppen van het paard	Houdt romp zelfstandig recht gedurende start- en stop beweging. Vertoont compensaties of moet zijn evenwicht herstellen. Mogelijke compensaties zijn: trage uitvoering, inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...
	5	Houdt romp zelfstandig recht* gedurende de volledige lengte (10m), anticipeert correct op de beweging van het paard	Houdt romp zelfstandig recht gedurende start- en stop beweging. vertoont geen compensaties of moet zijn evenwicht niet herstellen

Appendix Table 3
HippoTrunC 2023-2024

HippoTrunc

Naam:

Testdatum:

Voornaam:

Naam paard:

Geslacht:

Geboortedatum:

Video-analyse toestemming: ja/neen

GMFCS level:

Hulpmiddelen		Downgrade score
	Duozit ter ondersteuning (-1) Duozit in kader van angst/onzekerheid (0)	
	Stijgbeugels: ja (-1) - nee (0)	
	Corset: elastisch (-1) - gips (-2)	
	Andere:	
	TOTAAL	

Algemeen

- Elke instructie mag 2x uitgelegd worden aan de zorggebruiker, vanaf dat moment wordt de zorggebruiker getest
- Voor de test op een bewegend paard wordt afgenomen, worden er twee rondes in de piste toegestaan zodat het kind zich kan aanpassen aan het bewegend paard.
- Met 'recht' wordt in de testbatterij de maximale oprichting bedoeld, die mogelijk is per individu.
- De zorggebruikers mogen aangespoord worden recht te zitten en dit zoveel als nodig.

Item 1. Hoofdcontrole statisch

instructie: ' kijk recht voor je terwijl het paard stil staat, gedurende 60 seconden'

Score 1

Onmogelijk om het hoofd recht te houden. Geen zelf geïnitieerde beweging mogelijk.

Score 2

Houdt het hoofd zelfstandig recht voor < 10 seconden

Score 3

Houdt het hoofd zelfstandig recht ≥ 10 en < 30 seconden

Score 4

Houdt hoofd zelfstandig recht voor ≥ 30 en < 60 seconden

Score 5

Houdt hoofd zelfstandig recht* voor ≥ 60 seconden	
Score item 1	

Item 2. Zitbalans statisch
Instructie: 'Zit zo recht mogelijk en kijk voorwaarts, gedurende 60 seconden'

Score 1
Houdt de romp recht en heeft maximale ondersteuning van de therapeut nodig om in de uitgangspositie te blijven zitten.

Score 2
Houdt de romp recht met gedeeltelijke ondersteuning van de therapeut voor < 10 seconden.

Score 3
Houdt romp recht met gedeeltelijke ondersteuning van de therapeut voor ≥ 10 en < 30 seconden OF Houdt romp zelfstandig recht voor ≥ 10 en < 30 seconden, bij evenwichtsverlies moeten de handen geplaatst worden.

Score 4
Houdt romp zelfstandig recht met compensaties voor ≥ 30 en < 60 seconden.
Mogelijke compensaties zijn: verhoogde rompflexie, inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...

Score 5
Houdt romp zelfstandig recht voor > 60 seconden, zonder compensaties.

Score item 2	

Item 3. Zitbalans actief (voorwaarts reiken)
Instructie: 'Probeer met één hand de wasknijper te tikken en keer daarna terug naar de beginpositie'

Score 1:
Reiken richting wasknijper (<20cm) enkel mogelijk met maximale ondersteuning van de therapeut.

Score 2:
Reiken tot aan de wasknijper (20cm) enkel mogelijk met maximale ondersteuning van de therapeut.

Score 3:
Mogelijkheid om zelfstandig voorwaarts te reiken (<20cm), bij evenwichtsverlies moeten de handen geplaatst worden. OF mogelijkheid om voorwaarts te reiken met gedeeltelijke ondersteuning van de therapeut (20cm)

Score 4:

Mogelijkheid om zelfstandig voorwaarts te reiken tot aan de wasknijper (20 cm), mits compensaties.Mogelijke compensaties zijn: trage uitvoering, inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...

Score 5:

Mogelijkheid om vloeiend voorwaarts te reiken (20 cm) en terug te keren naar de beginpositie zonder compensaties.

Score item 3	

Item 4. Zitbalans actief (zijwaarts reiken)

Instructie: 'Probeer met één hand de stok aan te tikken die naast het paard staat, ga hiervoor zo ver mogelijk richting de stok. Keer daarna terug naar de beginpositie'

Score 1:

Reiken richting de stok (<10cm) enkel mogelijk met maximale ondersteuning van de therapeut

Score 2:

Reiken richting de stok (10cm) enkel mogelijk met maximale ondersteuning van de therapeut.

Score 3:

Mogelijkheid om zelfstandig zijwaarts te reiken (<10cm) met of zonder evenwichtsverlies. Bij evenwichtsverlies vertoont het kind ofwel zelf compensaties of is er hulp van de therapeut nodig.

OF Mogelijkheid om zijwaarts te reiken met gedeeltelijke ondersteuning van de therapeut (10cm)

Score 4:

Mogelijkheid om zelfstandig zijwaarts te reiken (10cm), mits compensaties.
Mogelijke compensaties zijn: trage uitvoering, inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...

Score 5:

Mogelijkheid om vloeiend voorwaarts te reiken (10 cm) en terug te keren naar de beginpositie zonder compensaties.

Score item 4	

Item 5. Zitbalans actief (normaal tempo)

Instructie: 'Blijf zo recht mogelijk op het paard zitten terwijl hij voortbeweegt'

Score 1

Onmogelijk om de romp adequaat op te richten. Maximale ondersteuning van de therapeut is nodig.

Score 2
Houdt de romp recht, gedurende de volledige lengte, door middel van > 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut.

Score 3
Houdt de romp recht, gedurende de volledige lengte door middel van ≤ 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut.

Score 4
Houdt de romp zelfstandig recht mits compensaties. Mogelijke compensaties zijn: inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...

Score 5
Houdt de romp zelfstandig recht zonder compensaties.

Score item 5	

Item 6. Hoofdcontrole actief
Instructie: 'kijk recht voor je terwijl het paard beweegt'

Score 1
Onmogelijk om het hoofd recht te houden.

Score 2
Houdt het hoofd recht gedurende enkele stappen.

Score 3
Houdt het hoofd recht gedurende de helft van de lengte.

Score 4
Houdt het hoofd recht gedurende volledige lengte mits compensaties om het hoofd recht te houden.

Score 5
Houdt het hoofd recht gedurende de volledige lengte, zonder compensaties.

Score item 6	

Item 7. Zitbalans actief (versneld tempo)
Instructie: 'Blijf zo recht mogelijk zitten op het paard terwijl hij sneller gaat stappen'*

Score 1
Onmogelijk om de romp adequaat op te richten. Maximale ondersteuning van de therapeut is nodig.

Score 2
Houdt de romp recht, gedurende de volledige lengte, door middel van > 2

interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut.

Score 3

Houdt de romp recht, gedurende de volledige lengte door middel van ≤ 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut.

Score 4

Houdt de romp zelfstandig recht mits compensaties. Mogelijke compensaties zijn: inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...

Score 5

Houdt de romp zelfstandig recht zonder compensaties.

Score item 7	

Item 8. Zitbalans reactief (slalom) *Instructie: 'Probeer zo recht mogelijk te zitten wanneer het paard beweegt in bochten' (kinesitherapeut/vrijwilliger beweegt met het paard aan de hand en bepaalt de bewegingen tussen de slalom)*

Score 1

Onmogelijk om de romp adequaat op te richten. Maximale ondersteuning van de therapeut is nodig.

Score 2

Houdt de romp recht, gedurende de volledige lengte, door middel van > 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut.

Score 3

Houdt de romp recht, gedurende de volledige lengte door middel van ≤ 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut.

Score 4

Houdt de romp zelfstandig recht gedurende de volledige lengte mits compensaties. Mogelijke compensaties zijn: inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...

Score 5

Houdt de romp zelfstandig recht gedurende de volledige lengte, zonder compensaties.

Score item 8	

Item 9. Zitbalans reactief (slalom 2)
Instructie: 'Probeer zo recht mogelijk te zitten wanneer het paard beweegt in bochten' (Persoon beweegt met het paard aan de hand en bepaalt de bewegingen tussen de slalom, deze bochten zijn scherper dan de vorige)

Score 1
Onmogelijk om de romp adequaat op te richten. Maximale ondersteuning van de therapeut is nodig.

Score 2
Houdt de romp recht, gedurende de volledige lengte, door middel van > 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut.

Score 3
Houdt de romp recht, gedurende de volledige lengte door middel van ≤ 2 interventies. Mogelijke interventies: handen plaatsen of ondersteuning van de therapeut.

Score 4
Houdt de romp zelfstandig recht gedurende de volledige lengte mits compensaties. Mogelijke compensaties zijn: inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of ledematen,...

Score 5
Houdt de romp zelfstandig recht gedurende de volledige lengte, zonder compensaties.

Score item 9	

Item 10. Zitbalans: reactief (start-stop)
Instructie: 'Probeer zo rechtop mogelijk te zitten wanneer het paard snelheidsveranderingen maakt'
(Persoon beweegt met het paard aan de hand en bepaalt de momenten van starten en stoppen)

Score 1
Maximale ondersteuning van de therapeut is vereist bij zowel de start- en stop beweging.

Score 2
Gedeeltelijke hulp van de therapeut is vereist bij zowel start- en stop beweging.

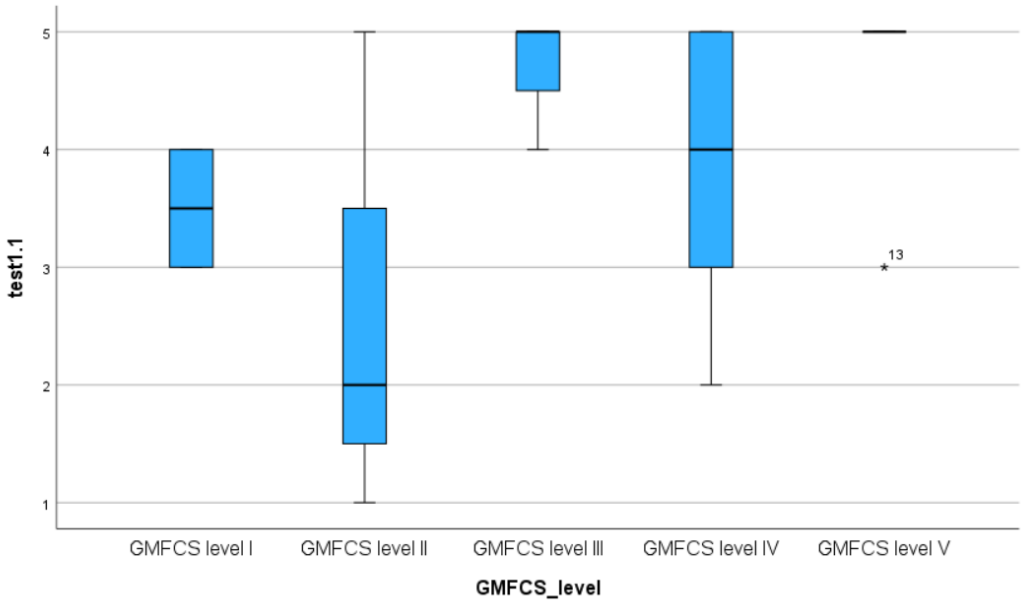
Score 3
Gedeeltelijke hulp van de therapeut is vereist bij start- OF stop beweging.

Score 4
Houdt romp zelfstandig recht gedurende start- en stop beweging. Vertoont compensaties of moet zijn evenwicht herstellen. Mogelijke compensaties zijn: trage uitvoering, inadequate voor-achterwaartse of zijwaartse bewegingen van de romp, ongecontroleerde bewegingen, toegenomen hypertonie van de romp of

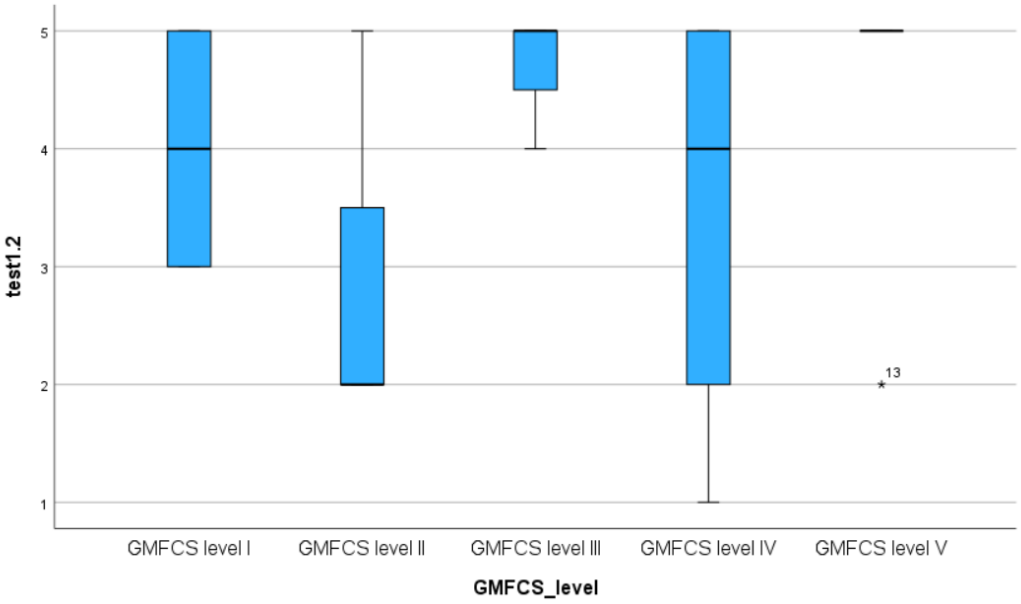
ledematen,... **<u>Score 5</u>** Houdt romp zelfstandig recht gedurende start- en stop beweging. vertoont geen compensaties of moet zijn evenwicht niet herstellen	
Score item 10	
Samenvatting HippoTrunc	
Totale score (/ 50)	
Downgrade	
Gecorrigeerde totale score	
Opmerkingen	

Appendix 1

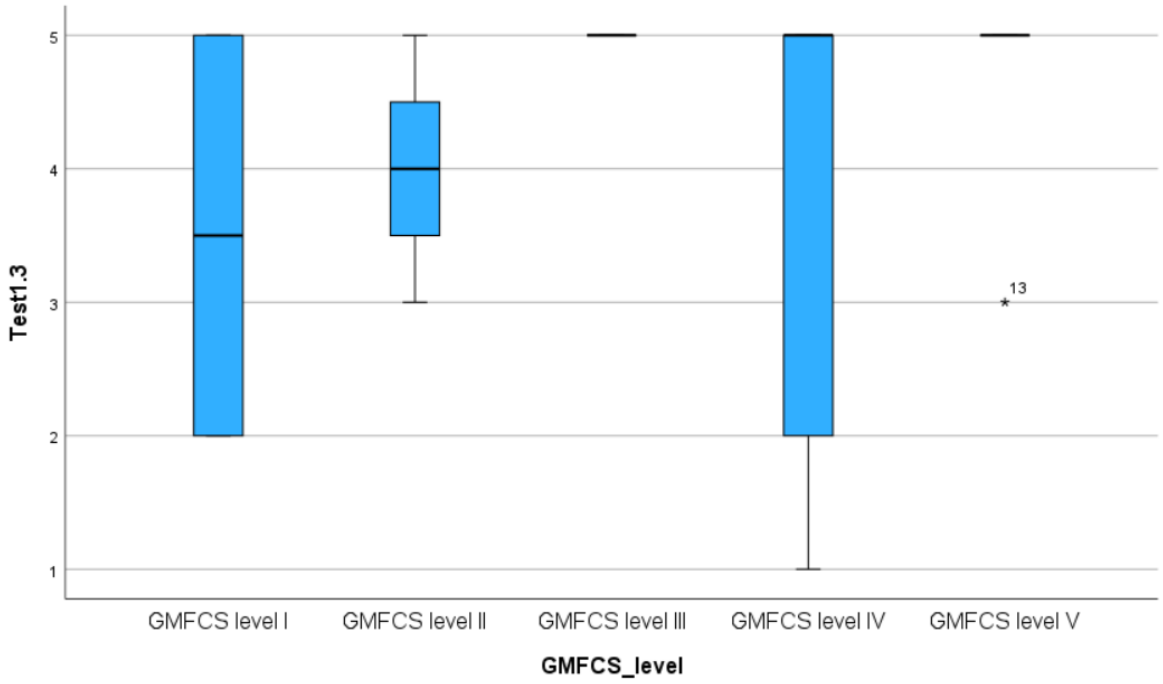
Figures HippoTrunC data 2022-2023



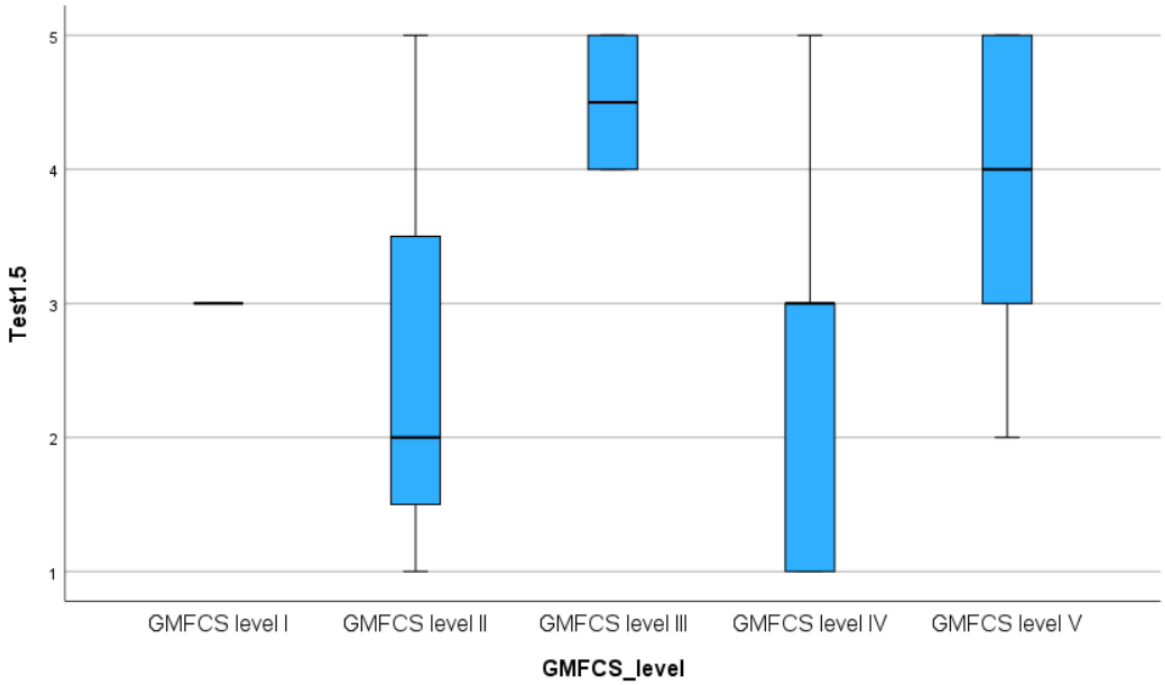
Appendix Figure 1.1: Boxplot item 1



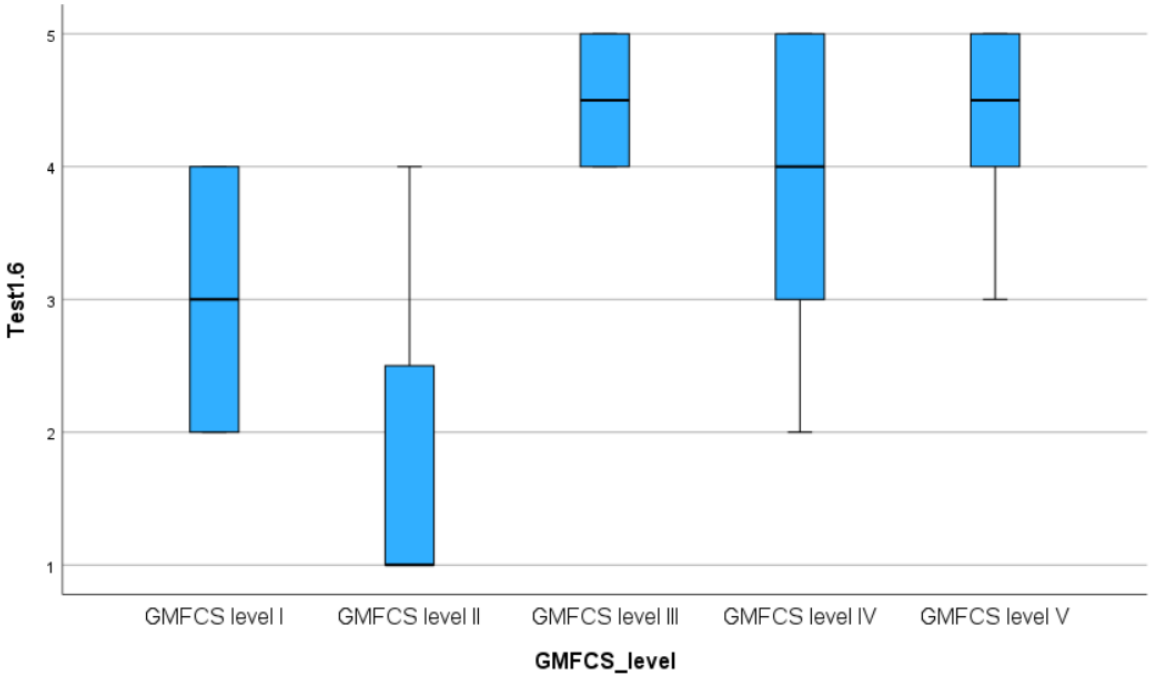
Appendix Figure 1.2: Boxplot item 2



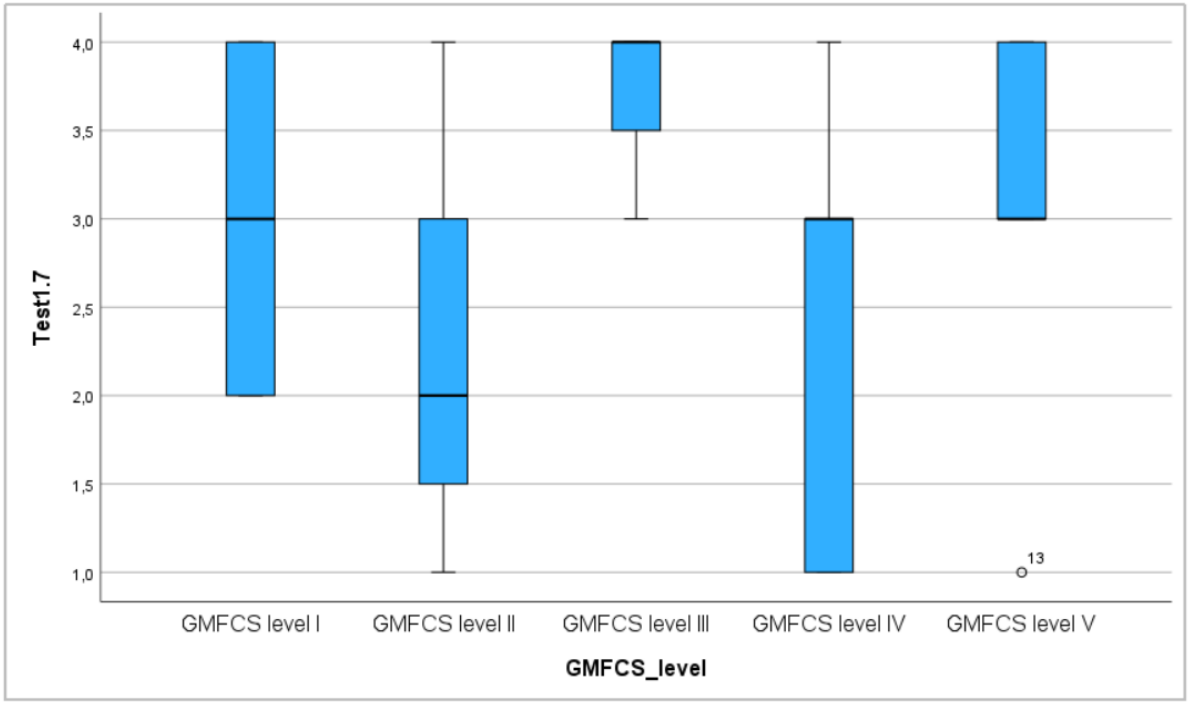
Appendix Figure 1.3: Boxplot item 3



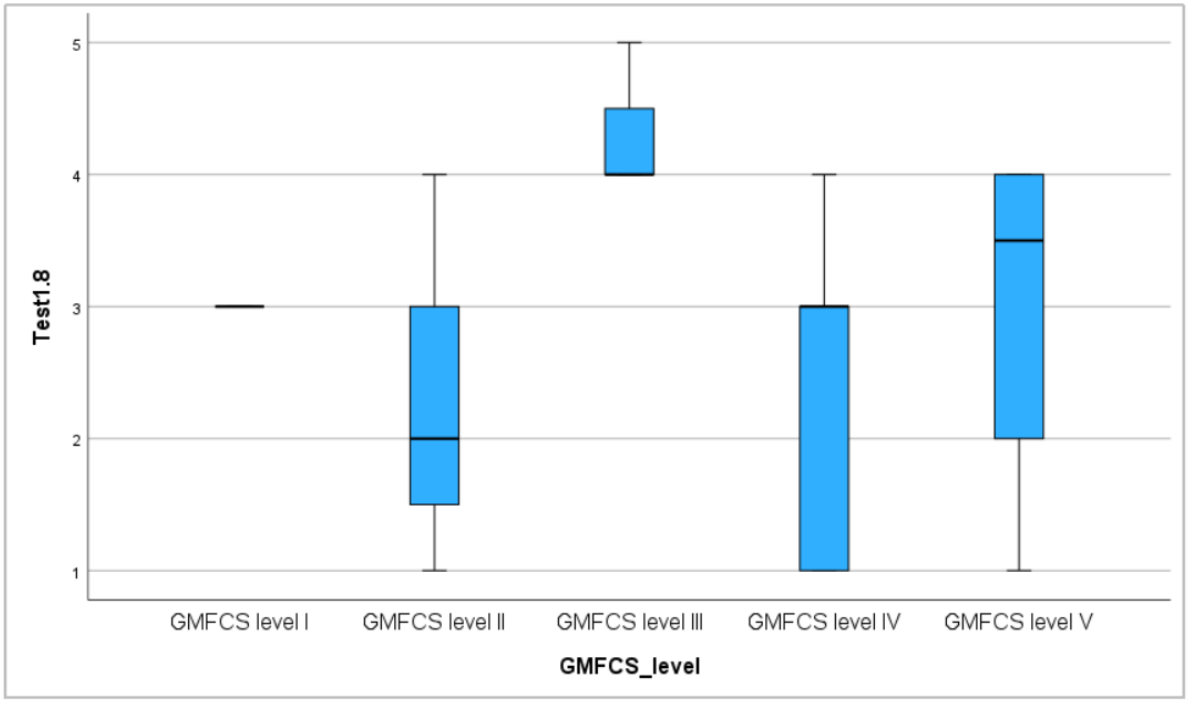
Appendix Figure 1.4: Boxplot item 5



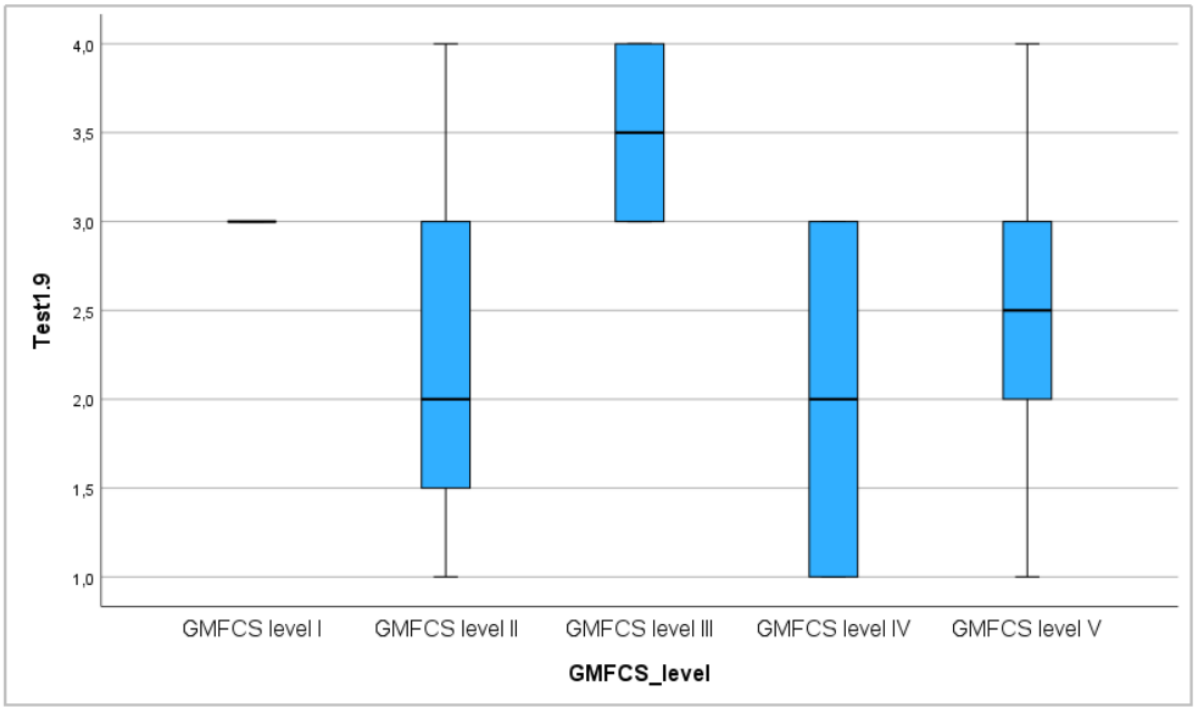
Appendix Figure 1.5: Boxplot item 6



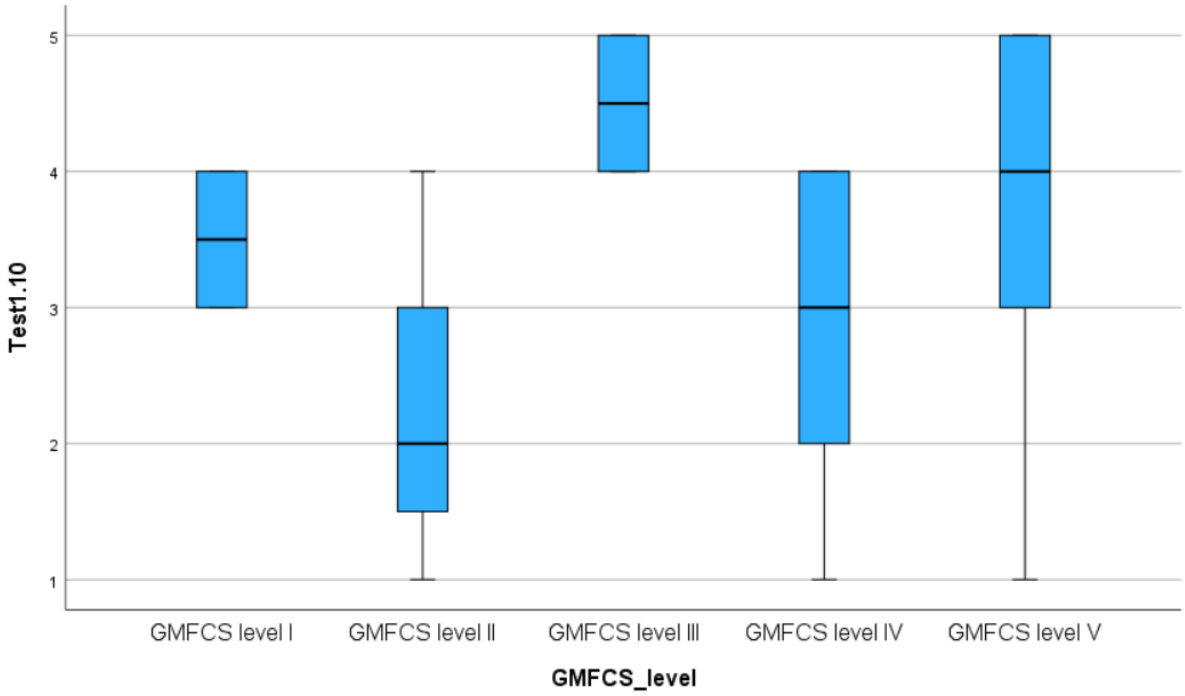
Appendix Figure 1.6: Boxplot item 7



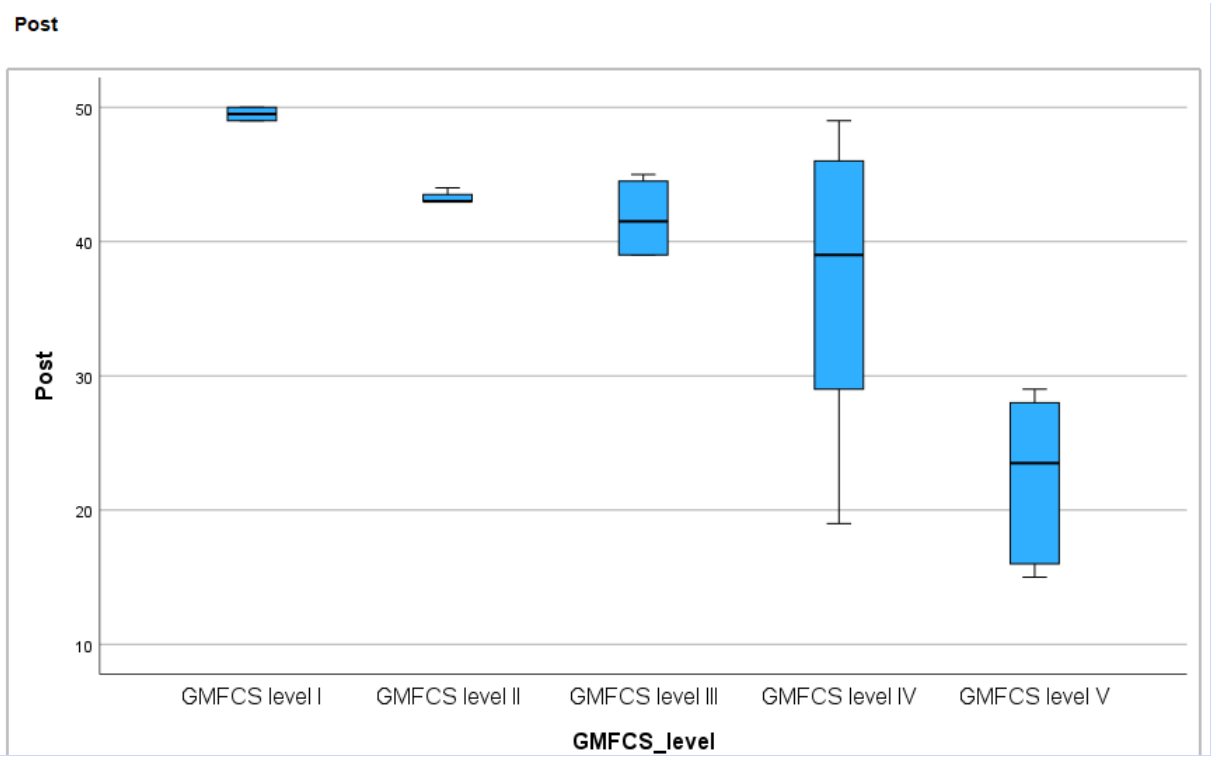
Appendix Figure 1.7: Boxplot item 8



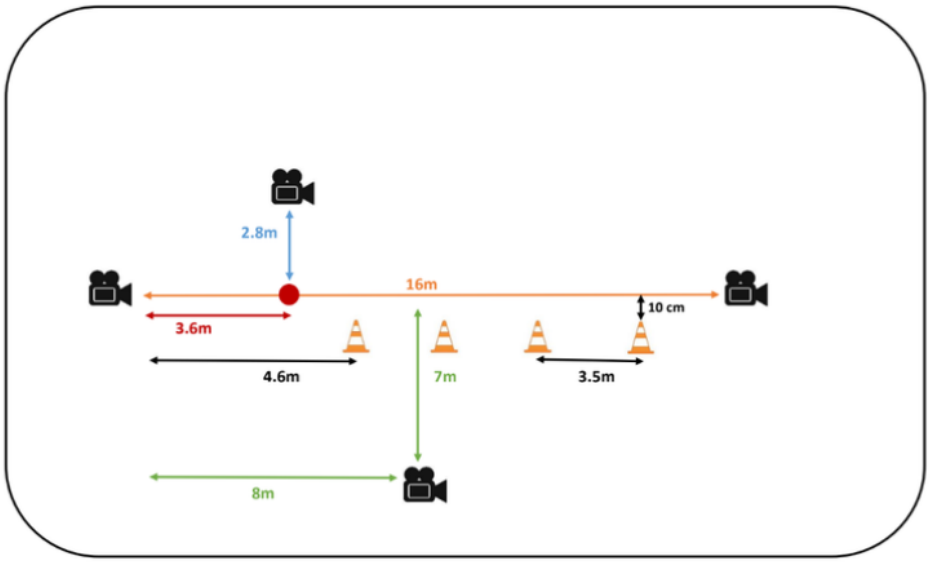
Appendix Figure 1.8: Boxplot item 9



Appendix Figure 1.9: Boxplot item 10



Appendix Figure 1.10: Boxplot data total score post-intervention

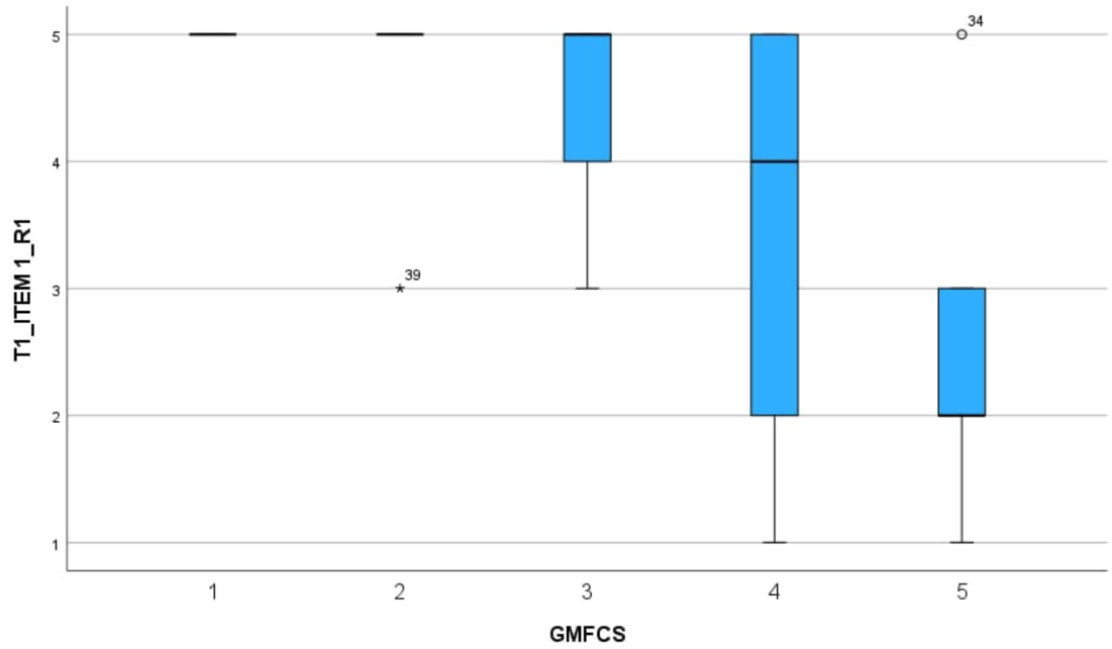


Legend: Red dot = startpoint item 1 till 4; m = meters

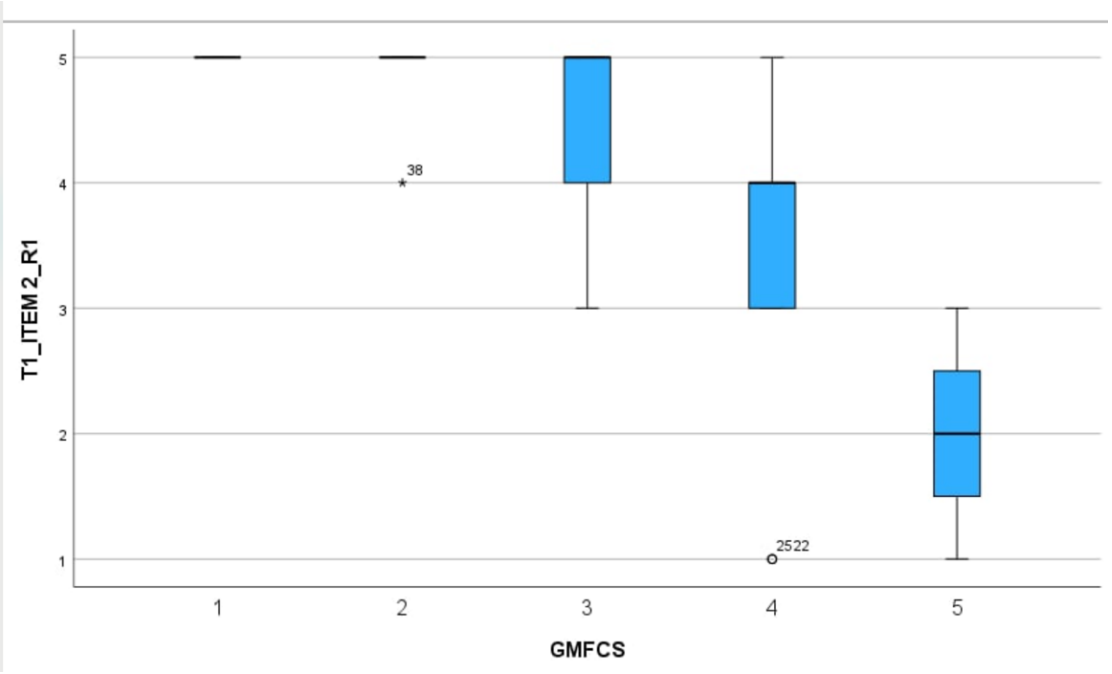
Appendix Figure 1: HippoTrunC Course Overview
Note. Figure from Bulen & Boers, 2023

Appendix 2

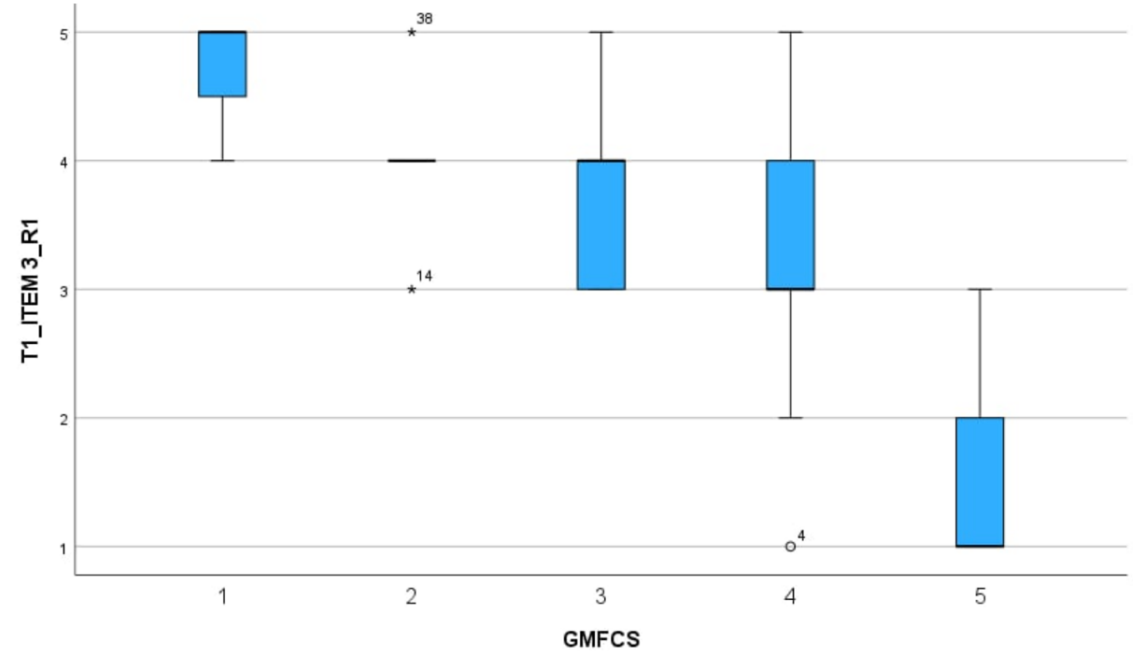
Figures HippoTrunC 2023-2024



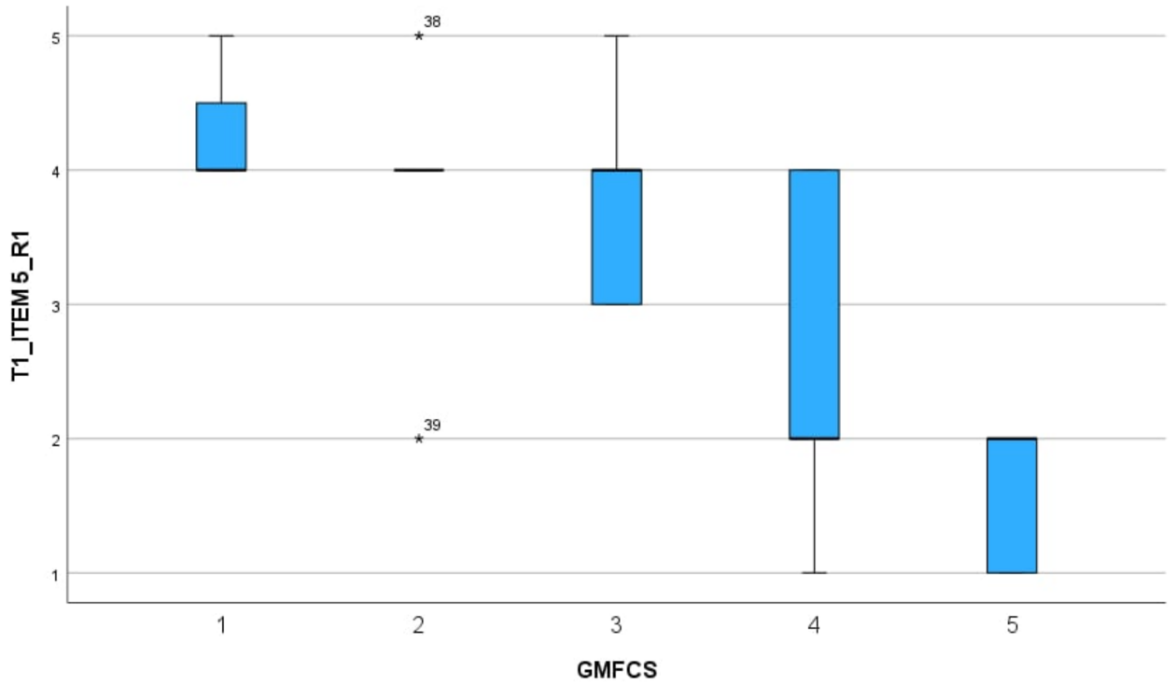
Appendix Figure 2.1: Boxplot HippoTrunC item 1



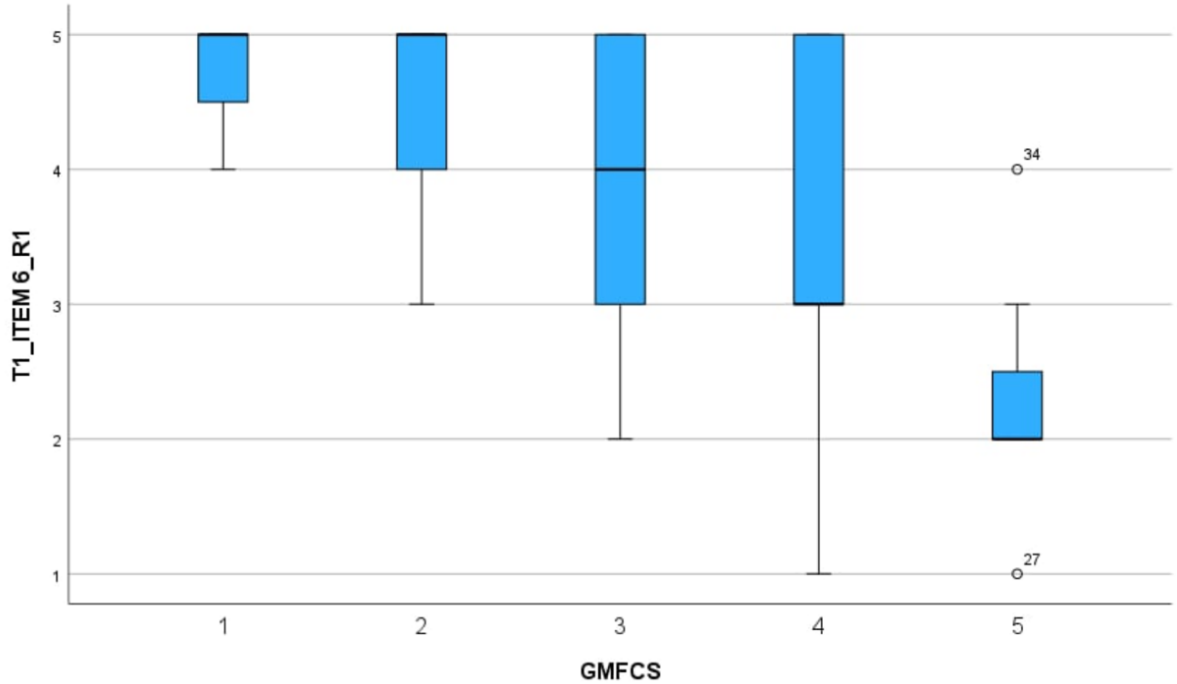
Appendix Figure 2.2: Boxplot HippoTrunC item 2



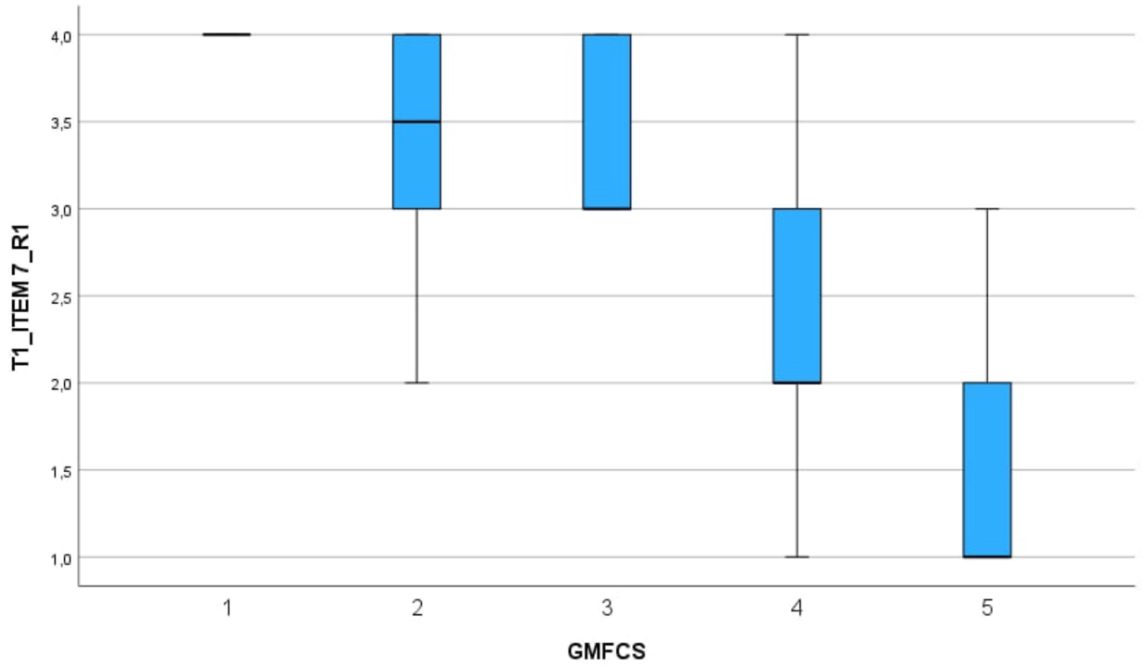
Appendix Figure 2.3: Boxplot HippoTrunC item 3



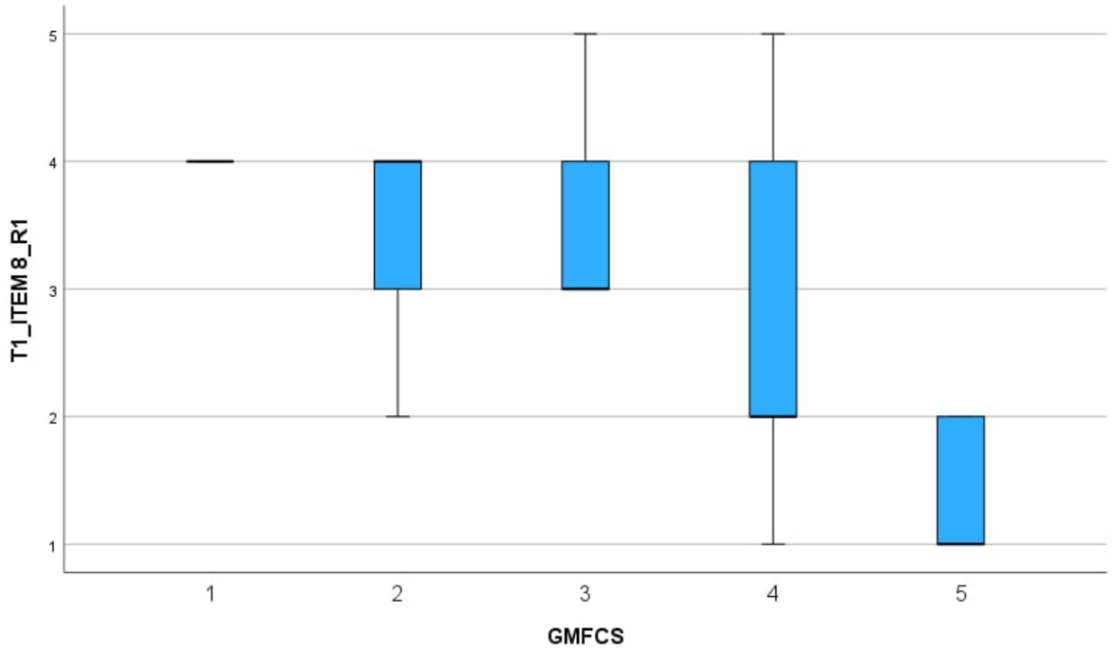
Appendix Figure 2.4: Boxplot HippoTrunC item 5



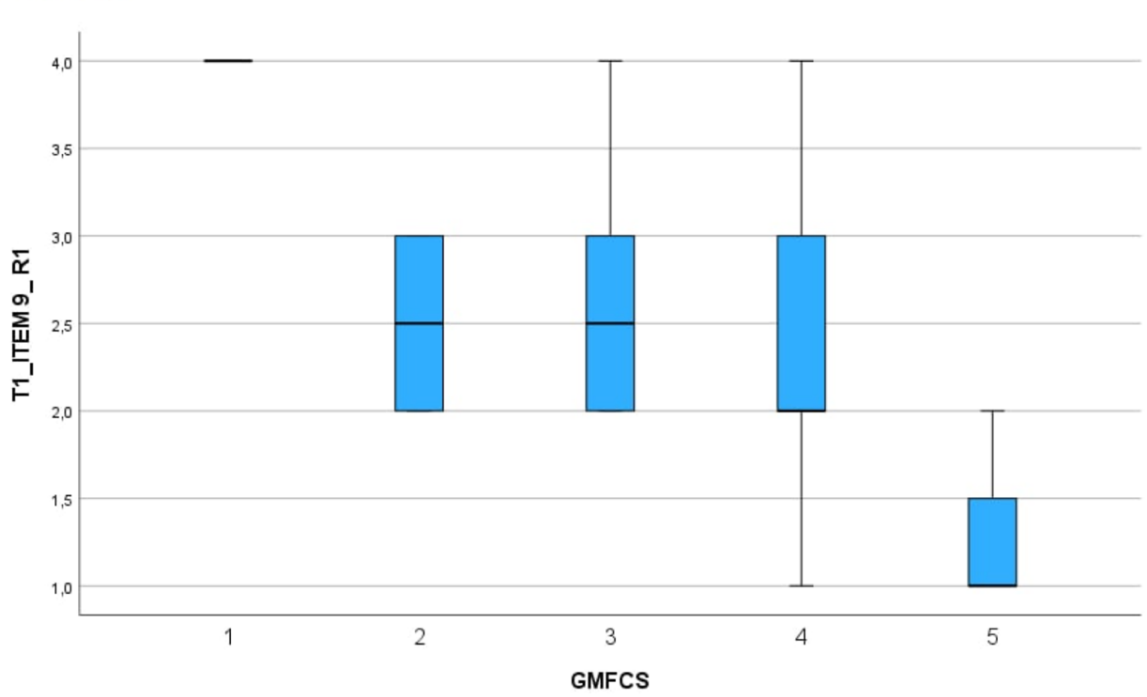
Appendix Figure 2.5: Boxplot HippoTrunC item 6



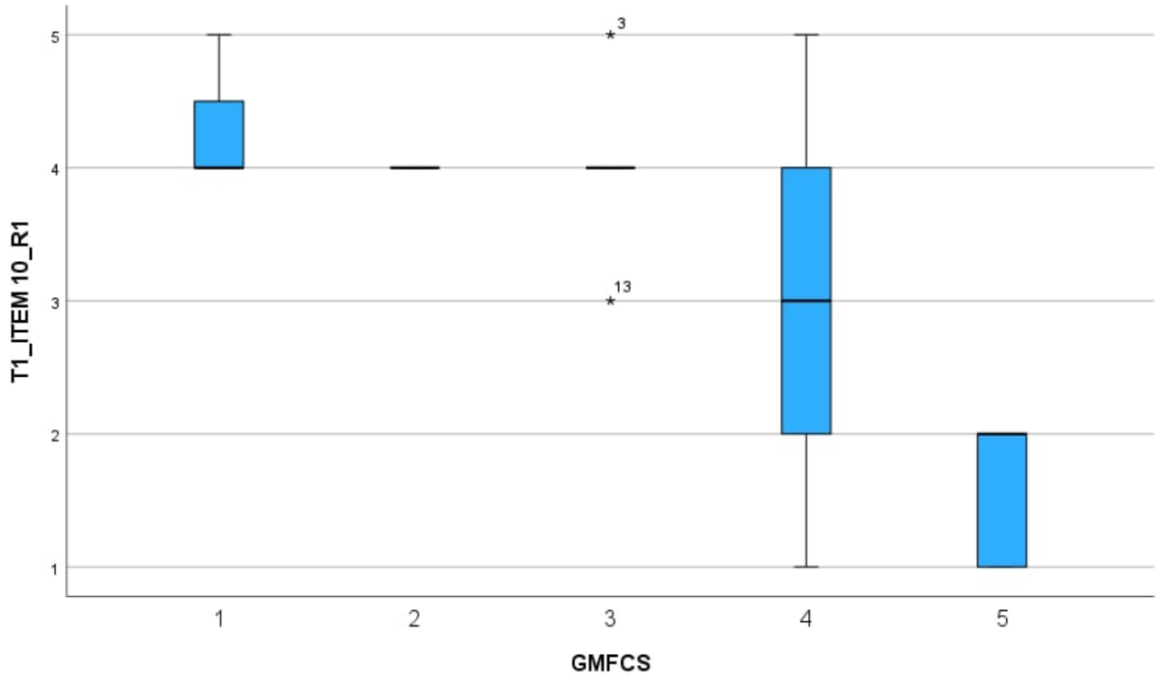
Appendix Figure 2.6: Boxplot HippoTrunC item 7



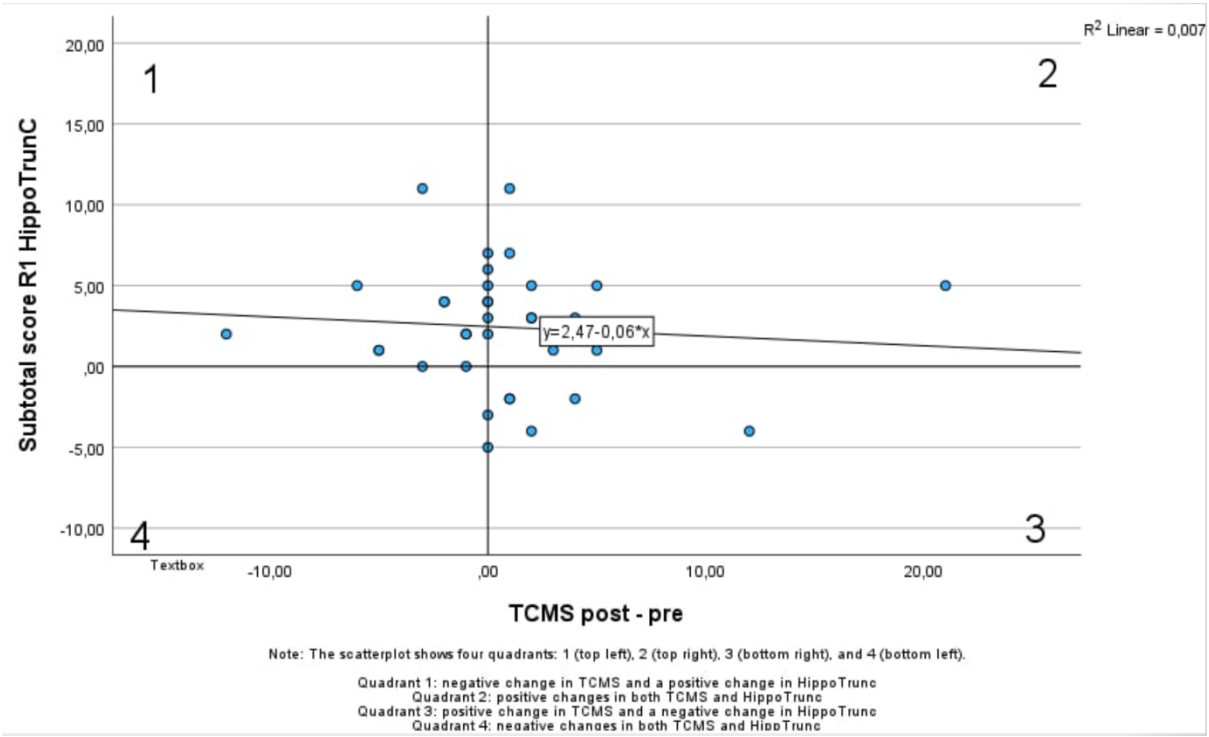
Appendix Figure 2.7: Boxplot HippoTrunC item 8



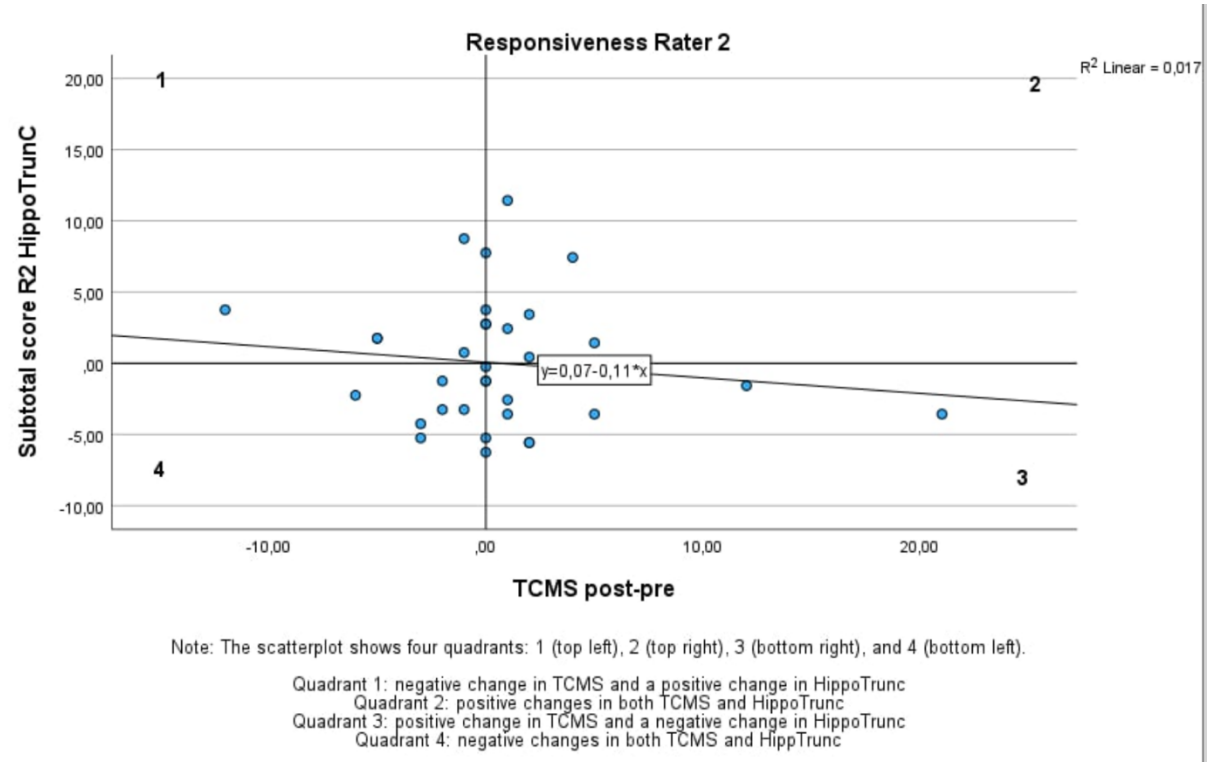
Appendix Figure 2.8: Boxplot HippoTrunC item 9



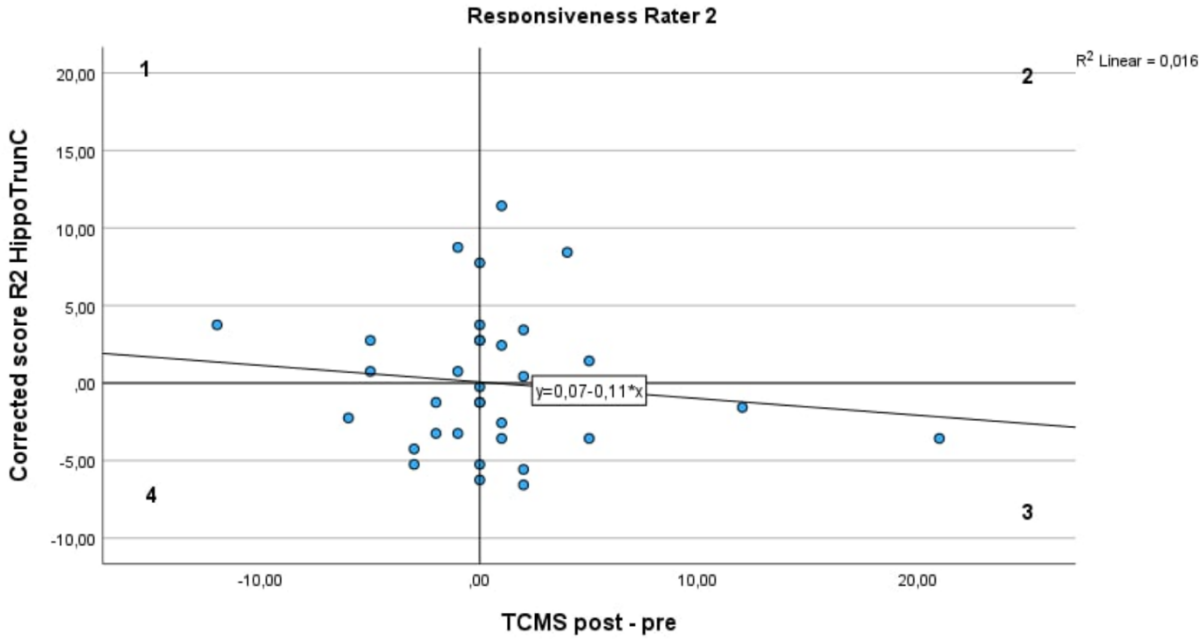
Appendix Figure 2.9: Boxplot HippoTrunC item 10



Appendix Figure 2: Scatterplot HippoTrunC subtotal score - TCMS rater 1



Appendix Figure 3: Scatterplot HippoTrunC subtotal score- TCMS rater 2



Note: The scatterplot shows four quadrants: 1 (top left), 2 (top right), 3 (bottom right), and 4 (bottom left).

Quadrant 1: negative change in TCMS and a positive change in HippoTrunc
Quadrant 2: positive changes in both TCMS and HippoTrunc
Quadrant 3: positive change in TCMS and a negative change in HippoTrunc
Quadrant 4: negative changes in both TCMS and HippTrunc

Appendix Figure 4: Scatterplot HippoTrunC corrected score- TCMS rater 2