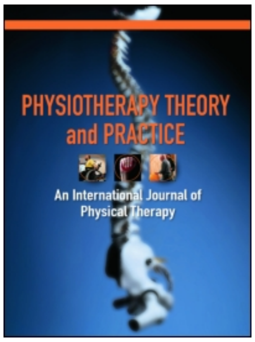

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REPORT

The relationship between segmental trunk control and gross motor performance in low birth weight born infants

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ABSTRACT

Objective: Trunk control is associated with gross motor development. This study examines the relationship between segmental trunk control and gross motor performance in low birth weight (LBW) infants

Methods: A total of 42 LBW infants and 43 normal birth weight (NBW) infants aged 3–9 months were sampled for this cross-sectional study. All infants were evaluated one time by the Segmental Assessment Trunk Control (SATCo) and the Alberta Infant Motor Scale (AIMS)

Results: Statistically high and significant correlations were found between gross motor performance and segmental trunk control in all sample populations ($r = 0.835$; $p = .001$). No statistically significant difference was found regarding the segmental trunk control between the groups ($p = .119$). The LBW infants with atypical motor development had poorer trunk control than the LBW infants with typical development ($f = 5.480$; $p = .001$).

Conclusion: Our results show that LBW infants with atypical motor development had poorer trunk control than LBW infants with typical motor development. It was found that the segmental trunk controls of LBW infants were 0.398 times lower than in NBW infants.

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Low birth weight; motor performance; posture; trunk control

Introduction

Postural control is an important and complex motor milestone acquired progressively during the 12 months of life. Postural control regulates sensory information and assists in maintaining body position in space, stability, and orientation. Postural stability and balance are the ability to engage in various static and dynamic activities and maintain or regain the body alignment within the base of the support in the line of gravity (Dusing and Harbourne, 2010). Sensory and motor systems work collaboratively to maintain alignment, maintain vertical control, and perform functional activities (Dusing and Harbourne, 2010; Rachwani et al., 2013). Moreover, efficient postural control of the trunk allows an individual to perform various tasks in an upright, vertical posture without any loss of balance. Efficient postural control also plays a significant role in assisting an infant to learn, move against gravity and facilitate motor development (Saavedra, van Donkelaar, and Woollacott, 2012).

The trunk control development occurs in a segmental way during cephalocaudal development (Graaf-Peters et al., 2007; Righetto Greco, Neves da Costa, and Tudella, 2018) and in descending order (Graaf-Peters et al., 2007; van Balen, Dijkstra, and Hadders-Algra, 2012). The acquisition of head control is the first sign of vertical posture when an infant is around 3-month old. Sitting ability begins at 4–5 months of age (Shumway-Cook and Woollacott, 2007). Then, an infant gains control of the head and upper trunk; this process is a preliminary preparation for independent sitting (Hadders-Algra and Carlberg, 2010). Independent sitting is achieved at approximately 6–9 months of age. The vertical development of the segmental trunk control improves between 3 and 9 months of age. Moreover, infants are capable of controlling their trunks in the thoracic region at 6–7 months of age. Full control is achieved at 8–9 months of age (Righetto Greco, Neves da Costa, and Tudella, 2018). Trunk control is one of the complex and significant motor milestones, acquired progressively during the first 12 months. However, trunk control is commonly delayed in children with motor impairments (Santamaria, Rachwani, Saavedra, and Woollacott, 2016).

In healthy infants aged 4–6 months, trunk control in the lumbar region positively enhanced better body movement and hand function than in infants who only

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had trunk control of the thoracic region (Rachwani et al., 2013). The trunk control is acquired in a segmental sequence across the development of upright sitting. It helps infants sit independently without support (Rachwani, Santamaria, Saavedra, and Woollacott, 2015).

The relationship between the proper postural control to maintain upright positions and gross motor development in infants has been well-proven. The development of motor performance and long-term cognitive abilities in low birth weight (LBW) and very LBW infants may be impaired (Evensen et al., 2020; Hack, Klein, and Taylor, 1995; Oudgenoeg-Paz et al., 2017). Trunk control in children with neurological disorders can be poor since a positive relationship is observed between trunk control and gross motor function (Saavedra and Woollacott, 2015). Thus, clinicians should examine how trunk control, level by level or segment by segment, is correlated with gross motor skills. If this is proven, this correlation would have a great impact on the early intervention of infants and children with or without neurological disorders. Early identification of the risk facing LBW infants requires early intervention as this category of infants is at a high risk of developing neurological disorders. Meanwhile, it is critical to examine if the segmental trunk control in LBW infants is different from their full-term born peers.

Few studies investigate the relationship between segmental trunk control and gross motor development in infants in the last 10 years (Rachwani et al., 2013; Rachwani, Santamaria, Saavedra, and Woollacott, 2015; Righetto Greco, Tiemi da Silva Sato, Cazotti, and Tudella, 2020; Saavedra, van Donkelaar, and Woollacott, 2012; Saavedra and Woollacott, 2015). This study compared the relationship between the gross motor performance and the segmental trunk control of the LBW infants who developed atypically in the 3–9 months corrected age and that of the normal birth weight (NBW) peers. This study hypothesizes that LBW infants who developed atypically had poorer trunk control than NBW infants at the 3–9 months of the corrected age.

Methods

Study design and participants

This cross-sectional study was approved by Marmara University, Institute of Health Sciences, Non-Interventional Clinical Research Ethics Committee with the Number 28.03.2014–9 (Clinical Trial Registration Number: NCT04313478). The LBW preterm and full-term infants, who were followed up by Dr. Lütfü Kırdar Kartal Training and Research Hospital, Neonatal Polyclinic, were included in the study. The parents were informed about the study and its contents before the assessment. Written consent was obtained from the parents of the children, and all procedures were conducted according to the Declaration of Helsinki.

Of 98 LBW infants followed up at the outpatient department, 42 infants (26 boys, 16 girls) met the inclusion criteria. The inclusion criteria for the LBW group were as follows: the written consent given by the parents, being 3–9 months of corrected age, and birth weight of ≤ 2500 g. Exclusion criteria were infants with any genetic, metabolic, or orthopedic congenital abnormalities, infants with chronic diseases, and parents' refusal to participate. In the control group, 43 NBW infants were included. The inclusion criteria for the NBW group were as follows: a healthy infant at 3 – 9 months' chronological ages, above 2500 g birth weight, without any neurodevelopmental problem, genetic, metabolic, orthopedic congenital abnormalities, or chronic diseases. An exclusion criterion is the parents' refusal to participate.

Measurements

Classification of postnatal characteristics

Sociodemographic and clinical characteristics (i.e. gender, birth weight, age, and delivery method) were recorded in the sociodemographic form. The corrected ages of all infants were calculated based on the gestational ages and outcomes of the ultrasonographic assessment. Birth weights were classified as LBW, very low birth weight (VLBW), and extremely low birth weight (ELBW). LBW is defined as a birth weight of ≤ 2499 g and is further categorized into VLBW (< 1500 g) and ELBW (< 1000 g) (World Health Organization, 2015).

Assessment of gross motor performance

The Alberta Infant Motor Scale (AIMS) is a practical and observational tool used to evaluate the gross motor performance of infants. The AIMS comprises 58 items, which is a norm-referenced standardized assessment tool for motor development in infants aged 0 to 18 months. AIM assesses infant motor performance through weight-bearing, posture, and antigravity movements in supine, prone, sitting, and standing positions. From the AIMS total score, gross motor performance is expressed in percentiles based on age (Piper and Darrah, 1994; Piper et al., 1992). Motor development was considered atypical or poor when it is below 5%, considered suspicious when between 6% and 24%, and considered typical when above 25% in the percentile scale. As the

AIMS total score increases, the infant's gross motor development improves, similar to that of their peers (Saccani, Valentini, and Pereira, 2016).

Assessment of segmental trunk control

Infants were evaluated using the Segmental Assessment Trunk Control (SATCo), a valid scale capable of assessing the level of segmental trunk control. In normal and motor-impaired infants, SATCo assesses the ability of infants to maintain and/or recover vertical position while sitting. It seeks to estimate the lack of trunk control level. In the assessment process, the infant was in a sitting position on a wooden bench, with the pelvis maintained in a neutral position using a belt system for the vertical axis and the head in the upright position to identify the level of trunk control. A video review was conducted for each assessment. The SATCo is an ordinal scale, which tests the infant's level of trunk control. The SATCo allows the evaluator to manually change the level of trunk support from a high level of support at the shoulder girdle to assess cervical (head) control, through support at the axillae (upper thoracic control), inferior scapula (mid-thoracic control), lower ribs (lower thoracic control), below ribs (upper lumbar control), pelvis (lower lumbar control), and no support to measure full trunk control. The tester applied the manual support horizontally around the trunk at different levels. Each score from 1 to 8 shows the level of trunk control. The score shows the region where infants lose control of posture: a score of 1 = loss of control at the head level; 2 = upper thoracic; 3 = mid-thoracic; 4 = lower thoracic; 5 = upper lumbar; 6 = lower lumbar; 7 = pelvis; and 8 = no loss of trunk control. A score of 7 shows that the infant has not fully mastered full trunk control to sit independently without hand support. A score of 8 indicates full trunk control, revealing that the infant can sit independently (Butler et al., 2010).

The three methods for assessing trunk control are: 1) static or steady-state control; 2) active or anticipatory control; and 3) reactive control (i.e. maintaining or regaining trunk control following a threat to balance produced by a brisk nudge). If the infant presented trunk control in all three balanced tests at the assessed level, the test continued by lowering the manual support level until the infant could not maintain the starting posture. Scores of 0 and 1 were given according to the upright posture, and the total score was calculated. SATCo tests were conducted, and the first and second authors scored the tests during the live testing. The inter-rater agreement for SATCo was 90%, in which 20% of the total sample was used for the calculation based on the following equation: number of agreements/(number of agreements + number of disagreements) x100. The SATCo is an instrument that has intra and inter-rater reliability of > 0.84 and e > 0.98, respectively, and the concurrent validity of AIMS ranges from 0.86 to 0.88 (Butler et al., 2010).

Assessment procedures

A pediatric physiotherapist (SKY) with 5-year experience used the SATCo and AIMS to evaluate all infants. Assessments were performed 2 h after feeding, in a quiet, well-lit room with a neutral temperature. The infant was calm, and most of the clothing was removed. All assessments were conducted in the same session, and there was an interval of rest to prevent fatigue. All measurements, including rest intervals, were completed within 1 hour.

Statistical analysis

Power Analysis of Two-Sample T-Test for Test of Equivalence was used to evaluate the effect of parameters in the NBW and LBW groups. The standard deviation for the sample was ±7.70 in the SATCo score obtained from Rachwani, Santamaria, Saavedra, and Woollacott (2015). The sample size comprised 84 individuals, with at least 42 individuals in each group. Here, approximately 80.9% power was obtained for the test. Statistical analyses were performed using the SPSS software version 21.0 (IBM Corp, 2012, Chicago, USA). Descriptive statistics were used to summarize the data in a manageable form. The one-sample Kolmogorov-Smirnov test was used to examine if the sample variables were normally distributed. Since the significance (p) value for AIMS and SATCo scores was less than 0.05 as a result of Kolmogorov-Smirnov normality test, non-parametric tests were applied. Chi-Square and Mann-Whitney U tests were used to compare sociodemographic and clinical characteristics of infants as well as to compare AIMS and SATCo scores between the groups (Table 3). The Spearman correlation coefficient was used to verify the relationship between the level of segmental trunk control, sub-scores, and the total score AIMS. The magnitude of the correlation was based on the Munro classification considering: low (0.26–0.49); moderate (0.50–0.69); high (0.70–0.89); or very high (0.90–1.00) (Munro, 2005). Ordinal logistic regression was used to analyze factor scores of SATCos. Since the dependent variable has an ordinal structure, Ordinal Logistic Regression Analysis was used to examine the effect of independent variables on the dependent variable. A p-value of 0.05 was considered a statistical significance level.

Results

The study included 42 LBW infants (26 boys and 16 girls) and 43 NBW infants (22 boys and 21 girls). The sociodemographic and clinical characteristics of the infants are summarized in Table 1. Postnatal risk factors did not differ in the study groups (p = .187). The mean gestational age of the LBW group was lower than that of the NBW group (p = .001). No difference was observed between the chronological age of the NBW group and the adjusted age of the LBW group (p = .836). Infants with LBW had longer hospital discharge times (p = .001).

Based on the AIMS percentile range of LBW infants, 16.6% are atypical, 19% suspicious, and 64.3% have typical motor performance. In the NBW group, no infants demonstrated atypical development. Table 2 summarizes the segmental trunk control, gross motor performance, and clinical characteristics of LBW infants with atypical and suspicious gross motor performance. Results showed that 6 mid-thoracic, 5 lower thoracic, 2 upper-thoracic, 1 lower lumbar, and 1 upper lumbar

Table 1. Comparison of sociodemographic and clinical characteristics of infants with respect to low and normal weight groups.

		LBW (n = 42)		NBW (n = 43)			
		n	%	n	%		p
Gender	Female	16	38	21	49	0.997^1	0.318
	Male	26	62	22	51		
Delivery Method	Cesarean	6	14	24	56	**9.150^1**	**0.002****
	Vaginal	36	86	19	44		
Birth Weight (g)	≤1000 (ELBW)	6	14	0	0	**25.052^1**	**0.001****
	1001–1500 (VLBW)	13	31	0	0		
	1501–2500 (LBW)	23	55	0	0		
	>2500	0	0	43	100		
Postnatal Risk Factors	Hyperbilirubinemia	6	75	2	25	6.174^1	0.187
	Sepsis	4	100	0	0		
	RDS	5	100	0	0		
	PDA	3	50	3	50		
	BPD	0	0	0	0		
	IVH	0	0	0	0		
	PVL	0	0	0	0		
	Others	7	88	1	12		
		Mean ± SD	**Median (IQR)**	**Mean ± SD**	**Median (IQR)**		
Birth Weight (g)		1530.12 ± 402.22	1645 (591)	3386.51 ± 532.06	3350 (650)	**−7.940^2**	**0.001****
Gestational Age (week)		31.36 ± 2.91	32 (4)	39.03 ± 1.00	39 (2)	**−7.984^2**	**0.001****
Chronological Age (month)		8.45 ± 1.97	8 (2)	6.40 ± 1.64	6 (3)	**−4.562^2**	**0.001****
Corrected Age (month)		6.43 ± 1.7	7 (2)	-		-	-
Length Of ICU Stay (day)		34.98 ± 23.79	28 (33)	2.74 ± 1.51	2 (1)	**−8.004^2**	**0.001****
One-Minute Apgar Score		7.17 ± 1.21	8 (1)	not obtained from discharge reports		-	-
Five-Minute-Apgar Score		8.62 ± 0.66	9 (1)	not obtained from discharge reports		-	-

ICU, intensive care unit; IVH, intraventricular hemorrhage; PVL, periventricular leukomalacia; RDS, respiratory distress syndrome; BPD, bronchopulmonary dysplasia; PDA, patent ductus arteriosus; NBW, Normal birth weight; LBW, Low birth weight; VLBW, very low birth weight; ELBW, extremely low birth weight; SD, standard deviation; IQR, Interquartile range; *p < 0.05; **p < 0.01; ^{1}: Chi-Square Test (x^2); ^{2}: Man Whitney U Test (*z*); Summary statistics is given as mean ± standard deviation and Median (IQR) values for numerical data, Number (Percentage) values for categorical data.

Table 2. Segmental trunk control and gross motor performance and clinical characteristics of LBW infants with atypical and suspicious gross motor performance.

Low Birth Weight Infants Developing Atypically (CA)	Birth Weight (g)	Gestational Age (week + day)	Gender	AIMS % Range	The level at which trunk control is lost	SATCo static score	SATCo active score	SATCo reactive score
First case (7 mo)	1950	33 + 5/7	F	0–5	Mid thoracic control	3	3	2
Second case (5 mo)	1030	28	M	6–10	Mid thoracic control	3	3	2
Third case (8 mo)	800	27 + 4/7	M	0–5	Lower thoracic control	4	4	3
Forth case (7 mo)	1200	26 + 4/7	M	6–10	Lower thoracic control	4	4	3
Fifth case (4 mo)	1355	31 + 4/7	M	6–10	Upper thoracic control	2	2	1
Sixth case (7 mo)	790	25 + 1/7	F	0–5	Upper thoracic control	2	2	1
Seventh case (4 mo)	1450	30	M	0–5	Lower thoracic control	4	4	3
Eighth case (5 mo)	1450	30	M	6–10	Lower thoracic control	4	4	3
Ninth case (5 mo)	1730	30 + 5/7	F	0–5	Mid thoracic control	3	3	2
Tenth case (7 mo)	2000	34 + 3/7	M	0–5	Mid thoracic control	3	3	2
Eleventh case (6 mo)	1800	34 + 6/7	F	0–5	Mid thoracic control	3	3	2
Twelve case (7 mo)	1940	36 + 1/7	M	10–24	Mid thoracic control	3	3	2
Thirteen case (6 mo)	2000	33	F	10–24	Lower lumbar control	6	6	5
Fourteen case (6 mo)	1715	31	F	10–24	Lower thoracic control	4	4	3
Fifteen case (8 mo)	2000	35	F	10–24	Upper lumbar control	5	5	4

F, Female; M, Male; AIMS, Alberta Infant Motor Scale; SATCo, Segmental Assessment Trunk Control; CA, Corrected Age; mo, month; g, gram.

level of segmental trunk control were found among the LBW infants with atypical and suspicious gross motor performance (Table 2).

In all sampled infants, SATCo total scores of infants with typical motor performance, according to AIMS were higher than infants with atypical motor performance ($p < .05$). A statistically significant difference was noted between SATCo total scores of LBW infants with atypical motor performance and LBW infants with typical motor performance ($p < .05$). LBW infants with atypical motor performance had lower SATCo total scores than LBW infants with typical motor performance (Table 3).

No statistically significant differences were observed between the groups, regarding the AIMS and SATCo total scores ($p = .772$, $p = .119$) (Table 4). Statistically moderate or high-level positive correlation values were noted between the segmental trunk control (SATCo), and gross motor performance (AIMS) in each group (LBW and NBW) ($p = .001$) (Table 5).

The results obtained from the ordinal logistic regression analysis are as follows: An increase in AIMS prone

Table 3. Comparison of SATCo scores between AIMS total score categories in the LBW group.

	AIMS Total Score Categories				
	AIMS (i)	AIMS (j)	Differences of SATCo Total Score Median	F (p)	Post Hoc (i-j)
LBW (n = 42)	0–5 (Atypical)	51–75 (Typical)	−7.23	5.480 (0,001)	0.011*
		76–90 (Typical)	−10.57		0.006*
		91–100 (Typical)	−11.57		0.011*
All infants (n = 85)	0–5 (Atypical)	26–50 (Typical)	−5.12500	5.628 (0,001)	0.033*
		51–75 (Typical)	−6.67857		0.002*
		76–90 (Typical)	−7.58333		0.003*
		91–100 (Typical)	−11.25000		0.001*

AIMS, Alberta Infant Motor Scale; SATCo, Segmental Assessment Trunk Control, AIMS (i), samples with atypical AIMS; AIMS (j), samples with typical AIMS; *ANOVA, Statistically significant difference ($p < 0.05$).

Table 4. Comparison of low and normal birth weight infants' AIMS and SATCo scores.

		LBW (n = 42)		NBW (n = 43)			
		Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)	z	p
AIMS	Prone	9.33 ± 5.01	8 (6)	9.07 ± 3.78	9 (6)	−0.451[1]	0.652
	Supine	7.19 ± 1.78	8 (3)	7.28 ± 1.72	8 (3)	−0.276[1]	0.783
	Sitting	6.07 ± 3.44	5 (7)	6.33 ± 2.63	6 (4)	−0.879[1]	0.380
	Standing	3.57 ± 2.25	3 (2)	3.09 ± 1.41	3 (1)	−0.289[1]	0.772
	Total score	26.17 ± 11.32	23 (15)	25.77 ± 8.48	25 (13)	−0.290[1]	0.772
SATCo[a]	Static control	4.74 ± 1.65	4 (3)	5.23 ± 1.34	5 (3)	−1.559[1]	0.119
	Active control	4.74 ± 1.65	4 (3)	5.23 ± 1.34	5 (3)	−1.559[1]	0.119
	Reactive control	3.74 ± 1.65	3 (3)	4.23 ± 1.34	4 (3)	−1.559[1]	0.119
The SATCo level at which trunk control is lost (Total Score)		13.21 ± 4.96	11 (10)	14.7 ± 4.03	14 (9)	−1.559[1]	0.119

SATCo, Segmental Assessment Trunk Control; AIMS, Alberta Infant Motor Scale; *$p < 0.05$; **$p < 0.01$; [1]: Mann Whitney U Test (*z*); Summary statistics is given as mean ± standard deviation and Median (IQR) values for numerical data.; [a]: Numbers in brackets = range of SATCo scores. The numbers represent medians of the SATCo trunk segmental level at which control was being learnt: 1 = head control, 2 = upper thoracic level, 3 = mid- thoracic, 4 = lower thoracic, 5 = upper lumbar, 6 = lower lumber, 7 = full trunk control, and 8 = full trunk control achieved. Please note that the SATCo is an ordinal scale and the learning levels shown in this table were the medians of each group of infants.

Table 5. Correlation value between segmental trunk control (SATCo) and gross motor performance (AIMS) in each group (LBW, NBW and Total).

		STACo Score(The SATCo level at which trunk control is lost)		
		LBW (n = 42) r	NBW (n = 43) r	Total (n = 85) r
AIMS subtest scores	Prone	0.749*	0.800*	0.775*
	Supine	0.629*	0.801*	0.704*
	Sitting	0.838*	0.783*	0.816*
	Standing	0.690*	0.666*	0.676*
Total score AIMS		0.819*	0.864*	0.835*

SATCo, Segmental Assessment Trunk Control; AIMS, Alberta Infant Motor Scale; *$p = 0.001$; Spearman correlation test and sitting subscores increased SATCo total score (p = .001). Since the "LBW" infants were considered as the reference category, the SATCo total score decreased by 0.398 times in LBW infants compared with NBW infants. Compared to the LBW infants, the NBW infants increased segmental trunk control by 1.731 times in sitting position, and by 1.481 times in prone position (Table 6).

Discussion

Insufficient evidence was noted regarding the relationship between gross motor performance and segmental trunk control in LBW infants. Scanty studies have explored this subject, and this study is the first to examine trunk control in LBW infants (Pin, Butler, Cheung, and Shum, 2018; Righetto Greco, Tiemi da Silva Sato, Cazotti, and Tudella, 2020). This study confirmed that LBW infants with atypical motor performance had poor trunk control. LBW could affect trunk control negatively, and previous studies revealed differences in motor development between preterm and term infants, regarding the trunk control (Pin, Butler, Cheung, and Shum, 2018; Pin, Darrer, Eldridge, and Galea, 2009; Pin, Eldridge, and Galea, 2010). Moreover, recent studies focused on preterm and term infants and presented the results of LBW infants who developed typically and atypically, which was compared to the results of the NBW infants in this study. Unlike most previous studies that focused on very LBW infants (≤ 1500 g), this study focused on infants with LBW (≤ 2500). Our results support previous studies and provide insight into segmental trunk control and motor performance of LBW children. Therefore, this study provides important evidence for the scientific community and clinical practice.

The infant with atypical gross motor development had lower segmental trunk control than the infant with typical gross motor development. In this study, 16.6% of LBW infants had atypical motor development. Righetto Greco, Tiemi da Silva Sato, Cazotti, and Tudella (2020) have found that the control in the lower thoracic region assists the preterm infants to sit independently, even at some point, they may lose balance when they withdraw the anterior hands' support. A study has shown that the infant has full trunk control at 8 months (Righetto Greco, Neves da Costa, and Tudella, 2018). Other studies have shown that term infants aged 8–9 months of corrected age maintain full trunk control, which is a period of a milestone in the motor development and complete control of the trunk (Pin, Darrer, Eldridge, and Galea, 2009; Righetto Greco, Neves da Costa, and Tudella, 2018). Thus, the motor development of LBW infants should be closely monitored. Moreover, the motor development and trunk control of LBW infants with either atypical development or typical development should be examined thoroughly by health professionals for appropriate early intervention.

In the previous studies, it is proven that LBW infants face a higher risk of motor delay compared with their NBW peers. Gestational age and LBW influence motor developmental delays (Hack, Klein, and Taylor, 1995; Hilaire et al., 2021). In this study, 15 LBW infants with atypical and suspicious gross motor performance were noted. When the gestational ages of LBW infants with atypical development were examined, most LBW infants were either very preterm or extremely preterm. Preterm infants may face difficulties with gross motor skills that require greater antigravitational control and trunk verticalization, such as sitting, standing, etc. Independent sitting requires antigravitational muscle strength of the

Table 6. Effects of gross motor performance (AIMS Subtest Scores) and birth weight on segmental trunk control (SATCo Total Score).

		Estimate ± Std. Error	OR (CI)	p
Dependent Values (Thresholds)	[SATCo Total Score = 2]	2.045 ± 1.117		0.047*
	[SATCo Total Score = 3]	4.230 ± 1.111		0.001**
	[SATCo Total Score = 4]	6.477 ± 1.218		0.001**
	[SATCo Total Score = 5]	8.898 ± 1.429		0.001**
	[SATCo Total Score = 6]	10.467 ± 1.567		0.001**
Independent Values	AIMS Prone	0.393 ± 0.123	1.481 (1.164–1.885)	0.001**
	AIMS Supine	0.105 ± 0.199	1.110 (0.752–1.640)	0.598
	AIMS Siting	0.549 ± 0.138	1.731 (1.321–2.268)	0.001**
	AIMS Standing	0.182 ± 0.284	1.199 (0.688–2.091)	0.521
	NBW	−0.921 ± 0.461	0.398 (0.161–0.984)	0.046*
	LBW (Reference)	1	-	-

−2 Log Likelihood = 174.166 p < .001
Cox and Snell = 0.727
Test of Parallel Lines = 160.423 p < .001

SATCo, Segmental Assessment Trunk Control; AIMS, Alberta Infant Motor Scale; Analysis, Ordinal Logistic Regression; *p < 0.05; **p < 0.01

trunk, and muscular hypotonia may cause muscle weakness in preterm infants (Harbourne and Stergiou, 2003; Saavedra and Woollacott, 2015). Although no statistically significant difference was observed between gross motor performance and segmental trunk controls of LBW and NBW infants, a difference was found between segmental trunk controls of LBW infants with atypical motor performance and LBW infants who developed typically.

The static, active, and reactive control of the trunk is crucial for postural control. Our results are positively correlated with the segmental trunk control and gross motor performance in LBW and NBW infants, which agree with the results of the previous studies that focus on the preterm infants (Pin, Butler, Cheung, and Shum, 2018; Pin, Darrer, Eldridge, and Galea, 2009; Pin, Eldridge, and Galea, 2010; Righetto Greco, Tiemi da Silva Sato, Cazotti, and Tudella, 2020). No differences were observed between static, active, and reactive trunk control of the LBW and NBW infants. The results show that segmental trunk control proceeds in parallel with the gross motor performance development of both LBW and NBW infants.

Thus, a moderate or high correlation is observed between gross motor performance and segmental trunk control, in the sitting posture in each group. Trunk control is vital for performing functional skills (Shumway-Cook and Woollacott, 2007). Infants can interact with their environment while maintaining a sitting posture through trunk control. At the ages of 3–9 months, typical infants improve vertical posture in sitting posture and begin acquiring more complex motor skills (Saavedra, van Donkelaar, and Woollacott, 2012). Our results show that the segmental trunk control ability in the sitting position correlates gross motor performance. This evidence indicates a significant correlation between segmental trunk control and sitting posture in LBW and NBW infants aged 3–9 months. There is a relationship between the SATCo scores and the gross motor performance in the prone and sitting positions. When the gross motor performance in the prone and sitting positions increases, it is predicted that SATCo scores have also increased. Compared to LBW infants, NBW infants increased segmental trunk control by 1.731 times with sitting motor performance and 1.481 times in prone motor performance at 3–9 months. In this study, we found that the segmental trunk controls of LBW infants were 0.398 times lower than in NBW infants. Therefore, investigating the relationship between the level of trunk control and gross motor performance is vital as it assists in identifying the differences between LBW and NBW infants.

The assessor is not blinded, which has been a limitation of this study. We avoided bias by performing data analysis without specifying, which group the cases belonged to. Overprotective parents of preterm infants did not participate in this study, which negatively affected the sample size.

Apart from the gross motor performance assessment, segmental trunk control assessment may give an idea about the presence of gross motor developmental risk in the identification of atypically developing infants. These results offer evidence that LBW infants with atypical development have insufficient trunk control. Considering the present data, insufficient trunk control and developmental problems in LBW infants with motor development delay should be determined in infants aged 3–9 months. Thus, the trunk control of LBW infants with atypical motor development was poor compared with LBW infants with typical motor development. The level of trunk control correlates with the improvement in gross motor performance in infants aged 3–9 months.

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References

Butler P, Saavedra MS, Sofranac MM, Jarvis MS, Woollacott M 2010 Refinement, reliability and validity of the segmental assessment of trunk control (SATCo). Pediatric Physical Therapy 22: 246–257. 10.1097/PEP.0b013e3181e69490.

Dusing SC, Harbourne RT 2010 Variability in postural control during infancy: Implications for development, assessment, and intervention. Physical Therapy 90: 1838–1849. 10.2522/ptj.2010033.

Evensen KAI, Ustad T, Tikanmäki M, Haaramo P, Kajantie E 2020 Long-term motor outcomes of very preterm and/or very low birth weight individuals without cerebral palsy: A review of the current evidence. Seminars in Fetal and Neonatal Medicine 25: 101116. 10.1016/j.siny.2020.101116.

Graaf-Peters VB, Bakker H, Eykern LA, Otten B, Hadders-Algra M 2007 Postural adjustments and reaching in 4- and 6 months old infants: An EMG and kinematical study. Experimental Brain Research 181: 647–656. 10.1007/s00221-007-0964-6.

Hack M, Klein NK, Taylor HG 1995 Long-term developmental outcomes of low birth weight infants. Future of Children 5: 176–196. 10.2307/1602514.

Hadders-Algra M, Carlberg E 2010 Postural control: A key issue in developmental Disorders. pp. 203. London: Mac Keith Press.

Harbourne RT, Stergiou N 2003 Nonlinear analysis of the development of sitting postural control. Developmental Psychobiology 42: 368–377. 10.1002/dev.10110.

Hilaire M, Andrianou XD, Lenglet A, Ariti C, Charles K, Buitenhuis S, Brusselen DV, Roggeveen H, Ledger E, Denat RS, et al. 2021 Growth and neurodevelopment in low birth weight versus normal birth weight infants from birth to 24 months, born in an obstetric emergency hospital in Haiti, a prospective cohort study. BMC Pediatrics 21: 143. 10.1186/s12887-021-02605-3.

IBM Corp 2012 IBM SPSS Statistics for Windows, Version 21.0. Armonk NY: IBM Corp.

Munro BH 2005 Statistical methods for health care research. 5th pp. 239–258. Philadelphia, PA: Lippincott Williams and Wilkins.

Oudgenoeg-Paz O, Mulder H, Jongmans MJ, van der Ham IJ, Van der Stigchel S 2017 The link between motor and cognitive development in children born preterm and/or with low birth weight: A review of current evidence. Neuroscience and Biobehavioral Reviews 80: 382–393. 10.1016/j.neubiorev.2017.06.009.

Pin TW, Butler PB, Cheung HM, Shum SFL 2018 Segmental assessment of trunk control in infants from 4 to 9 months of age - A psychometric study. BMC Pediatrics 18: 182. 10.1186/s12887-018-1153-4.

Pin TW, Darrer T, Eldridge B, Galea MP 2009 Motor development from 4 to 8 months corrected age in infants born at or less than 29 weeks' gestation. Developmental Medicine and Child Neurology 51: 739–745. 10.1111/j.1469-8749.2009.03265.x.

Pin TW, Eldridge B, Galea MP 2010 Motor trajectories from 4 to 18 months corrected age in infants born at less than 30 weeks of gestation. Early Human Development 86: 573–580. 10.1016/j.earlhumdev.2010.07.008.

Piper MC, Darrah JM 1994 Motor Assessment of the Developing Infant. pp. 36–205. Alberta: WB Saunders.

Piper MC, Pinnell LE, Darrah J, Maguire T, Byrne PJ 1992 Construction and validation of the Alberta Infant Motor Scale (AIMS). Canadian Journal Public Health 83: 46–50.

Rachwani J, Santamaria V, Saavedra SL, Wood S, Porter F, Woollacott MH 2013 Segmental trunk control acquisition and reaching in typically developing infants. Experimental Brain Research 228: 131–139. 10.1007/s00221-013-3544-y.

Rachwani J, Santamaria V, Saavedra SL, Woollacott MH 2015 The development of trunk control and its relation to reaching in infancy: A longitudinal study. Frontiers in Human Neuroscience 9: 94. 10.3389/fnhum.2015.00094.

Righetto Greco AL, Neves da Costa CS, Tudella E 2018 Tudella E 2018 identifying the level of trunk control of healthy term infants aged from 6 to 9 months. Infant Behaviour Development 50: 207–212. 10.1016/j.infbeh.2017.12.007.

Righetto Greco AL, Tiemi da Silva Sato N, Cazotti AM, Tudella E 2020 Is segmental trunk control related to gross motor performance in healthy preterm and full-term infants? Journal Motor Behaviour 52: 666–675. 10.1080/00222895.2019.1673694.

Saavedra SL, van Donkelaar P, Woollacott MH 2012 Learning about gravity: Segmental assessment of upright control as infants develop independent sitting. Journal Neurophysiology 108: 2215–2229. 10.1152/jn.01193.2011.

Saavedra SL, Woollacott MH 2015 Segmental contributions to trunk control in children with moderate-to-severe cerebral palsy. Archives of Physical Medicine and Rehabilitation 96: 1088–1097. 10.1016/j.apmr.2015.01.016.

Saccani R, Valentini NC, Pereira KR 2016 New Brazilian developmental curves and reference value for Alberta infant motor scale. Infant Behaviour Development 45: 38–46. 10.1016/j.infbeh.2016.09.002.

Santamaria V, Rachwani J, Saavedra S, Woollacott M 2016 Effect of segmental trunk support on posture and reaching in children with cerebral palsy. Pediatric Physical Therapy 28: 285–293. 10.1097/PEP.0000000000000273.

Shumway-Cook A, Woollacott MH 2007 Development of postural control. In: Motor control: Translating research into clinical practice 3rd. pp. 187–211. Philadelphia, PA: Lippincott, Williams & Wilkins.

van Balen LC, Dijkstra LJ, Hadders-Algra M 2012 Development of postural adjustments during reaching in typically developing infants from 4 to 18 months. Experimental Brain Research 220: 109–119. 10.1007/s00221-012-3121-9.

World Health Organization 2015 International statistical classification of diseases and related health problems. https://apps.who.int/iris/handle/10665/246208.