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Normative Values of Star Excursion Balance Test in 6 To 14 Years Old School Children: An Analytical Cross Sectional Study

Tejas Borkar[1], Dr. Prashant Nigvekar[2]

[1]Associate Professor, Department of Pediatric Physiotherapy Dr APJ Abdul Kalam College of Physiotherapy, Pravara Institute of Medical Sciences-DU
[2]Professor, Department of Pediatrics, Dr. DBVP RMC, Pravara Institute of Medical Sciences-DU

Corresponding Author: Tejas Borkar

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ABSTRACT

Introduction: Balance is essential in many daily activities. The Star Excursion Balance Test (SEBT) is a simple, rapid, and affordable test that can be used in clinical and field settings to evaluate lower limb dynamic balance, monitor recovery, evaluate post-injury deficits, and identify athletes at high risk for lower extremity injuries. This cross-sectional study has been conducted to establish the normative values of SEBT for the purposes of injury prevention and rehabilitation in school-going children.
Methodology: After ethical approval total 1308 children of 6 and 14yrs age from various schools were selected via simple random sampling. Both boys and girls with normal range of motion in lower extremity. Participants with a history of lower extremity deformity, spinal dysfunction, recent surgery, ankle trauma, dizziness/vertigo, pre-existing inner ear disorder, visual loss, and any else affecting balance control were all excluded. Each child performed SEBT in all 8 directions with barefoot for right and left leg.
Data analysis: Data was analyzed using Software IBM SPSS 20. Descriptive statistics was used to obtain normative values
Conclusion: As the age increases the reach distance of both left and right leg increases. Also the reach distance for both legs varied for certain directions.In Medial , Posteromedial, Posterior and Posterolateral the left reach was more than the right reach while in Anterolateral the right reach was more than the left reach

Keywords: SEBT, dynamic balance, school children, normative values

INTRODUCTION

Balance is essential for all movements in every daily activity. Balance is essential in many daily activities, which includes standing on feet to reach something on the top shelf, walking up and down the stairs or on an uneven surface, running, swimming, biking, and many others. Any impairment in balance will reduce performance and increase the risk of injury and fractures, causing daily activities to be hampered. Thus, balance is crucial in any rehabilitation/prophylactic physiotherapy programme. (Sarkar et al. 2018) There are numerous outcome metrics for evaluating balance, but there are very few tests for evaluating dynamic balance.(P. A. Gribble, Hertel, and Plisky 2012) While many daily activities required dynamic balance, the standardised tests used to evaluate balance clinically tended to focus more on static balance. Because lower extremity injuries are so common and costly, it is essential to create screening tools to determine who will

be most at risk and to put appropriate preventative measures in position. The majority of dynamic balance assessment tools, like the berg balance scale and functional reach tests, were created especially for pediatric, geriatric, and neurological patients.

To assess dynamic balance However, these devices are not practical or affordable for many clinical settings due to their space and cost requirements. Therefore, a straightforward, trustworthy, and valid method is required to evaluate lower extremity functional performance. The Star Excursion Balance Test (SEBT) is a simple, rapid, and affordable test that can be used in clinical and field settings to evaluate lower limb dynamic balance, monitor recovery, evaluate post-injury deficits, and identify athletes at high risk for lower extremity injuries. SEBT calls for neuromuscular abilities like balance, flexibility, and strength in the lower extremities. (P. A. Gribble, Hertel, and Plisky 2012; Hertel et al. 2006) (P. Gribble 2003)This test tests the subject's postural control, strength, range of motion, and proprioceptive abilities by requiring them to balance on one lower limb while using the other lower limb to reach along previously marked lines in eight different directions. The distance covered in each direction is measured independently and interpreted as an indicator of dynamic balance, providing a useful alternate method for clinicians to evaluate dynamic balance. The more the subject can reach while balancing on the other leg, the better their functional performance. To quantify dynamic balance, the distance covered is measured in centimeters and typically normalised to the participant's height or leg length, though it is also possible to complete it without doing so.

According to the body of research, normative values of the SEBT have the potential to predict the likelihood of lower extremity injury and can provide objective measures to distinguish between deficits and improvements in dynamic postural control related to fatigue or lower limb injury. (McCann et al. 2015)

The normative values of the star excursion balance test in school-age children lack sufficient literature reviews. In order to help the therapist establish more precise levels of neuromuscular function for the purposes of injury prevention and rehabilitation, the goal of this cross-sectional study has been to establish the normative values of the star excursion balance test in school-going children. The need to develop screening of dynamic balance to identify those at risk of injury and implement appropriate preventative measures is critical given the prevalence and financial burden of lower extremity injuries.

MATERIALS & METHODS

An ethical approval from the Institute Ethical Committee (IEC) was obtained before the study began, and a stratified purposive sample design was used to select the samples. This prospective cross sectional study measured the excursion values of SEBT from school-going children aged between six and fourteen in Loni, Ahmednagar, India between December 2021 and February 2023.

The participants were school-going children between the ages of 6 and 14 who had normal ranges of motion in their hips, knees, and ankles. Participants with a history of lower extremity deformity, history of spinal dysfunction, recent surgery history of ankle trauma requiring medical attention within the previous two years, history of any dizziness or vertigo, a pre-existing inner ear disorder, a pre-existing bone or joint abnormality, participants with visual loss, and anyone else with conditions that could negatively affect balance control were all excluded from the study.

1308 participants agreed to participate and signed the informed consent form, which includes permission to use their data and photographs for presentation and publication purposes, in their preferred language of Marathi, hind, or English, out of a total of 1350 school-aged children. Of

these, 42 were excluded. There were 444 males and 864females among them.

PROCEDURE: -

The study's proposal was made to the participants. The study's objective and methodology were explained in the most understandable language to both participants and carers. Age, sex, height, leg length and Body Mass Index (BMI) were taken into account when compiling the demographic information.

On the floor, a star-like pattern was drawn with lines 45 degrees apart in the following eight directions: anterior (A), posterior (P), medial (M), lateral (L), anteromedial (AM), anterolateral (AL), posteromedial (PM), and posterolateral (PL).

Test: -

All of the participants watched the tester perform the test. Participants were instructed to stand with one foot in the centre of the star pattern and the other as far as they could before returning to the starting position by lightly touching the line with their big toe. All the testing and trials were performed barefoot. Participants maintained single leg stance while reaching with contralateral leg touched as far as on chosen line. Furthermost point reached by distal part of the leg marked and measured by examiner. Each participant completed the test in all 8 directions with both feet.

Star Excursion Balance Test

STATISTICAL ANALYSIS & RESULT

Table 1 and 2 depicts the normative values of SEBT for different age. The SEBT values for all directions showed an upward trend over the age from age 6 years to 11 years and thereafter and remains almost same between 11 to 14 years.

Table 3 shows the comparison of the SEBT values between right and left reach. The reach is significantly different for Medial, Posteromedial, Posterior, Posterolateral and Anterolateral values. While it was same in Anterior, Anteromedial and Lateral reach.

In Medial, Posteromedial, Posterior and Posterolateral the left reach was more than the right reach while in Anterolateral the right reach was more than the left reach

Table 1: Normative SEBT Values of Right Reach for different Ages (Years)

Age	**6 - 7 years (290)**	**7 - 8 years (52)**	**8 - 9 years (91)**	**9 - 10 Years (132)**	**10 - 11 Years (155)**	**11 - 12 Years (248)**	**12 - 13 Years (110)**	**13 - 14 Years (231)**
Directions	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**
Anterior	61.07±13.90	65.80±11.83	68.00±13.10	70.71±11.86	73.79±12.30	77.50±13.85	77.53±13.79	77.98±11.23
Anteromedial	55.53±13.11	57.61±11.57	64.42±11.78	65.02±12.54	67.78±13.37	69.23±14.34	69.55±13.01	71.01±9.91
Medial	32.92±12.22	37.90±14.44	38.06±13.76	39.79±13.90	42.63±12.04	43.09±17.00	43.18±13.67	43.22±12.48
Posteromedial	42.52±13.84	44.06±14.20	46.59±15.55	49.49±12.73	50.76±14.57	56.96±16.74	57.12±15.46	57.48±11.60

Posterior	48.06±13.33	49.67±14.48	50.12±12.69	53.81±14.37	57.95±13.63	61.15±17.91	61.62±17.48	61.89±12.01
Posterolateral	54.00±14.23	58.99±13.61	60.03±14.32	61.58±15.06	65.96±14.78	68.06±19.79	68.81±41.45	69.23±13.22
Lateral	57.86±15.34	59.25±14.51	60.20±15.32	63.33±14.90	65.14±12.59	72.91±21.44	73.02±19.63	73.89±15.96
Anterolateral	63.92±14.52	70.38±13.17	72.25±14.44	76.84±14.30	80.10±13.62	82.62±18.37	82.90±17.12	82.90±13.68

Table 2: Normative SEBT Values of Left Reach for different Ages (Years)

Age	**6 - 7 years (290)**	**7 - 8 years (52)**	**8 - 9 years (91)**	**9 - 10 Years (132)**	**10 - 11 Years (155)**	**11 - 12 Years (248)**	**12 - 13 Years (110)**	**13 - 14 Years (231)**
Directions	**Mean ±SD**	**Mean ±SD**	**Mean ±SD**	**Mean ±SD**	**Mean ±SD**	**Mean ±SD**	**Mean ±SD**	**Mean ±SD**
Anterior	62.33±13.69	63.48±10.95	67.93±12.25	71.34±10.14	76.03±11.30	78.51±14.51	78.75±14.07	78.81±11.89
Anteromedial	55.93±13.00	58.44±14.86	62.46±12.94	66.04±10.75	69.39±13.37	71.26±14.37	71.41±15.52	71.54±11.03
Medial	33.16±12.92	39.37±14.64	41.92±14.48	45.72±14.17	49.06±14.32	53.14±17.94	56.93±16.19	56.92±12.99
Posteromedial	44.27±14.13	45.99±12.95	47.98±14.78	52.32±14.21	56.25±14.90	56.83±17.11	59.85±14.88	59.89±12.22
Posterior	48.96±13.92	49.74±13.32	50.41±13.03	56.06±14.22	59.52±12.63	63.87±19.53	64.24±16.65	64.43±14.42
Posterolateral	54.19±13.30	56.36±14.57	59.94±14.83	62.14±14.87	67.35±12.78	72.43±21.69	72.87±19.45	72.95±16.22
Lateral	58.11±15.99	60.23±11.93	61.12±14.74	65.89±14.31	70.79±13.59	74.10±20.22	74.27±19.30	74.32±19.35
Anterolateral	60.95±11.90	62.28±35.25	66.24±12.26	72.54±12.61	79.37±11.62	81.48±16.34	81.60±15.11	81.85±14.27

Table 3: Comparison of SEBT Values between Right and Left Reach

SEBT Directions	**Reach**	**Mean±Std. Deviation**	**Mean Difference**	**t**	**P Value**	**Result**
Anterior	Right	71.70±14.41	0.40	1.685	0.092	Not Significant
	Left	72.65±14.49	0.40			
Anteromedial	Right	65.14±13.78	0.38	1.65	0.099	Not Significant
	Left	66.06±14.52	0.40			
Medial	Right	39.92±14.61	0.40	11.613	0.000	Significant
	Left	47.14±17.10	0.47			
Posteromedial	Right	51.15±15.60	0.43	3.478	0.001	Significant
	Left	53.27±15.65	0.43			
Posterior	Right	56.08±15.87	0.44	2.848	0.004	Significant
	Left	57.90±16.76	0.46			
Posterolateral	Right	63.39±20.07	0.55	2.627	0.009	Significant
	Left	65.37±18.42	0.51			
Lateral	Right	66.44±20.31	0.56	1.96	0.056	Not Significant
	Left	67.94±18.60	0.51			
Anterolateral	Right	76.46±17.16	0.47	3.585	0.000	Significant
	Left	74.03±17.52	0.48			

Table 4: Normative SEBT Values for different Gender

Reach	**SEBT Directions**	**Male (444)**	**Female (864)**
		Mean±SD	Mean±SD
Right	Anterior	74.86±14.86	70.07±13.91
	Anteromedial	66.41±14.71	64.49±13.24
	Medial	44.18±16.96	37.73±12.70
	Posteromedial	56.03±17.75	48.63±13.71
	Posterior	61.59±17.30	53.24±14.29
	Posterolateral	68.41±18.41	60.81±20.40
	Lateral	72.19±19.85	63.48±19.91
	Anterolateral	79.55±18.29	74.87±16.33
Left	Anterior	75.52±15.78	71.17±13.55
	Anteromedial	68.41±16.18	64.85±13.43
	Medial	51.04±19.65	45.13±15.25
	Posteromedial	58.29±17.24	50.68±14.09
	Posterior	63.03±18.96	55.25±14.84
	Posterolateral	70.49±20.38	62.74±16.73
	Lateral	72.75±19.35	65.46±17.70
	Anterolateral	76.08±20.92	72.98±15.39

Observations/Results of your study should be written in this section along with tables/charts/figures etc. write serial numbers and appropriate heading/title of tables and legend/caption of figures.

DISCUSSION

In this study reference values of SEBT were obtained from 1308 healthy children aged 6 to 14 years for star excursion balance test. These values can be used to quantify balance in children for therapy or to monitor growth. This normative data reflects differences in SEBT excursion distance related to Gender, age, leg length and isometric strength of knee flexors and extensors. These gender, height and BMI specific reference values would enhance the interpretation of the SEBT in regular clinical practice and offer reference values against which the performance of patients could be compared; moreover, these reference values of SEBT could be used as reach targets during the progression of rehabilitation of patients.

The excursion reach of SEBT with respect to gender shows that male individual's has higher excursion reach scores in all 8 directions when compared with females, because height and leg length of males was comparatively greater than females.(Gill 1986) These findings are supported by ,(Sarkar et al. 2018; "Normative Values of Spinal Flexibility for Nigerians Using the Inclinometric Technique," n.d.) where they mentioned that females are generally have shorter legs as compared to males, hence lesser SEBT excursion reach in females.

Similarly on comparison of right and left reach, we found that The reach is significantly different for Medial, Posteromedial, Posterior, Posterolateral and Anterolateral values. While it was same in Anterior, Anteromedial and Lateral reach. In Medial, Posteromedial, Posterior and Posterolateral the left reach was more than the right reach. This maybe the difference in strength and stability of the dominant leg while in Anterolateral the right reach was more than the left reach. (Risberg et al. 2018; Guan et al. 2021; McKay et al. 2017) The possible explanation for reduced excursion reach distance in posterolateral, lateral and posterior direction could be that the participants got reduced visual cues or feedback in these direction especially in posterior and posterolateral direction, furthermore increasing demand on somatosensory system and joints of participants.(Davlin-Pater 2010; van Lieshout et al. 2016)This findings are supported by Coughlan et al (2012) who found that in SEBT and Y-balance test the reach distance in posterolateral directions is decreased because in the posterolateral directions, visual awareness is reduced, thus it places an increased demand on the somatosensory system and therefore, the inability of the participants to see their scores may limit their reach. (Coughlan et al. 2014, 2012) In the anterior reach direction, participants received visual feedback from the reach leg as they move and can observe the scored reach distance on each trial, so the excursion distance in this direction are more.

CONCLUSION

This study provides the normative values for SEBT of school going children from 6 to 14 years for different gender, height and BMI strata. SEBT excursion values in young adults increase with increase in height in both males and females. It can be also concluded from the result of this study the values of SEBT excursion are more on right stance leg as compared to left stance leg in different heights in both genders.

To account for the effects of height, BMI, and gender variability, it is advised that physical therapists and clinicians can assess SEBT values in relation to the normative values mentioned above.

Limitations Of the Study: -

Data was only collected from one centre and a nearby locality, so the normative values of the star excursion balance test established in this study may not be generalized to the entire Indian population. Further correlation

between bilateral leg length, BMI and SEBT value can be done. Normative data reflects differences in SEBT performance related to sex, age. The Normative data reflects differences in SEBT performance related to sex, age. The SEBT can be used to predict injury risk; however, clear cut-points have not been sufficiently explored.

Declaration by Authors

Ethical Approval: Approved (PIMS/DR/PhD/2020/COPT/107)

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Conflict of Interest: The authors declare no conflict of interest.

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