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Influence of gender and age on balance performance in healthy school-going children: A cross-sectional study

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***Abstract*---**Introduction: Balance is the ability to control the position of the body's Centre of mass (COM) over its base of support (BOS) to prevent the body from falling and to achieve specific functional task. It was hypothesized from the studies that along with the age, gender differences may exist for postural stability. Therefore, the aim of this study was to investigate the static postural stability of primary school-aged children and to determine whether this was moderated by age and/or gender. Methods: There were eight Government & Private schools were selected from Vadodara city. Total 10 students were selected from each class randomly; the anthropometric measurements of the students were taken. Each participant then completed timed unipedal balance test on both right and left foot, and tandem stance. For two balance test, each subject completed 3 trials on each leg. A 60 second rest was given between trials set to avoid fatigue. Result: Total 556 school children among them male students were 282 and female students were 274 who were selected and performed two balance test. And the results of present study found postural stability increases with age and in tandem stance no significant difference between male and female and in Unipedal stance highly significant difference found between the genders, with girls outperforming the boys. Conclusion: static postural stability in primary school aged children was found to be affected by gender and age, whereby boys displayed greater postural sway than girls and balance performance improved with age.

***Keywords*---**gender, balance, static test, balance, children.

Introduction

School-age children are faced with the daily responsibility of transporting a variety of items to, from, and around the school and environment. The process by which humans maintain the integrity of their postural control is referred to as balancing. [1, 2, 3]Balance is the ability to control the position of the body's Centre of mass (COM) over its base of support (BOS) to prevent the body from falling and to achieve specific functional task.[1, 2, 3,4] Balance is usually divided into two basic components: the STATIC and the DYNAMIC.

Children's proficiency in postural control develops not only as they increase in age but also from interacting with their environment and through fine-tuning of muscular torques during growth and development.[5,6] It was hypothesized from the studies that along with the age, gender differences may exist for postural stability. These gender differences may exist due to earlier maturation of the neurological, visual, vestibular and proprioceptive systems in girls and that postural stability would improve with age.[7]

Many authors have discussed variations in postural control related to age and gender. Nolan et al[8] found age and gender differences in standing balance in children aged 9 to 16 years. Odenrick and Sandstedt[9] and Riach and Hayes[10] found that movements of the center of pressure stabilized earlier in girls than in boys. Sellars[11] found a significant gender difference on the 1-foot standing balance test in children with a mean age of 61 months with girls demonstrating higher quality static balance than boys. Donahoe et al[12] reported that age, not gender, contributed to variance in balance measured by the Functional Reach Test (FRT). Habib et al[13] examined balance abilities in children aged 5 to 13 years and found both age-related and gender differences. All children demonstrated improved balance abilities with increasing age, and variation occurred between genders depending on socioeconomic status (SES). In the high SES group, boys demonstrated superior balance compared to girls; however, in the lower SES group, girls excelled in static balance activities.[13] In contrast, Williams et al[14] found no significant difference. Despite the importance of balance in the development of fundamental movement skills, very few studies have investigated postural stability in healthy school children. Therefore, the aim of this study was to investigate the static postural stability of primary school-aged children and to determine whether this was moderated by age and/or gender.

Material and Methodology

Study Design: Cross-sectional, observational.

Inclusion criteria

All School going children – age group between 6-12 years

Exclusion criteria

- Children with any neurological, musculoskeletal problem in lower limbs, and cardiovascular deficit.

- Any history of balance impairment.
- Loss of vision or uncorrected reduced visual acuity.

Methodology

After the approval by Institute Ethical Committee, the number of schools from each area was selected on the basis of the stratified randomized sampling; by lottery method. The principals of the selected schools were explained about study and asked for their official permission. The total numbers of schools to be included in the survey from all four zones were eight, 556 normal school going subjects in the age group between 6-12 years were recruited. Total 10 students (5 boys & 5 girls) were selected from each class (i.e. from standard 2 to standard 8), randomly, selected The selected subjects from each school were explained about the nature & purpose of the study.

The participants completed a written informed consent form. Each participant was enquired of baseline questions regarding previous history of injury, etc. Following this each child was explained about the complete procedure. This study was carried out in School's class room, where source of light was good and also in secured place so that risk of fall during tests was prevented. The tests were performed barefoot on a floor surface. The order of leg examination (right /left) for each subject was same, selected for each test. For two balance tests, each subject completed 3 trials on each leg. A 60 second rest was given between trials set to avoid fatigue. For all trials, the participants placed their hands across the chest and time start upon elevation of the opposite foot from the floor. Participants were asked to focuses on a target placed at eye level, the measurements were timed using a stopwatch.

First step, the anthropometric measurements of the subjects were taken prior to balance testing, participants were familiarized with the balance test and provided practice sessions on the testing procedures to decrease the chance of a learning effect occurring during testing. Each participant then completed timed unipedal balance test on both right and left foot, and tandem stance on child's dominant leg. Dominant limb was selected by asking the child to kick a ball placed on the floor in front of him.

For tandem stance, participants were made to stand with feet in a heel-to-toe position on straight line drawn with chalk stick on the floor, and arms across the chest, with eyes open as shown in the figure 4. Three trials of this test were timed with stopwatch till the subject can maintain / hold the position. Time commences when the subject place the dominance foot in front of non- dominance foot on the straight line and time ending when the subject either: (1) use his arms (i.e., uncrossed arms), (2) displace any foot,(3) movement of the foot from original position/ stepping. The procedure was repeated 3 times and for each trial time was recorded on the data collection sheet.

The mean of the 3 trials were recorded (Figure 1). For Unipedal stance, participants were asked to stand barefoot on the limb of their choice, with the other limb raised so that the raised foot is near but not touching the ankle of their stance limb. Prior to raising the limb, the subject was instructed to cross his arms

over the chest as shown in figure 5. The investigator using a stopwatch to measure the amount of time the subject is able to stand on one limb. Time commences when the subject raised the foot off the floor and time ending when the subject either: (1) use his arms (i.e., uncrossed arms), (2) use the raised foot (moved it toward or away from the standing limb or touched the floor), (3) move the weight-bearing foot to maintain his balance (i.e., rotated foot on the ground).The procedure was repeated 3 times and for each trial time was recorded on the data collection sheet. The mean of the 3 trials were recorded (Figure 2).

Figure 1: Tendam stance

Figure 2:Unipedal stance

Result

Data was collected from a total of 556 school children.
Students of a Government school were 278 and private school was 278.
Total male students were 282 and female students were 274.
Total right dominant 518 and left dominance 38.

Table: 1 shows the comparison of tandem stance value in total of students in standard 2^{nd} – 8^{th}

Variable	Standard	N	Mean
lnTS	2	80	4.2323
	3	80	4.7054
	4	79	4.9271
	5	79	5.2372
	6	80	5.4614

7	78	5.6443
8	80	5.8231
Total	556	5.1457

Table 2: Independent t-test for comparison of Tandem stance in total (combined) between male and female of government and private school

	Sex	N	Mean	Std. Deviation	Std. Error Mean	T value	P value
lnTS	Male	282	5.1157	.74019	.04408	-.982	.326
	Female	274	5.1766	.72109	.04356		

Table 3: Descriptive statistics of unipedal (RIGHT& LEFT) stance

Variable	Standard	N	Mean(LnUSR)	Mean(LnUSL)
	2	80	3.3722	3.2958
	3	80	3.6857	3.6988
	4	79	4.0072	3.9850
	5	79	4.1675	4.1497
	6	80	4.3544	4.3372
	7	78	4.5502	4.4790
	8	80	4.5586	4.5308
	Total	556	4.0978	4.0666

USR- Unipedal stance right, USL- Unipedal stance left.

Table 4: Independent t-test for comparison of unipedal stance of right and left leg amongst male and female combined of government and private schools

	N	Mean	Std.	Std. Error	T value	P value

Sex			Deviation	Mean		
lnUSR Male Female	282	4.0024	.67033	.03992	-3.421	
	274	4.1960	.66351	.04008		.001
lnUSL Male Female	282	4.0029	.63925	.03807	-2.432	.015
	274	4.1321	.61318	.03704		

USR- Unipedal stance right.USL- Unipedal stance left.

Discussion

Balance is thought to be of great significance as it is an integral part of all movements. It has been suggesting that balance control is strongly coupled to visual information very early in infancy. Furthermore, this coupling seems to require little experience of standing or even sitting upright.[15] Postural control development relies on CNS to select and integrate inputs from various systems viz. somato-sensory, visual, and vestibular to generate appropriate motor output. These systems develop at different rates, somatosensory system as reported by some studies matures by 9-12 years of age while others suggest it maturing by 3-4 years. Visual system maturation also has different rates reported 7- 10 years of age and some suggesting as late as 15years of age, similarly with regards to vestibular system it is stated to have slowest speed of development as compared to the other systems, however variability again is maturity as early as 7years by some and as late as 15-16 years by others.[16]

It is said continuous fine tuning of the interaction between the movements of different joints is needed to maintain stable vertical posture, with relatively small BOS and with COM high above the BOS. Thus maintaining stability in a standing position is actually a static task[17]. Tandem stance is the ability to stand in a heel to toe position, this reflects degree of postural steadiness when the BOS in the medial/lateral direction is narrow.[17] In the present study mean tandem stance was 5.1457 in normal school going children in 6 to 12 year. The results of present study shows the significant difference in mean of tandem stance between students from standard 2 -8.(p value < 0.01) well in agreement with the literature.

Studies showed that age had a more evident relationship with postural ability than gender their results demonstrated an improvement in static balance in the 6-10 year age range, showing no significant differences in balancing activities between boys and girls, the author further states that sporadically statistical differences have been shown by some studies between genders, indicating that there is not a clear cut boy –girl difference in static balance performances. In the said study significant gender differences occurred only in tandem stance for 6 to 8 year age groups indicating that girls are significantly superior in performing the tandem stance compared to boys of same age group[18]. The present study found no significant difference in tandem stance between male and female (Table 2).

Task of standing on one leg requires voluntary shift of COM to the standing leg, followed by maintenance of postural orientation in space by controlling weight, supporting the vertical alignment of different segments of the body and equilibrium.[17] Well in agreement with the literature the present study too found both the static balance tests (tandem stance and unipedal stance) significantly related to age.

But regards gender, well in agreement to the literature was the highly significant difference between the genders only in unipedal stance, with girls outperforming the boys (Table 4).Several studies which report the females as having better balance and postural stability as compared to boy's state various reasons like Girls are more capable of integrating their sensory inputs, whereas boys treat each sensory input somewhat separately and rely more on somatosensory feedback.[2]Alsothat girls at the age of 7-8 years have better use of vestibular information and consequently reduce the body sway as compared to boys of the same age.[2] Taking into consideration that at the preschool age, the biological characteristics of boys and girls are similar rather than diverse, the grounds of the performance differences reported in the aforesaid studies should be traced according to the author firstly back to the social context in which children's motor behaviour is shaped. In some populations, discrete expected roles for the boys and girls are formed and influence children's motor performance. On the other hand, even in "modern" societies, qualitative differences in encouragement, support, and opportunities regarding participation in play-game type of activities can be identified [3].

Conclusion

In conclusion, static postural stability in primary school aged children was found to be affected by gender and age, whereby boys displayed greater postural sway than girls and balance performance improved with age.

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