Comparative Study of Static and Dynamic Balance of School Age Children With and Without Backpack

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ABSTRACT

Background and purpose: Balance is a complex process involving the coordinated activities of multiple sensory, motor, and biomechanical components. The purpose of this study was to compare the data of static and dynamic balance between genders in school age children. Subjects: Forty school children their age between 6 to 12 years were divided into two equal groups. Group A, twenty boys their age 8.82 ± 2.31, height 130.12 ± 10.88 and weight 33.52 ± 7.74 , and group B, twenty girls their age 8.27 ± 3.08, height 129.94 ± 9.69 and weight 32.8.02 ± 6.92). Methods: Subjects were tested on the Balance Master® to obtain objective measures of static balance as eye open target sway (EOTS), eye closed target sway (ECTS), and center target target sway (CTTS), and dynamic balance as, reaction time (RT), rhythmic weight shift left/right (RSW.LR), rhythmic weight shift forward/backward (RWS.FB), limits of stability (LOS), and random limits of stability (RLOS). All parameters were done with and without backpack weight 15% of children weight and carried on both shoulders. Results: Our data indicate that significant gender differences were not found except for the reaction time (p-0.018). Conclusion: Although no significant differences between gender were found, several trends regarding static and dynamic balance were reported that most boys' results scores in static and dynamic balance tests demonstrated less value than girls.
Key words: *Static and dynamic balance test, backpack, school age children, Gender.*

INTRODUCTION

School age children are in a critical developmental stage regarding musculoskeletal development. Spinal ligaments and muscles are not fully developed until after the 16th year of life. Wang stresses that these students represent the largest group of weight-bearing individuals that use backpack form of load carriage. School age children are faced with the daily responsibility of transporting a variety of items to, from and around school[11,17].

There has been growing concern among health care professionals, parents and educators that backpack are damaging the back. This issue of back pain with backpack use is controversial within the scientific literature with some studies finding no association and some finding an association[4,6,10,14,15,16].

The combined effects of heavy loads, position of the load on the body, size and shape of the load, load distribution, time spent carrying, physical characteristics and physical condition of the individuals were hypothesized as factors which were associated with these problems. Haisman, Knapik et al., and Grimmer et al., studied the effects of backpack load on postural parameters, craniovertebral angle (CVA), or forward head tilt in adolescent. The backpack used was the weight of the backpack of that subject as carried it to school that day. There was a significant change in CVA for all grade levels, year 6 through year 12. Based on this information,

between 17% and 37% of the students, increasing percentage with decreasing grade level, were determined to be at-risk for these symptoms[3,5,9].

Few researches have focused on the impact of load carriage on high school students, Chansirinukor et al., investigated the effects of modes of carrying the school bag, weight of bag, carriage time and year level of students on spinal asymmetry and shoulder obliquity in students aged 10 to 17 years. The results showed no effect on the spinal asymmetry. Pascoe et al., used a video camera and computer digitizing system to investigate the effect of different methods of carrying school bags on gait and postural changes in 10 students aged 11 to 13 years. The authors measured shoulder and spinal angles in a static standing, as well as head angle, trunk angle, head range and trunk range in dynamic conditions. Different methods of carrying the backpack included, carrying it over one and both shoulders. The results in a static position showed an increased forward head position and shoulder elevation when comparing unloaded posture with carrying a unilateral load. It was found that the trunk also assumed a forward lean posture in order to counterbalance the load[1,13].

Grimmer et al., studied the effect on 250 adolescents sagittal plane standing posture of different loads and positions of a common design of school backpack. They found that the typical school backpack should be positioned with the center at waist or hip level and there is no evidence for the 10% body weight limits[4].

Correct postural balance is basic to wellbeing. Its effects will be felt in every movement in every activity. The development of postural stability in children is critical for being able to engage and explore their surrounding environment. Previous studies have indicated a transition period between the ages of 6 and 10 years in which children begin to exhibit adult balance performance. These studies have failed to fully explore the extent to which task demands can influence balance control[1].

Kruse et al., studied the effect of backpack load carrying on dynamic balance by measuring limits of stability, reaction time, movement velocity, end point excursion, maximum excursion and directional control. They found that the backpack load carrying has an effect on the movement velocity and directional control[10].

The purpose of this study was to compare the data of static and dynamic balance between genders in school age children.

METHODS AND PROCEDURE

Subjects

Forty school children their age between 6 to 12 years divided: into two equal groups. Group A, twenty boys their age 8.82 ± 2.31 years, height 133.12 ± 10.86 cm. and weight 37.52 ± 6.74 kg., and group B, twenty girls their age 8.27 ± 3.08, height 131.94 ± 9.69 and weight 35.80 ± 7.92) table 1. All subjects were apparently normal at the time of testing and none had history of chronic low back pain. Subjects came to a balance lab for one full day in order to complete the required test. To stimulate a real situation, the most popular schoolbag was used in this study and books were added to the schoolbag to provide the 15% of the subject's body weight (the limits recommended by the American Academy of Orthopedic Surgeon). The two shoulders straps of the schoolbag were adjusted for each subject so that it could be carried in a comfortable position on the back. We had an approval from the school and children's parents to be participated in our tests.

Table (1): Characteristics of subjects data.

Group (No.)	Age (years)	Weight (Kg)	Height (cm)
A (20 boys)	8.82 ± 2.31	37.52 ± 6.74	133.12 ± 10.86
B (20 girls)	8.27 ± 3.08	35.80 ± 7.92	131.94 ± 9.69

Instrumentation

Balance master® (US47DIHOHG, USA) as an objective measure for static and dynamic balance. Weight scale and height scale.

Procedure

All children came with their mothers to Physical Therapy Department. Every child was subjected to static balance test, eye open target sway (EOTS), eye closed target sway (ECTS), and center target target sway (CTTS) with and without carrying backpack. The dynamic balance tests were rhythmic weight shift left/right (RWS.LR), rhythmic weight shift forward/backward (RWS.FB), limits of stability (LOS), and random limits of stability (RLOS), with and without carrying backpack. The procedure was explained to the child before starting the test. The first trial, every child was asked to stand upright without backpack on the marking stripe of the force plate of the balance master. Ensure that both children's feet make equal pressure for the proper center of gravity during the test. The hands were held beside the body and head facing forward to the balance master monitor to follow the circle for all tests. The second trial was performed with backpack and following the previously mentioned procedures.

Data Analysis

Data were collected by print out from the balance master (mean and stander deviation) for all the static and dynamic balance tests. Data were analyzed using SPSS ver. 11.0, (paired sample t test). The level of significance utilized through out the analysis was $p<0.05$.

RESULTS

The results of this study indicated that there were no significant differences in static and dynamic balance between boys and girls at the age of 6 to 12 years except the reaction time without backpack. Table (2), figure (1 & 2) shows the mean and standard deviation for all static tests with and without carrying backpack. The results of open eye target without backpack for boys were 0.61±0.41, and with backpack 0.73±0.66 and for girls without backpack were 0.57±0.49 and with backpack 1.06±0.55. Closed eye target sway without backpack for boys were 0.44±0.34, and with backpack 0.78±0.56 and for girls without backpack were 0.48±0.35, and with backpack 0.97±0.42. Center target target sway without backpack for boys were 0.79±0.52, and with backpack 1.64±0.74 and for girls were 0.86±0.48, and with backpack 1.03±0.41. All the results were showed no significant difference in static balance test between genders.

Table (2): Static test of group A and B with and without backpack.

Static balance test	Without carrying backpack		t - value	p	With carrying backpack		t- value	P
	Group A	Group B			Group A	Group B		
Open eye target sway	0.61±0.41	0.57±0.49	0.761	0.29	0.73±0.66	1.06±0.55	0.352	0.727
Closed eye target sway	0.44±0.34	0.48±0.35	0.529	-0.3	0.78±0.56	0.97±0.42	0.556	0.809
Center target target sway	0.79±0.52	0.86±0.48	0.438	0.07	1.64±0.74	1.03±0.41	0.039	0.485

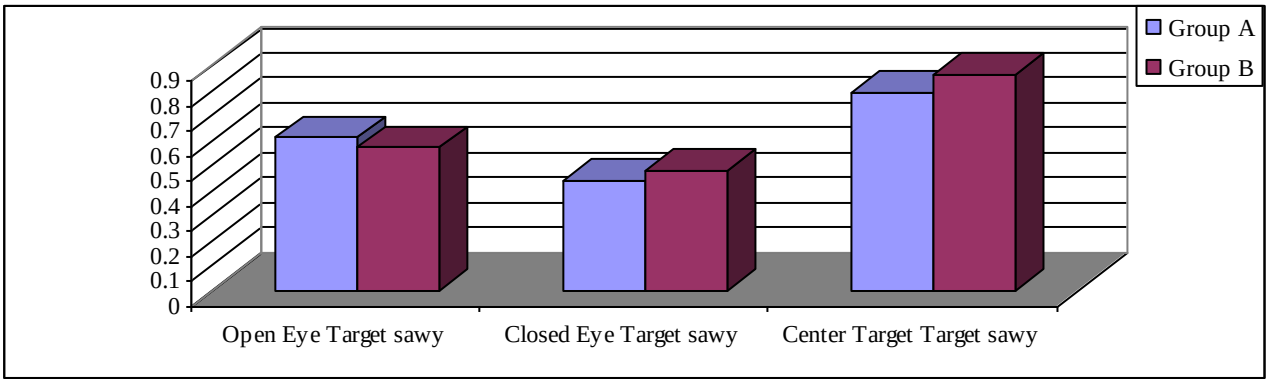

Fig. (1): Statistical comparison between Group A & B as regards static balance test parameters without carrying backpack.

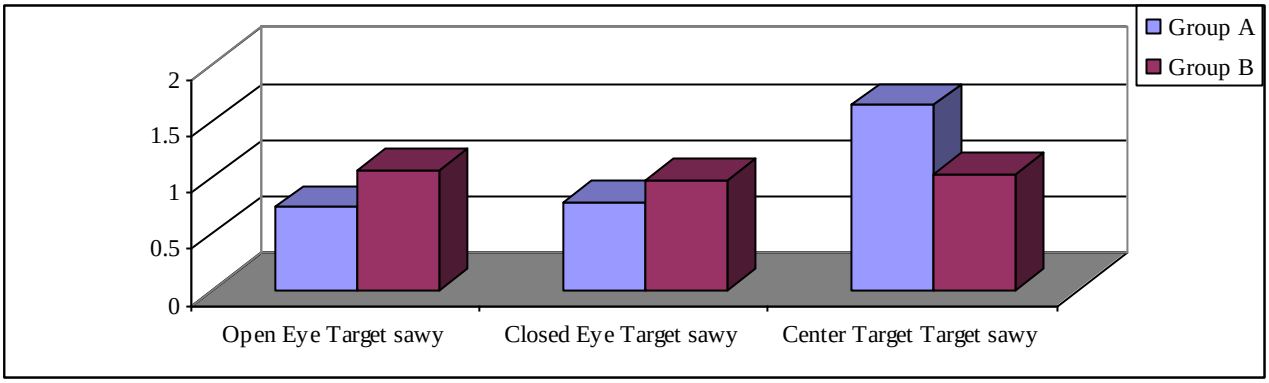

Fig. (2): Statistical comparison between Group A & B as regards static balance test parameters with carrying backpack.

The results of dynamic balance between genders showed no significant differences between genders except for the reaction time without backpack (p-0.018). The results of reaction time with backpack for boys were 3.20±0.35, and for girls were 3.20±1.02. Random weight shift left/right without backpack for boys were 13.16±5.62, and with backpack 14.45±7.03, and for girls without backpack were 14.49±3.04, and with backpack 16.11±7.81. The random weight shift forward/backward without backpack for boys were 30.47±7.73, and with backpack 42.57±9.65, and for girls without backpack were 28.21±10.07, and with backpack 47.46±10.41. the random limits of stability without backpack for boys were 55.5±9.3, and with backpack 67.31±8.7 and for girls without backpack were 54.2±5.47, and with backpack 75.6±6.12 (table 3, figure 3 & 4).

Table (3): Dynamic test of group A and B with and without backpack.

Dynamic balance test	Without carrying backpack		t-value	p	With carrying backpack		t-value	p
	Group A	Group B			Group A	Group B		
Reaction Time (sec)	1.94±0.90	3.09±1.46	2.499	0.018	3.03±0.35	3.20±1.02	0.701	0.499
Random weight shift left/right	13.16±5.62	14.49±3.04	0.777	0.443	14.45±7.03	16.11±7.81	0.718	0.489
Random weight shift forward/backward	30.47±7.73	28.41±10.07	0.573	0.579	42.57±9.65	47.46±10.41	0.909	0.384
Random limits of stability	55.5±9.3	54.2±5.47	0.064	0.950	67.31±8.7	75.6±6.12	1.197	0.258

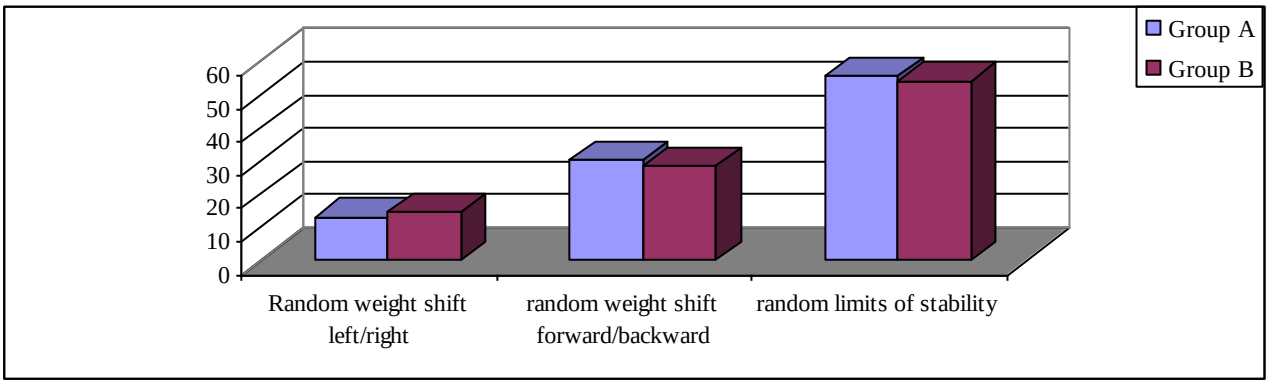

Fig. (3): Statistical comparison between Group A & B as regards dynamic balance test parameters without carrying backpack.

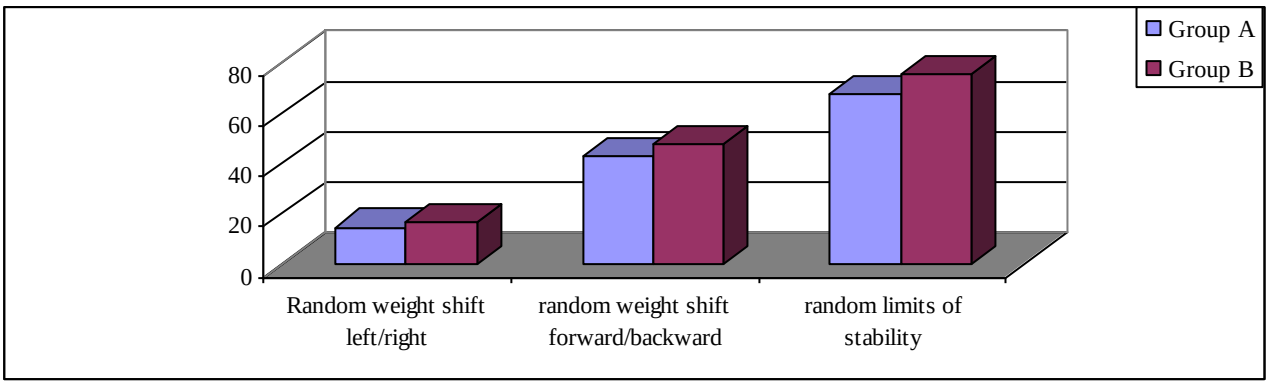

Fig. (4): Statistical comparison between Group A & B as regards dynamic balance test parameters with carrying backpack.

DISCUSSION

The purpose of this study was to compare the data of static and dynamic balance between genders in 40 school age children between 6 and 12 years. Although the results of our study showed that there were no significant differences in static and dynamic balance between boys and girls except for the reaction time without backpack (p-0.018), several trends regarding static and dynamic balance control were reported. Most boys' results scores in static balance tests demonstrated less value than girls; this may be explained as the boys have the ability to keep the body as motion less as possible than girls (more stable). But for dynamic tests, boys have the ability to rhythmically transfer their center of gravity (COG) from left to right and forward to backward with more excursions than girls. Subjects also demonstrated more variability between genders in dynamic balance testing until approximately 13-14 years of age. In our study we used backpack weighing 15% of child's body weight (the limits recommended by the American Academy of Orthopedic Surgeons), and this is in agreement with Forssberg and Nashner who observed significant changes in gait patterns and trunk posture when the loads were

increased from 15% to 20% of body weight. The results of Chansirinukor et al., suggested that the postural responses in high school students age between 13 to 16 years were sensitive to load carriage equivalent to 15% of body weight, supporting a hypothesis that heavy loads have a significant effect on postural alignment. From these results we can say that backpack allow a child to carry load and the back will compensate for any load applied to it for an extended period of time by cause a person to lean forward to adjust his balance. The results of current study may be affected by the use of the same procedure during repeated measures as the children become familiar with balance test and may altered and adjusted their performance in response to the researchers instructions[1,2,7].

Further researches are required to investigate static and dynamic balance school age children carrying different weight and styles of backpack. More studies are needed to identify the effect of carrying backpack for different period of time on posture. A similar study with a large sample size may give more significant differences in static and dynamic balance of school age children with and without backpack. Lon-term studies are needed to be done to determine the long-term effect of this childhood load bearing effect and by this way, it would be easier to establish the needed guidelines to protect children from injuries and altered posture.

Conclusion

Balance represents a complex integration of mechanical, sensory and motor processing strategies. The results of this study indicated that there were no significant differences in static and dynamic balance between boys and girls during age of 6 to 12 years with or without carrying backpack of 15% of body weight except the reaction time without carrying backpack.

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الملخص العربي

دراسة مقارنة بين الأتزان الثابت وأثناء الحركة فى الأطفال فى سن المدرسة بوجود أو عدم وجود دعامة للظهر

الأتزان هو عملية معقدة تحتاج الى تأذر حسى وحركى والعديد من التوافق بين أنظمة الجسم المختلفة الحسية والحركية. الهدف من هذه الدراسة هو دراسة ومقارنة الأتزان أثناء الثبات وأثناة الحركة فى الأطفال فى سن المدرسة مع وجود دعامة للظهر وايضا المقارنة فى حالة عدم وجود هذة الدعامة للظهر. أشتملت الدراسة على 40 طفل أصحاء تراوحت أعمارهم بين 6-12 سنة وتم تقسيمهم الى مجموعتين، المجموعة الأولى أشتملت على 20 طفل والمجموعة الأخرى أشتملت على 20 طفلة . تم أختبار الأتزان فى الأطفال فى كلا المجموعتين بأستخدام جهاز (Balance Master) وذلك للحصول على قراءات محددة للأتزان فى الأطفال فى كلا المجموعتين من خلال أوضاع مختلفة وذلك فى وجود دعامة للظهر وأيضا تم أخذ هذه القياسات فى عدم وجود دعامة للظهر . أظهرت النتائج عدم وجود فروق ذات دلالة أحصائية بين الجنسين فى ماعدا وقت رد الفعل و ذلك بالرغم من وجود العديد من الدراسات التى أثبتت وجود فروق احصائة فى الأتزان بين الجنسين وذلك فى صالح الأناث على الذكور .