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Original empirical article

THE EFFECTS OF AGE AND GENDER ON BALANCE SKILLS IN PRESCHOOL CHILDREN

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Abstract. *The aim of the present study was to investigate the effect of age and gender on balance skills in preschool children. For that purpose, the balance subtest of the Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978) was administered to 283 children, 4½ - 6 years old (M=61.77 months, SD= 5.43). For the data analysis, both an ANOVA and a MANOVA were applied on the total subtest score and the eight item scores, respectively. Age was found to have a significant effect on both the subtest ($F_{2,277}$ = 32.77, p< .001, η^2= .19) and item scores (min. $F_{2,277}$= 17.78, p< .001, min. η^2= .11). Significant gender differences were found in the subtest score ($F_{1,277}$= 14.70, p< .001, η^2= .05) and on six of the items (min. $F_{2,277}$= 4.35, p< .038, min. η^2= .01). However, the low values of the η^2 associated with gender indicated that those differences were not of great significance.*

Key words: *balance skills, BOTMP, preschool age, gender differences.*

INTRODUCTION

Balance is thought to be of great significance as it is an integral part of all movements (Westcott, Lowes & Richardson, 1997). It can be defined as the ability to maintain or recover the body's centre of mass within the body's base of support to prevent falling and complete the required movements (Shumway-Cook & McCollum, 1991) and it is usually divided into two basic components: the static and dynamic. Static balance is the ability to maintain a posture in a resting position, while dynamic balance is the ability to maintain postural control during the performance of functional tasks (Westcott et al., 1997).

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Preschool age is a very important period for human motor behavior because it is critical in the development of fundamental motor skills (Gallahue & Donnely, 2003). The mastery of certain fundamental motor skills is a prerequisite if we are to function on a daily basis and participate in later physical or sport-specific activities. As it has been proved that, especially at the preschool age, balance plays a significant role in the performance of several fundamental motor skills (De Oreo & Keogh, 1980; Shumway-Cook & McCollum, 1991; Ulrich & Ulrich, 1985), its importance for motor performance at that particular age is obvious.

During the preschool years, balance reaches an adequate level, while its development is completed in later childhood (Scheid, 1994). Among the variables which influence the level of balance skills we include age and gender. The significant effect of age on static and dynamic balance tests has been revealed in previous studies (see: Beitel & Mead, 1980; Fjørtoft, 2000; Lam, Ip, Lui, & Koong, 2003; Morris, Williams, Atwater & Wilmore, 1982; Toriola & Igbokwe, 1986; Ulrich & Ulrich, 1985).

Regarding gender, the findings are conflicting. In many studies it has been found that even at the preschool age, girls have higher scores than boys on balance tasks (Broadhead & Bruninks, 1982; Fjørtoft, 2000; Lam et al., 2003; Lejarraga et al., 2002; Sigmundsson & Rostoft, 2003; Toole & Kretzschmar, 1993). On the other hand, several researchers report no significant differences between preschool boys and girls (Du Toit & Pienaar, 2002; Kourtessis et al., 2008; Ulrich & Ulrich, 1985; Venetsanou, 2007; Waelvelde, Peersman, Lenoir, Smits - Engelsman, & Henderson, 2008).

Apart from the close association between balance skills and young children's motor performance, a dysfunction in postural control may be used as an indication of various types of developmental deficits. Children with disabilities, ranging from mild to severe ones, have a poor performance on balance tests (see: Cinelli & De Paepe, 1984; Gagnon, Friedman, Swaine, & Forget, 2004; 2001; Visscher, Houwen, Scherder, Moolenaar, & Hartman, 2007; Wright, Galea, & Barr, 2005). Physical therapists and occupational therapists have historically placed high priority on the treatment of patients with postural control problems because this control appears to be an integral part of all motor abilities (Westcott et al., 1997). Additionally, the examination of postural stability and motor control is essential to the vestibular evaluation of infants and children as bilateral vestibular failure may manifest itself as a deterioration or delay in motor milestones (Snashall, 2007).

Due to the importance of the evaluation of balance skills in children, developmental assessment instruments include various balance tasks such as one-foot balance, walking on a balance beam, or walking heel-to-toe. By focusing on specific items within the subtests, these tests can be used as both discriminative tools to document general postural stability problems and evaluative measures to document movement changes related to the treatment of postural stability (Westcott et al., 1997).

However, studies investigating preschoolers' motor performance do not provide a clear picture of children's balance skills. In the cases when an assessment tool with an adequate number of balance items is used, a total subtest score is reported (see: Butterfield, 1990; 1989; Butterfield & Loovis, 1994; 1993; Kourtessis et al., 2008; Ulrich & Ulrich, 1985). In that way a general balance index is given, while educationally valuable information about children's deficits or superiorities in specific balance skills is masked.

On the other hand, in several studies one or two balance items are included (see: Du Toit & Pienaar, 2002; Lam, et al., 2003; Oja & Jürimäe, 2001). However, it is well known that balance is task-specific (Ulrich & Ulrich, 1985) and as a result, a high score on one balance task does not necessarily correlate with a high score on another one (Drowatzky & Zuccato, 1967; Shimada et al., 2003; Tsigilis, Zachopoulou & Mavridis, 2001). Consequently, it is obvious that the performance on a couple of items cannot provide a sufficient overall picture of balance.

As a result, an information deficiency regarding balance skills in preschool aged children exists. Taking into consideration that such information will contribute to both the planning of developmentally adequate movement programs (Zimmer & Cicurs, 1993) and the study of developmental specificities during such critical years as the preschool age, the aim of the present research was to examine the effect of age and gender on preschool children's balance skills.

THE METHOD

The participants

Two hundred and eighty three children (145 boys and 138 girls), 4½ - 6 years old (M=61.77 months, SD= 5.43), attending public kindergartens in the Peloponnesus Territory in Southern Greece participated in the study. Prior to their partaking, all the participants were required to bring a consent form signed by their parents. The children were divided into three age-groups [54-59 months (n= 86), 60-65 months (n= 102) and 66-71 months (n=95)].

The method of stratified sampling was used to select the participants of the study from a number of randomly selected public schools, using gender and age as the stratification variables. Eight children from the initial sample (n=376) were not given permission from their parents to be tested, which led to a 97.9% response rate.

The measures

The eight items from the balance subtest of the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP-LF, Bruininks, 1978) were used for the assessment of children's performance in balance skills. Those items are the following: *Standing on the preferred leg on the floor, Standing on the preferred leg on a balance beam, Standing on the preferred leg on a balance beam – eyes closed, Walking forward on a walking line, Walking forward on a balance beam, Walking forward heel–to-toe on a walking line, Walking forward heel-to-toe on a balance beam, Stepping over a response speed stick on a balance beam*.

The BOTMP-LF is one of the most popular motor assessment batteries for children 4½ - 14½ years old (Burton & Miller, 1998; Miles, Nierengarten & Nearing, 1988) providing "a comprehensive index of motor proficiency as well as separate measures of both gross and fine motor skills" (Bruininks, 1978; p. 11). Regarding the psychometric properties of the balance subtest, information is given in the BOTMP manual (Bruininks, 1978). Specifically, the aforementioned subtest score shows a good internal consistency (r=.40 - .80), has a moderate correlation with age (r=.57) and "it differentiates between normal and handicapped children in a manner consistent with that observed in similar comparative studies of motor performance" (Bruininks, 1978; p. 31). Regarding the sub-

test's reliability, a moderate test-retest correlation coefficient is reported (r=.64). That specific subtest has been administered in numerous studies assessing balance (see: Engel-Yeger, Golz & Parush, 2004; Habib, Westcott & Valvano, 1999; Gagnon et al., 2004; 2001; Wright et al., 2005). It has also been used as a test-criterion in DePaepe and Ciccaglione's (1993) research, in order for the concurrent validity of the Papcy-DePaepe balance test (DePaepe & Ciccaglione, 1993) to be determined.

A child's raw score on each balance item is noted and converted into a numerical point score. Point scores are then added and compile the subtest score points. Normative data collected on children from 4½ to 14½ years of age is provided in the manual, and subtest scores can be expressed in the form of standard scores. For the purposes of this study, the subtest standard score and the raw scores of the eight balance items were used.

The procedure

The children were individually assessed on the BOTMP-LF balance items in an indoor area, according to the test guidelines (Bruininks, 1978). The examiner was a doctoral student experienced in the BOTMP administration and familiar with motor assessment in general. In order to facilitate the administration of the test, the translated datasheets and guidelines from Venetsanou, Kambas, Aggeloussis, Serbezis and Taxildaris's (2007) study were used.

Statistical analyses

First, the ANOVA was used to test the significance of age and gender on the Balance subtest standard score. The model of the analysis was 3 (age groups: 54-59 vs 60-65 vs 66-71 months) X 2 (boys vs girls).

Then a 3 (age groups) X 2 (gender) MANOVA, with the raw scores of the eight Balance items as the dependent variables, was applied. We preferred the raw to the point scores, so as not miss valuable information due to the conversion of the raw scores into point ones. Post hoc comparisons were made using the Bonferroni test, with alpha set at .05.

In addition to p values, effect sizes as measured by Eta Squared (η^2) values were also used for data interpretation. Values of $\eta^2 > .14$ were judged as sufficiently large to be of some importance (Cohen, 1988).

THE RESULTS

Table 1 shows the mean values of children's performance on both the total balance score and the eight balance items.

Regarding the total balance score, the results of the ANOVA showed that, as expected, age was significantly associated with these children's performance ($F_{2,277} = 32.77$, $p < .001$, $\eta^2 = .19$) (Table 2). According to the results of the Bonferroni test, the mean balance score of the group aged 66-71 months was significantly greater than the total scores of all the younger groups. Moreover, the group of 60-65 months had a significantly higher mean balance score than the group of 54-59 months (Table 3).

Table 1. Means and Standard Deviations for total balance score and each balance item of the BOTMP-LF by age group and gender.

Battery items	Age groups					
	54-59 months		60-65 months		66-71 months	
	Boys	Girls	Boys	Girls	Boys	Girls
Total Balance score	9.65+1.74	11.31+3.19	11.96+3.54	14.65+2.18	14.89+7.27	16.40+3.73
Standing on the preferred leg on the floor	2.19±1.8	5.05±2.9	6.79±2.5	7.89±2.6	7.91±3.0	9.5±1.3
Standing on the preferred leg on a balance beam	0.47±0.5	3.11±1.7	4.66±2.7	6.46±2.5	6.56±4.6	8.7±2.0
Standing on the preferred leg on a balance beam – eyes closed	0.005±0.2	0.62±1.0	1.30±1.0	2.68±1.0	3.12±2.3	4.24±2.3
Walking forward on a walking line	5.29±1.1	4.88±1.1	5.89±.31	5.89±0.3	5.98±.13	5.97±0.1
Walking forward on a balance beam	2.70±1.4	1.65±2.1	3.66±1.7	3.65±1.2	4.52±1.6	3.85±1.5
Walking forward heel–to-toe on a walking line	0.52±1.2	0.88±1.6	2.50±2.1	3.69±1.5	4.61±2.1	4.65±0.9
Walking forward heel-to-toe on a balance beam	0.14±0.3	0.17±.43	0.94±1.5	1.86±1.6	2.40±1.8	2.55±1.8
Stepping over a response speed stick on a balance beam	0.002±0.1	0.001±0.13	0.001±0.1	0.13±0.3	0.32±0.47	0.25±0.4

Table 2. Anova results for the main effects of the factors "age" and "gender" and their interaction.

Items	Age			Gender			Age * Gender		
	F	p	η^2	F	p	η^2	F	p	η^2
Total Balance score	32.767	.000	.191	14.699	.000	.050	.560	.572	.004
Standing on the preferred leg on the floor	91.199	.000	.397	35.842	.000	.115	2.789	.063	.020
Standing on the preferred leg on a balance beam	97.774	.000	.414	43.001	.000	.134	.505	.604	.004
Standing on the preferred leg on a balance beam – eyes closed	99.437	.000	.418	29.169	.000	.095	1.571	.210	.011
Walking forward on a walking line	48.628	.000	.260	3.115	.079	.011	2.781	.064	.020
Walking forward on a balance beam	33.290	.000	.194	8.197	.005	.029	2.311	.101	.016
Walking forward heel–to-toe on a walking line	112.914	.000	.449	6.349	.012	.022	2.919	.056	.021
Walking forward heel-to-toe on a balance beam	55.288	.000	.285	4.354	.038	.015	2.660	.072	.019
Stepping over a response speed stick on a balance beam	17.782	.000	.114	.048	.827	.000	2.246	.108	.016

Gender was also found to have a significant effect on the total balance score ($F_{1,277}$ = 14.70, p< .001, η^2= .05) while the interaction of age by gender was not statistically significant. Girls were found to have higher balance scores (M=13.90, SD=3.73) than boys (M=12.53, SD=543). However, the η^2 value was weak.

The multivariate analysis that was performed on the item scores revealed a significant effect of age (Pillai's trace= .742, p< .001, η^2= .37), gender (Pillai's trace= .267, p< .001, η^2= .27) and their interaction (Pillai's trace= .166, p< .001, η^2= .08). Subsequent univariate analyses indicated that age by gender interaction was not significant for any of the eight item scores.

Age had a significant effect on every item score (min. $F_{2,277}$= 17.78, p< .001, min. η^2=.11 for the item *Stepping over a response stick on balance beam*) (Table 2). Post hoc comparisons of the age effect revealed significant differences among all three age groups on most of the item scores (Table 3). Older children had higher scores than the younger ones.

Table 3. Significant Differences in item scores between means of age groups as tested by the Bonferroni Test.

	Items																							
	Total Balance score			Standing on the preferred leg on the floor			Standing on the preferred leg on a balance beam			Standing on the preferred leg on a balance beam – eyes closed			Walking forward on a walking line			Walking forward on a balance beam			Walking forward heel – to- toe on a walking line			Walking forward heel-to-toe on a balance beam			Stepping over a response speed stick on a balance beam		
Age groups	54-59	60-65	66-71	54-59	60-65	66-71	54-59	60-65	66-71	54-59	60-65	66-71	54-59	60-65	66-71	54-59	60-65	66-71	54-59	60-65	66-71	54-59	60-65	66-71	54-59	60-65	66-71
54-59		**	**		**	**		**	**		**	**		**	**		**	**		**	**		**	**		+	**
60-65	**		**	**		*	**		**	**		**	**		+	**		+	**		**	**		**	+		**
66-71	**	**		**	*		**	**		**	**		**	+		**	+		**	**		**	**		**	**	

*p< .005, **p<.001, +p >.05

A significant gender effect was found for six items (min. $F_{2,277}$= 4.35, p< .038, min. η^2=.01 for the item *Walking forward heel-to-toe on a balance beam*). Mean values indicated that girls had higher scores than boys on five of the items *(Standing on the preferred leg on the floor, Standing on the preferred leg on a balance beam, Standing on the preferred leg on a balance beam - eyes closed, Walking forward heel-to-toe on a walking line, Walking forward heel-to-toe on a balance beam*), while the boys outperformed the girls on *Walking forward on a balance beam* (Table 1). However, the associated η^2 did not exceed the recommended value of .14 for any of the aforementioned items.

DISCUSSION

In this study, the effect of age and gender on the performance of preschool children in terms of balance skills was investigated. Age was found to significantly affect both the total and the balance items scores. *Stepping over a response stick on a balance beam* was the only item on which the associated η^2 did not exceed the recommended value of .14. This finding may be caused by the fact that the aforesaid item had a high degree of difficulty for younger children that caused a floor effect on their scores.

Generally positive and statistically significant differences were revealed across the age groups. This is consistent among studies that deal with preschool children (Beitel & Mead, 1980; Fjørtoft, 2000; Lam et al., 2003; Morris et al., 1982; Toriola & Igbokwe, 1986; Ulrich & Ulrich, 1985) and can be interpreted by the rapid progress caused by the biological processes of development during the period between four and eight years of age. That progress contributes to the great improvement in coordination (Demeter, 1981).

On the other hand, gender was found to have a statistically significant effect on the total balance score, but the η^2 value was small. Regarding individual items, the girls outperformed the boys on *Standing on the preferred leg on the floor, Standing on the preferred leg on a balance beam, Standing on the preferred leg on a balance beam - eyes closed, Walking forward heel-to-toe on a walking line, Walking forward heel-to-toe on a balance beam* while the boys had statistically significant higher scores on *Walking forward on a balance beam.* However, the η^2 value of the effect of gender on BOTMP balance items was weak, indicating that the observed superiority of the girls was not of great importance. This is consistent with the results of several researchers who state that significant differences in the balance tasks should not be expected until later on in childhood (Cratty, 1994; Thomas, 2000; Thomas & French, 1985). The absence of differences between preschool boys and girls' balance skills has been determined in several studies (Du Toit & Pienaar, 2002; Kourtessis et al., 2008; Shala, 2009; Ulrich & Ulrich, 1985; Venetsanou, 2007; Waelvelde et al., 2008).

Nevertheless, other researchers report significant gender differences in balance skills (Al- Haroun, 1988; Chow, Henderson & Barnett, 2001; Fjørtoft, 2000; Lam et al., 2003; Lejarraga et al., 2002; Morris et al., 1982; Sigmundsson & Rostoft, 2003). Taking into consideration that at the preschool age, the biological characteristics of boys and girls are similar rather than diverse (Gallahue & Ozmun, 1998) the grounds of the performance differences reported in the aforesaid studies should be traced firstly back to the social context in which children's motor behavior is shaped. In some populations, discrete expected roles for the boys and girls are formed (Al-Haroun, 1988; Du Toit & Pienaar, 2002) and influence children's motor performance (Malina, 2004). 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 (Toole & Kretzschmar, 1993).

Another important issue to be taken into consideration, when statistically motor performance differences between preschool aged boys and girls are being reported, is their potential significance. All of the studies reviewed in this paper reporting statistically significant differences fail to mention the effect sizes associated with gender. It is well known that the effect size is defined as the strength of the relationship between the independent variable and the dependent one (Gliner, Morgan, Leech & Harmon, 2001), while the *p* value only describes a relationship that is unlikely to occur, assuming the null hy-

pothesis is true. It does not reveal the extent of that relationship. Therefore, concerns arise about how "real" the reported motor performance differences are.

In conclusion, age seems to be a significant factor for preschoolers' performance in terms of balance skills, while gender does not. On some balance skills, statistically significant gender differences were determined, but they were not of great importance. Nevertheless, balance is a multidimensional structure and as such cannot be affected by only a couple of factors. Further research is needed so that the influence of other factors can be investigated. Among them, factors such as children's anthropometric characteristics (height, weight, base of support), environmental demands during the test administration and task constraints may provide interesting study findings and food for thought.

However, the identification of motor performance differences should only be the first step. Its application in education is the second and perhaps the most vital one. Movement skills assessment is critical for the educational process, providing valuable information in order for the movement activities to be planned according to the individual needs and capacities of each child. Each student's developmental level and not his/her gender should be the prism under which developmentally adequate movement programs should be planned, implemented and evaluated.

The reported gender differences on balance tasks are not important, but they will persist unless other expectations with respect to children's motor behavior and their encouragement for practice are equal for both boys and girls. In that way all the children will undoubtedly reap significant developmental benefits.

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UTICAJ GODIŠTA I POLA NA SPOSOBNOST BALANSIRANJA MEĐU PREDŠKOLSKOM DECOM

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Cilj ovog istraživanja bio je da razmotri uticaj godišta i pola na sposobnost balansiranja među predškolskom decom. Iz tog razloga, koristili smo pod test za balansiranje Bruininks-Oseretsky testa za motoričke sposobnosti (Bruininks, 1978) i primenili ga na 283 dece, uzrasta 4½ - 6 godina (M=61,77 meseci, SD= 5,43). Radi analize podataka, primenili smo i ANOVA i MANOVA analiz na celokupan skor pod testa i na osam pojedinačnih skora, tim redosledom. Ustanovljeno je da godište ima značajan uticaj na oba pod testa ($F_{2,277}$ = 32,77, p< ,001, η^2= ,19) i na pojedinačne testove (min. $F_{2,277}$= 17,78, p< ,001, min. η^2= ,11). Značajne razlike u pogledu pola utvrđene su na skoru pod testa ($F_{1,277}$= 14,70, p< ,001, η^2= ,05) i na šest pojedinačnih testova (min. $F_{2,277}$= 4,35, p< ,038, min. η^2= ,01). Ipak, niske vrednosti η^2 koje se povezuju sa polom bile su indikacija da te razlike nisu imale veliki značaj.

Ključne reči: *sposobnost balansiranja, BOTMP, predškolski uzrast, razlike u polovima.*