REABILITACIJOS MOKSLAI
Slauga, kineziterapija, ergoterapija

Reabilitacijos mokslai: slauga, kineziterapija, ergoterapija, 1 (30) 2024, 74–83, eISSN 2538-8673; DOI: https://doi.org/10.33607/rmske.v1i30.1487

Extra Physical Activities Positively Affect Balance in Children Aged 5–11 Years

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Abstract

Background. Extra-physical activities (EPA) are necessary for children because they contribute to the development of motor skills and general development.

Aim. To evaluate the effect of EPA on balance, measured with the Bruininks-Oseretsky Test-2 (BOT-2), in children aged 5–11 years old.

Methods. This study was designed as a cross-sectional study. Children (n = 68) aged 5–11 years were divided into two groups depending on the activity they participated in. 36 children participated in standard physical education (physical education group, PEG) lessons, and 32 children attended extra-physical activities (EPA). Nine subscales of the BOT-2 balance test were evaluated and compared between balanced PEG and EPA.

Results. An independent sample t-test revealed a significant difference in balance between PEG and EPG (t (66) = -2.2, p = 0.02), with EPG being greater than PEG. A Kruskal-Wallis test revealed no difference in EPA specificity (H = 3.62, df = 6, p = 0.72) or the EPA participation frequency (H (4) = 0.93, p = 0.92).

Conclusions. The extra physical activity group performed better in balance than the physical education group. This finding suggests a role for extra physical activity in promoting balance. The frequency and specificity of participation in extra-physical activities did not influence the balance.

Keywords: balance, motor skills, motor development, physical activity

1. INTRODUCTION

Balance is a fundamental skill necessary for completing many everyday tasks (Tokur et al., 2020) and might be categorized as a complex motor skill, along with locomotor, manipulative, or object handling skills and stability skills (Yanci et al., 2017). In childhood, mastering a variety of motor skills (MS) contributes to the acquisition of more complex motor skills (Chen et al., 2023). Therefore, tracking balance performance and correlating it with typical motor development is important in physiotherapy. It helps detect early motor developmental delays and poor balance-related issues, thereby preventing traumatic injuries. Motor development is affected by intrinsic elements such as biological and family characteristics and by extrinsic elements such as environmental conditions in preschool age (Özal et al., 2020). Children have to discover how to manage and synchronize their body parts and this process not only takes time but requires involvement in PA and experience (Haywood & Getchell, 2021). Although fundamental movement skills develop rapidly at the age of 3 years, children have the possibility of mastering them by 5–7 years old (Goodway et al., 2019).

Ensuring sufficient physical activity (PA) levels is one of the ways to improve balance performance (DuBose et al., 2018; Onofrei & Amaricai, 2022). Children can promote MS by participating in physical education lessons (PE). It is claimed that preschool children with limited motor competence can engage in PA less (Navarro-Patón et al., 2021). However, attending only PE is insufficient to ensure that children are involved in the needed levels of PA (Neil-Sztramko et al., 2021). Therefore, extra time dedicated to PA is necessary for children to reach their optimal level of PA and refine MS. Moreover, physically active children possess greater postural control than their sedentary counterparts, which has been demonstrated to positively affect the maturation of postural control in children (García-Soidán et al., 2020).

We hypothesized that children who participate in EPA in addition to the usual PA at school will perform at greater levels of balance. The hypothesis stems from the belief that the additional time dedicated to PA provides children with more opportunities for refining their MS, potentially leading to a greater ability to maintain balance (McDonough et al., 2020).

The aim was to evaluate the effect of extra physical activities on balance, measured with BOT-2, in children aged 5 to 11 years old.

2. METHODS

Ethical Approval. The research was approved by the Lithuanian Sports University Biomedical Scientific Research Ethics Committee on March 15, 2023, in Kaunas, Lithuania (bioethical authorization number: 2023-04-03 MNL-KIN (M)-2023-589). Written informed consent was obtained from the institution where research was done and from children's parents or guardians. The study was conducted following the Ethical Principles of the Declaration of Helsinki and Good Clinical Practices

Study Design. The research was designed as an analytical cross-sectional study and was executed in an international school in Vilnius, Lithuania.

Participants. Sixty-eight children were recruited, of which 36 were female (mean age 8.3 years± 1.4) and 32 were male (mean age 8.1 years ± 1.5). Participants who were aged between 5 and 11 years, were enrolled in a regular PE framework and had no intellectual impairment were included in the study. For the EPG, the inclusion criteria were participating in EPA either on school premises that are arranged by the school administration or any other structured physical activity for more than 6 months. Participants were excluded if they could not understand testing instructions in English.

Questionnaire. To collect information regarding whether the child is participating in any EPA or not, if yes, for how long, what kind of activity, and how many days per week, parents and guardians of the children had to fill in a questionnaire. Duration of participation in extra-activities as well as frequency and specificity of EPA were recorded.

Sampling Procedure. Based on the questionnaire results, inclusion and exclusion criteria, the participants were split into two groups: Children who took part in only PE were allocated to the Physical Education Group (PEG; n = 36), whereas children who engaged in any EP for 6 and more months were allocated to the extra physical activity group (EPG; n = 32). Since the recruitment was made by a single organization, all participants in the study were under the instruction of the same PE curriculum, and there were no interclass differences in PE class frequency and duration.

Test Day. The testing procedure took place between the 15th of January 2024 and the 29th of January 2024 in the sports hall of an international primary school.

Outcome Measures. Balance and BOT-2. The balance of both groups was assessed using the BOT-2 (Bruininks & Bruininks, 2005). Firstly, the collected raw scores in seconds or steps were converted to total point scores and then to scale scores by utilizing sex and age-specific norm tables. In this study, instead of combined tables, sex-specific norm tables were used. The BOT-2 was developed to assess motor proficiency in individuals aged 4 to 21 years old (South & Palilla, 2013). The balance subpart

possesses sufficient internal consistency in addition to its outstanding test-retest and inter-rater reliability (Kim & Kim, 2022). The balance subpart comprises nine separate tasks, each of which is tailored to test the individual's balance in various conditions. The nine tasks are presented in Table 1.

Table 1. **Balance subparts from BOT-2 (Bruininks & Bruininks, 2005)**

Standing on a straight line with feet apart - eyes open
Walking forward on a line - eyes open
Standing on one leg in a straight line- eyes open
Standing on a straight line with feet apart- eyes closed
Walking forward heel-to-toe on a straight line-eyes open
Standing on one leg in a straight line - eyes closed
Standing on one leg on a balance beam- eyes open
Standing on heel-to-toe on a balance beam - eyes open
Standing on one leg on a balance beam- eyes closed

Before implementing the test, the chronological age of the subject must be calculated, and the preferred hand and leg must be determined by asking the subject to throw and kick a tennis ball. On the individual record form, depending on the requirements of the tasks, measurements are recorded either in seconds or in steps. Each raw score (steps or seconds) corresponds to a scale ranging from 0 to 4, with 0 representing the lowest level of performance and 4 indicating the highest level of performance. Upon implementation of the test, converting scores is part of the process to complete the test. Firstly, the collected raw scores in seconds, and steps are converted to point scores, and then all point scores are added up to create total point scores. Lastly, total point scores are converted into scale scores by utilizing sex-specific and age-specific norms or combined tables. Subtest scale scores are ranked as well-below average (1–5), below average (5–10), average (10–20), above average (20–25) and well-above-average (25–35).

Statistical Analysis. IBM SPSS Statistics Version 25 was used to complete the statistical analysis. The level of marginal significance (p-value) was set at 0.05 for all the statistical tests. To determine the distribution of the sample size, Shapiro-Wilk was used to determine the normalization of the sample. To analyze the equality of variances of age, height, BMI, and weight, Levenes's test was used. To demonstrate the participant characteristics (age, gender, weight, height, and BMI), descriptive statistics were performed. An independent sample t-test was performed to compare the mean of the balance score of the PEG and EPG. To present the frequencies and percentages of scale score categories, crosstabulation tables and figures were created. To compare the balance scores across genders in each group, a t-test was performed. The Kruskal-Wallis test was used to see if there were any statistically significant differences between the medians of the specificity of EPA and EPA participation frequency.

3. RESULTS

Characteristics of Participants. For participant characteristics, Levene's test revealed no significant difference in variances between PEG and EPG (Age $F(1, 66) = 1.7$, $p = 0.06$), Weight $F(1, 65) = 0.3$, $p = 0.5$, Height $F(1, 66) = 1.1$, $p = 0.2$, BMI $F(1, 65) = 0.01$, $p = 0.9$) (Table 3.). To analyze the homogeneity of genders, a Chi-square test was performed, and it was homogenous (X^2 (1, N = 68) = 0.89, p = 0.34) (Table 3.). There were no differences in the characteristics of the participants across groups. Detailed descriptive statistics for participants can be found in Table 3. During the data collection, one participant in the EPG refused to be weighed; therefore, that participant's weight was not included in our data.

Table 2. **Participants characteristics**

Indicators	Groups		F/X^2	*P*
	PEG (n = 36)	**EPG (n = 32)**		
Age (yrs. ± SD)	8.05 ± 1.6	8.4 ± 1.4	1.71	0.24
Weight (kg ± SD)	27.2 ± 7.9	30.1 ± 6.8	0.35	0.10
Height (cm ± SD)	131.13 ± 11.4	134.2 ± 10.1	1.13	0.24
BMI (kg/m² ± SD)	15.5 ± 2.4	16.5 ± 2.2	0.01	0.07
Gender: F / M	21 / 15	15 / 17	0.89	0.34

SD – Standard deviation; PEG – Physical Education Group; EPG – Extra Physical Activity Group; F – Female; M – Male.

Comparison of Balance Across Groups. Since we had a relatively small sample size, determining the distribution of the data was important for choosing an appropriate statistical method. Based on the Shapiro-Wilk test results, the balance scores of both the PEG (W = 0.97, p = 0.45) and EPG (W = 0.95, p = 0.25) were normally distributed. Therefore, an independent sample t-test was used to compare the means of PEG and EPG on balance. There was a significant difference between the means of groups on balance (t (66) = -2.2, p = 0.02). The mean of EPG (M = 15.53) was 2.47 (95% CI: -0.3, -4.6) higher than the mean of PEG (M=13.05). In total, 75% (n = 51) of the participant's balance score was around average, and in the PEG, this percentage was 72.2% (n = 26) and in the PEG – 78.1% (n = 25) (Table 3).

Table 3. **Distribution of balance evaluation across groups**

Groups	Balance Score Categories, % (n)				Total, % (n)
	Well-Below Average	Below Average	Average	Above Average	
PEG	2.8 (1)	22.2 (8)	72.2 (26)	2.8 (1)	100 (36)
EPA	-	9.4 (3)	78.1 (25)	12.5 (5)	100 (32)
Total	1.5 (1)	16.2 (11)	75.0 (51)	7.4 (6)	100 (68)

Relationship between balance and participants' age and BMI. Since BMI (W = 0.9, p = 0.006) and age (W = 0.93, p = 0.03) were not normally distributed in the PEG and balance was normally distributed, Spearman's correlation was performed to examine the correlation in the PEG between balance score and BMI and balance score and age. According to Spearman's correlation coefficient in the PEG, there is a negative correlation between BMI and balance performance, but this correlation is not statistically significant (r (36) = -0.29, p = 0.08). Therefore, as BMI increases, the balance score also tends to decrease. The correlation between age and balance score is also negative. However, the existent negative correlation between age and balance score is not statistically significant (r (36) = -0.23, p = 0.17). Pearson correlation was performed to examine the correlation in the EPG between balance performance and BMI and balance performance and age because both BMI (W = 0.98, p = 0.93) and age (W = 0.97, p = 0.58) were normally distributed. In the EPG, a non-significant negative correlation between BMI and balance score was observed, r (32) = -0.12, p = 0.50. However, the correlation between age and balance score was positive, but it is not non-significant; r (32) =0.02, p = 0.90.

The Effect of Gender, Frequency, and Activity Specificity. In the EPG, an independent t-test revealed a significant difference between the means of females and males on balance, t (30) = 2.2, p = 0.03. The mean of females (M = 17.2) was 3.14 higher than the mean of males (M = 14.05). Whereas in the PEG

group, there were no significant differences between the balance performance of genders, t (34) = 0.6, p = 0.5.

In the EPG, 14.29% of participants were participating in basketball and soccer, 28.57% in swimming, 18.37% in martial arts, 14.29% in dance, and 10.2% in gymnastics. Children who participated in gymnastics performed the best balance performance with a mean score of 20.9 in the EPG (Fig. 1), and those taking part in basketball had the lowest scores with a mean of 6.5.

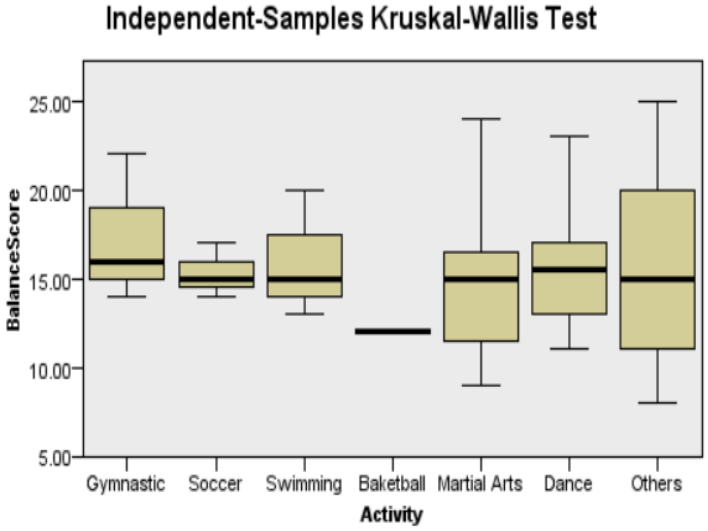

Figure 1. **Effect of specificity of extra activities on balance**

Due to the inadequate number of subjects in some of the groups, a Kruskal-Wallis test was performed and revealed that there were no significant differences in the means among the activity groups (H (6) = 3.62, p = 0.72). In the EPG, participants who participate in EPA 5 days a week have the highest mean rank (22.25), indicating that, on average, this group tends to have higher values in comparison to the other groups. Nevertheless, there appears to be a non-significant difference between the EPA participation frequency groups, H (4) = 0.93, p = 0.94 (2.) in terms of balance performance. Therefore, a post-hoc test was not performed. However, due to the small sample size in some groups, these results should be carefully interpreted.

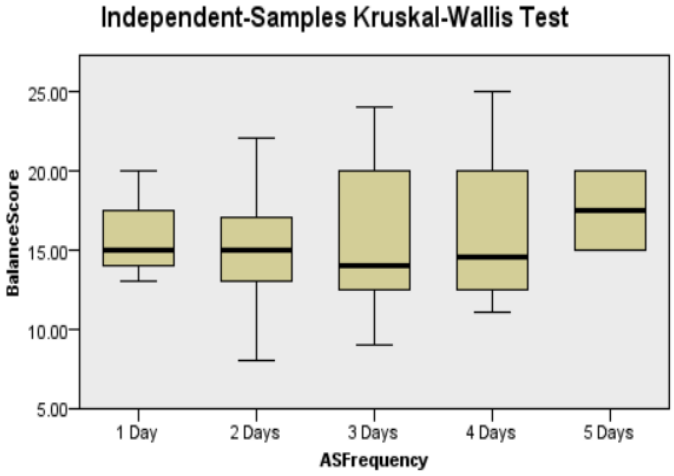

Figure 2. **Effect of frequency of extra activities on balance**

4. DISCUSSION

The current study aimed to analyze the effect of EPA on children's balance compared to PE. It was hypothesized that children who participated in EPA were anticipated to perform better in terms of balance than those who only participated in conventional PE curriculums. The current literature focuses on EPA's effects on PF in different age groups. However, there are no adequate studies that focus on the impact of EPA on the balance performance of healthy children in particular. The results of this study showed that children who took part in EPA performed better in balance tasks than children who took part in only PE, which confirmed the hypothesis. Another finding is that there was a non-significant difference between the balance scores of males and females in the PEG, whereas, in the EPG, females significantly scored higher than males. Furthermore, in the EPG, a non-significant positive correlation was found between age and balance score and a non-significant negative correlation between BMI and balance score. Whereas in the PEG, the correlation between age and balance score and BMI and balance score was found to be negative. Lastly, another finding is that the specificity and frequency of EPA did not influence the balance performance, and those who took part in gymnastics scored the highest balance score, whereas those who took part in basketball scored the lowest.

As mentioned previously, in a study conducted by Greco et al., which supports the main findings of the current study, it was found that an 8-week extra physical activity program, in addition to a standard PE program at the school, resulted in significant gains in static balance among children (Greco et al., 2019). Similarly, Tiktampanidi et al. found that a creative movement program with a focus on developing MS, coordination, and balance may have a positive effect on the balance of preschool children (Tiktampanidi et al., 2021). Moreover, during the COVID-19 pandemic, due to the increase in sedentary time and eventually increase in physical inactivity, a decline in balance performance for children was observed (Martínez-Córcoles et al., 2022)especially in children. In Spain, to avoid infections, a home quarantine was declared, which caused a drastic reduction in daily or weekly physical activity in children.\n\nObjective\nto analyse the balance performance after the COVID-19-induced quarantine on children's balance, through the use of balance tests, considering the type of sport practiced.\n\nMethods\nan observational and longitudinal study was carried out with a sample size of 150 healthy children (69 boys and 81 girls. In the literature, it was stated that additional time dedicated to PA provides children with more time for refining their MS, potentially leading to a greater ability to maintain balance (McDonough et al., 2020). The outcome of this study is contrary to that of Anderson et al. (2022), who found no statistical difference between the gymnastic group and the typical PE group in terms of balance performance. However, they discovered that the gymnastics group altered postural stability in a greater way.

Exercise after school hours is critical to boosting kids' levels of habitual physical activity, particularly MVPA. According to a recent observational study of kids in England, children who participated in additional physical exercise 3–4 times per week had a mean increase in MVPA of 8 minutes daily (Jago et al., 2017). This particular study is important for our findings because the underlying reason for the current hypothesis was the positive correlation between the time dedicated to physical activity and its positive impact on MS. As children spend more active time and decrease the sedentary time in their everyday lives, they have more time to refine their MS.

Both groups showed a non-significant negative correlation between BMI and balance score. Therefore, Kolic et al., 2020 link BMI to children's decline in balance, and Verbecque et al., 2021 link high BMI to children's low motor competence. The current investigation found no significant difference between the balance scores of males and females, and gender did not significantly affect the balance scores of 5-year-old to 11-year-old children in the PEG. However, physically more active females (EPG) performed significantly better than physically more active males. Gender-specific studies that analyzed MS mostly agreed on the superiority of females in balance tasks at primary school ages. According to

Anderson et al. (2022) and Rodríguez-Negro et al. (2021), females are more successful than males at balancing tasks. The non-significant results in the PEG may be due to their inadequate PA levels.

Age and balance performance have a non-significant positive correlation between them in the EPG and, surprisingly, a negative one in the PEG. We believe that findings regarding the relationship between age and balance are controversial at young ages, which is a possible reason for non-significant results. On the one hand, Turon-Skrzypinska et al. (2020) concluded that balance parameters in children do not correlate with age. On the other hand, Kolic et al. (2020) found that balance ability improved with age.

However, children's ability to maintain balance during various activities is not solely based on their age, but also depends on the specific demands of the task or the environment they are in (Puta et al., 2022). Moreover, it is important to take into account that children demonstrate the capacity to employ different strategies for maintaining balance based on the specific demands presented by a given task or environmental factors (Puta et al., 2022). As a result, the use of different types of EPA may have an impact on the balance score.

In conjunction with the last paragraph, another finding that stands out from the results reported earlier is the specificity of sports activities and participation frequency. Surprisingly, the data analysis revealed non-significant results for both the specificity of EPA and participation frequency, which suggests the specificity of EPA and participation frequency did not significantly influence the balance score. With a non-significant value, we found that children who engage in EPA more frequently performed better in balance. This finding aligns with the finding of García-Soidán et al., which is that active children possess better postural control than their counterparts who are sedentary. Consistent with the literature, this study found that participants who took part in gymnastics performed the highest balance scores, and basketball participants performed the lowest (Skaltsa et al., 2021). It's essential to acknowledge the potential impact of the small sample size on the statistical power of these particular results, and we believe the non-significant results for this particular analysis stem from the small sample size.

When evaluating the findings of the current study, it is important to keep in mind its limitations. The main reason for this could be the current research's limited sample size and the children's involvement in the EPA's miscellaneous specificity. Apart from this, another factor to take into account is that, because our sample was recruited from a single organization, the findings might not be very generalizable. However, recruiting participants from one organization allowed us to reduce variability in teaching methods, curriculum, and facilities and increase homogeneity in terms of PE, and the variety in the specificity of the EPA allowed us to observe the effect of different types of sports on balance performance. More information on the effect of EPA on children's MS would help us establish a greater degree of accuracy in this matter.

5. CONCLUSION

Children who attended extra physical activities performed better in balance performance than children who attended only scheduled curricular physical education lessons. The frequency and specificity of extra physical activity participation did not influence balance performance.

Conflict Of Interest: The authors declare that they have no conflicts of interest.
Fundings: None.

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Papildomos fizinės veiklos poveikis 5–11 metų vaikų pusiausvyrai

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Santrauka

Įvadas. Papildoma fizinė veikla (PFV) yra būtina vaikams, nes ji prisideda prie jų vystymosi, pusiausvyros lavėjimo ir traumų prevencijos.

Tikslas. Nustatyti papildomos fizinės veiklos poveikį 5–11 metų vaikų pusiausvyrai, kuri vertinta naudojant Bruininks-Oseretsky testo antrąją versiją (BOT-2).

Metodai. Atliktas skerspjūvio tyrimas. Tiriamieji – 5–11 metų amžiaus vaikai (n = 68) – suskirstyti į dvi grupes, atsižvelgiant į tai, kokioje veikloje jie dalyvavo. Standartinėse kūno kultūros (kūno kultūros grupė, KKG) pamokose dalyvavo 36 vaikai, o papildomos fizinės veiklos (PFV) grupėje – 32 vaikai. Vertintos devynios BOT-2 pusiausvyros testo subskalės, kurios palygintos tarp KKG ir PFV grupių. Vaikų pusiausvyra vertinta naudojant BOT-2 testavimo rinkinį.

Rezultatai. Nepriklausomų imčių t testas parodė reikšmingą pusiausvyros vertinimo skirtumą tarp KKG ir PFV grupių (t (66) = -2,2, p = 0,02) PFV naudai. Kruskal-Wallis testas parodė, kad PFV specifiškumas (H = 3,62, df = 6, p = 0,72) ir dalyvumo veikloje dažnis (H (4) = 0,93, p = 0,92) neturi poveikio pusiausvyros rezultatams.

Išvada. Papildomos fizinės veiklos grupėje vaikų pusiausvyra buvo geresnė nei kūno kultūros pamokų grupėje. Ši išvada rodo papildomo fizinio aktyvumo svarbą gerinant pusiausvyrą. Papildomas fizinio aktyvumo dalyvavimo dažnis ir specifiškumas pusiausvyrai įtakos neturėjo.

Reikšminiai žodžiai: pusiausvyra, motoriniai įgūdžiai, motorikos raida, fizinis aktyvumas

Gauta 2024 04 01
Priimta 2024 05 15