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Original empirical article

THE RUNNING PERFORMANCE OF SCHOOLCHILDREN ON DIFFERENT SURFACES*

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Živorad Marković[1], Aleksandar Ignjatović[1], Dragan Radovanović[2], Dragoljub Višnjić[3]

[1]Faculty of Pedagogy Jagodina, University of Kragujevac, Serbia
[2]Faculty of Sport and Physical Education, University of Niš, Serbia
[3]Faculty of Sport and Physical Education, University of Belgrade, Serbia

Abstract. *The aim of our study was to compare the running performance of schoolchildren on three different surfaces (parquet floor, asphalt and grass) which are mostly used for physical education classes. The study sample consisted of 97 healthy schoolchildren (age 11±0.5 years) divided into two groups in relation to sex: 42 boys (group 1) and 45 girls (group 2). The speed was evaluated by two tests: the 30m sprint with a high start and a 3x10m agility run. The results indicate statistically significant differences in terms of running performance in relation to the surface for both groups. The best average results on both tests were achieved on the asphalt surface, while the weakest average results were determined for the 3x10m agility test in both groups on the parquet floor. The obtained results regarding the influence of different surfaces should be used to prevent injury and provide security for schoolchildren, and as a factor when testing motor skills in this age group.*

Key words: *surfaces, running, schoolchildren, prevention.*

INTRODUCTION

Running tracks are a basic requirement for all sports facilities. Providing the best running track surface is very important for athletes preparing for competitions, as well as for the schoolchildren during regular physical education classes. The running track composition will have a great impact on not only the performance, but also the health of the runners who use them.

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Corresponding author: Živorad Marković
Faculty of Pedagogy in Jagodina, University of Kragujevac, Milana Mijalkovića 14, 35000 Jagodina, Serbia
Tel: +381 35 223 805, Fax +381 35 223 805 • E-mail: zimarkovic@yahoo.com
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Different surface properties have different effects on the dynamics and mechanics of movement (Ferris et al., 1999; Kerdok et al., 2002), and also affect the energetics of running (Kerdok et al., 2002). They also found that the metabolic rate on various surfaces is positively related to surface stiffness.

Running on different surfaces will have different effects on the human body and it is important to know the benefits and downsides of each surface. The grass surface is soft, therefore, easy on impact, and this shields the joints. Similarly, wooden floors are considered soft surfaces and they are easy on impact. In addition, unlike indoor surfaces, outdoor surfaces are often uneven so the body gets a complete workout with its stabilizing musculature working harder, and logically burning more calories. The downside of uneven terrain is the increased possibility of injury.

Concrete and asphalt surfaces create the greatest impact on runners' legs and can lead to a variety of overuse injuries as well as lower back strain. Patellofemoral syndrome and medial tibial stress syndrome (known to most of us as runner's knee and shin splints) are associated with harder running surfaces such as concrete and asphalt.

Tracks built within this enhanced performance range (250 kN/m) at Harvard University, Yale University, and Madison Square Garden have been shown to increase running speeds by 2–3% and to decrease running injuries by 50% (McMahon & Greene, 1979). Tracks tuned at 250 kN/m also optimize energy return (Stafilidis & Arampacis, 2007).

The studies that investigated running on different surfaces were carried out by other authors on recreational samples (Leger & Lambert, 1982; Pinnington, & Dawson, 2001a; Kerdok et al., 2002) and samples consisting of athletes (Zampar et al., 1992; Pinnington & Dawson, 2001b; Vitor Tessutti 2007), and very rarely on samples including school-age participants. However, the studies which focus on gender differences appear to be lacking. Some studies investigated the effect of training on different running surfaces on the performance of athletes. To assess the effect of training on different running surfaces they used the calf and thigh circumference of athletes, and their running performance (Karve & Tiwari, 2010). The greatest physiological and performance changes were found after a 6-week sand running program, which was expected because it is the most intense and demanding surface.

The aim of this study was to compare the running performance of schoolchildren on three different surfaces which are mostly used for physical education classes.

METHODS

Our studied sample consisted of 97 healthy schoolchildren, aged 11 years ± 6 months. That sample was further divided into two groups in relation to sex: 42 boys (group 1) and 45 girls (group 2). All of the subjects regularly took part in their physical education classes at school. None of the subjects showed any evidence in their anamnesis of recent injury.

The assessment of their running performance was performed according to the standardized criteria and protocols for this period of development. Two tests were applied: the 30 m run with a standing start (M-30 m) - to assess sprint speed, and the 3 x 10 m agility run (M-3 ×10 m) - to assess speed - agility. The assessment was carried out for speed on asphalt, grass and indoor parquet in standardized conditions for all subjects. The asphalt surface was washed and dried, the grass was 4 cm and the dry, wooden floor has been washed and dried, so that the potential injuries during the assessment of speed would be prevented, as well as any possible changes in the direction of slips that could affect the accuracy of the obtained results.

In all three measurements the students were running in the same shoes, thus excluding the impact of different lower surfaces on the obtained results. All of the assessments were conducted in the morning hours during regular physical education classes. The procedures presented were in accordance with the ethical standards on human experimentation.

Statistical analyses. The descriptive parameters were calculated for each observed variable. The differences between the subgroups of the sample of subjects were analyzed using the ANOVA. The data are described as means ± standard deviation (SD). Statistical significance was set at $p<0.05$ for all the statistical analyses.

RESULTS

Central and dispersion parameters of the running speed of the boys on three different surfaces are presented in table 1. The general agreement is that the results are fairly homogeneous and there are no values that deviate significantly from the expected and the real potential value. During the 30m test, the best result (6.21 s) was obtained on the asphalt surface. Also, during the 3x10m agility run, the best result (9.0 s) was obtained on the asphalt surface.

Table 1 Descriptive statistics for group 1 (boys, n=42)

Variables		Mean	SD	Min	Max	Sk	Ku	KS-p
M-30m	Asphalt	6.21	0.46	5.5	7.2	.69	-.66	.026
	Grass	6.29	1.01	6.0	7.3	.35	2.76	.023
	Parquet	6.36	0.46	5.6	7.2	.48	-1.00	.206
M-3×10m	Asphalt	9.00	0.43	8.3	10.0	.68	-.03	.102
	Grass	9.19	0.46	8.4	10.2	.42	-.33	.956
	Parquet	9.58	0.57	8.6	11.0	.45	-.34	.673

The central and dispersion parameters of the running speed of the girls on three different surfaces are presented in table 2. During the 30m test the best result (6.64 s) was obtained on the asphalt surface, and the weakest result (6.97 s) was obtained on the grass surface. Also, during the 3x10 m agility run, the best result (9.64 s) was obtained on the asphalt surface, but the weakest result (10.21 s) was obtained on the parquet surface.

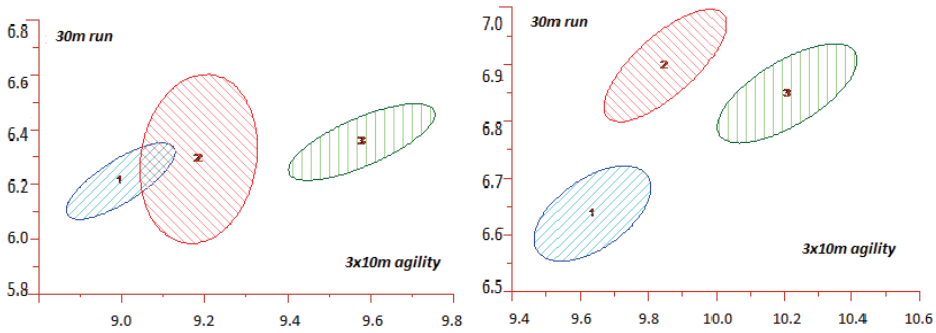
Table 2 Descriptive statistics for group 2 (girls, n=45)

Variables		Mean	SD	Min	Max	Sk	Ku	KS-p
M-30m	Asphalt	6.64	0.28	6.2	7.5	.87	.48	.059
	Grass	6.97	0.33	6.4	7.7	.41	-.71	.465
	Parquet	6.85	0.29	6.3	7.6	.50	-.37	.193
M-3×10m	Asphalt	9.64	0.58	8.7	10.7	.27	-1.08	.622
	Grass	9.85	0.6	8.9	11.2	.38	-.79	.413
	Parquet	10.21	0.7	9.1	11.6	.29	-.96	.690

The MANOVA revealed statistically significant differences ($F= 7.64$; $P<0.001$) in the case of two performance tests (30m & 3x10m) between the three different surfaces in the case of the boys, and a statistically significant difference ($F= 9.33$; $P<0.001$) in the case of two performance tests (30m & 3×10m) between three different surfaces in the case of the girls.

In the case of the boys, the ANOVA revealed no statistically significant difference between the surfaces in the 30m test ($F = .453$, $p = .637$), and a statistically significant difference between the surfaces in the 3 x 10m agility test ($F = 9.351$, $p < 0.001$). In the case of the girls, the ANOVA revealed a statistically significant difference between the surfaces in the 30m run test ($F = 15.361$, $p < .001$), and in the 3 × 10m agility test ($F = 9.513$, $p < .001$).

Ellipses (confidence intervals) for the running speed in the case of the boys (figure 1.) and girls (figure 2.) on different surfaces, for the 30m run test and the 3 × 10m agility test.



Legend: asphalt 1; grass 2; parquet 3

DISSCUSION

Our aim was to investigate the impact of possible differences between speed performance tests including schoolchildren under the present conditions, where the most usual surfaces for physical education classes are the parquet floor, asphalt and grass. The best average results in both tests were achieved on the asphalt surface. The asphalt surface is the hardest, and duration of the foot contact time (i.e., the duration of the stance phase of the gait cycle) is shorter, which of course accelerate the runners' paces (McMahon, & Greene, 1979). In addition, most time of the time during physical education classes as well as afterschool free time is spent on asphalt surfaces, as the most frequent type of surface in school facilities (Petrović et al., 1995).

On the other hand, the worst average results for the 30m run test for both sub-samples, and for the 3x10m agility test in the case of the boys was obtained on the parquet surface. Nevertheless, the female participants obtained the worst average result during the 3x10m agility test on the grass surface. Beside the fact that the runners slowed down dramatically on the softer surfaces, the female participants in this age group were rarely engaged in activities that were carried out on grassy surfaces. Similar results were reported (Marković & Višnjić, 2008) for participants of the high school age.

In general, the best running surfaces are those that are moderately soft and smooth. Even though the hard surfaces are better for the achievement of best results, they are toughest on the body and increase the risk of injury. Hard surfaces produce high ground reaction forces (GRF's) which transmit shock through the body as the foot strikes the ground. However, during steady state running runners adjust the stiffness of their stance leg to accommodate surface stiffness. This adjustment allows them to maintain a similar center of mass movement (e.g., ground contact time and stride frequency) regardless of

the surface stiffness (Ferris, Liang & Farley, 1999). During short distance running it is hard to accommodate and adjust the stiffness of the leg before the heel strikes the ground based on the perception of the hardness of the surface.

The asphalt surface, as most often present in school facilities (Petrović et al., 1995), is one of the most common causes of injury in class, and the loads that are present on the underside of the foot may over time result in plantar foot injury. Soft surfaces, in addition to greater security, would affect attendance, as attendance at physical education classes by students in the first place depends on the ambient environment (Radovanović et al., 1993).

The difference observed between the results on softer surfaces between boys and girls during the 3x10m agility test could be also explained in terms of a gender specific muscular response to surface changes. The muscle activity pattern as well as the muscular response to changing surfaces showed to be gender specific. Running on different surfaces produces different EMG signals, and has been shown to be gender specific. The modification of muscle activation depending on the surface condition was pronouncedly opposite for men and women, especially with regard to the m. peroneus longus and m. vastus medialis (Wissemann et al., 2006). Gender specific muscular responses to surface changes are to be considered with respect to differences between the muscle activation patterns of men and women. They may be also related to gender specific discrepancies in factors such as body weight, connective tissue, anthropometry or dynamic segment alignment (Wissemann et al., 2006).

The knowledge obtained about the influence of different surfaces, their hardness, extent of the damage, level of acceptance by schoolchildren and students should be used to prevent injury and enable the safety of schoolchildren, and as a factor when testing motor skills, resulting in the adequate planning and implementation of teaching content for physical education.

CONCLUSION

The present study provided information on the running performance of schoolchildren on three different surfaces which are mostly used for physical education classes. The surface on which the planned activities of physical education are done is an important factor in the process of increasing safety and reducing the risk of possible injury. In addition to the security impact, different surfaces can contribute to achieving better results on the speed performance test for schoolchildren. Considering the relatively small number of schoolchildren who were involved in the study, further studies should be conducted before giving precise recommendations to education authorities and architects involved in the planning of the construction of school buildings.

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POREĐENJE BRZINE TRČANJA ŠKOLSKE DECE NA RAZLIČITIM PODLOGAMA

Živorad Marković, Aleksandar Ignjatović, Dragan Radovanović, Dragoljub Višnjić

Cilj rada je bio poređenje brzine trčanja učenika na tri različite podloge (parket, asfalt i trava) koji se najčešće koriste za nastavu fizičkog vaspitanja. Uzorak ispitanika od 97 zdravih učenika (uzrast 11 ± 0.5 godina) je prema polu podeljen na dve grupe: 42 dečaka (grupa 1) i 45 devojčica (grupa 2). Brzina trčanja određivana je korišćenjem 30 m sprint testa sa visokim startom i testom agilnosti 3h10 m. Analiza rezultata pokazala je statistički značajne razlike kod obe grupe ispitanika u odnosu na podlogu po kojoj je trčano. Najbolji prosečni rezultati u testovima su postignuti na asfaltu, dok su najslabiji prosečni rezultati su bili na testu agilnosti 3h10 m na parketu kod obe grupe ispitanika. Dobijene rezultate o uticaju različitih podloga na brzinu trčanja treba da se koristi za sprečavanje i potpunu sigurnost školske dece, i kao faktor prilikom testiranja motoričkih sposobnosti u ovoj uzrasnoj grupi.

Ključne reči: *podloga, trčanje, školska deca, prevencija.*