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INFLUENCE OF DIFFERENT TYPES OF SURFACES ON THE RESULTS OF RUNNING SPEED TESTS IN YOUNG SOCCER PLAYERS

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Abstract. The main purpose of this study was to determine the influence of different types of surfaces on the sprint test results. 33 male football players from two age categories – U15 and U18 – performed sprint tests (7 distances between 5 and 30 m) and a 150 m shuttle run test on three types of surfaces: natural grass [n], a synthetic surface [s] and a rubber surface [r]. The longer distance a player covers, the more likely it is that the importance of the type of running surface will be noticed. The rubber surface diminishes the negative effects of changeable factors on the reliability of the tests and therefore, in our opinion, is recommended for control tests and especially for longitudinal tests. Comparing the results of running speed tests performed on different surfaces and especially in different weather conditions is unjustified.

Key words: Sprint tests, football, sport physiology, exercise test, physical performance

Introduction

The ability to run quickly is one of the most important motor abilities of football players. Because of the specificity of the game, the type and quality of the surface used during a football match plays a crucial role in the quality of the sports event, which is highly dependent on the running speed of the players. According to game regulations, a football match can be performed in different weather conditions and on various surfaces. Synthetic and natural surfaces are both commonly used, but natural surfaces are more common worldwide. However, the use of synthetic surfaces has increased recently because of their lower maintenance costs and ability to be used in adverse weather conditions, especially in countries with extremely hot or cold climates. Synthetic, weather-resistant running surfaces consist of rubber granules bound by polypropylene or polyethylene.

Many scientists have assessed the impact of different surfaces on the effectiveness of coaching processes and on the health of football players. Ekstrand et al. (2006) found that synthetic surfaces have a significant influence on the occurrence of injury among football players. Katkat et al. (2009) studied the increased muscle fatigue that results from practicing on fields with an artificial layer. However, Zanetti (2009) focused on a different aspect of football training on various surfaces. Her studies confirmed the significant positive impact of synthetic surfaces on the technical skill levels of the players. Nevertheless, the results of studies by Andersson et al. (2008) revealed that it was more difficult to perform certain techniques on synthetic surfaces and so synthetic surfaces were deemed inferior to natural grass. However, no differences were found between the total distances covered during the match. Moreover, the study showed that tackling the ball took longer on the synthetic surface. Gains et al. (2010) provided similar results regarding the speed and agility abilities of football players on college teams. The results revealed that the type of surface significantly influenced the subjects' performance. Müller et al. (2010) analyzed the influence of the surface on football players' physical capacity.

Different surfaces may also affect the results of control tests, which are often used to assess skill development. Based on these results, coaches modify the training program (Mujika et al. 2009; Sporis et al. 2011). Therefore, inconsistencies in the tests, especially regarding running speed, may negatively influence the optimization of the preparation for match play.

The majority of studies analyzed either the influence of the surface on players' health and technical skills or the influence of applied footwear on their game effectiveness for different types of surface. However, little is known about the differences in the results of running speed tests performed on natural, synthetic, or rubber indoor surfaces when poor weather conditions (rain or strong wind) prevented the subjects from testing on the football pitch. Therefore, the aim of this study was to determine the influence of different types of surfaces on running test results. It was assumed that the running speed of young football players, regardless of their age category and running distance length, was the highest when tested on the rubber surface and the lowest when tested on natural grass.

Methods

The tested materials consisted of three types of surfaces: natural grass [n], a synthetic surface [s] and a rubber surface [r]. The running speeds were also measured during the tests on each surface. The participants started running from a standing position [stat.] or with a 2 m run up [dyn.] for the 5 and 10 m (stat. and dyn.) distances and from standing for the 15 m and 30 m (stat.) distances; the subjects also performed a 150 m shuttle run. The research was conducted on a sample of 33 football players from two age categories: U15 and U18 (Table 2). Standard anthropometry (calendar age, body height and mass, and BMI) and performance characteristics (21 time results: 3 types of surfaces combined with 7 types of runs) were collected for each participant.

The players were members of the Football Academy in Malbork. Each week, they participated in five training sessions (approximately 1.5 h each) and three physical education periods (45 min each). All the participants were students of the Sports Middle School who played football and had valid medical cards. In accordance with the Helsinki Declaration, the players and their parents or guardians were provided with detailed information about the research procedures and gave their written consent. The protocols received ethics approval from the institution.

Young football players were subjected to running speed tests on three different running surfaces. For the first week, the tests were conducted on a football pitch with natural grass [n] grown from Polish seeds designed for football pitches. The football pitch was well-rooted (three years of vegetation) and mowed to a height of 50 mm before the test. The tests in the second week were carried out on a synthetic surface [s] (Dutch firm Greenfields Sport Turf System) with 47 mm high fibers (Real FT 45 V-slide TPE/el). In the third week, a rubber indoor surface [r] from the sports hall of the Dutch firm BV Descol Kunststof Chemie (Pulastic 2000) was used.

All the running time measurements were taken on Tuesday mornings between 10:30 and 12:00 of three consecutive weeks at the end of August and the beginning of September. On the days leading up to the test dates, the subjects played friendly matches on Saturday mornings. Sundays and Mondays were recovery days. Because the players rested for 72 hours after their last physical effort, this time was considered sufficient for full recovery. The tests were conducted at the end of the preseason period. For the first week, the air temperature was between 20 and 22°C, the air pressure was 1025 hPa, and the wind speed did not exceed 2 m/s. In the second week, the corresponding conditions were 19–20.5°C, 1010 hPa, and 2.5 m/s. In the third week, in the gym hall with air-conditioning, the air temperature was 22°C, the air pressure was 1005 hPa, and the air movement reached 1 m/s. During the first two weeks, no precipitation occurred three days before the tests. Moreover, each field had a drainage system, thus no stagnant water was present at the testing place. The sports footwear used during the running tests on both the natural and synthetic surfaces was the same (Puma v1.08 leather). During the tests on the rubber surface, the players used footwear with rubber soles (Puma Esito Finale type) designed for indoor activity.

Before each test, the players performed warm-up exercises for 25 min, including 8 min of running at 50% HR_{max}, then 5 min of stretching (2.5 min active and 2.5 min static), 3 min of individual exercises for general strength, and 3 min of explosive strength exercises (low hurdle jumps). At the end of the warm-up, the subjects ran for 2 min at low intensity (jog) with three individual sprints of 15 m, 20 m, and 30 m. This running was followed by marching for 1 min and 2 min of a low-intensity run (jog) with three individual sprints of 15 m, 20 m, and 30 m.

Before the running tests were performed, the wind speed and direction were measured. Speeds that did not exceed 2 m/s were assumed to be appropriate for the experiment. The starting line was always placed in the same manner to minimize the air resistance. The players ran in the direction of the wind. The time was measured using an electronic TAG Heuer system (model HL 2-31, Switzerland), recommended by Yeadon, Kato, & Kerwin (1999), and it included two photocells with a mechanism for preventing premature switching on (starting line) and off (finishing line). Each distance was covered by the players separately. The time between crossing the starting line and reaching the finishing line was measured. Times between other photocells within the distance were not considered. The measurements were taken during the following runs: 5 m from the standing position [5 m stat.], 5 m with a 2 m run-up [5 m dyn.], 10 m from a standing position [10 m stat.], 10 m with a 2 m run-up [10 m dyn.], 15 m from a standing position [15 m], and 30 m from a standing position [30 m]. The 5 m and 10 m runs from a standing position were performed twice, and the shorter time results were analyzed. The players always started the run from a standing position with their forward foot on the starting line. The recovery time between the tests was 2 min after the 5 m run from a standing position, 3 min after 5 m run with a run-up, 4 min after the 10 m run from a standing position, 5 min after the 10 m run with a run-up, and 6 min after the 15 m run from a standing position. Active recovery (2 min of marching alternated with 2 min of static stretching) was administered to the players during the breaks. After the 30 m run, there was a 15 min break, including a 3 min march, a 2 min low intensity run, 5 min of static stretching, and 5 min of individual preparation for the shuttle run test (e.g., running back and forth). The test involved a 150 m shuttle run. The subject started from the standing position with his forward foot on the starting line. Then, he sequentially covered distances of 5 m, 10 m, 15 m, 20 m, and 25 m. After touching the finishing line of each distance with his foot, the participant ran back to the starting line. All the results were registered by an Msports Pro V.2.05 system attached to the TAG Heuer electronic system.

Statistica v.10 was used for all analyses. The Kołmogorow-Smirnow test with Lilliefors's amendment and the Shapiro-Wilk test were applied to check the homogeneity and normality of the times for each distance collected on three different surfaces. Cochran's C, Hartley, Bartell, and Levene tests were used to check the homogeneity of the variance. Box's M test was used to verify the homogeneity of the covariance hypothesis. Statistically significant differences were determined with the application of multivariate analysis of variance (MANOVA) and secondary ANOVA tests with the application of post hoc LSD Fisher and HSD Tukey tests. Next, the assumption of parallel regression lines was verified and followed by an analysis of covariance (ANCOVA) to include the influence of the variables for different surfaces that were involved in the running time results for different distances. The significance was set at $p < 0.05$.

Results

First, the football players' anthropometric variables were analyzed; the homogeneity of dispersion from a normal distribution was checked. For all the players involved in the experiment, no normality was found (regarding age and BMI). The bar chart of age showed the possibility of creating two subsets. The subjects were divided into two age categories: up to 15 years and over 15 years. After checking the homogeneity and normality of the subsets, a two-set predictor for the age category variable [U15, U18] was determined, enabling the application of parametric statistics. As a result, 19 subjects represented U15 with a mean age value of M = 14.2 ±0.6, and 14 football players were allocated to U18 with M = 16.5 ±1.1 years.

After checking the homogeneity and normality of the variables in all combinations, including the age category and surface factors (6 subgroups were set up), the BMI variable was excluded from further analysis. All other variables met the statistical requirements for a parametric analysis. Moreover, the homogeneity of the multidimensional covariance of the time results for seven running distances was determined (permutations of different sets of Box's M test). Because of the statistical analysis, the shuttle run variable was rejected because of the lack of homogeneity with the other results, most likely because of the acceleration changes during the shuttle run.

Differences between the time results obtained for the same running distance on various surfaces were counted with the application of a multidimensional analysis of variance (MANOVA). First, the homogeneity of variance of all variables that met the statistical requirements for further comparisons (Shapiro-Wilk, Levene, and Box's M tests) was checked.

As shown in Table 1, the type of surface ($p < 0.040$) and the age category ($p < 0.001$) can have a significant influence on the running time results for the 10 m dyn., 15 m, and 30 m distance runs of the tested football players. However, no significant effect of the surface ($p > 0.180$) on the time results was found for the 5 m stat. and 5 m dyn. runs, unlike the age category variable.

Although a significant influence of the type of surface and age category on the running time results for the chosen distances was not confirmed for all the participants, it can be assumed, based on the Shapiro-Wilk test, that there is a probability that these predictors have a significant influence on variables for the entire group of tested subjects (Table 2).

Table 1. Comparison of influence of the predictors on the dependent variables (running distances) in all subjects (n = 33)

	Degr. of	SS	MS	F	p	SS	MS	F	p
Variable		5 m stat.				5 m dyn.			
Intercept	1	137.82	137.82	40,241.29	0.00	87.01	87.01	29,133.34	0.00
surface	2	0.01	0.00	0.78	0.46	0.01	0.01	1.72	0.18
category*	1	0.21	0.21	59.91	0.00	0.11	0.11	36.67	0.00
Error	95	0.33	0.00			0.28	0.00		
Total	98	0.54				0.40			
		10 m stat.				10 m dyn.			
Intercept	1	399.40	399.40	38,264.45	0.00	297.01	297.01	30,517.45	0.00
surface*	2	0.04	0.02	1.84	0.16	0.07	0.04	3.63	0.03
category*	1	0.52	0.52	49.35	0.00	0.57	0.57	58.98	0.00
Error	95	0.99	0.01			0.92	0.01		
Total	98	1.55				1.57			
		15 m				30 m			
Intercept	1	763.32	763.32	33,653.01	0.00	2,323.25	2,323.25	22760.31	0.00
surface*	2	0.28	0.14	6.24	0.00	0.88	0.44	4.30	0.02
category*	1	1.51	1.51	66.58	0.00	6.56	6.56	64.25	0.00
Error	95	2.15	0.02			9.70	0.10		
Total	98	3.94				17.13			

* Significant interaction between predictors and running distances.

Table 2. Shapiro-Wilk test results regarding the influence of the surface and age category predictors on the running time for different distances with young soccer players

Variable	Test	Value	F	Effect	Error	p
Intercept	Wilks	0.00	8253.75	6	90	0.00
Surface	Wilks	0.63	3.84	12	180	0.00
Category	Wilks	0.54	12.69	6	90	0.00

The post hoc Tukey test results for pairs of variables confirmed that the type of surface had a significant influence on the running time results for the 10 m dyn. ($p < 0.030$), 15 m ($p < 0.002$), and 30 m ($p < 0.020$) runs, regardless of the age category (Table 3).

The next step of the statistical analysis was to determine whether the regression lines were parallel. Then, ANCOVA was applied to determine the influence of the age, body height, and body weight covariates on the measured running times for the given distances. The results showed that the age, height, and weight variables had no significant influence on the surface predictor for assessing its impact on the 5 m stat., 5 m dyn. and 10 m stat. variables. However, the influence was significant when considering other variables: 10 m dyn., 15 m, and 30 m (Tables 4, 5).

A similar significance for the type of surface was observed in the 10 m run with run-up, but only when the age and height of the subject were included. Moreover, statistically significant differences were found between the time results measured during trials performed on natural and rubber surfaces (Figure 2).

Table 3. HSD Tukey test results and a surface predictor for pairs of times measured during the run for certain distances

Tukey HSD	5 m stat. Error: Between MS = .00342. df = 95.000			5 m dyn. Error: Between MS = .00299. df = 95.000		
surface	n	s	r	n	s	r
n		0.45	0.68		0.16	0.59
s	0.45		0.92	0.16		0.66
r	0.68	0.92		0.59	0.66	
	10 m stat. Error: Between MS = .01044. df = 95.000			10 m dyn. Error: Between MS = .00973. df = 95.000		
n*		0.25	0.20		0.32	0.02
s	0.25		0.99	0.32		0.43
r*	0.20	0.99		0.02	0.43	
	15 m Error: Between MS = .02268. df = 95.000			30 m Error: Between MS = .10207. df = 95.000		
n*		0.12	0.00		0.71	0.02
s	0.12		0.27	0.71		0.11
r*	0.00	0.27		0.02	0.11	

* Significant differnces between predictors and distances.

No statistically significant differences with respect to the surface were found between the running times for 5 m, either stat. or dyn. (Figure 1), and 10 m stat. (Table 3).

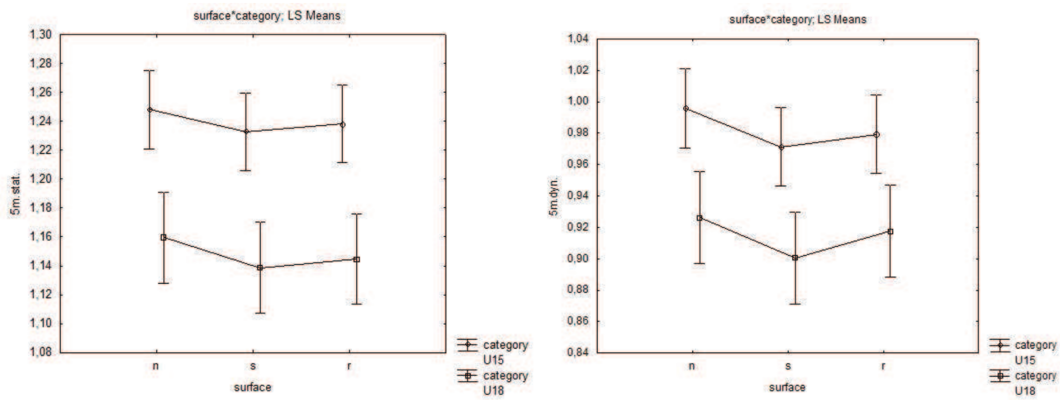

Figure 1. Time results of the 5 m run on different surfaces as a function of age

When the 15 m run was considered, the subject's age was the main factor determining the influence of the type of surface. Including this variable in the covariance analysis increased the probability for the running time results to depend on the type of surface (Table 4).

After the age category was included, a two-fold decrease in the p value for the type of surface was revealed (Table 4). Therefore, the distance and the type of surface significantly influenced the running time results of the subjects. This fact is confirmed by the less strict Fisher test. Table 5 presents those results.

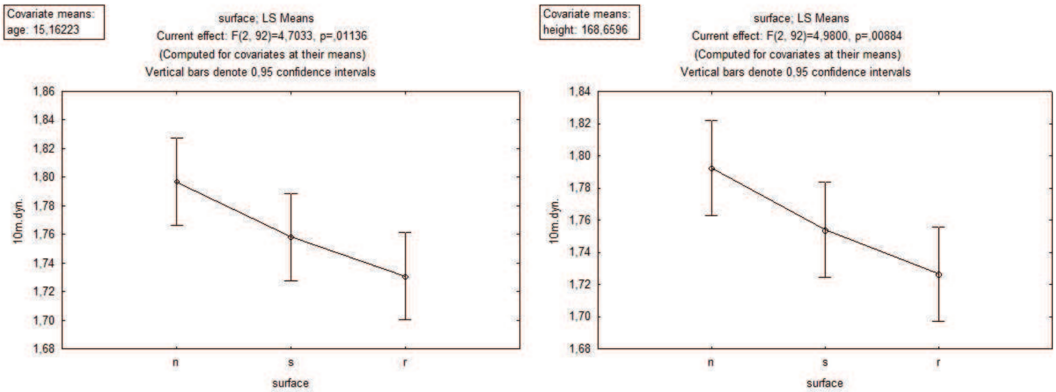

Figure 2. Time results for the 10 m dyn. runs on various surfaces with respect to the age and height of the subjects

Table 4. HSD Tukey's test results from comparing pairs of 15 m running times with the surface predictor that included the soccer players' ages

Tukey HSD	No covariate			Covariate means: age: 15,16223		
surface	15m. Error: Between MS = .02268. df = 95,000			15m. Error: Between MSE = .01667. df = 92,000		
n*		0.12	0.00		0.06	0.00
s	0.12		0.27	0.06		0.17
r*	0.00	0.27		0.00	0.17	

* Significant differnces between predictors and 15 m running distance.

Table 5. Results verifying the assumption of parallel regression lines for surface and age (surface&category&age)

Variable	SS	Degr. of	MS	F	p
Intercept	5.36	1	5.36	335.99	0.00
Surface*	0.03	2	0.01	0.81	0.45
Category	0.13	1	0.13	8.16	0.01
Age	0.74	1	0.74	46.54	0.00
Surface&category*	0.01	2	0.00	0.22	0.81
Surface&age*	0.02	2	0.00	0.58	0.56
Category&age	0.12	1	0.12	7.78	0.01
Surface&category&age*	0.01	2	0.00	0.27	0.77
Error	1.39	87	0.02		

* Significant interaction between surface and age.

For the 30 m run, the covariates of age body height, and weight (Figure 4) had an even greater impact on whether the surface influenced the running time than they did for the 15 m run. The time results obtained for the runs on natural and synthetic surfaces were significantly higher than the results obtained on the rubber surface.

Figure 3 shows the influence of body height, body weight, and type of surface on the time results for the 15 m run.

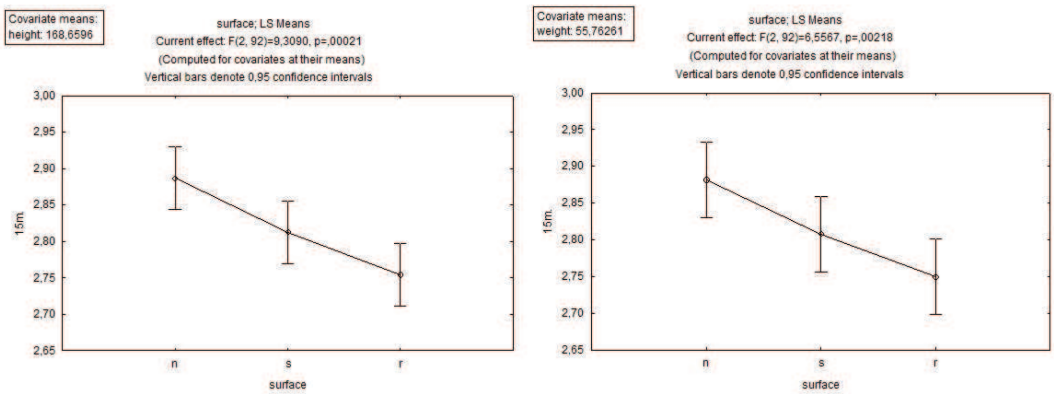

Figure 3. The influence of the running surface on the time results from the 15 m run with reference to the body height and weight of soccer players

As in the 15 m run results, the body height and weight variables significantly influenced the time results of the 30 m run. Moreover, these analyses clearly indicated the significant influence of the rubber surface on the running time of the football players (Figure 4).

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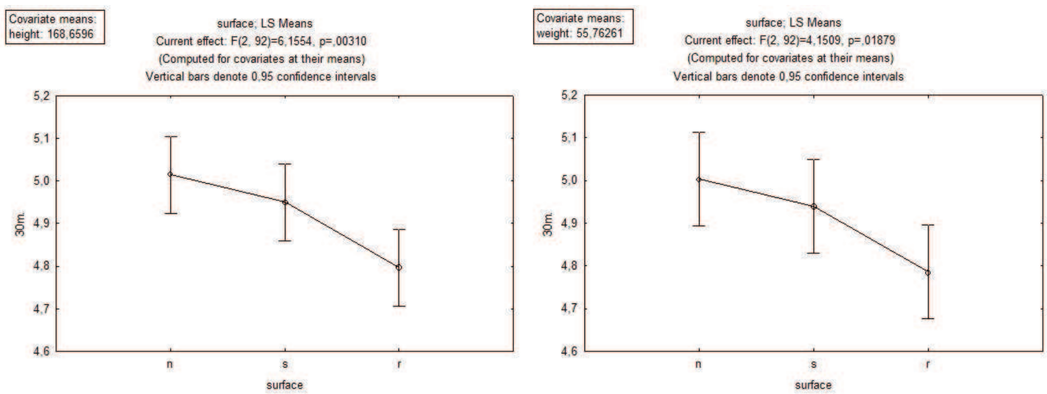

Figure 4. The influence of the running surface on time results for the 30 m run with reference to the body height and weight of soccer players

Discussion

The analyses showed that the times for the 10 m run with run-up and the 15 m run for the football players on the rubber surface in the hall were significantly shorter than those on the football pitch with natural grass. The results from the running tests on a synthetic surface revealed no significant differences from the others, except for the 30 m trial. For this distance, the players achieved significantly shorter time results on the rubber surface than on the other two surfaces. A covariance analysis including age, body height, and mass statistically demonstrated the influence of the type of surface on the running time results obtained for different distances among young football players. Therefore, the assumption made at the beginning of the experiment was proven. Nevertheless, the statistical post hoc analysis revealed no significant influence of the type of surface on the time results for the 5 m stat. and dyn. or 10 m stat. runs, regardless of the age category. In our opinion, this finding could be caused by the lower amount of total friction that the players had to overcome during the trial. Moreover, because of the age of the subjects, the players experienced intensified dynamic strength development. Therefore, this aspect of the motor fitness of the players could have been a factor in our research. Considering all these results, what are the factors with the most influence on the time differences for runs performed for distances longer than 5 m and on different surfaces?

Zanetti (2009) studied the influence of synthetic surfaces on football players' motor perception and found that this type of surface was the preferred surface for the subjects. This choice may result from the elimination of (or the limiting of) the influence of weather conditions on the training quality. Synthetic surfaces always provide the same hardness and height and quality of grass, regardless of rain or temperature (low or high). However, these factors significantly change the training conditions on natural grass. The features of the latest generation of synthetic surfaces are qualitatively similar to those of natural grass. This similarity was confirmed by Gains et al. (2010) who tested amateur football players on natural and synthetic surfaces and claimed that the 40-yard run time results showed no significant differences. The results of Muller et al. (2010) and Anderson et al. (2008) from professional football players were consistent with the above. Furthermore, these researchers proved that the type and quality of the soles of the footwear that was used had the greatest influence on the running speed of the players. The research of other authors is consistent with our experimental results, suggesting that natural and synthetic surfaces provide comparable experiences during running speed tests. Therefore, the test results can be compared, as long as the weather conditions or the quality of the natural surface on the field do not distort the test results (Stiles et al. 2009). Given these conditions, why were our results for the tests performed on the rubber surface significantly better? In our opinion, this improvement occurred because the players had a lower amount of friction to overcome when performing on a smooth surface with no grass. Moreover, the hardness of the rubber surface caused no "sinking" into the ground effect, which diminishes the energetic cost of the effort. The indoor sports hall also eliminated the effect of air movement and other weather factors. Considering all these interfering variables, the longer distance a player covers, the more likely it is that the importance of the type of running surface will be noticed. In addition, the rubber surface diminishes the negative effects of changeable factors on the reliability of the tests and therefore, in our opinion, is recommended for control tests and especially for longitudinal tests.

Conclusion

The results that are presented in this article from studies of the influence of the surface on running speed in young football players are highly applicable. In coaching practice, there are many tests in which the dominant element is the running speed of the players. The tests often assess the general or specific fitness of the players during their performances in different directions. Therefore, the type of surface on which the players perform becomes even more important. We rejected the shuttle run during the initial stage of analyses because the shuttle run had minimal diagnostic ability for assessing specific running speed (performed on different surfaces). Only the surface factor played a crucial role during the players' to and fro movements in different directions. Nevertheless, there is no other reason for rejecting this test. However, the test should be performed in the same manner as other running trials: in a straight line, on the same surface and wearing the same type of footwear. The rubber surface appears to be the best in this case, especially if the test results serve a practical purpose – precise load regulation.

Based on this study, it can be assumed that comparing the results of running speed tests performed on different surfaces and especially in different weather conditions is unjustified. Comparing results from different authors can only provide qualitative information and cannot serve as an assessment of training effects.

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