 Kinesiologia Slovenica, 23, 2, 22–32 (2017), ISSN 1318-2269

Saša Jakovljević[1]
Milivoje Karalejić[1]
Jelena Ivanović[1]
Erik Štrumbelj[2]
Frane Erčulj[3]

EFFICIENCY OF SPEED AND AGILTY DRIBBLING OF YOUNG BASKETBALL PLAYERS

UČINKOVITOST HITROSTI IN AGILNOSTI VODENJA ŽOGE PRI MLADIH KOŠARKARJIH

ABSTRACT

In the study we have measured and analyzed dribbling efficiency i.e. performance ratio (PR) of young basketball players. For this purpose five speed and agility tests (with and without the ball) were aplied on the group of 65 participants from two age groups (U16 and U18) and three players types groups (guards, forwards, centers). The results shows that guards performed the best in all tests with or without the ball, followed by forwards, while centers performed the worst. All player types achieve better results in tests without the ball, as dribbling the ball adds additional complexity to each test. The PR values are the smallest by the guards which means that basketball slow forwards and centers down more than guards. The older group players (U18) are on average better in all tests both with and without the ball. The PR is fairly consistent across all tests and there are no substantial differences between U18 and U16. We can conclude that ball dribbling has a substantial negative effect (slowdown) for speed and agility performance of heigher and less skilled players (forwards and especcilay centers), but not also for younger players.

Keywords: basketball, performance ratio, speed, agility

[1] University of Belgrade, Faculty for Sport and Physical Education, Blagoja Parovića Street 156, 11030 Belgrade, Serbia

[2] University of Ljubljana, Faculty of Computer and Information Science, Tržaška 25, 1000 Ljubljana, Slovenia

[3] University of Ljubljana, Faculty of Sport, Gortanova 22, 1000 Ljubljana, Slovenia

Corresponding author:
Frane Erčulj; University of Ljubljana, Faculty of Sport, Gortanova 22, 1000 Ljubljana, Slovenia; E-mail: frane.erculj@fsp.uni-lj.si;
Tel: + 386 1 520 77 66; Fax: + 386 1 520 77 40

IZVLEČEK

V raziskavi smo merili in analizirali učinkovitost vodenja žoge, t. j. količnik uspešnosti (PR), pri mladih košarkarjih. 65 udeležencev, ki so bili razdeljeni v dve starostni skupini (U16 in U18) in tri skupine glede na tip igralca (branilec, krilo, center), je opravilo pet testov hitrosti in agilnosti (z žogo in brez nje). Rezultati kažejo, da so se najbolje v vseh testih z žogo in brez nje izkazali branilci, sledila so jim krila, centri pa so imeli najslabše rezultate. Vsi tipi igralcev dosegajo boljše rezultate v testih brez žoge, saj vodenje žoge povečuje kompleksnost vseh testov. Vrednosti PR so najnižje pri branilcih, kar pomeni, da žoga krila in centre upočasnjuje bolj kot branilce. Starejša skupina igralcev (U18) je v povprečju boljša v vseh testih, tako z žogo kot brez nje. PR je približno enaka pri vseh testih, zato med U18 in U16 ni bistvenih razlik. Zaključimo lahko, da ima vodenje žoge močan negativni učinek (upočasnitev) na hitrost in agilnost višjih in manj izkušenih igralcev (krila in zlasti centri), vendar pa to ne velja za mlajše igralce.

Ključne besede: košarka, količnik uspešnosti, hitrost, agilnost

INTRODUCTION

Basketball is a fast and dynamic ball game characterised by short sprints, abrupt changes of direction and pace, sudden stops and accelerations, and requires quick reactions of the players. Successful and efficient execution of all these movements is enabled by a psycho-motor ability – speed (Erčulj, 2005).

Therefore speed and agility represent important efficiency factors in basketball (Abd Al Jabbar, 2015) and players who are not fast enough cannot succeed in modern top-level basketball. Players with well developed speed and agility are capable of executing the elements of the modern basketball technique and tactics more efficiently (Harley, Doust, & Mills, 2008). It is owing to the above and to hereditary determination that speed has become an important factor in all selection phases of basketball players, especially with young boys and girls.

Basketball movements are executed with and without the ball. The speed of running and executing other movement with and without the ball depends on the frequency of leg movement (movement of arms in ball dribbling), nerve–muscle co-ordination (quality technique) as well as rapid, explosive, and maximum power (Mero, Komi, & Gregor, 1992; Locatelli, Arsac 1995; Donatti, 1995).

Fast transitions of the ball from the defensive to offensive half of court (that is, fast-breaks), starts of dribbling, dribbling against the defender, penetrations, and other types of dribbling are movements that require highly developed speed and agility with ball. Getting open, cutting, fast running to defence or offence, covering offensive player are those movements in which speed and agility without the ball come to the foreground.

In terms of co-ordination and technique, movement with the ball is more demanding than movement without the ball. Fast movement with the ball requires a very good ball handling, that is, being able to control the ball at high speed. It may happen that a player who moves fast without the ball is much slower with the ball. This is particularly true for complex movements as well as for players with poor technique of movement with the ball (Zwierko, Lesiakowski, & Florkiewicz, 2005; Bogdanis, Ziagosa, Anastasiadis, & Maridaki, 2007).

The goal of this study was to measure and analyze elite U16 and U18 basketball players' speed-related motor skill test performance and the differences in performance with and withouth the ball. Therefore we want to calculate a dribbling efficiency, that is performance ratio, by dividing a subject's dribbling time to his movement time (without the ball) over the same course. Morrow, Jackons, Dish, & Mood (2005) were already trying to determine a dribbling efficiency with a performance ratio. They found it a very effective motivational tools for highly skilled but also less skilled performers (players). In their opinion players should reduce the ratio to as close to 1 as possible. But how close to 1? And how the performance ratio relates to different age groups, different player types (playing positions) and also to complexity of the task (movement) itself?

In basketball there are three main types of players. We generally separate them into guards, forwards, and centres, according to their playing tasks and the roles they have on the court and according to their playing position in the offense. Since the role of individual types of players in the game differs certain differences occur between them in their model dimensions (Trninić, & Dizdar, 2000; Dežman, Trninić, & Dizdar, 2001; Sampaio, Janeira, Ibáñez, & Lorenzo, 2006).

The differences are also pronounced in the peformance of speed and agility tests (Erčulj, Bračič, & Jakovljević, 2011; Erčulj, Blas, Čoh, & Bračič, 2009; Dežman et al., 2001).

Regarding to previous studies we already know that there are differences in speed and agility tests performance related to the basketball player's types (for both, movement tests and dribbling tests). We also know that dribbling time is usually longer than movement time. In the study we want to find out if this is the same with every types of players (playing positions)? Ball dribbling is primary task of guards (Trninić, & Dizdar, 2000; Trninić, Karalejić, Jakovljević, & Jelaska, 2010). Therefore, the aim of the study is to find out whether ball dribbling slows down the movement of forwards and centres more than that of guards. In our opinion, at the level of the top young basketball players of this age, such differences between individual player types should not be large since ball dribbling is considered to be the basic technical element of basketball play. Training of ball dribbling in young age categories should receive a lot of attention and time, regardless of player type. Moreover, playing roles and player types are not finally determined in young basketball players (especially in the U16 category), which is why their training should be universal, particularly regarding such an important and fundamental element of basketball play, i.e. ball dribbling.

We assume that younger players are less experienced and they are not so skilled in ball dribbling than older players. Therefore our expectation is that basketball slow cadet (under 16) players more than junior (under 18) players. We also expect that differences between different age groups and player types are bigger with more complex tasks and the performance ratio is getting closer to 1 with complexity of the task.

MATERIALS AND METHODS

Subjects

The total numbar of participants was 65, of which 36 were from the U18 group (18 guards, 13 forwards, 5 centers) and 29 from the U16 group (15 guards, 11 forwards, 3 centers). Therefore, both age groups were very similar in terms of the relative frequency of different player types, which simplifies direct comparison. All participants have been pre-selected either in the U18 or U16 national team of Serbia so they represent the best and most talented players in the country. Both teams took the bronze medal at the European Championship 2012, so they were among the best European national teams. Therefore we can consider the participants as elite players for their age. The measurement took place in July 2012 as a part of development programme of the most talented young players in Serbia. The subjects provided their written consent and participated voluntarily in the measurements that had been approved by the Ethical Committee of Faculty of Sport and Physical Education, University of Belgrade.

For each player, we recorded his height, body mass, and age. The mean values were (198.6, s = 7.3 cm; 87.5, s = 11.4 kg; 17.4, s = 0.6 years) and (194.8, s = 7.6 cm; 80.9, s = 10.0 kg; 15.5, s = 0.6 years) for U18 and U16, respectively. Furthermore, each player was tested in several speed and agility tests, both with and without the ball.

Procedures

Speed and agility tests, also called total body movement tests, assess the speed at which a performer completes a task that involves movement of the whole body in a restricted area. These tests can be administarted quickly and they usually have a high degree of reliability (Morrow et al., 2005).

Five different speed and agility tests were used in the study: 5-meter (5M), 20-meter (20M), cross-over (CO), control movement (CM), and suicide run (SR). Each test was performed both with the ball (dribbling) and without it (just running). These test represent a most common ways of movement in basketball: accelerations, short sprints, changing directions, and slalom sprint.. All tests were conducted on a marked track in a basketball court, with photocells-based time measurements (Micro Gate, Italy). All measurements were made at hundreds-of-a-second precision.

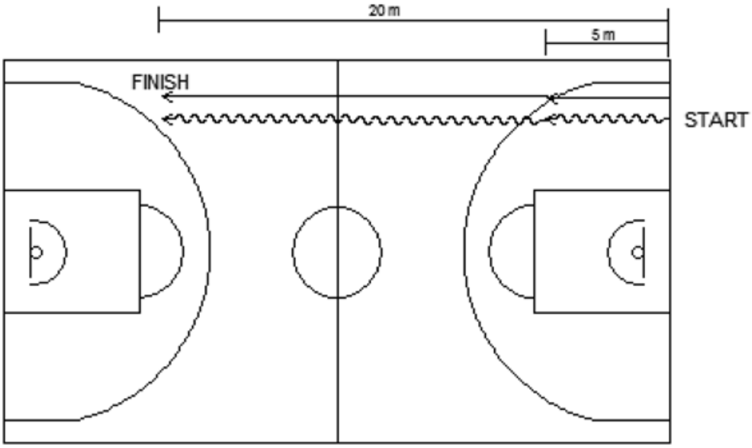

Figure 1. Illustration of the 5m and 20m run/dribble tests.

The 5-meter and 20-meter tests were conducted on a marked track in a basketball court, with photocells positioned at 5 and 20 meters from the starting line and at 1-meter height (see Figure 1). The participants started from a standing position with a foot sticking out at a distance of 70 cm from the first photocell and were instructed to run (or dribble) as fast as they could.

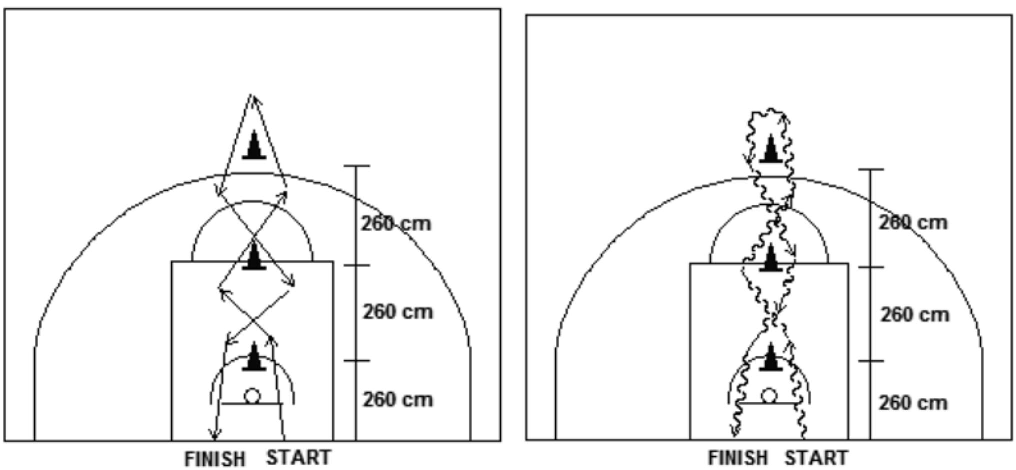

Figure 2. Illustration of the run/dribble cross-over tests.

The participant starts the cross-over sprint in triple threat position behind the baseline of the basketball court. Ont the measurers signal, the player starts running (dribbling) as fast as possible. He runs (dribbles) between the cones as shown in Figure 2. When dribbling, the participant has to switch the ball-handling hand.

The control movement test is performed on a marked track in a basketball court. When signaled, the participant starts to run (dribble) around the cones as fast as possible, as shown in Figure 3.

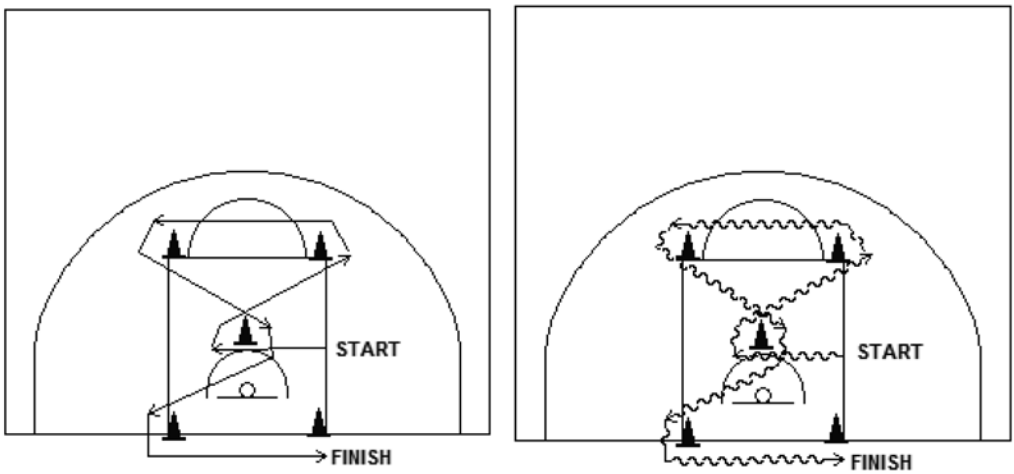

Figure 3. Illustration of the run/dribble control movement tests.

In the suicide test the participant starts in the triple-threat position behind the baseline of the basketball court. At the measurers signal, the participant starts running (dribbling), as fast as possible, and changes direction as shown in Figure 4. He sprints to the free-throw line first, then to the mid-court line and finaly to the free-throw line again. Before every change of direction, he must step on the line with one foot. After changing direction, he must also change the dribbling hand.

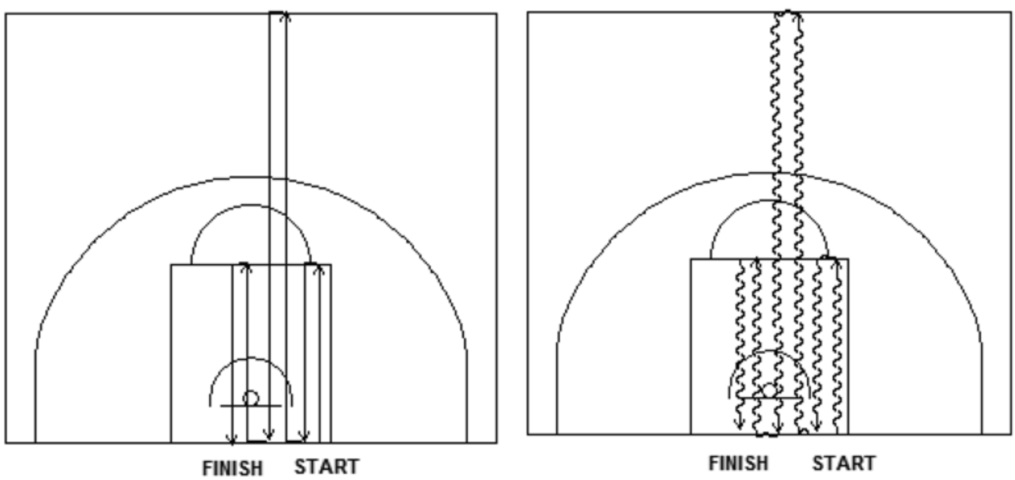

Figure 4. Illustration of the run/dribble suicide test.

A summary of the measurements is shown in Table 1. Note that for the 5-meter, 20-meter, cross-over, and suicide tests, each participant had 2 attempts both with and without the ball (one after the other) and the better time was recorded. Unlike the other tests, each participant performed the control movement test 3 times with and without the ball and the first time was discarded. More information on the 5-meter, 20-meter, cross-over, and suicide test are given in Lehman (1981) and Abd Al Jabar (2015). More information about the control movement test can be found in AAHPERD (1984) and Jakovljević, Karalejić, Pajić, Macura, & Erčulj, 2012.

Table 1. A summary of the measurements (means and standard deviations) by age group. The '-d' suffix indicated results with the ball (dribbling)

	m_{U18}	s_{U18}	m_{U16}	s_{U16}
5M	2.02	0.1	2.07	0.11
5M-d	2.1	0.13	2.17	0.14
20M	3.04	0.15	3.12	0.15
20M-d	3.16	0.2	3.23	0.16
CO	4.19	0.23	4.22	0.29
CO-d	4.32	0.28	4.28	0.2
SR	11.99	0.61	12.6	0.6
SR-d	12.53	0.63	13.43	0.85
CD1	6.32	0.38	6.48	0.39
CD1-d	6.59	0.53	6.81	0.54
CD2	6.26	0.39	6.5	0.43
CD2-d	6.51	0.48	6.76	0.51

Statistical analysis

The questions of interest revolve around comparing measurements (times or performance ratios) across two or more groups. In order to test our hypoteses, we used two types of analyses. First, estimating the mean for each group. And second, estimating the difference between two groups, in particular, the probability that one group has a higher/lower mean than the other.

In such a setting, a classical t-test is typically used (or ANOVA, if there are more than two groups). However, these approaches are limited to testing against and rejecting the null model, but not estimating the effects size. Instead, we approach hypothesis testing with parameter estimation, using a hierarchical Bayesian model. This simplified the probabilistic interpretation of the results and partially mitigated the problem of multiple hypothesis testing.

While the number of groups varied (U16 against U18, between player types, with aganst without the ball) all the results were obtained using the following statistical model:

Let the data contain k>0 groups and let $y_{i,1},\ldots,y_{i,n(i)}$ represent the n(i) measurements from the i-th group. We assume that data from a group are drawn from a normal distribution with a group-specific mean parameter μ_i and a common variance parameter σ^2:

$$y_{i,1},\ldots,y_{i,n(i)} \mid \mu_i, \sigma^2 \sim_{iid} N(\mu_i, \sigma^2), \; i = 1..k$$

The group means were given a common second-level distribution prior

$$\mu_1, \mu_2, \ldots, \mu_k \mid \mu_0, \sigma_0^2 \sim_{iid} N(\mu_0, \sigma_0^2)$$

and the following hyper-priors

$$\mu_0 \sim N(m_0, s_0),$$
$$\sigma^2 \sim Gamma(a_0, b_0),$$
$$\sigma_0^2 \sim Gamma(a_0, b_0).$$

Estimates of differences between groups and probabilistic statements of interest, in particular, if some group A has a higher mean that another group B, can be obtained directly from the model. That is, $P(\mu_A > \mu_B) = P(\mu_A - \mu_B > 0)$ can be obtained directly from the cumulative normal distribution.

Inference from the above statistical model was performed usin a MCMC (Markov Chain Monte Carlo) approach. The prior parameters were set to weakly-informative values $a_0=b_0=0.0001$, $m_0=0$, $s_0 = 100$. The number of sampling iterations was 10.000 for all experiments and all sampling Standard Errors were estimated to be below 0.001.

Statistical analyses were performed using the R programming language (R Core Team, 2014), we used the Stan language for Bayesian (MCMC) inference (Stan development team, 2015), and the ggplot2 package for visualization (Wickham, 2009).

RESULTS

U16 and U18

Figure 5 shows a comparison of the U16 and U18 estimates. For all tests and both groups the estimated mean times with the ball are higher than without the ball. Furtheromre, the U18 group is, on average, faster than the U17 group with high posterior probability for all tests, with the exception is if the CO test, where the differences are too small for us to conclude with a reasonably high probability, that the U18 group is, on average, faster.

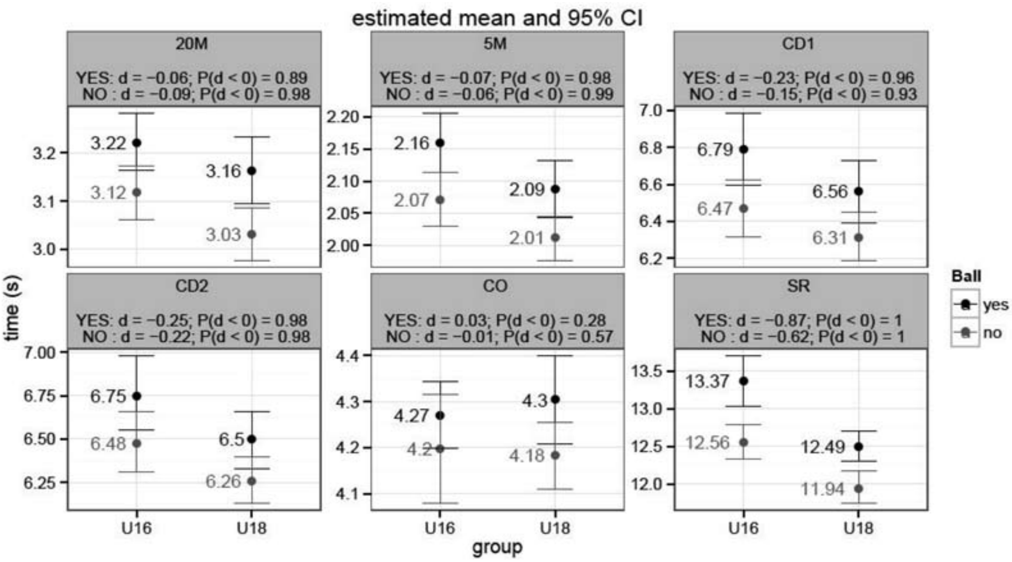

Figure 5. The estimated mean times for all four combinations of the two age groups (U16/U18, left/right) and two types of tests (with/without ball, black/gray). The whiskers represent the 95% posterior confidence interval for the estimate. Also included are the estimated posterior probabilites of a negative mean difference in time between the U18 and U16 groups, for with (YES) and without (NO) the ball separately.

The performance ratios for the U16 and U18 groups are very similar and we can not conclude with high probability that there are any differences (see Figure 6). Furthermore, the PR are similar across all types of tests.

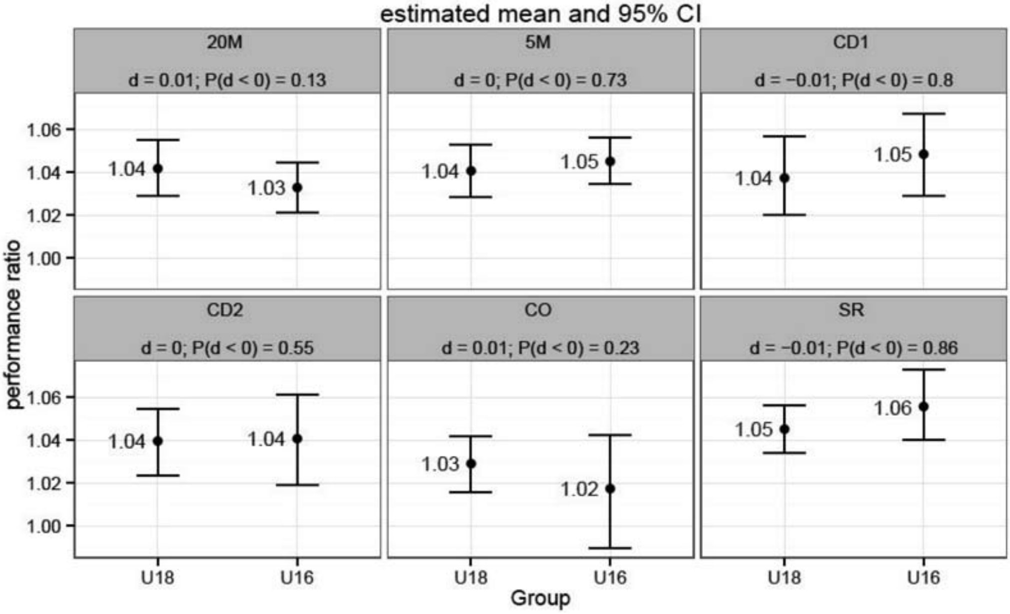

Figure 6. The estimated performance ratio (PR) for U18 and U16 separately. The whiskers represent the 95% posterior confidence interval for the estimate. Also included are the estimated posterior probabilities of U18 having a lower value of PR.

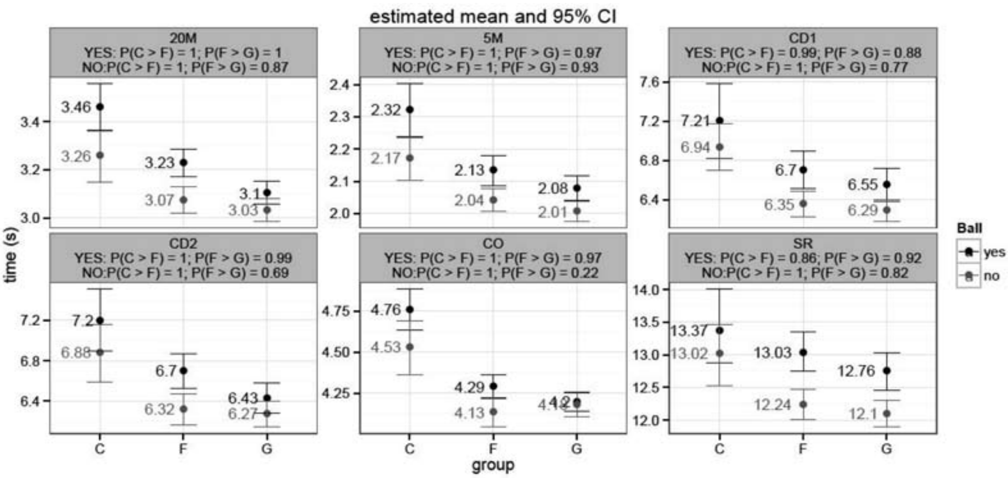

Figure 7. The estimated mean times for all six combinations of the three player types (Centers, Forwards, Guards) and two types of tests (with/without ball, black/gray). The whiskers represent the 95% posterior confidence interval for the estimate. Also included are the estimated posterior probabilites of a negative mean difference in time between Forwards and Centers (C > F) and Forwards and Guards (F > G), for with (YES) and without (NO) the ball separately.

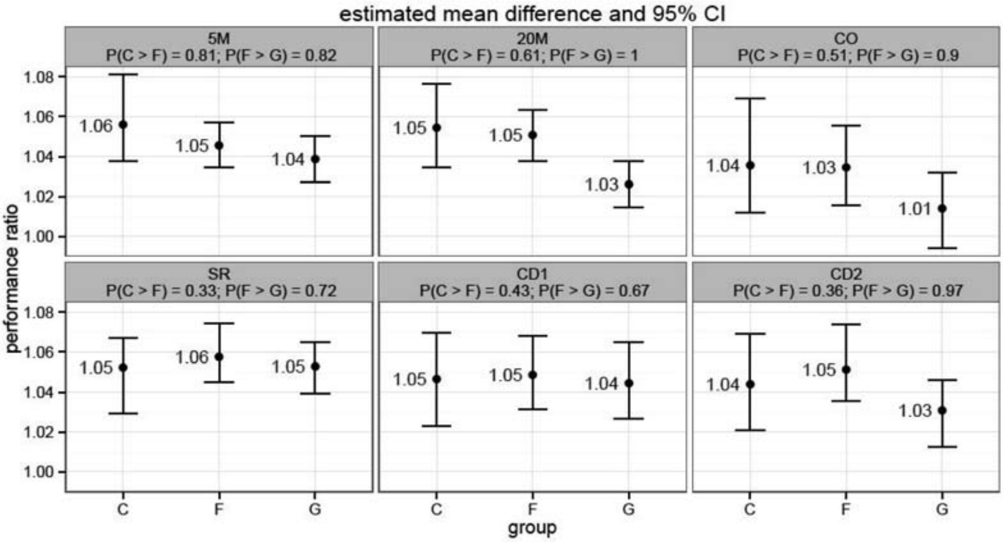

Figure 8. The estimated performance ratio (PR) for Centers, Forwards, and Guards. The whiskers represent the 95% posterior confidence interval for the estimate. Also included are the estimated posterior probabilities of Guards having a lower value of PR than Forwards and Forwards having a lower value of PR than Centers.

Guards, Forwards, and Centers

Figure 7 shows a comparison of the three player types. On average, Centers are have higher mean times than Forwards who have in turn higher mean times than Guards. This holds for both the with the ball and without the ball variants of every test. Only for the CO test we can not conclude with high probability that Forwards are slower than Guards. Similar to U16 and U18, adding the ball to the test slows down, on average, all player types on all tests.

The performance ratios of the three players types are also similar and similar across all types of tests (see Figure 8). We can, however, conclude, with high probability, that Guards have a better (lower) PR than Forwards (and therefore Centers) for the 20M, CO and one of the CD tests.

DISCUSSION AND CONCLUSIONS

Guards performed the best in all tests with or without the ball, followed by forwards, while centers performed the worst. These result are in line with expectations and results from related work (Erčulj et al., 2011; Erčulj et al., 2009). Shorter players, typically guards, achieve a higher level of speed and agility, compared to taller players, typically forwards or centers. In part, this can also be attributed to the guards playing role, which requires of them fast accelleration and changes of direction, as these are key to actions such as cutting, dribbling, fast breaks, etc... On the other hand, centers and, to a lesser extent, forwards, do not participate in fast breaks and dribble the ball less often (Trninić, & Dizdar, 2000; Dežman et al., 2001), so these elements are also not emphasized in the training process. However, in general, it is difficult to establish how much of the guards superior speed and agility is due to training and how much of it is due to the selection process.

All player types achieve better results in tests without the ball, which was expected, as dribbling the ball adds additional complexity to each test. Also expected is that the performance ratio, how much adding driblling affects performance, is, on average, the smallest in guards, and slightly higher in forwards and centers. The smallest performance ratios were achieved by guards in the cross-over test, which is not surprising, as it is a very demanding test in terms of coordination. For all the other tests, the performance ratios are very similar and lie around 1.03-1.04.

The older group (U18) are on average better in all tests both with and without the ball. This can be attributed to two years of physical and motor skill developement as well as two more years of training, compared to the younger group (U16). An interesting question and path for potential further work is if this developement of agility and dribbling skills continues beyond 18 years and when does it slow down and cease. Relatively, however, the PR is fairly consistent across all tests and there are no substantial differences between U18 and U16, with the exception of the cross-over test. For this test, both age groups had the best PR and also the smallest difference between the two groups. Therefore, the addition of dribbling least effects the test that is based predominately on movement with directional changes. This kind of movement is key in basketball and a lot of emphasis is put on it in the training process, which could explain these results. This result also suggests that most of the adverse effects of dribbling the ball on execution times can be mitigated with training.

According to the results we can conclude that ball dribbling has a substantial negative effect (slowdown) for speed and agility performance of higher basketball players playing at forward's and center's positions, but not also for younger and less trained players as we have assumed prior the study. As the ability for fast and agile ball dribbling is also an important performance factor in basketball among tall basketball players (Zwierko, Lesiakowski, & Florkiewicz, 2005), we believe that more attention should be given in their training process to ball dribbling so they can achieve the ball-dribbling efficacy of guards as much as possible. This applies to tall players in all analysed age categories (U16 and U18). In this age category, coaches should dedicate more time to the basketball game basics, including training in ball dribbling. Namely, in our opinion coaches in this age category are too focused on special elements of the game and the technique of tall players and often forget the basics of basketball.

We assume that ball-dribbling effectiveness would be even worse in less successful players than those analysed in our study. As part of further work, this could be confirmed by repeating the analysis on a set of less well-trained non-elite players.

REFERENCES

Abd Al Jabar, S.M. (2015). Dribbling Skill of Junior Basketballers. *The Swedish Journal of Scientific Research, 2*(2), 23-26.

AAHPERD - American Alliance for Health, Physical Education, Recreation and Dance (1984). Basketball for boys and girls: skill test manual. Reston, VA: American Alliance for Health, Physical Education, Recreation and Dance.

Bogdanis, G.C., Ziagosa, V., Anastasiadis, M., & Maridaki, M. (2007). Effects of two different short-term training programs on the physical and technical abilities of adolescent basketball players. *Journal of Science and Medicine in Sport, 10*(2), 79-88.

Dežman, B., Trninić, S., & Dizdar, D. (2001). Expert model of decision-making system for efficient orientation of basketball players to positions and roles in the game - empirical verification. *Collegium Antropologicum, 25*(1), 141-152.

Donatti, A. (1995). The development of stride length and frequency in sprinting. *New Studies in Atletics, 1,* 51-56.

Erčulj, F. (2005). Correlation between various types of speed in 17 years old basketball players. In: D. Milanović & F. Prot (Eds.), *4th International Scientific Conference on Kinesiology "Science and Profession - Challenge for the Future" (pp. 378-381).* Zagreb: Faculty of kinesiology, Univesity of Zagreb.

Erčulj, F., Blas, M., Čoh, M., & Bračič, M. (2009). Differences in motor abilities of various types of European young elite female basketball players. *Kinesiology, 41*(2), 203-211.

Erčulj, F, Bračič, M, & Jakovljević, S. (2011). The level of speed and agility of different types of elite female basketball players. *Facta Universitatis Series: Physical Education and Sport, 9*(3), 283–293.

Harley, R.A, Doust, J., & Mills, S.H. (2008). Basketball. In: Winter et all (eds) *Sport and Exercise Physiology Testing Guidelines Volume I: Sport Testing* (pp. 232-240). London: Routledge.

Jakovljević, S., Karalejić, M., Pajić, Z., Macura, M., & Erčulj, F. (2012). Speed and agility of 12- and 14-year-old elite male basketball players. *Journal of strength and conditioning research, 26*(9), 2453-2459.

Lehman, G. (1981). *Basketball is my game, Lessons by Lehman. Riverside,* New York: Pro Kids.

Locatelli, E., & Arsac, L. (1995). The mechanics and energetics of the 100m sprint. *New Studies in Atletics, 1,* 81-87.

Mero, A., Komi, P.V., & Gregor, R.J. (1992). Biomechanics of Sprint Running. *Sport Medicine, 13,* 376-392.

Morrow, J.R., Jackons, A.W., Dish, J.G., & Mood, D.P. (2005). *Measurement and Evaluation in Human Performance (pp.*319). Champaign, IL: Human Kinetics.

R Core Team (2015). A Language and Environment for Statistical Computing, Foundation for Statistical Computing. Retrieved May 2nd, 2015 from: http://www.R-project.org/

Sampaio, J., Janeira, M., Ibáñez, S., & Lorenzo, A. (2006). Discriminant analysis of game-related statistics between basketball guards, forwards and centres in three professional leagues. *European Journal of Sport Science, 6* 3), 173–178.

Stan Development Team (2015). *RStan: the R interface to Stan, Version 2.7.0.* Retrieved May 5th, 2015 from: http://mc-stan.org/rstan.html

Trninić, S., & Dizdar, D. (2000). System of the performance evaluation criteria weighted per positions in the basketball game. *Collegium Antropologicum, 24*(1), 217–234.

Trninić, S., Karalejić, M., Jakovljević, S., & Jelaska, I. (2010). Structural Analysis of Knowledge Based on Principal Attributes of the Game of Basketball. *Physical culture, 64*(1), 5-25.

Wickham, H. (2009). *Ggplot2: elegant graphics for data analysis.* New York: Springer.

Zwierko, T., Lesiakowski, P., & Florkiewicz, B. (2005). Selected Aspects Of Motor Coordination In Young Basketball Players. *Human Movement, 6*(2), 124-128.