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José L. Arias , Francisco M. Argudo & José I. Alonso

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Effect of Ball Mass on Dribble, Pass, and Pass Reception in 9–11-Year-Old Boys' Basketball

José L. Arias, Francisco M. Argudo, and José I. Alonso

The objective of the study was to analyze the effect of ball mass on dribble, pass, and pass reception in real game situations in 9–11-year-old boys' basketball. Participants were 54 boys identified from six federated teams. The independent variable was ball mass, and dependent variables were number of dribbles, passes, and pass receptions. Three situations were established in which the participants played four games with each of the following: (a) regulation ball (485 g, 69–71 cm), (b) ball of smaller mass (440 g, 69–71 cm), and (c) ball of greater mass (540 g, 69–71 cm). Four observers recorded data from observing game videos using a computerized register instrument. Participants executed more dribbles, passes, and pass receptions with the 440-g ball when compared to the regulation ($p < .05$) and 540-g ball ($p < .01$). Reduction of ball mass seems to have enabled the children to go from paying attention to aspects related to ball handling to aspects of game interpretation.

Key words: children, physical education, rule modification, team sport

Children normally lack the strength and physical characteristics required to use the equipment used in adult sports. Various studies proposed game modifications as a strategy to adapt the game to children's interests, possibilities, and needs (Evans, 1980; Kirk, 2004). Studies of basketball support use of basketball equipment suitable for children's physical characteristics and training needs (Chase, Ewing, Lirgg, & George, 1994; Regimbal, Deller, & Plimpton, 1992; Satern, Messier, & Keller-McNulty, 1989). The problem is that most studies analyzed equipment modifications with tests and in conditions dissimilar from those in a real basketball game.

The internal logic of a game, that is, the dynamic relations established between structural elements and players, is defined by rules (Parlebas, 1999) that determine participant relationships in game action, with: (a) other participants, (b) game space, (c) equipment, and (d) the mode in which they adjust to game time. When changing a rule, such as the size of the game ball, game actions may change. Such a change requires that studies be conducted to analyze subsequent game action. Changes during game play can be seen in game actions as visible results of internal logic. Game action is expressed through motor behaviors that can be objectively observed.

The ball is an important piece of equipment that mediates confrontation in team sports (i.e., the ball determines the attacking or defending team). The literature on motor learning and development recommends using a ball with a smaller circumference (63.83 cm) when learning to dribble (Burton & Welch, 1990). An increase in circumference tends to make throwing more difficult (Burton, Greer, & Wiese, 1992). However, there is no agreement about what kind of ball would facilitate pass reception (Evans, 1980; Isaacs, 1980; Koslow, 1985; Payne, 1985).

In a literature review, we found several studies of youth basketball that analyzed the effect of ball dimensions through shooting tests. These studies indicated that a ball of smaller dimensions (496–538.65 g and 70.8–73

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José L. Arias is with the Department of Physical Activity and Sport Sciences at the Catholic University of San Antonio. Francisco M. Argudo is with the Department of Physical Education, Sport, and Human Movement at the Autonomous University of Madrid. José I. Alonso is with the Department of Plastic, Musical, and Dynamic Expression at the University of Murcia.

cm) allowed for better shot technique (Regimbal et al., 1992) or did not impair it (Satern et al., 1989), satisfied children's preferences (Regimbal et al., 1992), increased their levels of perceived self-efficacy (Chase et al., 1994), and increased shot effectiveness (Isaacs & Karpman, 1981; Regimbal et al., 1992) or did not impair it (Chase et al., 1994; Satern et al., 1989).

Piñar (2005) and Arias, Argudo, and Alonso (2009) conducted two studies on youth basketball games. One of Piñar's objectives was to increase the frequency of passes per ball possession. Piñar modified: (a) court size, (b) free-throw line, (c) three-point line, (d) game duration, and (e) number of players. There were no differences in the average number of passes after introducing the modifications (0–2 passes: 86.8% vs. 87.1%; 3–5 passes: 12.3% vs. 12.2%; 6–8 passes: 0.8% vs. 0.6%; 9–11 passes: 0.1% vs. 0%). Arias et al. (2009) compared the effect of two shapes of the three-point line on game dynamics and the number of passes, among other variables. The results showed an increase in the number of passes with the three-point line delimited by the area of the free throw lane (M = 1.29, SD = 1.26 vs. M = 1.14, SD = 1.16, respectively). Recent studies analyzing the effect of ball modification on several game situations showed contradictory results (Arias, Argudo, & alonso, 2011, 2012a, 2012b).

In 1996, the American Sport Education Program (ASEP) suggested that changes needed to be made in youth basketball rules to decrease dribbling and increase passes and pass reception. Dribbling, passing, and pass reception are motor skills that facilitate the quality of shots under the best conditions (ASEP, 1996; Sampaio, Ibáñez, & Feu, 2004). Game styles in which passing and pass reception predominate over dribbling were recommended to break up game rhythm, generate imbalances in the defense, and increase shot attempts (ASEP, 1996; Chamness, 2000; Grawer & Rains, 2003; Hanlon, 2005; Ortega, Cárdenas, Sainz de Baranda, & Palao, 2006). The predominance of passes and pass reception over dribbling allows for an increase in game speed and in throwing the defense off balance (e.g., the defense does not focus its attention on only one player, and the actions of the team on offense are less predictable).

When passes and pass reception predominate over dribbling, players have more opportunities to practice and enjoy the game experience (ASEP, 1996; Arias et al., 2009; Chamness, 2000; Grawer & Rains, 2003; Hanlon, 2005; Ortega et al., 2006; Piñar, 2005). Quantity and variability of practice are necessary variables in children's formative process (Memmert & Harvey, 2008; Schmidt & Lee, 2005; Thomas, 1994). According to Piñar, Cárdenas, Conde, Alarcón, and Torre (2007), children have more fun and feel better when they have more opportunities to practice motor skills.

In our literature review, we found no study that analyzed the effect of ball mass decrease and/or increase on dribbling, passes, and pass reception in a real-game context. These motor skills are open in team sports; thus, analyzing these skills during the game can provide valuable information (Chen, Rovegno, Todorovich, & Babiarz, 2003). According to the literature, the ball with the least mass facilitates ball handling (Burton et al., 1992; Burton & Welch, 1990; Pellett, Henschel-Pellett, & Harrison, 1994).

The objective of this study was to analyze the effect of ball mass on dribble, pass, and pass reception in 9–11-year-old boys' basketball. Our hypothesis was that the average number of dribbles, passes, and pass receptions would increase with a ball of lesser mass and decrease with a ball of greater mass.

Method

Participants

Participants included 64 children ages 9–11 years (M age = 10.88 years, SD = 0.43) from six official, federated basketball teams that played regionally in Spain. Prior to this study, the children had played on these teams for 3.57 years (SD = 0.51). Inclusion criteria for team selection in the current study required that: (a) teams participate in all scheduled games, and (b) the same children participate in all games. Eight coaches selected participants among the highest performing players in the league based on age, previous experience, and game level. Each week, participants practiced an average of 2.52 days (SD = 0.75) for a total average of 6.03 hr (SD = 0.60) per week. Participants' parents and the coaches completed informed consent forms, and participants provided assent. The university's Research Ethics Committee approved the study.

Research Design

We established three game situations in which the participating teams played with three balls that differed only in mass: (a) four games with the regulation ball (485 g, 69–71 cm), (b) four games with a ball of smaller mass (440 g, 69–71 cm), and (c) four games with a ball of greater mass (540 g, 69–71 cm). We organized a 3-day tournament consisting of 12 games in which six teams were randomly matched. Each day, the teams played one or two games. The ball used for each game was also randomly chosen. Each team played a minimum of one game and a maximum of two games with each ball. In 12 games, participants achieved 1,858 ball possessions, of which 630 occurred during 4 games played with the regulation ball, 581 in 4 games played with a ball of smaller mass, and 647 in 4 games played with a ball of greater mass.

We selected ball mass according to proposed sizes in studies on ball modification. For the smaller mass ball, we chose one close in size to the 467.76-g ball proposed by

Satern et al. (1989). For the greater mass ball, we chose a size between the 538.65-g ball Chase et al. (1994) proposed and the 552.8-g ball Isaacs and Karpman (1981), Regimbal et al. (1992), and Satern et al. (1989) proposed.

One month before the tournament, the first author informed the coaches that the teams would play in a tournament in which: (a) teams would use balls the organizing committee provided, (b) games would be previously determined, (c) all participants would receive a diploma, and (d) the coaches would have to adhere to team inclusion criteria as well as the requisites of intersessional consistency. These requirements for all games were that: (a) the same participants played in each game; (b) they played all games on identical courts (28 x 15 m); (c) the rest time between games was at least 1 hr; (d) each game consisted of four 10-min periods; (e) participants warmed up with a ball similar in mass to the game ball; (f) man-to-man defense was mandatory; (g) the height of the basket was 2.60 m; and (h) balls were the same with regard to texture, color, circumference; and bounce height.

Procedure

Definition of Variables. Six experts (three researchers specialized in basketball and three coaches with experience coaching 9–11-year-old basketball players) delimited and defined the following variables when the team had possession of the ball:

1. The number of dribbles executed, defined as pushing the ball toward the floor so that it returned to the same player (Broderick & Newell, 1999; Chen et al., 2003).
2. The number of passes a team executed, defined as throwing the ball toward a player, between the player's waist and top of the head, with the strength necessary for the teammate to receive it (MacPhail, Kirk, & Griffin, 2008; Rovegno, Nevett, Brock, & Babiarz, 2001; Strohmeyer, Williams, & Schaub-George, 1991).
3. The number of pass receptions by a team, defined as the action of catching the ball from a teammate's pass (MacPhail et al., 2008; Rovegno et al., 2001; Strohmeyer et al., 1991).

Observer Training and Reliability. Five observers were trained until they accumulated a minimum of 30 hr of experience. Intra- and interobserver reliability were calculated through intraclass correlation coefficients. Intraobserver reliability reached values between .94 and 1, and interobserver reliability reached values between .97 and 1.

Monitoring Ball Properties and Recording Games. In accordance with Crisco, Drewniak, Alvarez, and Spenciner (2005), Isaacs and Karpman (1981), and Mathes and Flatten (1982) as well as basketball regulations, the ball properties monitored were: (a) mass, (b) circumference, and (c) bounce height. Three researchers monitored these properties .5 hr before and after each game and followed a protocol adapted by Crisco et al. (2005), which consisted of taking three measurements of each property and calculating the mean. A scale (PCE-LS 3000, PCE Group Ibérica S.L., Spain) was used to monitor mass based on the ball size we had selected. A meter tape (Lufkin Industries, Lufkin, TX) was used to measure ball circumference, which had to be 69–71 cm. For bounce, the ball was dropped from a height of 1.80 m and the height it reached after bouncing was measured (Hamilton & Reinschmidt, 1997; Huston & Grau, 2003). Measurements were calculated by recording the heights and extrapolating them through the calibration mark. For this purpose, a video camera (Everio Full HD-GZ-HD7, JVC, Japan) connected to the computer (Acer Aspire 3630, Acer Inc., Taiwan), was used and the image was passed to the Virtual Dub 1.6.15 program. Dribble height had to be between 1.20 and 1.40 m (Hamilton & Reinschmidt, 1997).

Two individuals video-recorded the games. The camera was situated transversely to the basketball court on the opposite side from the scoring table. It was placed 5 m off the ground and 2 m from the sideline, focused on the center of the court and with the open field to record the greatest possible space. The camera rotated on a tripod axis. As a rule, the recording included the player with the ball, the court, and the basket, in addition to the remaining players.

Data Recording of Observations. Five observers used a systematized register to record data from the game videos (Anguera, 2003). This technique consisted of indicating the number of times each variable appeared per ball possession (Anguera, 2003). The unit of analysis was ball possession. The observers viewed each ball possession three times at real speed to increase observation reliability. If necessary, they observed each possession at a speed of 25 frames/s. Each observer registered three games and recorded the corresponding number for each variable.

Statistical Analysis

Statistical analysis of the data was conducted using SPSS v. 17.0 for Windows (SPSS, Inc., Chicago, IL). We developed descriptive analyses for each variable through means, standard deviations, total number of game actions analyzed, and the minimum and maximum value in each ball possession. Mean values were calculated from the number of occurrences of each variable (i.e., in each ball possession). We determined the normality of the data through the Kolmogorov-Smirnov test and determined the data were nonparametric. We used Kruskal Wallis H to assess any differences between variables. Then, we performed post hoc comparisons using Mann-Whitney's U test to determine where these differences occurred. Statistical significance was set at $p < .05$.

Results

As shown in Table 1, there were statistically significant differences for the number of dribbles, $\chi^2(2, N = 1{,}858) = 9.670$, $p = .008$, passes, $\chi^2(2, N = 1{,}858) = 10.656$, $p = .005$, and pass receptions, $\chi^2(2, N = 1{,}858) = 10.909$, $p = .004$. Participants performed 0.42 more dribbles ($U = 176899.5$, $Z = -1.789$, $p = .05$), 0.14 more passes ($U = 173224$, $Z = -2.436$, $p = .015$), and 0.14 more pass receptions ($U = 172631$, $Z = -2.540$, $p = .011$) with the 440-g ball when compared to the regulation ball. They also executed 0.54 more dribbles ($U = 166956$, $Z = -2.652$, $p = .008$), 0.15 more passes ($U = 165238.5$, $Z = -3.003$, $p = .003$), and 0.15 more pass receptions ($U = 165221.5$, $Z = -3.014$, $p = .003$) with the 440-g ball compared to the 540-g ball.

Discussion

The objective of this study was to analyze the effect of ball mass on dribble, pass, and pass reception in 9–11-year-old boys' basketball. Results confirmed our hypothesis, as dribbles, passes, and pass receptions increased with the 440-g ball when compared to the regulation and the 540-g balls. This result seems to be in line with the studies we consulted about facilitating ball handling when decreasing ball mass (Burton & Welch, 1990; Pellett et al., 1994).

Chen et al. (2003) found that children handled the ball and pushed it with the pads of their fingers when they dribbled and walked or jogged with the ball. However, they had less control over the ball and hit it with the palms of their hands during more difficult dribbling tasks. The study by Chen et al. (2003) seems to confirm that a decrease in ball mass may contribute to facilitating game situations and increasing the number of dribbles.

Ortega et al. (2006) observed that losing teams spent more time dribbling. This meant that fewer players acquired the ball during possession and their plays were more predictable. Further, although all players know how to dribble, the quality and appropriateness of the dribble is deficient most of the time (ASEP, 1996; Chen et al., 2003).

In youth basketball, there is a tendency for players without the ball to move toward their teammate to gain access to the ball (ASEP, 1996). When teammates get closer to each other, they facilitate the defense's work. Therefore, the player with the ball is forced to dribble as a resource and rarely with the goal of making a play. Playing without goals causes players to crowd around the ball and not take advantage of the game space (ASEP, 1996; Piñar, 2005).

Past results about reception were similar to those for the pass. This seems logical, as reception acquires its full contextualized meaning in the game in relation to the pass (MacPhail et al., 2008; Rovegno et al., 2001). But in contrast to the pass, average pass receptions in our study decreased. This suggests that not all passes allowed for corresponding reception with all three balls.

The average number of passes and receptions was greater with the 440-g ball and less with the regulation and 540-g balls. This result is in line with studies about ball handling facilitation when reducing ball mass (Pellett et al., 1994). According to Burton et al. (1992), an increase in ball circumference could make passing more difficult. However, in the present study, we maintained ball circumference and modified mass only, so that the decrease in ball mass resulted in an increase in passes and receptions.

Piñar (2005) found that in 86.8–87.1% of ball possessions, participants performed 0–2 passes both before and after rule modification. Arias et al. (2009) obtained average values of 1.29–1.14 for the pass before and after modifying the three-point line. Results from previous studies were lower than the mean 1.85 passes per possession with the 440-g ball found in the present study. When compared to the literature, there was a higher mean number of passes with the 440-g ball. In general, however, the pass average was reduced with all three balls.

MacPhail et al. (2008) and Rovegno et al. (2001) identified various errors children committed during youth basketball that could cause a decrease in average passes per ball possession. The children tended to execute long passes with parabolic trajectories, passed to teammates who were being defended, kept the ball without passing it for long periods of time, passed the ball over the defenders' head, and prevented the receiver's progression by sending the ball to a position too far back on the court.

The decrease in ball mass facilitated reception. Because the ball was easier to handle, receivers seemed to be

Table 1. Descriptive analyses and significant differences of the compared variables

Variables	Ball 440 g	Ball Regulation	Ball 540 g
No. of dribbles			
M	5.75	5.33*	5.21**
SD	4.67	4.61	4.82
n	3,342	3,358	3,371
Min, max	0, 27	0, 24	0, 30
No. of passes			
M	1.85	1.71*	1.70**
SD	1.42	1.51	1.58
n	1,076	1,027	1,100
Min, max	0, 9	0, 9	0, 9
No. of pass receptions			
M	1.72	1.58*	1.57**
SD	1.39	1.48	1.53
n	998	995	1,016
Min, max	0, 9	0, 9	0, 9

Note. *M* = mean; *SD* = standard deviation; Min, max = minimum and maximum.
*$p < .05$, comparing the 440-g ball with the regulation ball.
**$p < .01$, when comparing the 440-g ball with the 540-g ball.

able to implement strategies to receive the ball. According to Strohmeyer et al. (1991), chest passes are easier than overhead or side passes. However, when the task is facilitated (e.g., by a decrease in ball mass), the difficulty also decreases (Chen et al., 2003; Strohmeyer et al., 1991).

According to Graça (1998), children direct their attention toward aspects of game interpretation when it is suitable for them. Reducing ball mass seems to have enabled the children to go from paying attention to ball-handling aspects to game interpretation. These aspects are relevant in pass and reception actions (MacPhail et al., 2008; Rovegno et al., 2001).

Various studies conducted in laboratory conditions found that balls of smaller dimensions allowed for a better quality pass reception (Halverson, 1966; Isaacs, 1980). However, the absence of controlling for mass prevented authors from reaching agreement about which ball would facilitate reception (Isaacs, 1980; Koslow, 1985; Payne, 1985). This would be an interesting topic for future studies on youth basketball.

In conclusion, the present study provides evidence of the effect of modifying ball mass on dribble, pass, and pass reception during real game play in youth basketball. The average number of dribbles, passes, and pass receptions was greater with the 440-g ball and less with the regulation and the 540-g balls.

The predominance of dribbling over passing and pass receiving provoked a decrease in game speed and caused the defense to gain stability. The defense focused its attention on only one player and team actions on offense were more predictable, which makes it more difficult to increase the options for shooting and scoring. Further, it more likely that fewer players will get opportunities to practice as well as enjoy their game experiences in possession of the ball. In this case, players without possession of the ball limit their actions to defensive ones (ASEP, 1996; Arias et al., 2009; Chamness, 2000; Grawer & Rains, 2003; Hanlon, 2005; Ortega et al., 2006).

This article provides information relevant to teachers and coaches considering ball modification for 9–11-year-olds. Modifying ball mass would allow for improved performance. In the present study, the ball of least mass contributed to an increase in the number of passes, receptions, and dribbles. Dribbling should be used to facilitate game dynamics and not slow it down, making it predictable and limiting practice time. Overall, these results reinforce the need to study other dribbling modifications and basketball skills for children's optimal participation. However, to our knowledge no other studies except those mentioned have investigated dribbling during real game situations. Other dribbling characteristics that may be significant in future research are the intent, usefulness, type, speed, height, and position of the dribble. The results exemplify the way modification of the relationship between participants and equipment can produce changes in game actions. This supports the need to lay the foundation for analysis of changes in game action.

This study had various limitations. First, all participants were boys. Second, anthropometric characteristics, biological age, and strength were not monitored. Third, despite the fact of significant differences between the 440-g ball with regard to the regulation ball and the 540-g ball, these statistical differences may be due more to the size of the sample than to differences in practicing; thus, any future data should be analyzed with caution.

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Authors' Notes

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E-mail: jlae84@hotmail.com