EFFECT OF BASKETBALL SHOES OF DIFFERENT WEIGHTS ON PERFORMANCE IN A GAME-LIKE SCENARIO

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Lighter shoes have been shown to improve running economy; however this same phenomenon has not been investigated in basketball shoes. The purpose of this study was to investigate the physiological effects of basketball shoes of different masses during an on-court, game like scenario. Twelve male basketball players participated in this study. One shoe that was modified to have three different masses (Light, Medium, and Heavy) was evaluated in this study. Subjects completed a basketball-specific 20 minute field-based work protocol (Basketball-20) in each shoe on three different days while five physiological variables of interest were collected. The light shoe condition resulted in significantly lower oxygen consumption, ventilation, and rate of energy expenditure than the medium and heavy conditions.

KEYWORDS: Basketball, Performance, Oxygen consumption, Heart rate, Caloric expenditure.

INTRODUCTION: Basketball is a highly popular sport, particularly in North America. Consequently, it has been studied from a variety of perspectives including injury risk (Arendt & Dick, 1995; Flood & Harrison, 2009; McKay, Goldie, Payne, Oakes, & Watson, 2001; Meeuwisse, Sellmer, & Hagel, 2003), measuring and improving performance (McClay et al., 1994; McInnes, Carlson, Jones, & McKenna, 1995; Narazaki, Berg, Stergiou, & Chen, 2009; Whitting, de Melker Worms, Maurer, Nigg, & Nigg, 2013), and game-related statistics (Ben Abdelkrim, Fazaa, & El Ati, 2007; McInnes et al., 1995; Narazaki et al., 2009). However, there has been limited research on the effect of basketball shoe mass as a key design characteristic that could affect performance (Blanche, Beguin, & Monteil, 2011; Wannop, 2013). In running, there have been a number of studies that have quantified physiological benefits, such as lower oxygen consumption and heart rate, of running in lighter shoes as compared to heavier shoes (Divert et al., 2007; Franz, Wierzbinski, & Kram, 2012; Martin, 1985). However, in addition to running, basketball is also largely comprised of jumping, sprinting, stopping and starting, and cutting maneuvers (McClay et al., 1994; McInnes et al., 1995), and therefore the effect of shoe mass on physiological variables may differ. Furthermore, the studies investigating the effect of running shoe mass were done in a controlled laboratory setting on a treadmill rather than in a real-world setting. Quantifying shoe effects in a game like setting provides a more realistic understanding of the effects of shoe mass on a player during a basketball game.
Therefore, the purpose of this study was to investigate the physiological effects of basketball shoes of different masses during an on-court, game like scenario. It was hypothesized that the light shoe would incur the lowest metabolic cost and the heavy shoe would incur the highest metabolic cost.

METHODS: Twelve male subjects (mean ± SD: 26.6 (5.7) years, 189.1 (4.6) cm, 90.2 (6.5) kg) who currently play a competitive level of basketball participated in this study. One type of shoe that was modified to have three different masses (Light, Medium, and Heavy) was evaluated in this study. The weights of the shoes for US sizes 12 and 13, respectively, were: Light – 705g, 736g, Medium – 1012g, 1024g, and Heavy – 1306g, 1316g. Each subject visited the University of Calgary on four separate days to participate in testing.
In order to individualize the steady state running economy portions of a continuous basketball work protocol, on day 1 subjects first completed a Leger 20 m shuttle run test (Leger & Lambert, 1982) to maximal volitional fatigue to determine each subject's anaerobic threshold. Day 1 also served as a familiarization session, whereby each subject was instructed regarding the drills portion of the basketball circuit. On days 2, 3 and 4, the subjects performed a 20 minute field-based work protocol (Basketball-20) that included two

3-minute steady state runs below anaerobic threshold alternated with two rounds of the basketball specific drill circuit (Figure 1), and ended with a 3-minute shuttle run at anaerobic threshold. During all tests the subjects wore a Polar H2 heart rate monitor (Polar Electro, Kempele , Finland) and a portable metabolic measurement system (K4b2, COSMED, Rome, Italy) that enabled the investigators to determine heart rate (HR), oxygen consumption (VO_2), respiratory exchange ratio (RER), minute ventilation (VE), and rate of energy expenditure (REE) as the primary physiological variables of interest.

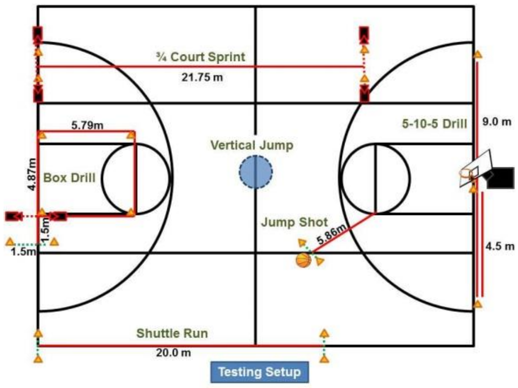

Figure 1: Schematic diagram for the layout of the testing protocol.
= Agility cones, = Timing lights.

During the Basketball-20, statistical analysis was conducted for the three individual steady state runs and the average of the steady state runs, the two individual drill circuits and the average of the two drill circuits, and the global average across the entire Basketball-20. A one-way repeated measures ANOVA was used to determine whether there were any significant effects for testing condition (between-day differences) for each physiological variable. Where a significant main effect was found, post-hoc t-tests were performed to find precisely where statistical differences existed between shoe conditions. All statistical tests were completed using IBM SPSS statistics (Version 20.0; SPSS Inc., Chicago, IL) and Microsoft Office Excel 2007 (Microsoft Corp., Redmond, Washington, USA) and all tests of significance were performed with an alpha level set at 0.05, although if the significance was at 0.01, it was also noted.

RESULTS: Table 1 summarizes the statistical findings from this study.

Table 1: Significant differences between the Light, Medium, and Heavy conditions for different time segments of the circuit. N/A reflects that no analysis was done on this variable, while NS refers to Not Significant. Significant difference between Light and Medium (A,a), Light and Heavy (B,b) and Medium and Heavy (C,c). Capital letters $p < 0.01$, lower-case letters $p < 0.05$.

	VO_2	HR	RER	VE	REE
Steady State 1	NS	NS	NS	a	NS
Steady State 2	A, b	NS	NS	b	A, b
Steady State 3	NS	NS	NS	b	NS
Average Steady State	a, b	NS	NS	a, b	a, b
Drills 1	A	NS	NS	NS	A
Drills 2	a, b	NS	NS	a, b	a, b
Average Drills	A	NS	NS	a, b	A
Global - Exercise	a	N/A	N/A	N/A	a

The light shoe condition resulted in significantly lower VO_2, VE and REE than the medium and heavy conditions, both during the steady state runs and the drill circuits. There were no significant differences in the HR or RER for any conditions. No significant differences were found between the medium and heavy shoe conditions for any variable. Figure 2 illustrates the mean VO_2 and REE data for the entire Basketball-20, as well as the total oxygen consumed and total energy expended for the three shoe conditions.

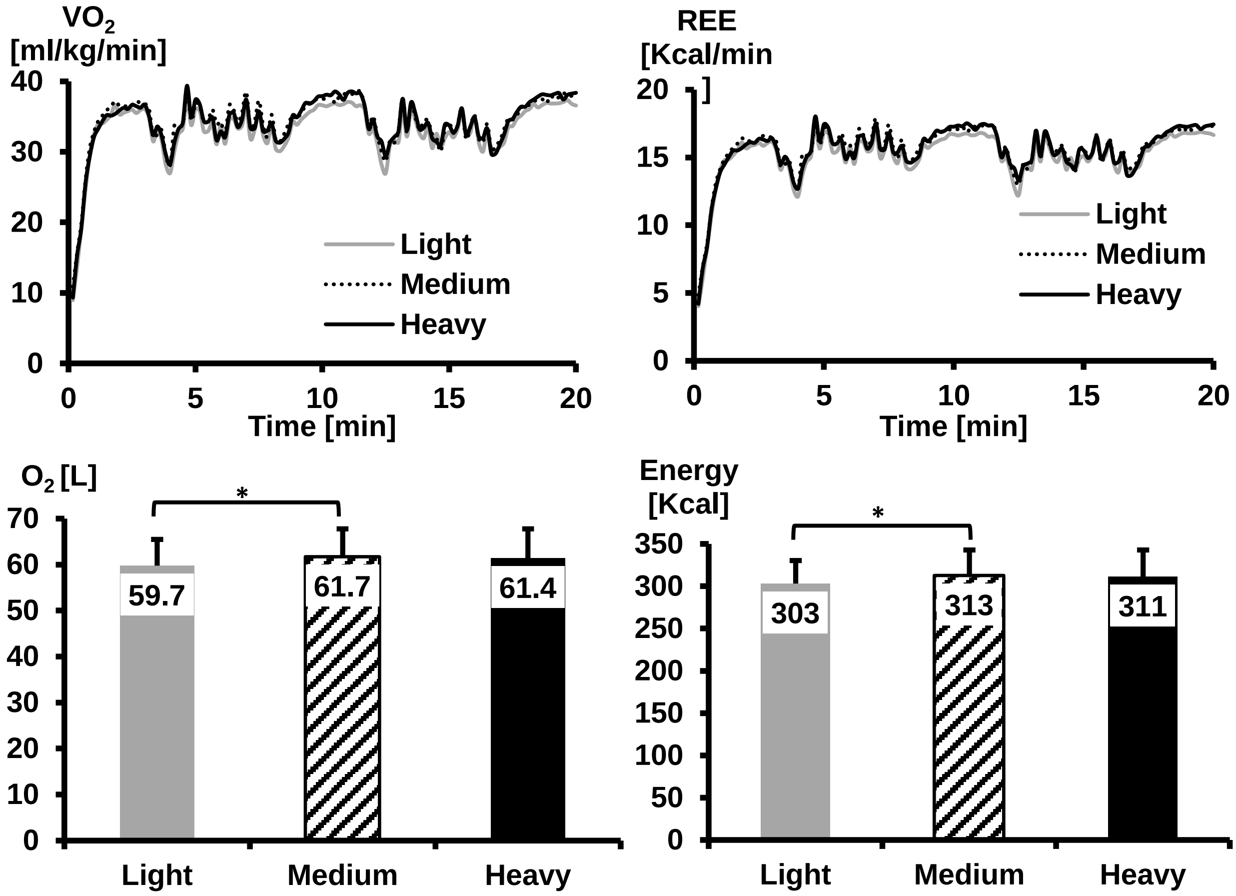

Figure 2: Mean VO_2 and REE for the entire Basketball-20 for the three shoe conditions (top) and mean ± SD global O_2 cost and global energy expenditure for the three shoe conditions (bottom).

DISCUSSION: This study illustrates that lighter basketball shoes provide players with a physiological advantage compared to medium or heavy basketball shoes in that lower oxygen consumption (VO_2), ventilation (VE), and caloric expenditure (RER) is required in order to complete the same set of drills. Furthermore, this study was done using a basketball-specific on court assessment, and therefore these results are highly relevant to game like scenarios. In fact, when extrapolating the global oxygen cost and global energy expenditure to a 60 minute game-length period, it is estimated that players wearing the light shoe would consume 5 to 6 litres less oxygen and require 25 to 30 fewer calories than had they been wearing the medium or the heavy shoe. While small in magnitude, these combined benefits could provide one team a sufficient advantage over another in a tight scoring game.
Use of the current on-court assessment rather than a laboratory setting provides valuable opportunities to assess numerous types of basketball-specific products, such as modification to basketball shoes including traction and stiffness properties, or assessment of compression apparel, which is commonly worn by basketball players.

CONCLUSION: While lighter shoes have been shown to provide physiological benefits to runners in laboratory settings, the effect of mass of basketball shoes on performance in a game-like setting had not been established. The current study showed that the lighter shoes enabled the greatest physiological benefits through lower oxygen consumption, ventilation and energy expenditure compared to the medium and heavy shoes during the Basketball-20. While the benefits were small, the additive effect through the duration of a basketball game could provide performance advantages.

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