Analysing Blood Glucose and Blood Lactate in Basketball Players (Guards) During A Competitive Game

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Abstract

Contributing to the knowledge base of physiological demands in basketball and demands on guards during a competitive game, the study aims to add to basketball players' actual demands, which should be explicitly considered during the training regime and conditioning. Twelve male university basketball players (6-shooting guards & 6-point guards), from the top 8 teams in 4 Qualifying matches, were studied in West Zone Intervarsity Tournament 2019-2020 the Association of Indian University (AIU).All the male guards were aged 22.6 ± 2 years, all the guards possess a mean competitive experience of 7.2 ± 1.5 years, 2 guards were later selected for Combine University Camp, 4 represented their states in Senior National Championships, and other 6 were former All India Inter-university participants.24 hours before the match anthropometric measurements including Height (cm), weight (kg), and Body Fat percentage were calculated. For blood glucose ONE-TOUCH SIMPLE SELECT GLUCOMETER and for blood lactate measurements LACTATE PRO LT1730 (CV- 2.7-5.1) were used, respectively. For the heart-rate measurement, POLAR H10 chest straps were attached to the guards, and heart rate was monitored in 15seconds intervals. Descriptive statistics for blood glucose and blood lactate include mean $\pm$ standard deviation. Further, Normality and homogeneity of variance assumptions were met using Shiparo-Wilk's test and Mauchly's sphericity respectively. One-way Repeated Measure ANOVA was used to compare the 3 data points of blood glucose and blood lactate during the match, followed by Bonferroni Adjustment to determine the significance. The data sets were analysed using IBM SPSS 20 (IBM Corp. Released 2020. IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp). The level of significance was set at $p \leq 0.05$ for all the statistical analyses. From the results it clearly states, with change in game intensities and demands the heart-rate increased significantly which put forward the intense demands on guards during a competitive game, BGLu significantly increased as the game progressed to meet the energy demands of the players

KEYWORDS – Blood Glucose, Blood Lactate, Basketball, Point-Guards, Shooting-Guards, Competition

INTRODUCTION

Basketball is a high-intensity team sport with intermittent movements and execution of sport-specific skills over a prolonged time (~1 h).(McInnes, Carlson, Jones, & McKenna, 1995).Descriptive analyses on heart rate monitoring and lactate accumulation in a 20 min practice game reveal aerobic and anaerobic metabolism with the energy supply in basketball(Montgomery et al., 2010; Narazaki et al., 2009). A series of fast plays on the offensive court depletes ATP-PC followed by the exploitation of muscle glycogen, and some phases of oxygen consumption shift it to the aerobic session adhering to recovery. In the absence of oxygen, anaerobic

metabolism stands responsible for the lactate accumulation ceasing muscle movement and generating fatigue (Sahlin, 1992).Physical, physiological, and anthropometrical demands vary according to the playing positions in basketball. Point guards and shooting guards tend to be more agile and active, therefore possess more significant physical needs than centers and forwards (Puente, Abián-Vicén, Areces, & López, 2017)

In a laboratory-controlled study on 24 male basketball players (regardless of playing positions), blood glucose levels after a high-intensity Nowacki treadmill test increased significantly by 1.15 mmol/l on an average, proportionally by the duration of time (Jovanovic, 2017).Researches have also been conducted to record the blood metabolites including Triglycerides [TG], Free Fatty Acid [FFA], Plasma glucose [G] (Ben, Castagna, El, Tabka, & El, 2009).

The majority of studiesfocused either on Blood Lactate [La] values or Blood Glucose in basketball players during various tests and simulated situations (Montgomery et al., 2010; Aaron, Jordan, Nattai, Patrick, & Vincent, 2018; Jovanovic, 2017). In another study that addressed both, Blood glucose and Blood lactate values, the physiological response of 10 basketball players show depleted blood lactate [BLa] and blood glucose [BGlu] values in the second half when compared to the first, but the evaluation was done on a simulated basketball match (4 x10mins), and not in formal competitive grounds, (Aaron, Jordan, Nattai, Patrick, & Vincent, 2018). Hence limited literature is available on the physiological load in terms of blood glucose and blood lactate monitoring on male guards (shooting and point guards) during a competitive match. As, official matches impose a greater physiological load on players than simulated situations and training sessions do (Grosgeorge, 1990).A study examined 38 males, including 8 guards, Tunisian U-19 elite-junior national level players resulted in a significant increase in the blood glucose values in 1st half from 4.05 ± 1.27 to 5.98 ± 0.88 mmol·L^{-1} but decreased in the 2nd half of the game(Ben, Castagna, El, Tabka, & El, 2009), however, blood lactate values were not considered in the study.

Nonetheless, various studies address the demands on basketball players, but there is an apparent insufficiency in the exact nature of blood glucose and blood lactate graphs in guards during the game. FIBA, the governing body of basketball, is being dynamic regarding the rule amendments to make the game more intense and demanding, and, unfortunately to our knowledge, there exists no recent study considering new amendments in the game, which comprises shot-clock revisions and truncating offense time (FIBA, 2020). The present research focuses on the analysis and monitoring of both blood glucose and blood lactate valuesduring a competitive match in point guards and shooting guards. The study also attempts to justify the relationship between glucose (aerobic) and lactate (anaerobic) dominance at various time duration during a match.

AIM

Besides contributing to the knowledge base of physiological demands in basketball and demands on guards during a competitive game, the study aims to add to basketball players' actual demands, which should be explicitly considered during the training regime and conditioning.

SUBJECTS

Twelve male university basketball players (6-shooting guards &6-point guards), fromthe top 8 teams in 4 Qualifying matches, were studied in West Zone Intervarsity Tournament 2019-2020the Association of Indian University (AIU). Since the matches were qualifying, the play's intensity and data collection were envisaged fairly well, which reflects true physiological demands. All the male guards were aged 22.6 ± 2 years, all the guards possess a mean competitive experience of 7.2 ± 1.5 years, 2 guards were later selected for Combine University Camp, 4 represented their states in Senior National Championships, and other 6 were former All India Inter-university participants. Mean Physical and Anthropometric profile of guards are mentioned in the table. With, none of the athletes under any medical treatment, injury, or any medication which may alter the results, all of themunderwent pre-season conditioning and training sessions for the tournament.

Table 1- Descriptive anthropometry of the players showing near homogenouscharacters.

	Height (cm)	Weight (kgs)	Fat	Body Mass Index
MEAN	180 cm	75 kg	13.7	25.7
S.D	3.1 cm	4.5 kg	2.2	1.4

ADMINISTRATION PROCEDURE

24 hours before the match anthropometric measurements including Height (cm), weight (kg), and Body Fat percentage were calculated. Players were monitored for dietary intake for 24 hours, and all the players and coaches were informed of the procedure involved in the study, and possible discomforts to be faced by players. Coaches and players were asked to avoid any training and intense practice sessions 24 hours before the study. All the players were instructed well of the procedure involved – wearing chest strap heart-rate monitor throughout the game, pricking fingers for blood samples before, during, and after the game. Coaches of all 8 teams and players were asked to fill a written consent form. Furthermore, the study was approved by the Lakshmibai Institute of Physical Education, Gwalior.

In a 2-day roaster, all 4 qualifying matches were organized inthe afternoon, from 11am, at indoor courts, the temperature recorded was 26 ± 4º, and humidity 48-54%. On the day of the match, players took a similar breakfast, consuming around 450-500kcal, before 3-4 hours of the competition, and no food or snacks were allowed further, till the post-game data collectionwas done,players reported 40mins, before the game schedule, dynamic warm-up including shuffling movements, exercises, ball handling drills, shooting drills were done 20 mins before the game. Players were asked to consume water before and after the warm-up. studied Guards in the study were restricted to 'isotonic drink' provided during the match to maintain the electrolytes (Matthew & Delextrat, 2009). No glucose or other energy drink was administered by the subjects during the study which alter the outcomes. Due to the limitation of instruments, and absence of incremental treadmill test, the maximum heart-rate attained during the game was considered the HR_{max} for the player (Rodríguez-Alonso, Fernández-García, Pérez-Landaluce, & Terrados, 2003; Ben, Castagna, El, Tabka, & El, 2009)

DATA COLLECTION

For blood glucose ONE-TOUCHSIMPLE SELECT GLUCOMETER (CV ≤5%) (Philis-Tsimikas, Chang, & Miller, 2011)and for blood lactate measurements LACTATE PRO LT1730 (CV- 2.7-5.1) were used, respectively(Bonaventura, Sharpe, Knight, Fuller, & Tanner, 2015). For the heart-rate measurement, POLAR H10 chest straps were attached to the guards, and heartrate was monitored in 15s intervals (Polar Electro Oy, Kempele, Finland) (Matthew & Delextrat, 2009; Ben, Castagna, El, Tabka, & El, 2009).Players playing time and Heart-rate values during free-throws, substitutions, time-out, and out-of-bound were eliminated from the total time, and mean playing time and heart-rate for the time of active playi.e. live time on the court was recorded (live time = Total time – breaks between quarters & halftime, free-throws, time-outs, official time-outs)(McInnes, Carlson, Jones, & McKenna, 1995).

All the measuring instruments were from the LNIPE physiology lab and were well-calibrated before the study. Three measurements for blood glucose and blood lactate were taken throughout the study,1stbetween warmup & beforethe beginning of the game, after the end of the first half (2nd quarter), and at the end of the game (4th quarter). None of the games went over-time. For the data collection, after the warm-up and before the game began, pre-data for blood glucose and blood lactate were taken. Capillary blood was tested from the middle or ring finger of the respondent's non-shooting hand, using a lancing device wiping off the first blood drop, using the next values, readings were noted(WHO, 2010). All the 3 readings i.e. pre-game, at half-time, and post-game were taken following the same protocols and under the supervision of an expert. Upon the completion of warm-up, half-time, and game, blood glucose values were recorded, after 3 minutes blood lactate values were tested and recorded(Jovanovic, 2017; Baldari & Guidetti, 2000).

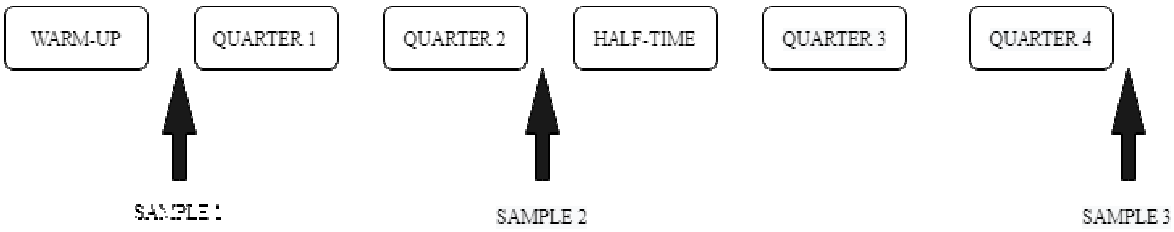


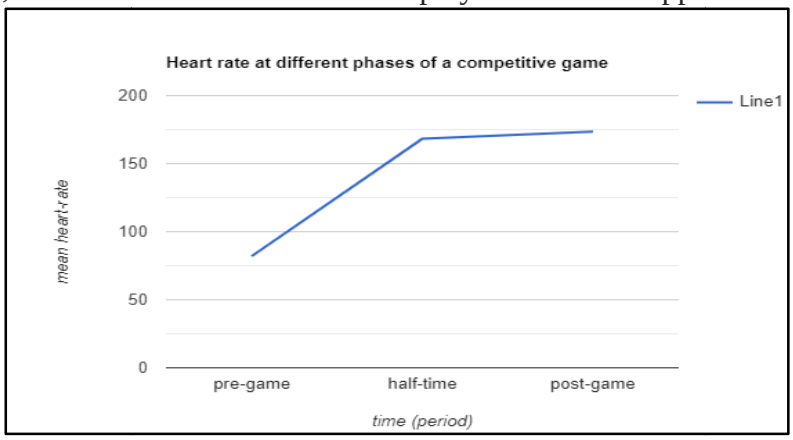
Figure 1 Diagramatic representation of sample collection through-out the game

STATISTICAL ANALYSES

Descriptive statistics for blood glucose and blood lactate include mean ± standard deviation. Further,Normality and homogeneity of variance assumptions were met using Shiparo-Wilk's test and Mauchly's sphericityrespectively.One-way Repeated Measure ANOVA was used to compare the 3 data points of blood glucose and blood lactate during the match, followed by Bonferroni Adjustment to determine the significance. The data sets wereanalyzed using IBM SPSS 20 (IBM Corp. Released 2020. IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp). The level of significance was set atp≤0.05 for all the statistical analyses.

RESULT

The mean maximum heart-rate (HRmax) for basketball guards was 192.5 ± 7.1 bpm, reflecting the rigorous game demands, the Heart-rate of all the guards significantly elevated as the game moved to late quarter from a mean of 82 bpm pre-game to 168 bpm (as shown in fig.1) at half-time and edging further to 173 ± 8.5 bpm post-game. Nonetheless, the mean live heart rate for the players remained approximately 171 bpm



which could be calculated to around 89% of maximum intensity.

Figure 2Heart-rate increased significantly form a mean of 82 bpm in 1st quarter(pre-game) to 168 bpm at half-time and further to 173 bpm by the end of the game.

Mean Glucose value displayed in table 2 for pre-game, halftime, and post-game. Data shows a mean of 4.8 ± 0.5 mmol/L in the pre-game measure which increased to 7.3 ± 1 mmol/L and later alleviated to 5.9 mmol/L.

Table 2

Descriptive Statistics GLUCOSE [BGlu] pre-game, half-time and post-game

	Mean	Std. Deviation	N
Glucose pre-game	4.8000	0.48430	12
Glucose half-time	7.3000	1.04185	12
Glucose post-game	5.9417	0.49992	12

Table 3

Tests of Within-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
GLUCOSE	37.594	2	18.797	42.576	.000
	9.713	22	0.441		

Repeated measure ANOVA signifies difference in blood glucose level at various phases of games at $F(2,22) = 42.57$ which is significant ($p<0.01$).

Table 4

Pairwise comparisons

(I) GLUCOSE	(J) GLUCOSE	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Pre-game	Half-time	-2.500*	.286	.000	-3.306	-1.694
	Post-game	-1.142*	.169	.000	-1.618	-.665
Half-time	Pre-game	2.500*	.286	.000	1.694	3.306
	Post-game	1.358*	.332	.005	.421	2.296
Post-game	Pre-game	1.142*	.169	.000	.665	1.618
	Half-time	-1.358*	.332	.005	-2.296	-.421

Based on estimated marginal means
*. The mean difference is significant at the .05 level.
b. Adjustment for multiple comparisons: Bonferroni.

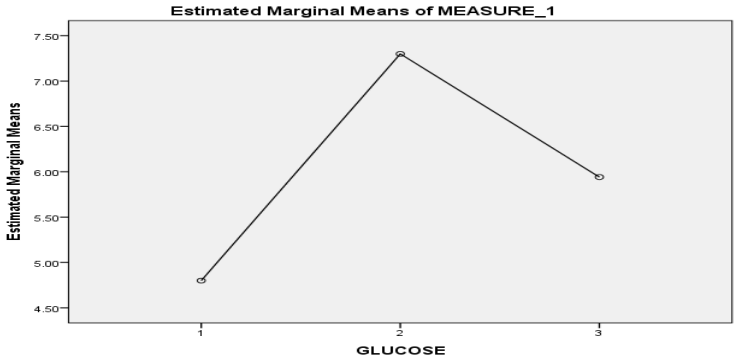


Figure 3 Profile plot of estimated marginal means of Glucose

Pairwise comparison table shows the significant improvement in blood glucose level, there had been a significant improvement in half-time blood glucose (4.8 ± 0.5 mmol/L vs 7.3 ± 1 mmol/L; $p<0.001$), same follows for pre-game and post-game value. But, the readings for half-time and post-game reveal a less imperative value (7.3 ± 1 mmol/L vs 5.94 ± 0.5 mmol/L; $p<0.05$) (as shown in fig.3) this could be addressed to the bounced intensity of game at half-time and also the mean heart-rate (from 93% HRmax to 95% HRmax) indicating the dominance of anaerobic concentratione and envisaged an increased blood lactate value.

Mean value of 2.03 ± 0.5 mmol/L [BLa] was recorded pre-game, which heightened to 5 ± 0.91 mmol/L (as shown in table) in half-time due to the intense game demands as the game proceeds, further hike in BLa values at 7.5 mmol/L ± 1.12 at the end of the game.

Table 5

Descriptive Statistics LACTATE [BLa]

	Mean	Std. Deviation	N
Lactate pre-game	2.0333	.50513	12
Lactate half-time	5.0167	.91734	12
Lactate post-game	7.5333	1.12358	12

Table 6

Tests of Within-Subjects Effects LACTATE [BLa]

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
LACTATE	181.936	2	90.968	92.178	.000
	21.711	22	.987		

Significant difference in blood lactate [bla] in different phases of the games were evident with $F(2,22) = 92.178$, at ($p<0.01$)

Table 7

Pairwise comparison

(I) LACTATE	(J) LACTATE	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
pre-game	Half-time	-2.983*	.287	.000	-3.791	-2.175
	Post-game	-5.500*	.419	.000	-6.680	-4.320
Half-time	pre-game	2.983*	.287	.000	2.175	3.791
	Post-game	-2.517*	.486	.001	-3.887	-1.146
Post-game	pre-game	5.500*	.419	.000	4.320	6.680
	Half-time	2.517*	.486	.001	1.146	3.887

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Pairwise comparison table shows the significant improvement in blood lactate level,[BLa], there had been a significant improvement in half-time blood lactate (2 ± 0.5 mmol/L vs 5 ± 0.9 mmol/L; $p<0.001$), same follows for pre-game and post-game value.The readings for half-time and post-game reveal a imperative change (5 ± 0.9 mmol/L vs 7.5 ± 1.1 mmol/L; $p<0.05$) this could be addressed to the bounced intensity of game at half-time and also the mean heart-rate (from 93% HRmax to 95%

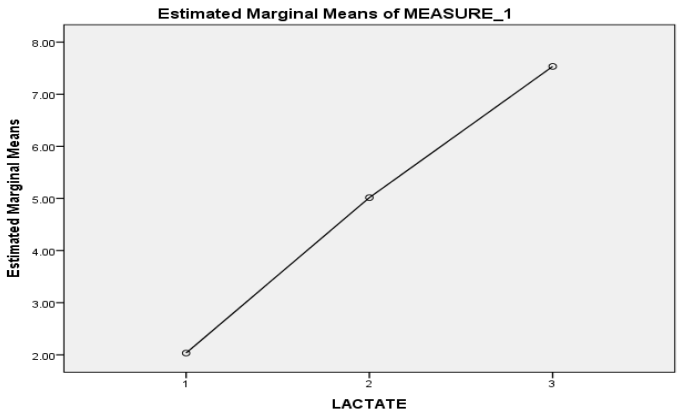


Figure 4 Profile plot of estimated marginal means of lactate

HRmax) indicating the dominance of anaerobic concentration and an increased blood lactate value.

DISCUSSION AND CONCLUSION

The study intended to analyse the physiological demands of basketball guards (position) in terms of Blood Glucose and Blood Lactate in a competitive game. From the aforementioned results it clearly states, with change in game intensities and demands the heart-rate increased significantly which put forward the intense demands on guards during a competitive game, BGLu significantly increased as the game progressed to meet the energy demands of the players, this result shows some contrary result with (Aaron, Jordan, Nattai, Patrick, & Vincent, 2018), this could be projected due to the simulated basketball activity used in the study, In competitive situations glucose in the blood streamed increased significantly (Jovanovic, 2017). At later stages the depletion of blood glucose could be witnessed as the game turned vigorous (93% HRmax to 95% HRmax) the glucose depleted significantly, as it indicates the anaerobic dominance nature of game during the later phases (after-halftime).

Unlike BGlu, BLa increased significantly in the prior phases of the game as the intensity shifts further near half-time, but the accumulation was even more at the later stages, this is evident due to the increased mean Heart-rate after half-time and literature suggest, the later stages of a basketball game put greater demand on players specifically guards. Study reflects the results in line with various studies(Ben, Castagna, El, Tabka, & El, 2009)(Narazaki et al., 2009).

This study adds on to the account of physiological demands of basketball guards as considered the most prominent and efforted positions in basketball, study dealt with the real competitive game which is crucial amongst the other studies done in the past on various simulated situations or practice matches. Intrestingly, study reveals the nature of blood glucose levels which is ample near half-time and the actual depletion starts after that which emphasises the elevated anaerobic demands near the later quarters, coaches could use this for major substitution decisions and supplementations to have a edge in 3rd and 4th quarters. Study points to the after fatigue anaerobic

conditioning to the players in order to sustain in the game. Since the rules and plays in basketball are dynamic this study takes the latest rule changes in confidence.

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