Original Research Article

Homeostatic, Glucolytic~~And~~ and Lipolytic Presentations Before ~~And~~ and After Soccer Game

Formatted: Right

ABSTRACT

Soccer is a worldwide game played for health, entertainment and economic purposes. The effect of soccer activities on homeostatic, glucolytic and lipolytic biochemical parameterswas estimated before and after 90 minutes of a full-time game. Twenty-two (22) male soccer players from a second-tier squad took part in the investigation. The biochemical parameters which included serum electrolyte, plasma glucose, serum proteins and lipids were analyzed using standard WHO-approved methods. All data were analyzed using student t-test on SPSS 23 version. The study showed that there was a significant increase in the concentrations of glucose & a decrease in potassium ($p<0.05$) after the soccer game. The other parameters analyzed were not significant. In conclusion, glucose and potassium concentrations should be monitored before and after regular exercise to avoid possible adverseoutcomes associated with hypoglycaemia and hyperkalemia.

Keywords: Soccer, electrolytes, glucose, lipids, homeostasis.

Formatted: Font: Not Bold, Italic

Formatted: Font: Italic

1.

~~1.0.~~ INTRODUCTION

Formatted: Normal, Line spacing: Double, No bullets or numbering

Formatted: Font: Times New Roman, Bold

Soccer is one of the most popular sports in the world and ithas the largest fan base in the modern world. Economically, it supports the creation of employment and enhances commercial activities. Similarly, its participation improves health status by increasing the expected life span[1]~~(1)~~. As a result of soccer's huge economic value, patronage is rising geometrically.Players must perform a variety of bodily activities during a soccer match. This includes hops, walks, short to lengthy runs, repeated turns with abrupt stops, diving for tackles, and other movements unique to the sport [~~(~~2~~)~~]. Consequently, numerous physiological changes have been linked to soccer-related activities[~~(~~3~~,4,~~-5~~)~~].

Soccer is an energetically demanding activity that frequently results in physiological and metabolic changes that could be beneficial or deleterious. Indeed lots of soccer players have collapsed on the pitch and died due to metabolic compromise and other idiopathic reasons[~~(~~6~~)~~]. There have been reports of changes to the hormonal environments that control anabolism and catabolism,[~~(~~7,8]~~)~~, muscle damage marker[~~(~~8,9~~)~~], and immunologic[~~(~~10~~)~~] and redox states following times of intense soccer training and competition[~~(~~11,12~~)~~].However, the focus of this study was on how soccer affects the body's homeostatic, glucolytic, and lipolytic systems.

Homeostatic biochemical parameters ensure that fluid content is optimally maintained within the various cellular components of the body. Electrolytes such as sodium, potassium, chloride and bicarbonate play a critical role in maintaining physiological water balance in the body.

The lipolytic parameters play a key role in preserving cellular tensile strength and ensuring that molecules are transported as efficiently as possible. Cholesterol, triacylglycerol, HDL and LDL are the major lipid parameters evaluated routinely in the laboratory. Since glucose is the main source of energy, glucolytic parameters like glucose are used in the assessment of glucose tolerance. The body ensures glucose concentrations are maintained within the physiological range. The physiological range varies between 2.5 mmol/L to 5.6 mmol/L.

After periods of intense soccer training and competition, there have been reports of changes in the anabolic and catabolic hormonal environments[~~(~~7,8~~)~~], muscle damage markers[~~(~~9,13~~)~~],

immunologic changes[(10)], and redox states [(11, 12, 14, 15)]. Numerous studies have highlighted how football players' constant practice can lead to fatigue [(16, 17, 18, 19)].

The topic of homeostatic, lipolytic, and glucolytic modifications related to soccer activities is understudied in the literature. If empirically assessed, this gap could improve sports medicine and reduce the increasing collapses and deaths associated with soccer. This study was therefore intended to examine, for the first time, homeostatic, lipolytic and glucolytic alterations in soccer players in Bayelsa State. The findings could be of optimal use in sport and preventive medicine especially as it concerns soccer in Bayelsa State and Nigeria at large.

2.~~0.~~MATERIALS AND METHOD

2.1~~.~~ Study Area

The study was carried out in Yenagoa, the capital of Bayelsa State, Nigeria. Samples for the study were collected from soccer players in Yenagoa Local Government Area of Bayelsa State.

2.2~~.~~ Study P~~p~~opulation

Twenty-two (22) players were present during the course of this study. They belonged to a soccer team in the second division. The participants were within the age range of 24 to 30 years and only those that did full time (90 mins) were included in the data analysis.All the subjects (players) weredeprived of intake of sugar containing drink or beverage prior to the exercise. In Subjects on any form of drugs were excluded.In similar vein, subjects with glucose concentration above the WHO approved threshold value of 5.6 mmol/L were excluded from the study.

2.3~~.~~ Sample ~~collection~~Collection and ~~preparation~~Preparation

Samples were taken before and after 90 minutes of play. The post-match samples were collected within 10 minutes after the final whistle was blown. All the players were duly counselled and informed consent was obtained. Using aseptic technique, 6ml venous blood samples were collected into the appropriate containers and processed before sending the laboratory for biochemical analysis. All participants underwent a health screening procedure before they were enrolled in the study. The study protocols were also thoroughly explained to the participants. All study participants were advised to consume a balanced diet throughout the investigation. The individuals maintained their customary pre-training meal pattern, including breakfast, on the days of the examination.

2.4~~.~~ Laboratory Analysis

The Glucose Oxidase-Peroxidase method was used to analyze plasma glucose using Randox reagent. The serum albumin was measured using the Bromocresol green technique. Serum cholesterol, triacylglycerol, and HDL were estimated enzymatically with the aid of Agape

Diagnostics Switzerland reagent. Serum LDL was derived mathematically according to Burtis et al (2003). Serum electrolytes concentrations were estimated with the Ion Selective Electrode (ISE) (Analyzer ISE 4000, France)

2.5. EthicalClearance

The ethical approval was obtained from the Bayelsa State Ministry of Health. This research was carried out following the Ethical Principles for Medical Research involving human subjects as outlined in the Helsinki Declaration in 1975 (revised in 2000).

2.6. Statistical Analysis

The statistical package for social sciences (SPSS), version 23 (SPSS Inc., Chicago, IL, USA) and Microsoft Excel version 2010 was used for all analyses. Results were expressed as mean±standard deviation while comparisons were made between before and after the activities using the students' *t*-test The level of statistical difference was set at $p<0.05$ at 95% confidence interval.

3.

Formatted: Left, Line spacing: single

Formatted: Font: (Default) Times New Roman

~~3.0.~~ RESULTS

Formatted: Normal, Left, Space Before: 0 pt, Line spacing: single, No bullets or numbering

Table 1~~:~~. Mean comparison of studied biochemical parameters between before and after soccer activities

Formatted: List Paragraph

*Key: * indicate a significant difference (P<0.05) between the compared mean values.*

PARAMETERS	BEFORE EXERCISE	AFTER EXERCISE	T-VALUE	P-VALUE
Glucose (mmol/dL)	4.32±0.945	5.27±0.89	-2.908	0.007*
Total cholesterol (mmol/L)	4.119±0.449	3.983±0.383	0.924	0.363
TG (mmol/L)	1.12±0.776	1.078±0.633	0.175	0.862
HDL (mmol/L)	1.119±0.449	0.983±0.383	0.924	0.363
Total protein (g/dL)	45.681±3.139	48.034±4.092	-0.825	0.078
Albumin (g/lL)	45.681±3.139	48.034±4.092	-0.825	0.078
Chloride (mEq/L)	114.515±26.191	113.923±24.008	0.067	0.947
Sodium (mmol/L)	134.454±42.364	136.942±10.138	-0.228	0.821
Potassium (mmol/L)	4.437±0.649	3.727±0.781	2.795	0.009*
Bicarbonate (mmol/L)	21±3	24±5	1.189	0.301

Table 1 shows the comparison between the concentrations of samples collected before & after the soccer game for Glucose, high density lipoprotein (HDL), total globulin (TG), Albumin, chloride (Cl^-), sodium (Na^+), potassium (K^+), and bicarbonate (HCO_3^-). The analysis revealed a significant increase in plasma glucose concentration after soccer, whereas serum potassium decreased.

~~4.0~~ 4. DISCUSSION

Formatted: Normal, No bullets or numbering

Formatted: Font: Times New Roman, Bold

This study found that, compared to before the game, there was a significant rise in plasma glucose concentrations and a decline in serum potassium concentrations. Other parameters did not differ significantly (Table 1). Glucose concentration is a measure of glycolytic capacity, whereas potassium functions both as a homeostatic and neural molecule.

Glucogenic capacity is a function of the rate of glucose entering the circulation balanced by the rate of removal. The considerable increase in glucose concentration seen in this study is an indication that a lot of energy must be expended to complete an exercise like soccer. Due to the increased energy demand, the body sources glucose from other parts of the body to maintain its glucogenic capability. Glucose could be sourced from stored glycogen and/or other non-glucose sources to maintain glucogenic tendencies. This has confirmed that only people who are fit and active should play sports like soccer.The study's position is consistent with the idea that during exercise, the rate of glucose release from the liver is high enough to offset the need for blood glucose during a game[~~(~~20~~)~~].

Nielsen & de Paoli [~~(~~21~~)~~] reported that when at rest, the Na^+-K^+ pump keeps the chemical gradients for Na^+ and K^+ within narrow bounds. However, as a result of the loss of K^+ during contractile activity, there is an increase in K^+ concentration in the body's extracellular compartments. The extent of this increase depends on the level of exercise and the size of the muscle groups involved [~~(~~21~~)~~].

In this study potassium concentration [K^+] also shows a significant reduction. Dehydration is responsible for this considerable alteration since exercise causes the body to lose water and electrolytes through perspiration. Similarly, the resultant hypokalemia could be due to the involvement of potassium in the breakdown of glycogen to supply energy for the body.To

provide energy for exercise, glycogen must be broken down, which depletes potassium in muscle cells. This finding is in tandem with the report by Lindinger[(22)], who noted that the onset of exercise is associated with a net release of K^+ from contracting skeletal muscle that increases in plasma [K^+]. Resultant decreases in intracellular [K^+] and increases in interstitial [K^+] in contracting skeletal muscle.This basis of hypokalemia was also advanced by handful of other authors [(23-25)].

Hypokalemia has been implicated in cardiac arrest and other illnesses associated with sudden deaths [(26)]. The alterations observed could be reversible after the period of exercise, however, intake of diets containing potassium could help maintain its optimal concentrations. Furthermore, checks on potassium concentration amongst athletes and others involved in exercise should be encouraged to avoid hypokalemia.

5. CONCLUSION

Immediately following soccer, an intense exercise, there is a rise in glucose concentration and a decrease in potassium concentration. The remaining serum electrolytes, proteins, and lipids were unaltered. These measurements should be included in baseline investigations among athletes and other activity participants since they are crucial to the health of athletes.

REFERENCES

1. Seabra, A., Katzmarzyk, P., Carvalho, M. J., Seabra, A., Coelho-E-Silva, M., Abreu, S., Vale, S., Póvoas, S., Nascimento, H., &Belo, L.(2016). Effects of 6-month soccer and traditional physical activity programmes on body composition, cardiometabolic risk factors, inflammatory, oxidative stress markers and cardiorespiratory fitness in obese boys. Journal of Sports Sciences, 2016;34(19),):1822–1829.
2. Russell, M., Sparkes, W., Northeast, J., Cook, C. J., Bracken, R. M., & Kilduff, L. P. (2016). Relationships between match activities and peak power output and Creatine Kinase responses to professional reserve team soccer match-play. *Human Movement Science*, *45*, 96–101.
3. Gravina, L., Ruiz, F., Lekue, J. A., Irazusta, J., & Gil, S. M. (2011). Metabolic impact of a soccer match on female players. *Journal of Sports Sciences*, *29*(12), 1345–1352.
4. Kaufman, E., & Lamster, I. B. (2002). The diagnostic applications of saliva—A review. *Critical Reviews in Oral Biology & Medicine*, *13*(2), 197–212.
5. Perrea, A., Vlachos, I. S., Korou, L.-M., Doulamis, I. P., Exarhopoulou, K., Kypraios, G., Kalofoutis, A., &Perrea, D. N. (2014). Comparison of the short-term oxidative stress response in national league basketball and soccer adolescent athletes. *Angiology*, *65*(7), 624–629.
6. List of association footballers who died while playing. (2022). In *Wikipedia*. https://en.wikipedia.org/w/index.php?title=List_of_association_footballers_who_died_while_playing&oldid=1103118875
7. Kraemer, W. J., French, D. N., Paxton, N. J., Hakkinen, K., Volek, J. S., Sebastianelli, W. J., Putukian, M., Newton, R. U., Rubin, M. R., & Gómez, A. L. (2004). Changes in

Comment [A1]: All works cited in the text must be listed in the References. . to elaborate the bibliographic citation and references format according to the needs of AIR.

Formatted: Highlight

Formatted: Font: Not Italic, Highlight

Formatted: Highlight

Formatted: Font: Not Italic, Highlight

Formatted: Highlight

exercise performance and hormonal concentrations over a big ten soccer season in starters and nonstarters. *Journal of Strength and Conditioning Research*, *18*(1), 121–128.

8. Handziski, Z., Maleska, V., Petrovska, S., Nikolik, S., Mickoska, E., Dalip, M., &Kostova, E. (2006). The changes of ACTH, cortisol, testosterone and testosterone/cortisol ratio in professional soccer players during a competition half-season. *BratislavskéLekárskeListy*, *107*(6/7), 259.
9. Heisterberg, M. F., Fahrenkrug, J., Krustrup, P., Storskov, A., Kjær, M., & Andersen, J. L. (2013). Extensive monitoring through multiple blood samples in professional soccer players. *The Journal of Strength & Conditioning Research*, *27*(5), 1260–1271.
10. Rebelo, A. N., Candeias, J. R., Fraga, M. M., Duarte, J. A. R., Soares, J. M. C., Magalhaes, C., &Torrinha, J. A. (1998). The impact of soccer training on the immune system. *Journal of Sports Medicine and Physical Fitness*, *38*(3), 258–261.
11. Magalhães, J., Rebelo, A., Oliveira, E., Silva, J. R., Marques, F., &Ascensão, A. (2010). Impact of Loughborough Intermittent Shuttle Test versus soccer match on physiological, biochemical and neuromuscular parameters. *European Journal of Applied Physiology*, *108*(1), 39–48.
12. Andersson, H., Karlsen, A., Blomhoff, R., Raastad, T., & Kadi, F. (2010). Active recovery training does not affect the antioxidant response to soccer games in elite female players. *British Journal of Nutrition*, *104*(10), 1492–1499.
13. Meister, S., Faude, O., Ammann, T., Schnittker, R., & Meyer, T. (2013). Indicators for high physical strain and overload in elite football players. *Scandinavian Journal of Medicine & Science in Sports*, *23*(2), 156–163.

14. Silva, J. R., Magalhães, J. F., Ascensão, A. A., Oliveira, E. M., Seabra, A. F., & Rebelo, A. N. (2011). Individual match playing time during the season affects fitness-related parameters of male professional soccer players. *The Journal of Strength & Conditioning Research*, *25*(10), 2729–2739.
15. Sporis, G., Jovanovic, M., Omrcen, D., & Matkovic, B. (2011). Can the official soccer game be considered the most important contribution to player's physical fitness level? *The Journal of Sports Medicine and Physical Fitness*, *51*(3), 374–380.
16. Filaire, E., Lac, G., & Pequignot, J.-M. (2003). Biological, hormonal, and psychological parameters in professional soccer players throughout a competitive season. *Perceptual and Motor Skills*, *97*(3_suppl), 1061–1072.
17. Kraemer, W. J., & Ratamess, N. A. (2005). Hormonal responses and adaptations to resistance exercise and training. *Sports Medicine*, *35*(4), 339–361.
18. Wankasi, M. M., Karari, L., Africa, P. E., Oriji, S. O., & Agoro, S. E. (2006). Effect of Soccer on Routine Urinalysis and Some Blood Biochemical Parameters. *Journal of Medical Laboratory Science*, *15*(2).
19. Schmikli, S. L., de Vries, W. R., Brink, M. S., & Backx, F. J. (2012). Monitoring performance, pituitary–adrenal hormones and mood profiles: How to diagnose non-functional over-reaching in male elite junior soccer players. *British Journal of Sports Medicine*, *46*(14), 1019–1023.
20. Krustrup, P., Mohr, M., Steensberg, A., Bencke, J., Kjær, M., & Bangsbo, J. (2006). Muscle and blood metabolites during a soccer game: Implications for sprint performance. *Medicine and Science in Sports and Exercise*, *38*(6), 1165–1174.

21. Nielsen, O. B., & de Paoli, F. V. (2007). Regulation of Na+–K+ homeostasis and excitability in contracting muscles: Implications for fatigue. *Applied Physiology, Nutrition, and Metabolism*, *32*(5), 974–984.

22. Lindinger, M. I. (1995). Potassium regulation during exercise and recovery in humans: Implications for skeletal and cardiac muscle. *Journal of Molecular and Cellular Cardiology*, *27*(4), 1011–1022. https://doi.org/10.1016/0022-2828(95)90070-5

23. Emenike, U. S., Ifeanyi, O. E., Chinedum, O. K., Okechukwu, O. R., & Chineneye, A. S. (2014). Effect of physical exercises on serum electrolyte. *IOSR Journal of Dental and Medical Sciences*, *13*(9), 118–121.

24. Medbø, J. I., & Sejersted, O. M. (1990). Plasma potassium changes with high intensity exercise. *The Journal of Physiology*, *421*(1), 105–122.

25. Vøllestad, N. K., Hallén, J., & Sejersted, O. M. (1994). Effect of exercise intensity on potassium balance in muscle and blood of man. *The Journal of Physiology*, *475*(2), 359–368. https://doi.org/10.1113/jphysiol.1994.sp020077

26. Kjeldsen K. (2010). Hypokalemia and sudden cardiac death. Exp Clin Cardiol. Winter;15(4):e96-9. PMID: 21264075; PMCID: PMC3016067.

Author's Contribution

The four authors contributed in various aspects of the study based on their competences and technique know-how. The conception, design, and interpretation of the results was done by E.S. Agoro. G.S. George performed data acquisition and analysis. The literature searches clinical correlations were performed by W.P. Alabrah. The revision was comprehensively the handiwork of M.M. Wankasi.

Funding

This work did not receive any form of a grant from funding agencies.

Acknowledgement

A worthy appreciation to our project studentsfor recruiting subject and the laboratory analysis. Likewise, an appreciation goes to Eni-Yimini Laboratory (eL) LTD, Yenezue-gene Epie, Yenagoa, Bayelsa State for the laboratory analysis and other research assistants.