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Comparison of Serum Cortisol Levels in Athletes and Esports Athletes

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Competing interests
The authors have declared that no competing interests exist.

Abstract

Background: *Physically active games like soccer, basketball and cycling promote cardiovascular health, improve muscle strength and enhance overall fitness. While physically inactive games may lead to sedentary lifestyle issues like obesity, poor posture and lower metabolism if not balanced with physical activity.*

Materials and Methods: *The study was designed to evaluate the impact of physically active athletes and esports athletes on cortisol and blood sugar level. A total of forty subjects were recruited in the study. Out of which 20 subjects were athletes and 20 subjects were esports athletes. Serum cortisol and blood glucose were assessed by enzyme-linked immunosorbent assay (ELISA).*

Results: *The findings of the study showed that serum cortisol and blood glucose was significantly increased ($P < 0.001$) in esports athletes as compared to athletes with mild elevation of both systolic and diastolic blood pressure in esports athletes as compared to athletes.*

Conclusion: *Esports athletes have high levels of cortisol, blood glucose, with elevated systolic and diastolic blood. Sedentary lifestyle may lead cardiovascular diseases, type II diabetes, osteoporosis etc. diseases.*

Key words: *Athletes, Cortisol, ELISA, Esports athletes, Gamers,*

Introduction

Different sports involve some degree of physical activity to play, such as body motion due to skeletal muscles that involves energy derived from ATP at cellular level (Biddle and Asare, 2011). There are three main types of sports i.e. games, exergames, and video games. The first two involves the physical activity whereas later one is more sedentary with limited to no physical activity. Exergames are technology driven activities that require a screen for the player to participate. Interactive fitness activities are often non screen-based technology driven games that require the player to use their body to play. Active learning games are technology driven activities that provide an academic focus while being physically active (Peng et al., 2013). The sports with extensive physical activities are good for health as it helps in weightloss due to muscles using stored fat for energy, strengthen bones and muscles (Donnelly et al., 2016; Khan and Hillman, 2014). On contrary video games (Esports) do not have moderate to vigorous physical activity (Boone et al., 2007) and the player have sedentary life style for most part of the day, that increases the risk of different types of health concerns like reduced muscle mass, effects on eyes due to constant exposure to the digital screen etc.

Playing video games have negative impacts on the body and mind of the player, as a young video gamer has been reported to kill his family due to his addiction of playing PubG and Free fire video games (Penko et al., 2010; Hebert et al., 2005). Playing video games in a competitive real-life situation can result in significant physiological arousal expressed by an increase in cortisol level. Video games like PUBG, Free Fire, GTA-5, Action RPG etc. significantly impact the player's behaviour, daily routine and thought process (Cauderay and Cachat, 2015). In Pakistan young people spend 15 to 20 hours/week playing video making them addict, who will feel discomfort if they don't play video game (Jones S., 2011). Current neuropsychological theories of emotion state that when the orbitofrontal and limbic regions feel a social situation as challenging or threatening, the central nucleus of the amygdala initiates a series of arousing

physiological processes that involve three neuro-endocrine systems that help prime the body for action: the hypothalamic–pituitary–adrenal axis, the sympathetic–adrenal–medullary axis, and the hypothalamic–pituitary–gonadal axis (Rolls, 2015).

The adrenocorticotropic hormone from anterior lobe of the pituitary gland under the influence of corticotropin-releasing factor from hypothalamus, stimulates the adrenal cortex in the adrenal gland to release the cortisol, the end product of this hypothalamic–pituitary–adrenal stress response in the blood (Rolls et al., 2006). Cortisol, a stress hormone has an inhibitory effect on testosterone production, This decline in testosterone level not only affects the dominant behaviors but also reinforces those dominant behaviors (Bos et al., 2012).

Cortisol increases blood glucose level which increase the supply of glucose to brain and repair tissue. In order to maintain homeostasis in the appearance of actual or perceived stress, the human stress response has developed. Auto-regulating neuronal and hormonal systems work together with central and peripheral clocks to accomplish this goal. One important regulatory pathway in the maintenance of these homeostatic functions is the hypothalamic-pituitary-adrenal axis. This system results in the pulsatile secretion of cortisol with variations in pulse amplitude generating a circadian rhythm. Pulsatility is maintained and cortisol levels increases during acute stress. As part of the fight-or-flight response, acute raise in cortisol levels helps to promote survival of the fittest. However chronic stress reverses the positive effects, making long-term cortisol exposure maladaptive. This can result in a variety of issues, such as the metabolic syndrome, obesity, cancer, mental health issues, cardiovascular disease, and an increased risk of infection (Russell and Lightman, 2019).

The hypothalamic-pituitary-adrenocortical axis is activated during the physiological stress response, when cortisol level increase (Stajer et al., 2020). The measurement of three hormones—cortisol, testosterone, and alpha-amylase that react to both physical and psychological stress may be helpful for assessing the psycho-physiological demands of athletic competition. Thus, examining these hormones at the same time may help us better understand how sports competition specifically affects athlete's abilities, specifically stress mediated release of cortisol (Arruda et al., 2018).

A psycho-physiological stress reaction is expected from playing esports competitively. Studies have reported a link between competition; a crucial component of esports, and changes in psycho-physiological states (Leis et al., 2020).

Present study was designed for the assessment of stress biomarker, blood glucose concentration in athletes and esports athletes.

Materials and Methods

The current study was approved by the Institutional Ethical Review Committee of Lahore Garrison University (LGU). A total of 40 subjects including athletes and esports athletes were recruited from different areas of Lahore ranging from 14-25 years of age. The subjects were grouped as athletes (active player) and esports athletes (video game players).

The inclusion criteria for the study was 1-4 hours of physical activity for the athletes and 5 hours of video game play for the esports athletes in 24 hours period. Whereas subjects with previous hormonal, hepatic, Renal and Cardiac history were excluded from the study. A uniform comprehensive questionnaire was designed to document the demographic variables for the study and informed consent was taken from the participants prior to the study.

Fasting Blood samples was drawn using CL blood collecting needle into properly labelled vacutainers (sodium fluoride tube) for blood glucose analysis and in Gel clot activator tubes for serum cortisol analysis. Sample tubes were transported to laboratory within thirty minutes to 1 hour. The sample label was verified with the questionnaire. The equipment and kits used to determine blood glucose and serum cortisol were approved by Federal Drug Agency (FDA), USA.

Blood samples were centrifuged at 3000 rpm for 5 minutes. Glucose reagent was thawed at room temperature. Subsequently, 1000 µl reagent and 10 µl sample was dispensed in eppendorf tube with the help of micropipette. The samples were analyzed in chemistry analyzer for quantitative assessment.

Statistical analysis

The data was analyzed through unpaired t-test using Graph pad prism version 6 software. The data is presented as Mean ± SEM

Results

A significant increase in serum cortisol level was found in esports athletes as compared to athletes (P<0.0001). Comparison of BMI in physically athletes and esports athletes' groups did not show any significant difference.

In addition, systolic blood pressure in both physically athletes and esports athletes groups presented no significant difference. Similarly, diastole blood pressure in physically athletes and esports athletes groups presented no significant variation (P > 0.05). The value of diastole was found to be 78.05 ± 1.41 mmHg in active group. Whereas value of diastole was found to be 81.95 ± 1.62 mmHg in inactive participants (Figure 1, Table 1).

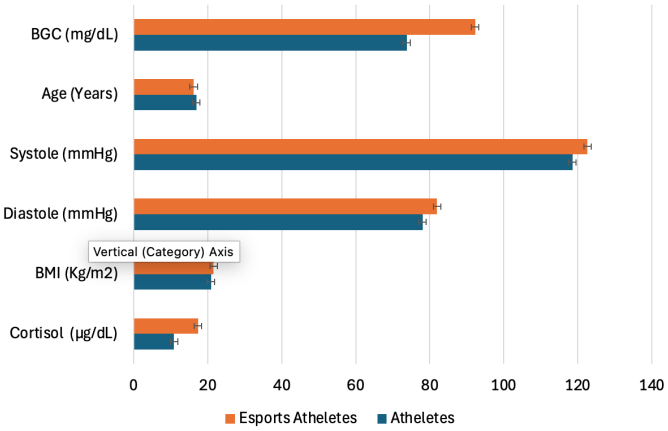

*Figure 1: Presenting comparison of cortisol, Blood Pressure, Blood sugar and in athletes and esports athletes. ***Indicate Significance at P < 0.001. BGC: Blood Glucose Concentration*

Comparison of blood glucose concentration (BGC) in physically athletes and esports athletes' groups presented significant variation (P<0.0001). The value of BGC was found to be 73.80

± 1.14 in active group. Whereas the value of BGC was found to be 92.30 ± 2.85 in inactive participants. Comparison of age in both physically athletes and esports athletes' groups presented no significant variation (Figure1; Table 1).

Discussion

Physical activity like walking, running, jumping cricket, badminton, hockey etc. is inversely related with the serum cortisol level (Klaperski et al., 2013, 2014; Rimmele et al., 2007, 2009; Strahler et al., 2016). Cortisol; a stress biomarker elevates in serum during sedentary lifestyle, leading to different health concerns. (Smyth et al., 2013).

Acute stress may enhance the decision-making ability and the brain capability for certain types of tasks (McEwen et al., 2013). On the contrary, chronic stress disrupts mental abilities and reduces the intracellular communication in hippocampus and prefrontal cortex that effect on decision-making power and short-term memory (Popoli et al., 2012).

Table 1: Comprehensive presentation of studied variable in physically active and physically inactive groups.

Parameters	Athletes (n=20)	Esports Athletes (n=20)	P –Value	%age Difference
Cortisol (µg/dL)	10.88 ± 0.63	17.37 ± 0.72	< 0.0001	60↑***
BMI (Kg/m²)	20.91 ± 0.77	21.56 ± 0.85	0.5	3.1↑
Diastole (mmHg)	78.05 ± 1.41	81.95 ± 1.62	0.07	4.99↑
Systole (mmHg)	118.6 ± 1.49	122.6 ± 1.70	0.08	3.3↑
Age (Years)	16.90 ± 0.20	16.20 ± 0.28	0.05	4.1↓
BG (mg/dL)	73.80 ± 1.14	92.30 ± 2.85	< 0.0001	25↑***

BMI: Body Mass Index**, BG:** Blood Glucose, **mg/dL**: milligram per deciliter, **µg/dL**: microgram per decilitre

Esports effect emotions causing stress in the players which lead to increase in cortisol level. Moreover, disturbance in sleep-awake cycle can disturb body's circadian rhythm affecting the hormonal level. Furthermore, esports of intensive nature cause overstimulation of CNS that triggers the body stress leading to increase in the cortisol level (Aliyari et al., 2019; Anderson 2004).

High cortisol level has been reported previously in athletes competition setting as compared to pre- and post-game (Arruda et al., 2014). Most of the sports involving physical activities are held in daytime, that does not affect the circadian rhythm of the athletes, hence, cortisol level is low. Stress induced elevated hormonal level helps to cope with stress (Casanova et al., 2020).

In current study, elevated BGC in esports athletes as compared to athletes are in agreement with previously published data that reported increase in BGC due to increase in cortisol level (Djakani et al., 2013). Due to competitive pressure, an esports athletes experience stress, leading to higher BGC due to epinephrine, nor-epinephrine and cortisol. The increase in BGC is because cortisol inhibits the action of insulin and promotes glucagon function (Pratiwi et al., 2014, PEI, 2015, Sukartini et al., 2020). BGC has been reported to decrease during aerobic exercise (Poehlman et al., 2000). BGC in diabetes type II patients is well controlled due to exercise (Yang et al., 2014).

Systolic and diastolic blood pressure is lower in physically active person as compared to physically inactive person with low the risk of cardiovascular disease, which is in accordance with previous studies (Adler et al., 2000). In esports athletes, stress mediated high level of cortisol stimulates the heartbeat and narrows the blood vessels which elevate the blood pressure (Smyth et al., 2013, Pires et al., 2020).

According to a number of studies, those who regularly exercise often have lower BMI values than people who lead sedentary lives. Frequent exercise, especially aerobic exercises like cycling, swimming, or running, improves fat oxidation and encourages the growth of lean muscle mass, all of which lead to a lower BMI and a better body composition (Willis et al., 2012). Sedentary habits, on the other hand, such as extended sitting or little exercise, are linked to lower energy expenditure and a greater risk of weight gain, which will ultimately result in higher BMI levels (Thorp et al., 2011; Chau et al., 2013).

Modern lifestyle, generational differences and technology accessibility led to the trend of younger people prefer esports over the regular sports (Granic et al., 2014). Parental approach to engage the children with mobile devices to make them busy is another factor of esports preference over regular sports. (Przybylski and Weinstein, 2017).

Conclusion

Athletes of active games are less prone obesity, cardiovascular disease, type-II diabetes etc. with normal serum cortisol levels. On the other hand, esports athletes spend most of the time with zero to no physical activity, that put them at high risk of obesity, cardiovascular diseases, type II Diabetes, dementia, depression, anxiety, etc. with poor cognitive function.

Author contributions

FB, SY; Sample and data collection, MAI; Data analysis and writeup, UR: Conceptualization of the study, AS Editing and proof reading, FL; Biochemical analysis.

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