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Cortisol, IL-6, TNF Alfa, Leukocytes and DAMP on Exercise

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ABSTRACT

Exercise is one of many physical stressor and causes the changes of human body regulation system. Physical activity causes significant changes of the endocrine system and affects the metabolism. It activates the inflammation signal resulting in a rapid and transient increase of number of leukocytes and induce the proinflammatory cytokines, i.e IL-1, IL-6 and TNF alpha. Also, affects the hypothalamus-pituitary-adrenal axis which regulate the cortisol secretion as a stress hormone. Cortisol levels will increase according to the level of stimulation provided through exercise. Duration and intensity of exercise influence the amount of body regulation response moderate to high intensity were effectively increase the plasma and salivary cortisol levels, both in men and women groups. Study showed significant differences in salivary cortisol levels between each specialists of swimmer athletes according to different amount of energy require and induce different level of stress effects, depending on the duration and intensity of each specialists.

Keywords: Cortisol, IL-6, TNF alpha, Leukocytes, DAMP, Exercise

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INTRODUCTION

The most important part of human body's regulation system in stress condition is corticotropin-releasing hormone (CRH), the locus ceruleus norepinephrine system and its peripheral effectors, the hypothalamus-pituitary-adrenal (HPA) system and the autonomic system.[1] Exercise is one of the stress triggers by raises the energy needs and causes the homeostasis imbalance.[2] Exercise stimulates strong HPA axis. Endurance training does not have a permanent effect on hypercorticolism because the biological markers in the HPA axis are the same as those who do not exercise at rest phase in healthy men. During practice, the HPA axis responds to many stimuli that reflect the regulation and integration functions of the HPA axis, it's known as neural homeostatic signals (chemoreceptor stimulation, baroreceptors, osmoreceptors), homeostasis circulation signal (glucose, leptin, grelin and atrial natreutic peptide), and also inflammation signal (IL-1, IL-6, and TNF alpha).[3,4]

The intensity and duration of exercise are the two main factors that stimulate the HPA axis response.[3] Different types of exercise causes the different effects to the hormonal system. Greater hormonal response is shown in strength training. Cortisol levels will increase according to the level of stimulation provided through exercise. High-intensity exercise will increase the activity of stress hormones such as cortisol, ACTH, and catecholamines, which cause the inhibition of protein synthesis and trigger the degradation of proteins that break the skeletal muscle protein.[2]

The main endogenous glucocorticoids in human body is cortisol (a steroid hormone produced and excreted by the fasciculation zone in the adrenal cortex).[2] Normal range levels of cortisol are 601 up to 689 nmol/L in the right adrenalis vein and 331 up to 335 nmol/L in the left adrenalis vein.[5] Cortisol concentration in the circulation regulated by HPA axis after an acute exercise,[6] or as the neuroendocrine system's respon that activated by physiological stimuli, such as stress, depression, Cushing's Syndrome, and exercise.[2] Stress can occur physically and psychologically, both are induces the stress hormone, such as cortisol. Ponce et al proved that strenuous physical activity (not moderate activity) and psychological stress both are increases the concentration of cortisol in saliva. Even, researches find no significant difference between salivary concentration in people experiencing physical stress and psychological stress.[7] In fact, in neonates the salivary cortisol concentration was higher in infants with partial rooming-in care than in infants with full rooming-in care, because of the breast-feeding and mother-child contact occurs more frequent and intense that will reduce the stress hormones reaction in the neonates.[8]

The results of a study by Lovallo et al showed cortisol responses to psychological stress were smaller in women than in men.[8] The results of the study by Qingyun Lu et al of 46 male and female adolescents aged (10-12 years) showed a positive correlation between height cortisol levels in hair with the signs of stress in adolescent boys. In contrast, adolescent girls actually have a lower cortisol concentrations in hair and saliva. This happens because the sign of stress which experienced by adolescent boys is related to the long-term cortisol concentration in hair, while the sign of anxiety in

adolescent girls is related to the hypoactivity of the HPA axis.[9,10]

Cortisol levels are most often measured from salivary specimens, the aim being to determine a person's stress level. Laboratory examination with this sample is easier, non-invasive, does not hurt, accurate and faster than examination with urine sample which is the second most commonly used method. To examining cortisol levels in athletes, blood is the most recommended specimens to identify the differences of cortisol levels in every phases during the exercises.[11]

Cortisol concentrations continuously getting higher along the increasing of exercise intensity and duration.[3] Exercise intensity is often expressed as a percentage of maximum aerobic capacity value or maximal oxygen capacity (VO2 max) .[12] VO2 max represents the maximum amount of oxygen that can be circulated from lungs to the muscles in millimeters, or in minutes per kilogram of body weight.[12,13] Percentage of the minimum VO2 max must be at least 60% to induce a significant HPA axis response and produce the cortisol.[13,14]

Study result by Papadopoulos et al showed that the cortisol values of control swimmers grup (non competition) were higher than the competitive swimmers, respectively 2.7 ng/mL and 2.5 ng/mL. Because, during quiet weeks athletes performing a longer duration of training, 14 until 19 hours per week, while the opposite group only practice 8.5 until 9.5 hours per week.[13,14] Similarly, study by Silva et al on males and females swimmer with different specialties (sprinter, long distance and middle distance) showed that there were no statistically significant differences in cortisol levels between before and after competition in male and female swimmers. However, there are significantly differences in salivary cortisol levels between each specialists.[15] This is because different specialists require different energy and induce different level of stress effects, depending on the duration and intensity of each specialities.

A similar study by Hill et al. showed that exercise with 60% and 80% VO2 max intensity caused a significantly greater cortisol levels compared to a session with only 40% exercise intensity. Moderate and high intensity exercise causes an increase in plasma cortisol levels. On the other hand, low intensity of exercise does not show a significant induction in cortisol levels, but rather causes a reduction in circulating cortisol levels.[16]

In some literatures, cortisol is called as stress hormone because it influences cellular metabolism and mobilizes energy sources for use in stressful situations by stimulating proteolytic, glycogenolysis, gluconeogenesis and lipolysis.[2] In addition, cortisol also works as an anti-inflammatory and suppresses the immune responses which can be as portal entry of infection agents, this is associated with the increases of upper respiratory tract infections' risk. During exercise, cortisol triggers the catecholamine synthesis.[17] The circulation of stress-induced catecholamine are hypothesized to selectively activates the adrenergic receptors on immunocompetent cells that modulates the inflammatory response to trauma or toxins from the environment.[18] Catecholamines are thought to trigger the begins of an increase in lymphocyte counts (lymphopenia) after the exercise activity.[17] Catecholamine responses have been shown increase significantly after Wingate sprints, both in men and women.[19]

When someone faces a stressor, cortisol will be released to prepare the body to regulate the behaviour and physiological responses. In athletes, the difference response can be identify from the performance during the competition. Increased stress regulation activities will also cause increased focus and attention, and suppress the pain response. The respiratory and cardiovascular systems become faster, catabolism increases and blood flow is diverted as much as possible to the brain, heart and muscle systems to produce more energy. Therefore, stress has the potential to improve the performance of athletes.[20] However, excessive exercise will cause effects on the endocrine system and organs, for example causing amenorrhea and low bone density in women. Ackerman et al conducted a study of eumenorrhoeic and amenorrhoeic young women who routinely do weightlifting. The result showed that cortisol concentrations in the amenorrhoeic group were higher than those the eumenorrhoeic and control groups, this correlated with lower LH hormone secretion which was useful for stimulating the ovulation.[21]

Research shows that there is a significant change in cortisol levels between before and after practice or competition. Test cortisol levels before participating in match can be an indicator level of stress that can affect the behaviour and physiological responses of the body, then this will caused some beneficial or even detrimental effects in terms of performance during the match.[11] Lautenbach et al has conducted a research to determine the relation between cortisol levels with competition results and athletes performance in 2 rounds of taekwondo competition with twenty international taekwondo athletes, men and women aged 13 until 17 years old. As the result, cortisol levels before the match and 30 minutes after match both significantly have a negative correlation with the number of match points during the first round, second round and the total of points. It's mean the higher cortisol level, the lower points achieved in the match. However, cortisol levels during the match did not have a significant correlation with the acquisition of total points.[22]

Consistently, various studies have shown that exercise with intensity more than 60% VO2 max will induce higher levels of cortisol release in adults. Studies also have shown that every teenagers' body has the same response to an increasing hypothalamic-pituitary-adrenal axis reaction and cortisol response after exercise. For example, in adolescents (15 to 16 years old) who performs an exercise for 12 minutes with intensity about 70-85% of the maximum pulse rate will experience a higher cortisol levels then the group with only moderate intensity exercise (50-65% maximum pulse).[23]

Duclos et al examined the difference in plasma cortisol and salivary cortisol levels between the after-break session and the after-training session with 8 male runners as the research subjects. The results showed the value of salivary cortisol in the after-training session, both from plasma and saliva, experienced a significant increase compared to the value of cortisol in after-break. Otherwise, plasma cortisol concentrations did not differ statistically between after-training and after-break. The cortisol ratio baseline value is

smaller in the after-rest session than in the after-training session.[24] As in Bolados et al's study of the comparison of cortisol levels in continuous aerobic exercise (AEE) and high-intensity interval training (HIIT), the results showed that the cortisol concentration in 12 hours after the intervention significantly increased in AEE and HIIT groups, compared with pre-intervention levels. This increase is likely related to the circadian variation of the cortisol hormone.[25]

A research conducted by Benjamin Siart et al to a group of athletes showed a significant increase in cortisol concentrations in salivary specimens immediately after the competition, compared to 24 hours before the competition.[26] Research by Keyan et al to 62 participants with healthy conditions (31 of them were did intense exercise for 10 minutes and the remaining 31 take a leisure walk. Then examination of cortisol levels in saliva, the results obtained a significant increase after doing intense training compared with the concentration before training.[5] Crewther et al conducted a study with the same aim with 71 junior athletes (45 males and 26 females) who participated in the weightlifting competition simulation, using blood and salivary spesimens. The result showed that after high intensity sports competition there was a significant increase in total cortisol concentration in the blood, both male and female athletes.[27,28] However, no significant change was found in cortisol levels in saliva between before and after the intervention.[28]

Research by Sanavi et al. conducted on 17 healthy young men (23 until 33 years old) who were trained (routinely performing training for at least 3 days per week for the last 2 years), they were asked to perform 3 sessions of aerobic training in the form of running 30 minutes on a treadmill with 3 different intensities, i.e. 70 %, 80% and 90% of the maximum heart rate (MHR). The results showed a significant increase in serum cortisol levels at 0 hours after exercise compared with the value before the exercise. Then, 1 hour after practice the levels will drop, both 70%, 80% and 90% MHR.[29] Similar studies by Mazdarani et al to the younger basketball athletes (average age 10.58 years) as the research subjects also showed the same results. From 12 teenage basketball players who were the subjects, the average salivary cortisol levels after participating in the basketball competition increased significantly compared to before the competition.[30]

In contrast, research by Mona et al to 60 patients as respondents, men and women (60-70 years old), they were divided into 3 groups and asked to perform exercises with different intensities: mild (group A), moderate (group B) and high (group C) intensity, there was a significant decrease in the median serum cortisol values measured by blood specimens after exercise compared to before training in groups A and B. While in group C there were no significant differences in the median serum cortisol values before and after exercise.[16] A similar finding was obtained in Rosa et al's study by blood specimens from 10 men. After following 2 concurrent training programs, there was a significant decrease in serum cortisol levels after the first and second exercise programs.[31] Another study conducted by Alfredo et al to a group of basketball players during 4 seasons (October, December, March and April), the results showed that basal cortisol levels changed significantly during the season, higher levels were found in October and March.[32]

Exercise and sports with heavy intensity and competitive become one of the causes of stress (stressors). However, training and exercise which continuously performed in the right dose will reduce the secretion of HPA axis, lower hypercortisol, activate proinflammatory cytokines IL-6, stimulate the growth hormone secretion, prolactin and increase the immunity by stimulating Th2. This is how the training and routine exercise can sustained positive effects on human body and enhance our wellbeing.[33] Physical fitness causes significant changes to the endocrine system, which then affects metabolism, including protein metabolism. The endocrine glands secrete hormones into the circulation, bind to specific receptors in the target cell, and have an effect on specific gene expression. In muscle cells, cortisol is the only hormone that stimulates protein degradation. The release of the cortisol due to stress can activate the sympathetic nervous system, characterized by an increase in pulse frequency. High levels of the cortisol in blood can also reduce a person's ability to think and react. The cortisol also plays a role in decreasing mood and muscle fatigue.[34]

However, the results of research by Nuryadi et al showed that there is a significant negative functional correlation between physical fitness and cortisol response that is -0.203 which means that the higher physical fitness generate the lower cortisol response with a contribution value of 4.12%. Researchers suspect that the area of residence will affect physical fitness, cortisol concentration and response abilities, which found differences in the percentage of physical fitness contribution to cortisol responses between respondents in highlands and lowlands region, which were 4.12% and 8.47%, respectively.[34]

Related to the effect of exercise time on cortisol levels, research by Haslinda to 10 subjects who were given futsal training at night as the intervention and another 8 subjects as control, showed that there was no significant effect on cortisol levels. Haslinda concluded that futsal activities can still be done at night with mild to moderate intensity in a not too long time because it does not affect the concentration of cortisol in plasma.[35] Haslinda also conducted the same research on subjects who carried out futsal activities in the morning. The results showed an increase in cortisol levels after futsal than before, but statistically this value was not significant. In fact the control group who did not do futsal experienced a significant increase in serum cortisol levels. This can be caused by a circadian cycle in which cortisol secretion levels are at the highest level. Serum cortisol secretion begins to increase in the middle of the night and reaching its peak in the morning. Furthermore, the possibility of this increase is due to other factors that can increase cortisol secretion, namely psychological stress which also triggers cortisol release, as discussed above.[36]

Training and exercise can cause the production of short-term inflammatory responses followed by leukocytosis, especially systemic neutrophil counts, damage to muscles and internal organs and immune suppression.[37,38] It also triggers increased oxidative stress, increased serum cortisol and plasma CRP levels.[38,39] This proinflammatory response is followed by long-term anti-inflammatory effects. Regular exercise will

decrease CRP, IL-6 and TNF alpha and increase anti-inflammatory substances such as IL-4 and IL-10. In healthy young people, a 12-week high-intensity aerobic exercise program will reduce the release of cytokines and monocytes. In fact, physical activities carried out during leisure time, for example walking casually, jogging, or running, will also reduce the concentration of high sensitivity CRP with gradual levels.[38]

Regular exercise has a positive effect on human body, but an acute exercise can actually be responded to by the body as a physical stressor resulting in a rapid and transient increase in the level of white blood cells, called leukocytosis, which indicates the process of margination or attachment of phagocytes and neutrophils to the endothelial wall.[40] Neutrophils are the first component of leukocytes released in response to a trauma, mainly caused by bacteria.[41] Likewise what happens under stress after exercise or sports, where an increase in leukocytes is followed by the increase of natural killer cells (NK) and T cells cytotoxic CD8+. The occurrence of NK marginalization and mobilization is partly due to the presence of epinephrine which mediates the response.[39,42,43,45] However, the inflammatory response will decrease during acute exercise to protect the body from chronic conditions of mild inflammation.[42] In addition, the body has an endogenous alarm signal called damage-associated molecular patterns (DAMP) to prevent secondary inflammatory responses due to the release of inflammatory factors intracellular to extracellular parts. One of these DAMP proteins is high mobility group box 1 (HMGB1), which is a sign of muscle cells damage and causes the mobilization of immune cells to the site of trauma.[4]

Research by Dimitrov et al showed a regulation of decreased monocytic TNF production during acute exercise mediated by high levels of epinephrine.[42,46,47] Muscle contractions directly induce the release of IL-6 which is an anti-inflammatory cytokine, working to weaken the production of alpha TNF and IL1 beta, both of which are known will form in the acute phase reaction and during cell proliferation. Moderate intensity training (MIT) is effective in reducing body fat, this condition prevents fat cell damage and prevents cell hypoxia, so proinflammatory cytokines, IL6 and TNF, are reduced through increased secretion of adiponectin and increased anti-inflammatory cytokines. Exercise with high intensity (High Intensity Interval Training or HIIT) is known to be effective in increasing lipid profile and the release of anti-inflammatory cytokine because when a person does HIIT there is muscle contraction that causes mitochondrial activity to be maximized in enzymatic reactions. This will increase glucose uptake in skeletal muscle which will eventually also cause an increase in adiponectin secretion.[4,13]

Table 1: Review of Research of Cortisol, IL-6, TNF Alfa, Leukocytes and DAMP on Exercise

<table>
<tr><th>No</th><th>Title (Author)</th><th>Respondents</th><th>Method</th><th colspan="2">Results</th></tr>
<tr><td rowspan="3">1.</td><td rowspan="3">Status, Stress and Performance in Track and Field Athletes during the European Games in Baku (Azerbaijan) (Benjamin Siart, Alfred Nimmerichter, Claudia Vidotto, Bernard W.)</td><td rowspan="3">19 athletes (11 males dan 8 female athletes).</td><td rowspan="3">Respondents asked to college their salivary specimens in the morning, before and immediately after the competition.</td><td>Before</td><td>After</td></tr>
<tr><td>3.89 ±1.77 ng/mL</td><td>7.57 ±3.72 ng/Ml</td></tr>
<tr><td colspan="2">Conclution:
There was a significant increase in cortisol concentration in salivary specimens immediately after the competition compared to 24 hours before the competition.</td></tr>
<tr><td rowspan="5">2.</td><td rowspan="5">Testosterone And Cortisol Changes In Professional</td><td rowspan="5">12 basketball professional players from Spain (±25.3</td><td rowspan="5">Peripheral blood specimens were taken at 4 times during the season: October,</td><td>Month</td><td>Cortisol Level (microgram/dL)</td></tr>
<tr><td>October</td><td>22.59 ± 1.75</td></tr>
<tr><td>December</td><td>16.38 ± 0.99</td></tr>
<tr><td>March</td><td>22.65 ± 1.22</td></tr>
<tr><td>April</td><td>17.67 ± 1.16</td></tr>
</table>

<table>
<tr><td></td><td>Basketball Players Through A Season Competition (Alfredo Cordova Marti´Nez, Jesus Seco Calvo, Josep A. Tur Mari´, Luis Carlos Abecia Inchaurregui, Enrique Echevarri´A Orella, Antoni Pons Biescas)</td><td>years old), ±96.8 kilograms body weight, ±198 cm body height and 56.6 ml/kg/minutes VO2 max. Subjects were not smoked,drank alcohol or took altered-hormonal response drugs.</td><td>December, March and April.</td><td></td></tr>
<tr><td>3</td><td>Acute response of serum cortisol to different intensities of resisted exercise in the elderly (Mona M. Tahaa, Khaled M. Mounir)</td><td>Total 60 elderly patients (60-70 years old), both males and females.</td><td>Subjects were divided into 3 groups and asked to performed the exercises in the difference intensities:mild (group A), moderate (group B) and high (group C). Cortisol serum dialyzed 15 minutes before and after the intervention</td><td><table><tr><td rowspan="2">Groups</td><td colspan="2">Cortisol Levels</td></tr><tr><td>Pre treatment</td><td>Post treatment</td></tr><tr><td>A</td><td>6.30</td><td>4.90</td></tr><tr><td>B</td><td>6.45</td><td>5.30</td></tr><tr><td>C</td><td>5.60</td><td>4.95</td></tr></table>Conclution:
There was a significant decrease in the median serum cortisol values measured by blood specimens after exercise compared to before training in groups A and B. While in group C there were no significant differences in the median serum cortisol values before and after exercise</td></tr>
<tr><td>4</td><td>Role of BDNF val66met polymorphism in modulating exercised-induced emotional memories (Dharani Keyan Richard)</td><td>62 health participants divided into 2 groups (31 people for each group)</td><td>The first group performed intens exercise for 10 minutes, second group performed stroll. Cortisol concentration changes analyzed by salivary specimens before and after 20 minutes of interventions.</td><td><table><tr><td rowspan="2">Interventions</td><td colspan="2">Cortisol Mean (µg/dL)</td></tr><tr><td>Pre intervention</td><td>Post intervention</td></tr><tr><td>10 minutes intens training</td><td>0.15</td><td>0.22</td></tr><tr><td>stroll</td><td>0.11</td><td>0.08</td></tr></table>Conclusion:
There was a significant increase of cortisol concentration after an intense training compared with the concentration before training.</td></tr>
<tr><td>5</td><td>The utility of salivary testosterone and cortisol concentration measures</td><td>71 junior athletes (45 males, 26 females) who will join the</td><td>Blood and salivary specimens were taken 2 times: before and after the simulation.</td><td><table><tr><td>Genders</td><td>Pre</td><td>Post</td></tr><tr><td colspan="3">Blood</td></tr><tr><td>Males</td><td>434±140</td><td>493±181</td></tr><tr><td>Females</td><td>381±94.2</td><td>497±199</td></tr><tr><td colspan="3">Salivary</td></tr></table></td></tr>
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<tr><td></td><td>for assessing the stress responses of junior athletes during a sporting competition (Crewther, B. T., Obmiński, Z., Orysiak, J., & Al-Dujaili, E. A. S.)</td><td>weightlifting competition simulation.</td><td></td><td>
<table>
<tr><td>Males</td><td>21.1±6.5</td><td>20.2±9.0</td></tr>
<tr><td>Females</td><td>20.4±3.9</td><td>23.4±9.9</td></tr>
<tr><td colspan="3">Conclusion:
A short and high intensity of sport competition as a physical stressor induced a significant increase in total serum cortisol concentration, both in male and female athletes. However, there was no significant response of cortisol in saliva.</td></tr>
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</td></tr>
<tr><td>6</td><td>Concurrent Training Decreases Cortisol but Not Zinc Concentrations: Effects of Distinct Exercise Protocols Guilherme Rosa, Marcos de Sá Rego Fortes, Danielli B. de Mello</td><td>10 male volunteers as the research subjects (±27.1 years old, with ±74,89 kg body weight, and BMI ±25,38), practiced aerobic and strength exercise for a minimun 6 months (at least 3 times a week).</td><td>Before the interventions, subject asked to fast for 12 hours, sleep at least 8 hours and do none of activity before the basal cortisol serum level examined by blood specimens. 2 hours after that, second blood specimens were taken. After 5 days, the subjects performed the first concurrent training (P1): indoor cycling followed by strength training, and after this season the blood samples were collected. The second program (P2) same as the first one and blood samples were collected after the intervention.</td><td>
<table>
<tr><td rowspan="2">Fase</td><td colspan="2">Cortisol Concentration (mcg/dL)</td></tr>
<tr><td>Pre</td><td>Post</td></tr>
<tr><td>Basal</td><td>13.94 ± 3.29</td><td>13.10 ± 3.17</td></tr>
<tr><td>P1</td><td>18.61 ± 5.43</td><td>13.71 ± 4.87</td></tr>
<tr><td>P2</td><td>14.98 ± 2.93</td><td>9.95 ± 2.26</td></tr>
<tr><td colspan="3">Conclusion:
After following 2 concurrent training programs, there was a significant decrease in serum cortisol levels after the first and second exercise programs</td></tr>
</table>
</td></tr>
<tr><td>7</td><td>Effects of aerobic exercise intensity on serum cortisol and testosterone in trained young men</td><td>17 healthy young age men (±23.33 years old), trained well (routinely performes the exercise, at least 3</td><td>Subjects asked to performed 3 sessions of aerobic exercise (running for 30 minutes using treadmill) in 3 different intensities: 70%,</td><td>
<table>
<tr><td>Waktu</td><td>70%</td><td>80%</td><td>90%</td></tr>
<tr><td>Pre</td><td>8.987 ± 2.375</td><td>8.992 ± 2.362</td><td>8.998 ± 2.364</td></tr>
<tr><td>0 jam post</td><td>7.6 85 ± 3.665</td><td>12.017 ± 6.121</td><td>19.907 ± 11.337</td></tr>
<tr><td>1 jam post</td><td>8.8 ± 6.415</td><td>7.57 ± 1.076</td><td>11.864 ± 5.908</td></tr>
<tr><td colspan="4">Conclusion:</td></tr>
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<tr><td></td><td>(Suzan Sanavi, Mohammad -Ali Kohanpour)</td><td>days a week for the last 2 years)</td><td>80% and 90% of maximum heart rate (MHR).</td><td colspan="4">The results showed a significant increase in serum cortisol levels at 0 hours after exercise compared with the value before the exercise. Then, 1 hour after practice the levels will drop in all levels of intensity.</td></tr>
<tr><td>8</td><td>Testosterone and Cortisol Responses to HIIT and Continuous Aerobic Exercise in Active Young Men (Cristian Cofré-Bolados, Patricia Reuquen-López, Tomas Herrera-Valenzuela, Pedro Orihuela-Diaz, Antonio Grcia-Hermoso and Anthony C. Hackney)</td><td>13 male students studying physical education, with 50.9 ml/kg/minutes VO2 max relative and performed 150 minutes a week physical activity in moderate to high intensity.</td><td>Subjects asked to performed the activity, started at 6.4 km per hour and speed increases 1.6 km per hour for every minute. 3 days after the intervention, subjects asked to performed 3 non consecutive sessions with 72 hours between each session. The sessions were control, AEE (treadmill), and HIIT (running). Blood sampels were taken 3 times (before, immediately after AEE and HIIT, and 12 hours after training)</td><td colspan="4"><table><tr><td></td><td>Break</td><td>0 hour</td><td>12 hour</td></tr><tr><td>Pre (control)</td><td>8.16</td><td>8.16</td><td>13.17</td></tr><tr><td>AEE</td><td>10.13</td><td>11.95</td><td>13.99</td></tr><tr><td>HIIT</td><td>8.75</td><td></td><td>13.25</td></tr></table>Conclusion:
The results showed that cortisol concentration in 12 hours after the intervention significantly increased in AEE and HIIT groups, compared with pre-intervention levels. This increase is likely related to the circadian variation of the cortisol hormone.</td></tr>
<tr><td>9</td><td>Corticotroph axis sensitivity after exercise in endurance-trained athletes (M. Duclos dkk)</td><td>8 male healthy runners, runs 55 km a week for at least last 8 years and completed the marathon in less than 3 hours.</td><td>Performed 2 session:post break and post training sessions, with 7 days off between each session.Blood and salivary samples were taken 5 times.</td><td colspan="4"><table><tr><td>Times</td><td colspan="2">Plasma Cortisol</td><td colspan="2">Salivary Cotrisol</td></tr><tr><td></td><td>Post break</td><td>Post training</td><td>Post break</td><td>Post training</td></tr><tr><td>T0</td><td>70.4 ± 13.3</td><td>111.2 ± 15.4</td><td>1.6 ± 0.3</td><td>2.9 ± 0.9</td></tr><tr><td>T15</td><td>45.4 ± 17.2</td><td>66.0 ± 14.6</td><td>0.9 ± 0.4</td><td>1.3 ± 0.3</td></tr><tr><td>T30</td><td>68.5 ± 20</td><td>78.5 ± 16.6</td><td>2.5 ± 0.7</td><td>2.8 ± 0.5</td></tr><tr><td>T60</td><td>102.3 ± 29.4</td><td>121.1 ± 28.4</td><td>5.8 ± 1.8</td><td>6.4 ± 1.3</td></tr><tr><td>T90</td><td>123.8 ± 34.1</td><td>147.3 ± 35.8</td><td>5.7 ± 1.4</td><td>8.1 ± 2.0</td></tr></table>Conclusion:
The results showed the value of salivary cortisol in the post-training session, both from plasma and saliva, experienced a significant increase compared to the value of cortisol in post-break. Otherwise, plasma cortisol concentrations did not differ statistically between post-training and post-break. The cortisol ratio baseline value is smaller in the after-rest session than in the post-training session</td></tr>
<tr><td>10</td><td>Exercise and circulating cortisol levels: The intensity</td><td>12 male subjects and actively trained.</td><td>Subjects asked to performed the exercise for at least 30 minutes in 40,</td><td colspan="4"><table><tr><td>Sesi / intensitas</td><td>Preintervensi</td><td>Post intervensi</td></tr><tr><td>Istirahat (kontrol)</td><td>13.5±4.4</td><td>9.1±4.9</td></tr><tr><td>40%</td><td>12.2±4.3</td><td>10.8±5.4</td></tr><tr><td>60%</td><td>12.3±4.1</td><td>20.1±6.0</td></tr></table></td></tr>
</table>

	thresfold effect (E.E. Hill dkk)		60, dan 80% intensity of VO2 max, on the different day they were asked to do nothing for 30 minutes as the break session to measure the control cortisol level.	80%	12.9±6.3	43.2±11.3
				Conclusion: Moderate and high intensity exercise causes an increase in plasma cortisol levels. On the other hand, low intensity of exercise does not show a significant induction in cortisol levels, but rather causes a reduction in circulating cortisol levels		
11	Hubungan Kebugaran Jasmani dengan Kemampuan Konsentrasi dan Respon Kortisol (Nuryad, Jajat Darajat KN, Tite Juliantine1, Didin Budiman, Suherman Slamet, Agus Gumilar)	Total 339 students of 4th, 5th dan 6th grade in highlands and lowlands regions in West Java (151 boys and 137 girls).	Subjects were performed Indonesia wellness test (vertical jump, sit-up, pull-up,dan 40 meters sprint). After those interventions, salivary specimens were collected from every students to analyze the correlation between the physical wellness and cortisol response.		Highlands Region	Lowlands Region
				Total Subjek	137	164
				Correlation Test	-0.203	-0.291
				Coeffition Of Determination	4.12%	8.47%
				P Value	0.017	0.000
				Conclusion: There was a significant negative functional correlation between physical fitness and cortisol response, which means that the higher physical fitness generate the lower cortisol response. Researchers suspect that the area of residence will affect physical fitness, cortisol concentration and response abilities, which found differences in the percentage of physical fitness contribution to cortisol responses between respondents in highlands and lowlands region.		
12.	The Effect of Night Futsal Sport on The Level of Cortisol Serum In Young Adults (Haslinda DS)	10 young adult students in Makassar City were performed night futsal spost and another 8 students as the control.	10 subjects were performed night futsal at 9 pm until 11 pm in 2 rounds (2x20 minutes). Blood samples were collected from all of subjects before and after futsal sport.		Futsal	Control
				Total subjects	10	8
				Median cortisol serum (pretest)	5.91 nmol/L	5.18 nmol/L
				median cortisol serum (posttest)	4.95 nmol/L	1.50 nmol/L
				value difference	-0.87 nmol/L	-0.03 nmol/L
				P value	0.678	1.000
				Conclusion: There was no significant effect on cortisol levels. Futsal activities can still be done at night with mild to moderate intensity in a relatively short time because it does not affect the concentration of cortisol in plasma.		
13	Effects of Official Basketball Competition on the Levels of Cortisol and Salivary Immunoglobulin (A) among female children	12 teenage girls and they were joined for basketball competition.	sSlivary specimens from all the subjects were collected twice: 5 minutes before and after the competition.	Components	Before competition	After competition
				average the salivary cortisol concentration	10.07	20.06
				P value	0.000	0.000
				Conclusion: The average salivary cortisol concentration after participating in the basketball competition increased significantly compared to before the competition.		

<table>
<tr><td></td><td>(Farivar Haji Mazdarani, Neda Khaledi, Mahdi Hedayati)</td><td></td><td></td><td></td></tr>
<tr><td>14</td><td>Cortisol Predicts Performance During Competition: Preliminary Results of a Field Study with Elite Adolescent Taekwondo Athlete (Franziska Lautenbach, Babett H. Lobinger)</td><td>20 taekwondo athletes (7 females, 13 males), about 13 until 17 years old and joined the internasional taekwondo competition.</td><td>Subject performed 2 rounds of competition. Salivary specimens collected 30 minutes before, during and 30 minutes after the competition in every round.</td><td>
<table>
<tr><td></td><td>n</td><td>M</td><td>Min</td><td>Max</td></tr>
<tr><td>C1</td><td>20</td><td>44.30</td><td>15.18</td><td>83.35</td></tr>
<tr><td>Winner's C1</td><td>14</td><td>47.17</td><td>15.18</td><td>83.35</td></tr>
<tr><td>Loser's C1</td><td>6</td><td>37.58</td><td>16.84</td><td>53.27</td></tr>
<tr><td>C2</td><td>16</td><td>35.86</td><td>9.66</td><td>86.94</td></tr>
<tr><td>Winner's C2</td><td>11</td><td>36.03</td><td>9.66</td><td>86.94</td></tr>
<tr><td>Loser's C2</td><td>5</td><td>35.49</td><td>20.42</td><td>53.27</td></tr>
<tr><td>C3</td><td>20</td><td>60.15</td><td>8.83</td><td>86.94</td></tr>
<tr><td>Winner's C3</td><td>14</td><td>65.53</td><td>16.56</td><td>86.94</td></tr>
<tr><td>Loser's C3</td><td>6</td><td>47.61</td><td>8.83</td><td>86.94</td></tr>
<tr><td>C4</td><td>19</td><td>64.80</td><td>26.50</td><td>86.94</td></tr>
<tr><td>Winner's C4</td><td>14</td><td>62.26</td><td>26.50</td><td>86.94</td></tr>
<tr><td>Loser's C4</td><td>5</td><td>71.93</td><td>62.10</td><td>86.94</td></tr>
<tr><td>Points round 1</td><td>20</td><td>4.05</td><td>0</td><td>10</td></tr>
<tr><td>Points round 2</td><td>20</td><td>9.70</td><td>1</td><td>18</td></tr>
<tr><td>Total points</td><td>20</td><td>13.75</td><td>1</td><td>27</td></tr>
</table>
Conclusion:
Cortisol levels before the competition and 30 minutes after competition both significantly have a negative correlation with the number of match points during the first round, second round and the total of points. It's mean the higher cortisol level, the lower points achieved in the match. Cortisol levels during the match did not have a significant correlation with the acquisition of total points</td></tr>
<tr><td>15</td><td>Pre And Post-Competition Cortisol In Athletes From The Brazilian Confederation Of Aquatic Sports (Glauber Castelo Branco Silva, Jose Roberto Andrade Do Nascimento Junior, Antonio Carlos Leal Cortez, Fabrizio Di Masi, Estelio Henrique</td><td>44 swimmers (28 males dan 16 females) about 15.4 years old from 5 regions in Brazil.</td><td>Subjects were performed the swim competition with 3 different specialists: sprinter, middle distance and long distance. Salivary specimens were collected while waiting to be called for the competition and after the competition.</td><td>
<table>
<tr><td colspan="2" rowspan="2">Components</td><td colspan="2">Average of Cortisol Consentration</td></tr>
<tr><td>Pre competition</td><td>Post competition</td></tr>
<tr><td rowspan="2">Gender</td><td>Male</td><td>0.36±0.13</td><td>0.50±0.17</td></tr>
<tr><td>Female</td><td>0.38±0.06</td><td>0.46±0.16</td></tr>
<tr><td rowspan="3">Spesialistik</td><td>Spinter</td><td>0.38±0.10</td><td>0.49±0.16</td></tr>
<tr><td>Middle distance</td><td>0.37±0.14</td><td>0.46±0.16</td></tr>
<tr><td>Long distance</td><td>0.33±0.08</td><td>0.50±0.15</td></tr>
</table>
Conclusion:
There were no statistically significant differences in cortisol levels between before and after competition in male and female swimmers. However, there are significantly differences in salivary cortisol levels between each specialists</td></tr>
</table>

	Martin Dantas, Gislane Ferreira De Melo)			

CONCLUSION

Exercise is one of physical stressor that affects the metabolic and regulation system in human body, include the cortisol concentration, inflammatory responses such as the released of leukocytes and pro-inflammatory cytokines (IL-1, IL-6 and TNF alpha), and also induces DAMP to prevent secondary inflammatory responses.

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