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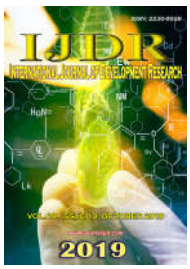

RESEARCH ARTICLE OPEN ACCESS

SALIVARY CORTISOL LEVELS CONCENTRATION AFTER RESISTANCE EXERCISE

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ABSTRACT

To analyze whether there are changes in salivary cortisol concentration levels before and after resistance exercises, with different rest periods. The sample was20 individuals allocated in 2 groups with: resistance exercise 30secandresistance exercise60sec. They performed plyometric jumps followed by squat. The salivary sample was collected to measure salivary cortisol concentration. There was no difference in cortisol concentration between pre and post exercise in any intervention (p> 0.05). The protocol used did not alter salivary cortisol after resistance exercise.

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INTRODUCTION

Physical exercise involves planning cyclical activities to improve physical fitness levels (Kraemer, 2002), such as increase of muscle strength, lean mass, cardiovascular fitness and reduction of fat mass (Kraemer, 2004; Fletcher, 2001). Such adaptations are complex processes that occur acutely and chronically in human organism through hemodynamic and physiological responses. The acute exercise effects occur shortly after exercise, such as increase of blood pressure and heart rate. In addition, chronic effects are related to a few training weeks, attending to adaptations such as increase of muscle insulin sensitivity, muscle hypertrophy and VO_2max (Monteiro, 2004). Regarding the acute effects, studies have shown that combined exercise, aerobic and anaerobic, reduces HDL, as well as increases mitochondria (Silva, 2019; Wilson, 2016; Lundby, 2016). Moreover, others conclude that a single isometric exercise session can diminish blood pressure in healthy and hypertensive subjects (van Assche, 2017).

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Consequently, these adaptations and oscillations change according to training variables such as intensity, interval (Silva, 2011) and duration (Fleck, 1997), quantitiy and orderexercises (Monteiro, 2005). Therefore, in the human body, changes in hormones also occur according on demand (Del Corral, 2016). The glucocorticoids (basically the cortisol) guide the body's stress response as well as nutrient metabolism and plasma glucose levels. When the body enter a stress state, the hypothalamus is stimulated to secrete corticotrophic hormones, which induce the anterior hypophysis to secrete adrenocorticotropic hormones, stimulating the adrenal cortex to release cortisol to supportin the adipose tissue synthesis (increasing lipolysis), as well as proteolysis (protein fractionation) (William, 2016). Hormonal oscillations are also guided by training variables, in which high intensities and short rest periods can lead the subject to a physiological stress characterized to higher cortisol secretions (Hall, 2011). Although, within normal limits, the increase of higher cortisol secretion by exercise does not seem to negatively affect the organism, because it process prepares the organism to receive such energy expendituredemand. However, when the subject

starts to training a lot and rest a less, the cortisol levels rises, which in this case, becomes harmful to health, since the cortisol has a catabolicand protein degradation effect, as well as a high degree of lipid synthesis (Hall, 2011). Thus, it has been suggested that to monitor the cortisol can help to determine recovery intervals andload control (Tian, 2015; Pauli, 2019). In this way, the study's aim is to analyze different rest periods in salivary cortisol concentration levels.The hypothesis of our study is that will not have difference in salivary cortisol concentration levels if collected in differentrecovery intervals.

MATERIALS AND METHODS

Sample: The sample consisted of 20 males with ages ranging from 18 to 40 years, without metabolic, musculoskeletal or other problems that impeded the exercise practice. They were randomly allocatedin 2 groupswith 10 volunteers in each group: resistance exercise with 30seconds of recovery timeand resistance exercisewith 60 seconds of recovery time.This research was approved by the ethics committee of the University Educational Center of Brasília, with number 62829616.5.0000.0023 and all volunteers signed the consent form.

Instruments and procedures: Each participantwent the physiology laboratory for 4 days, at 11:00 a.m. to 1:00 p.m., with a 24 hour interval.Anthropometric and morphological measures were assessed at first meeting, the body mass was measured using the FILIZOLA®clinical scale,the stature was measured usingtheSanny-Model ES 2060 stadiometer (Lohman, 1988). Therefore, to estimate fat percentage skin folds of pectoral, mid-axillary, triceps, subscapular, abdominal, suprailiac and thigh were measured using the Cescorf® clinical compass,with Jackson and Pollock (Jackson, 1978) equation. After sample characterization, familiarization protocol was applied. The second meeting, theindividuals perform 1RM back squat test (Uchida, 20313). In addition, to maintain accuracy of the values obtained, a re-test was done 24h after the first 1RM test, on the third meeting.

The back squat exercise was chosen, because it involves large muscle groups, which increases the cortisol values (Castinheiras-Neto, 2010), and themovement was standardized (Haff, 2016). There was no speed control in repetitions in order to get as close to the maximum as these exercises are performed on a typical sessions. However, in order to minimize the speed variation during the repetitions, volunteers were oriented to maintain a constant and moderate speed (American College of Sports, 2019). The fourth meeting, the individuals performed exercises protocol, the back squat, as described before, andplyometric jumpswith squat, executed as follows: standing, with feet apart at hip width and with contracted abdominal muscles in order to stabilize the spine, the knees were flexed followed by a blast movement jumping and landing in 60cm box from the ground.Therefore, the individuals did2 series of 10 repetitions of back squat,at 70% of 1RM for back squat, followed by 10 plyometric jumps with squats, with60secor 30secof rest. The protocol was adapted fromJakeman, Byrne and Eston (Jakeman, 2010).

Hormonal collect: The salivary cortisol was collected before and afterexercises protocol, theSalivette® saliva collection was used and the individuals received the following guidelines:

- 3 hours fasting if and only if experiment is done after the main meals (lunch);
- Do not eat any food or any drink (other than water) for a period of 30 minutes prior to collection;
- Remain at rest for 10 minutes prior collect;
- Rinse mouth with water through light mouthwash immediately prior collect;
- Collect was denied in the following cases: oral collect lesions with active or potential bleeding, having undergone dental treatment in the last 24 hours, and not having brushed teeth in last 3 hours;
- During collection period, ingestion of food or drink, was not permitted, including water;
- Place cotton inside the Salivette® under tongue and wait for 2 to 3 minutes. It was allowed to chew gently to stimulate salivary flow;
- After indicated period, remove cotton from mouth and return it to the Salivette®;
- After collection, sample was refrigerated for posterior analysis.

Statistical analysis: All analyses were performed using the SPSS (IBM Corporation, Armonk, NY, USA, 24.0) for Windows. For sample characterization, descriptive statistics were performed with mean and standard deviation for quantitative variables, and simples frequency for qualitative variables.The data normality was verified using the Shapiro-Wilk test. The interactions between cortisol response on pre and post exercise protocols were analyzed with a factorial ANOVA of repeated measures (intervention X moment). The Bonferroni post-hoc was used to identify significant differences. Statistical significance level was set at $p \leq 0.05$.

RESULTS

Sample characterization are described in Table 1.

Table 1. Sample chacarterization

	60sec	30sec
Age (years)	23.90 ± 5.22	25.20 ± 5.61
Weight (kg)	84.25 ± 9.78	79.87 ± 5.93
Height (m)	1.78 ± 0.74	1.78 ± 0.44
Fat (%)	16.89 ± 6.12	14.07 ± 5.42
Leanmass (kg)	69.71 ± 7.42	68.38 ± 4.16

Table 2 shows that there was no significant difference in cortisol concentration levels between groups, 30sec x 60sec, neither intragroup, pre x post exercise, $p > 0.05$.

Table 2. Cortisol comparison at pre and post exercise on both groups

		Pre	Post	*p*
Cortisol	60sec	5.71 ± 2.70	7.80 ± 5.50	0.084
µg/mL	30sec	6.89 ± 2.50	6.40 ± 2.48	0.147

DISCUSSION

The analysis of salivary cortisol concentration levels on resistance exercises with different rest periods, do not show significant difference. It is hypothesized that the result presented can be due to the training volume and intensity factor.

Powell *et al*. (2015) concluded that salivary cortisol may be a more sensitive marker for assess cortisol levelson the exercise

recovery phase. In addition, the authors suggest that 11β-hydroxysteroid dehydrogenase enzyme activity may be suppressed after exhaustive exercise compared with low intensity exercise.Expressed in the liver, the adipose and the bone tissue, the central nervous system and the muscles, 11β-hydroxysteroid dehydrogenase is an enzyme carry out as dehydrogenase, transforming cortisol into cortisone, as well as the reverse process called reductase (Nascimento, 2014).. Moreover, Del Corral *et al*. (2016) demonstrate that physical exercise when performed at high intensity induces cortisol increases, which seems to be higher in the morning when compared to the night time. Hence, it reinforces the idea that cortisol is related to the circadian cycle, which might have affectedthe data analysis, as cortisol secretion appears to be higher in the morning than in the evening (Thuma, 1995). Furthermore, a recent study (Villanueva, 2012) demonstrates that acute cortisol hormone changes does not appear to be significant in strength (85% 1RM, 3 x 8 repetitions) and muscle hypertrophy (70% 1RM, 3 x 10 repetitions) protocols with short rest intervals,60 and 90 seconds. The authors did not find acute pre and postexercise differences, and they suggest that increase exercise volume appears to be both, anabolic and catabolic stimuli. Perhaps if salivary cortisol was collected at different times or the exercises chosen were different, there could have been differences between groups or intragroups. In fact, Rahimi *et al*. (2010) investigated the effects of 4 sets at1RM 85% of bench press and back squat with 60, 90 and 120 second recovery intervals. The study show that cortisol had a significant increase after 30 minutes on the 60second and 90second recovery interval protocols. In addition, Gonzales *et al*. (2015) also observed cortisol concentrations levels on high and low intensity exercise protocols performed at 1RM 90% and 1RM 70% respectively, from 3 to 5 sets of 10 to 12 repetitions for both protocols, and the cortisol response was higher on high intensity exercise compared to low intensity. There are few limitations associated with the present study. The first limitation is that the plyometric exercise is unhabitual exercise neither routinely practiced by individuals, despite they have experienced. The second limitation is that circadian cycle seems to influence cortisol secretions, and the study was conducted between 11 a.m. and 1 p. m., could have hormone fluctuations, perhaps. The third limitation is volume and intensity, perhaps it would have been better to analyze plyometric and resistance exercises separately. Future researchescould pay attention to these details. To practical application, the time of day has influence on cortisol concentrations levels, and the cortisol seems to have higher values on the morning than in the evening. Therefore, to control volume and intensity for periodization.

Conclusion

Different recovery intervals between series, 30 or 60 seconds, on acute resistance exercise protocol, does not alter salivary cortisol concentration levels.

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