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Report of Health Care
Volume 2, Issue 2, 2016, p. 69- 76

Original Article

The Effect of High Carbohydrate and Fat Consumption on Growth Hormone Response to Physical Activity in Children

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Received: 8 November 2015
Accepted: 21 February 2016

Published online: 1 May 2016

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Competing interests: The authors declare that no competing interests exist.

Citation: Zilaei Bouri S, Khalafiaan H, Andishi N. The effect of high carbohydrate and fat consumption on growth hormone response to physical activity in children. Rep Health Care. 2016; 2 (2): 69- 76.

Abstract

Introduction: present study aimed to investigate the effect of type of food on growth hormone concentrations in response to physical activity in children.

Methods: 25 boys (aged 9-14) with complete physical health were randomly divided into three groups, including high carbohydrate (65% carbohydrate, HC), high fat (50% fat, HF), and Normal (N) diet. Physical activity included 10 cycles of 6 seconds sprint running for 20 minutes. Blood was taken in the fasting state, 45 minutes after diet, and 15 minutes after physical activity. Repeated measure ANOVA, factorial analysis of variance and Tukey's post hoc test at significant level of 0.05 were used to analyze the data.

Results: After breakfast, the growth hormone decreased in HC and HF groups. In the HF group, the increase in growth hormone after activity was significant compared to the fasting state (P = 0.01) and post-breakfast state (P = 0.03). The increase after activity was significant in comparison with the post-breakfast state (P = 0.03) in the HF group. In the N group, the growth hormone increased after breakfast (P = 0.03) and activity (P = 0.04) compared to the fasting state.

Conclusion: Consumption of food with carbohydrates and lipids reduces the growth hormone secretion, but does not change the response to activity.

Keywords: Carbohydrate, Children, Fat, Growth Hormone, Physical Activity

Introduction

The Growth Hormone (GH) is a hormone released from the anterior part of the pituitary or adenohypophysis, the most important and largest part of the pituitary (1). Growth hormone plays an important role in the health and development of children and affects many metabolic processes of somatic cells in children (2). The overall biological function of GH is very diverse, which includes the effects on protein metabolism, carbohydrates and lipids, stimulation of prolonged bone growth sites, muscle growth, height, gluconeogenesis, immune system, and so on (3, 4). Recent evidence suggests that a diet or physical activity patterns can also trigger changes in GH secretion (5), for example, during hyperglycemia; an increase in GH can be seen in the continuing primary suppression of GH levels. The effect of primary suppression is probably due to an increase in the release of somatostatin. The reversal of this acute suppression results from a reduction in the release of somatostatin and, consequently, its release from GHRH (6); although Cappon *et al.* (1993) showed that the growth hormone secretion after activity in adult males was not affected by high-carbohydrate diet (2). Research also found that in healthy subjects with fit weight, a high-fat meal, shortly before exercise severely suppressed GH (7). Galassetti *et al.* (2006) also found that the acute consumption of fatty foods, as compared to non-calorie placebo, resulted in a decrease in GH release in response to physical activity in children (1). Considering that today, the use of sweet snacks (cakes, juices, ice cream, etc.) and high-fat snacks have become very common among children, the study of dietary intervention of carbohydrates and high fat due to controversies in children remains unclear. It seems that the diet may interfere with the activity of the GH response. It also seems that low intensity exercise (50% lactate threshold) does not increase GH secretion, while high intensity exercise (50% difference in lactate threshold and vVO2max) leads to stimulation and response to GH secretion (8). In this regard, Pritzlaff *et al*. (1999) by performing a training program of running on treadmill at different intensity levels demonstrated that with increasing intensity of training to the threshold of lactate, a linear increase in GH secretion was observed (9). Stokes *et al.* (2003) also examined the effect of speed training 6-30 seconds on the ergometer bike on GH changes, and concluded that with an increase in training time of up to 30 seconds, GH also increased (10). Therefore, in the present study, physical activity for children was considered as intermittent sprint type because it is more similar to their daily physical activity. While the importance of examining the factors affecting the growth hormone in children is important, it is likely that there is an interaction between diet and physical activity on the growth hormone in children. Therefore, the present study seeks to answer the question of whether the type of nutrition prior to the one-bout intermittent sprint activity in children can affect the amount of growth hormone release.

Methods

Eighteen healthy boy children (9 to 14 years old) participated in this study. The anthropometric information of the participants including height, weight, body mass index and fat percentage were calculated (11). Finally, the samples were randomly divided into three groups: high-carbohydrate (HC; 7 people); high-fat (HF; 7 people); and normal (ND; 11people) diet. The present study was conducted as cross-over field trials. Prior to the study, its protocol was approved by the Graduate Committee of Islamic Azad University, Shoushtar Branch. In the first session at 8:00 am, in the fasting state, three cc bloods were taken from all participants' left brachial vein in the first and second groups. Then, all subjects consumed breakfast with HC (65% carbohydrate, 20% fat and 15% protein) or HF (35% carbohydrate, 50% fat and 15% protein) and 45 minutes later blood retention was again performed. After blood capturing, each sample performed physical activity including the intermittent sprint activity for 20 minutes, which consisted of heating and cooling for 3 minutes, and the main part of the activity including 10 cycles of 6 seconds sprint and one minute running softly in the form of intermittent run (2, 12); 15 minutes after the activity, three cc blood was taken again. At the second session, the subjects performed the same procedure as the first one only consuming ND (50% carbohydrate, 35% fat and 15% protein) at breakfast. It should be noted that breakfast was identically consumed at 500 calories in the three groups (baguette, cream, honey, milk, simple cornflex, peanut butter and protein powder), and only had a different amount of carbohydrate and fat (13). To measure the concentration of the growth hormone the ELISA kit (DiaMtera, Italy, Product Code No.: DKO050) with a sensitivity of 0.105 µlU / mL according to the kit catalog was used. The normal distribution of data was done by Kolmogorov- Smirnov test and the intra-group variation of the data was done by repeated measure analysis of variance. To evaluate the effects of time on food type, factorial analysis of variance 3 × 3 was performed using Tukey's post hoc test. All analyses were performed using SPSS software version 20. The significance level was considered as $p < 0.05$.

Results

Table 1 shows the mean ± SD of the demographic characteristics of the participants in the study, and in Table 2, the mean growth hormone in the three states of fasting, post-breakfast and post-physical activity is seen in three groups of high-carbohydrate, high fat and normal diet. In the breakfast group with HC (8%, P = 0.75) and HF (72%, P = 0.86) 45 minutes after breakfast, growth hormone reduced which was not statistically significant compared to the fasting state. On the other hand, in the HC group, changes in the growth hormone increased significantly after physical activity compared to fasting (P = 0.08) and 45 minutes after breakfast (Figure 1). In the HF breakfast group, there was a significant increase after physical activity compared to 45 minutes after breakfast (P = 0.03) and fasting (P = 0.01) (Figure 2). In the ND group, breakfast intake with a proportionate amount of carbohydrate and fat significantly increased the growth hormone 45 minutes after breakfast (P = 0.03); also increase after physical activity was significant compared with fasting (P = 0.004) and 45 minutes after breakfast (P = 0.01) (Figure 3). Factor analysis of variance of breakfast type consumed at different times did not show a significant difference in growth hormone (P=0.098). But the findings indicated a significant increase in growth hormone in response to physical activity compare to the fasting state in all three groups. There was also a significant reduction in growth hormone after HF intake (P = 0.02) compared to its increase after activity in the HC (P = 0.02), HF (P = 0.001), and ND (Figure 4).

Table 1. Demographic characteristics of the participants in the research

	High Carbohydrate Diet	High Fat Diet	Normal Diet
Number of Sample	7	7	11
Age (Year)	12.85±1.9	12.85±93.2	12.36±2.34
Height (cm)	153±14.5	152.86±20.35	154.91±17.88
Weight (Kg)	53.57±18.72	57.86±14.12	58.82±15.90
Body Mass index (Kg/m^2)	22.45±5.56	24.98±5.245	24.32±4.4
Fat Percentage	27.6±6.1	28.21±7.26	29.15±0.0045

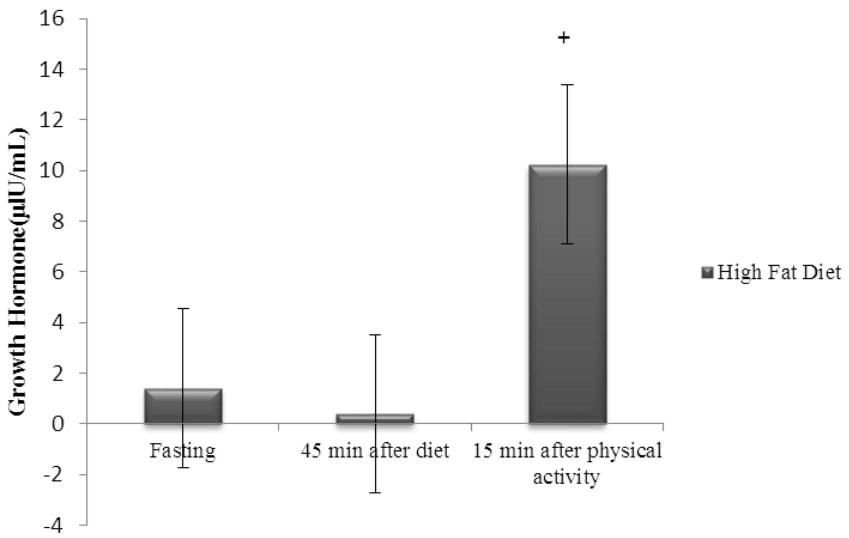

Figure 1. Mean Growth Hormone (GH) Changes in the High-Carbohydrate Diet Group
+ Significant difference was observed between 45 minutes after diet and fasting (P <0.05).

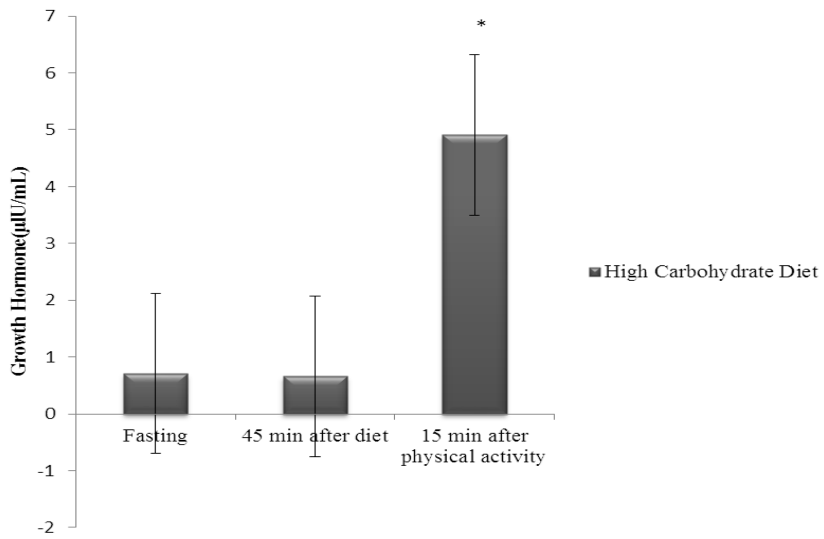

Figure 2. Mean Growth Hormone (GH) Changes in the High-Fat Diet Group
*Significant difference compared to 45 minutes after diet (P <0.05).

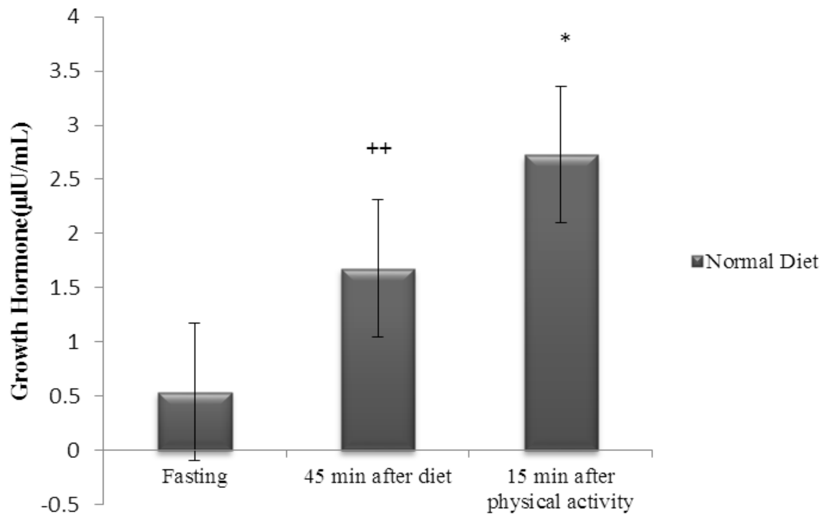

Figure 3. Mean Growth Hormone (GH) Changes in the Normal diet
* Significant difference was observed in fasting state and 45 minutes after diet; ++ Significant differences in fasting state (P <0.05).

Table 2. The mean growth hormone (µlU / mL) at different times in the study groups

	High Carbohydrate Diet	High Fat Diet	Normal Diet
Fasting	0.71±0.61	1.4±3.2	0.54±0.53
45 Minutes After Breakfast	0.66±0.89	0.39±0.27	1.68±1.43
15 Minutes After Activity	4.91±3.87	10.24±8.79	2.73±2.99

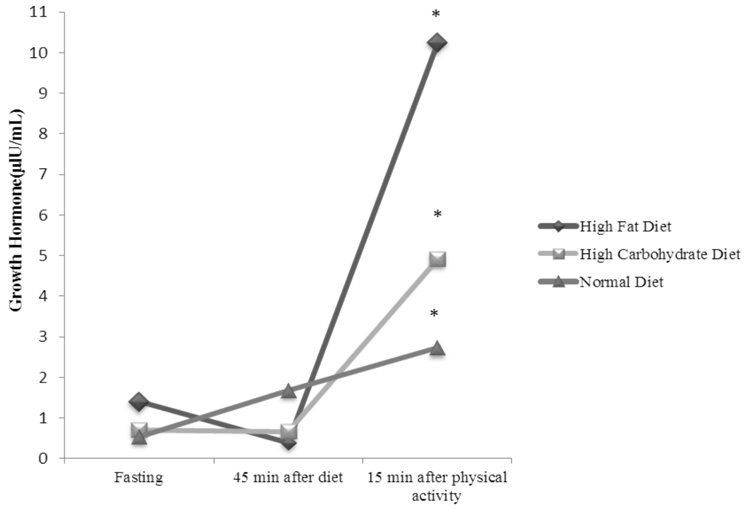

Figure 4. Growth hormone changes with different food types at different times
* Significant difference compared to 45 minutes after taking a high fat diet (P <0.05).

Discussion

Physical activity is one of the most potent stimulants of GH secretion that can be affected by a meal. The aim of this study was to investigate the effect of HC and HF diet on GH response to physical activity in children. The main results of this study were that the concentration of GH was reduced 45 minutes after breakfast of HC and HF, but after 15 minutes of physical activity in three groups increased. In line with the results of this study, Shin *et al.* (2013) showed that consuming HC foods before an hour of walking with 50% of the maximal oxygen uptake (Vo2max) for 60 minutes increased GH (14). Wahl *et al.* (2010) showed a significant increase in GH in response to high intensity exercise in eleven healthy men (15). Foster *et al.* (2008) also found that consuming HC or isotonic food would increase the response of growth hormone to activity without being affected by food (16). In addition, in an investigation on the effect of HC food consumption on eleven young male subjects, Cappon *et al.* (1993) found that the concentration of GH after consumption of HC diet was modestly reduced, but its increase after activity was significant (2). Unfortunately, due to little research done in this area, there were no conflicting results even among adults. In the present study, we did not see any significant reduction in GH release to HC diet compared to the fasting state. However, in comparing the Normal diet and HC groups, GH concentration significantly increased after breakfast with proportionate carbohydrates. While hypoglycemia is a potent inhibitor of GH, it appears that elevated levels of glucose also increase the response of HC foods as a result of high levels of intake. Failure to see significant difference in GH response to activity after two types of breakfast may have at least four main reasons. The first is related to the possible mechanism of GH response to activity that may not be easily related to blood glucose. The second reason may be the start-up time. Given that activity started 45 minutes after breakfast. Glucose reduction may have occurred before the onset of activity, so GH levels without intervention of blood glucose levels have increased. The next reason may be that although increased blood glucose causes a transitory and temporary cessation of GH levels due to somatostatin secretion, it increases levels of GH by diminished somatostatin (17). The fourth reason may be related to the temperature of the air on the day of the test in the normal diet group. Despite all attempts to maintain a constant temperature in two days of the experiment, according to the test schedule, the air temperature was higher on the second day of the test (2 degrees Celsius), and research has shown that the ambient temperature can be a deterrent to the secretion of the growth hormone (18) and perhaps the reason for the lower growth hormone in the normal diet group is related to this environmental phenomenon. Considering that breakfast intake should provide about 20-35% daily calories (19), and researchers consider it appropriate to use some 300 to 700 calories in the morning (20), therefore, the type of breakfast meal, especially in children, can affect their growth factors. Also, today due to the excessive use of sugary and HC substances, it seems that the consumption of foods with carbohydrates of 65% or more can untowardly affect children's GH release at least in children, although high-intensity physical activity has been able to increase GH even after consumption of HC foods. A significant reduction of GH secretion in HF breakfast was the result of our research, which is consistent with the results of Cappon *et al.* (1994) and Galassetti *et al.* (2006). In both studies, the amount of GH after HF meal decreased significantly compared to the fasting state. However, both of these studies showed a significant increase in GH response to post-consumption of HF foods, although this increase was significantly lower than that of placebo (without calorie), which was not consistent with the result of this study. It should be noted that Cappon *et al.*measured GH response to eleven healthy men in three HC, HF (40% consumed calorie) and calorie-free diets. The activity included ten minutes of jerking on an ergometer bike, and the results showed a 50% reduction in GH response to activity in the HF diet group compared to placebo and the HC group. In this study, sample included adults who had had their growth time and these responses were due to metabolic regulation. The response of GH to activity in the HF diet group was approximately 4-5 times that of fasting state, and in the placebo group 8 times that of fasting state. The severe response of GH to activity in the placebo group may be partly due to their fasting state, as research suggests an increase in GH response to fasting state (17). A study by Gallassetti *et al.* (2006) was performed on twelve children aged 11 to 15 years. In this study, the GH response to 30 minutes of activity on an ergometer bike (10 repetitions of two minutes with 80% of the maximum aerobic capacity separated by one minute of rest) in two situations of HF food consumption (0.8 grams per kilogram of body weight) and placebo (no calorie) were measured (1). In this study, GH response to HF dietary activity was significantly higher, but was 40% lower than the Normal group. The increase in GH in this study in the HF diet group was approximately 7 times that of the fasting state and in the Normal group 11 times that of the fasting state, which shows that the HF dietary group was similar to the present study. Also, in this study, a comparison was made between two free-calorie and HF diets, in which free-calorie state may have affected the the GH response to activity and increased its secretion; contrary to our research, in which samples of control group consumed foods with 30% fat. In our research, we tried to give normal food to children regarding a true life pattern, so there are some theoretical differences with previous research. In Galassetti research, the amount of fat consumed was 385 calories compared to 250 calories in our study, which may have had a significant effect on GH response by increasing somatostatin (4, 17). Studies have also shown that physical activity is associated with an increase in release of cytokines (21, 22), including IL-6, which seems to have a close interconnectedness with growth hormone, so that during the injection of IL-6 into healthy subjects the amount of growth hormone significantly increases (23). Meksawan *et al.* (2004) showed that consuming HF foods (50% fat) after activity did not significantly change IL-6 secretion, but had a downward effect on other cytokines (21). Therefore, it can be estimated that higher levels of fat intake (such as Galassetti research) by suppressing the production of cytokines such as IL-6 have reduced GH response to high fat intake; and the last reason that has already been raised may be related to the temperature on the day of the test in the normal dietary group. Perhaps the reason for the lower growth hormone (5 times versus 7 times) in the normal diet group can be related to this environmental phenomenon. This research was designed to examine the conditions that occur every day in the normal life of children. First, the intensity and duration of the activity were selected in a manner consistent with the normal life of the children, and secondly, the time and calorie intake were selected according to the predetermined patterns that were measured. This form of HF foods has become widespread today and is used by children in various forms or promises, or in type 1 diabetic or obese children (who are advised to consume less carbohydrate) or athletes who seek to earn a lot of energy from low-volume diets.

Conclusion

The results of this study indicate the disparaging effects of food intake with high levels of carbohydrate and fat on growth hormone. Parents are advised to be careful about the choosing their children's food and considered the effects of physical activity.

Ethical issues

Not applicable.

Authors' contributions

All authors equally contributed to the writing and revision of this paper.

Acknowledgments

The author expresses deepest thanks and gratitude to Dr. Ghamchili and Mrs. Makvandi for their unparalleled support in laboratory work. Also, special thanks are offered to all the children and parents who participated in the present research, as well as those involved in the oil and gas exploitation company in Masjed-e-Soleiman city who accompanied us in this research.

References

1. Galassetti P, Larson J, Iwanaga K, Salsberg SL, Eliakim A, Pontello A. Effect of a high-fat meal on the growth hormone response to exercise in children. J Pediatr Endocrinol Metab. 2006; 19 (6): 777- 786.
2. Cappon JP, Ipp E, Brasel J ,Cooper D. Acute effects of high fat and high glucose meals on the growth hormone response to exercise. J Clin Endocrinol Metab. 1993; 76 (6): 1418- 1422.
3. Binder G, Wittekindt N, Ranke MB. Noonan syndrome: genetics and responsiveness to growth hormone therapy. Horm Res Paediatr. 2007; 67 (Suppl. 1): 45- 49.
4. Coutant R, Bouhours-Nouet N. Endocrine control and regulation of growth hormone: an overview. in: Preedy VR, editor. Handbook of Growth and Growth Monitoring in Health and Disease. New York: Springer Science & Business Media. 2011.
5. Kosarian M, Javan prast S, Valayee N. A study comparing response to growth hormone in two groups of children. J Mazandaran Univ Med Sci. 2001; 11 (30): 1- 7.
6. Broglio F, Benso A, Gottero C, Prodam F, Grottoli S, Tassone F, et al. Effects of glucose, free fatty acids or arginine load on the GH-releasing activity of ghrelin in humans. Clin Endocrinol. 2002; 57 (2): 265- 271.
7. Prior SJ, Jenkins NT, Brandauer J, Weiss EP, Hagberg JM. Aerobic exercise training increases circulating insulin-like growth factor binding protein–1 concentration, but does not attenuate the reduction in circulating insulin-like growth factor

binding protein–1 after a high-fat meal. Metabolism. 2012; 61 (3): 310- 316.
8. Felsing NE, Brasel J, Cooper DM. Effect of low and high intensity exercise on circulating growth hormone in men. J Clin Endocrinol Metab. 1992; 75 (1): 157- 162.
9. Pritzlaff CJ, Wideman L, Weltman JY, Abbott RD, Gutgesell ME, Hartman ML, et al. Impact of acute exercise intensity on pulsatile growth hormone release in men. J Appl Physiol. 1999; 87 (2): 498- 504.
10. Stokes K. Growth hormone responses to sub-maximal and sprint exercise. Growth Horm IGF Res. 2003; 13 (5): 225- 238.
11. Ross JG, Dotson CO, Gilbert GG, Katz SJ. New standards for fitness measurement. J Phys Educ Recreat Dance. 1985; 56 (1): 62- 66.
12. Mohr M, Krustrup P, Nielsen JJ, Nybo L, Rasmussen MK, Juel C, et al. Effect of two different intense training regimens on skeletal muscle ion transport proteins and fatigue development. Am J Physiol Regul Integr Comp Physiol. 2007; 292 (4): R1594- R1602.
13. Bassami M, MacLaren DP, Ahmadizad S, Doran D. Effects of mixed isoenergetic meals on fat and carbohydrate metabolism during exercise in older men. J Nutr Metab. 2011; 2011.
14. Shin Y-H, Jung H-L, Ryu J-W, Kim P-S, Ha T-Y, An J-Y, et al. Effects of a pre-exercise meal on plasma growth hormone response and fat oxidation during walking. Prev Nutr Food Sci. 2013; 18 (3): 175.
15. Wahl P. Hormonal and metabolic responses to high intensity interval training. J Sports Med Doping Stud. 2013; 3 (1): e132.
16. Fisher G, Foster B, Pascoe DD. Acute regulation of IGF-1 by differential binding protein expression, inhibition, and proteolysis: 2411. Med Sci Sports Exerc. 2009; 41 (5): 337.
17. Bideci A, Çamurdan O. Physiology of growth hormone secretion. J Clin Res Ped Endo. 2009; 1: 1- 7.
18. Ööpik V, Timpmann S, Kreegipuu K, Unt E, Tamm M. Heat acclimation decreases the growth hormone response to acute constant-load exercise in the heat. Growth Horm IGF Res. 2014; 24 (1): 2- 9.
19. Timlin MT, Pereira MA. Breakfast frequency and quality in the etiology of adult obesity and chronic diseases. Nutr Rev. 2007; 65 (6): 268- 281.
20. Schusdziarra V, Hausmann M, Wittke C, Mittermeier J, Kellner M, Naumann A, et al. Impact of breakfast on daily energy intake-an analysis of absolute versus relative breakfast calories. ***Nutr J***. 2011; 10 (1): 5.
21. Meksawan K, Venkatraman JT ,Awad AB, Pendergast DR. Effect of dietary fat intake and exercise on inflammatory mediators of the immune system in sedentary men and women. J Am Coll Nutr. 2004; 23 (4): 331-340.
22. Nemet D, Oh Y, Kim H-S, Hill M, Cooper DM. Effect of intense exercise on inflammatory cytokines and growth mediators in adolescent boys. Pediatrics. 2002; 110 (4): 681- 689.
23. Tsigos C, Papanicolaou DA, Kyrou I, Defensor R, Mitsiadis CS, Chrousos GP. Dose-dependent effects of recombinant human interleukin-6 on glucose regulation. J Clin Endocrinol Metab. 1997; 82 (12): 4167- 4170.