Journal of Applied Biological Sciences
E-ISSN: 2146-0108 12 (3): 21-25, 2018

Paradoxical Advantage of Middle Aged Sedentary over Young Sedentary on Starting Exercise in Terms of GH/IGF-1 System

Nizamettin GÜNBATAR[1] Mehmet Salih KAYA[2] Tahir KAHRAMAN[3] Fahri BAYIROĞLU[2*]
[1]Department of Physiology, Van Yuzuncu Yil University, School of Health, Van, Turkey.
[2]Department of Physiology, Faculty of Medicine, Yildirim Beyazit University, Ankara, Turkey.
[3]Department of Medical Biochemistry, Faculty of Medicine, Karabuk University, Karabuk , Turkey.

*Corresponding Author
E-mail:fbayiroglu@ybu.edu.tr

Received: October 25, 2018
Accepted: November 29, 2018

Abstract

The aim of this study was to investigate the effects of the submaximal running exercise on the GH/IGF-1 axis in the middle aged sedentary non-obese and pre-obese males. Twenty-four healthy volunteer males were divided into two groups and then two subgroups according to their age ranges (20-25 and 35-43) and Body Mass Indexes (BMI) (non-obese - NO and pre-obese - PO) respectively. All subjects underwent a submaximal running exercise for 30 minutes a day / 4 days a week and for a period of 6 weeks. Serum GH, IGF-1, IGFBP-3, and insulin levels were measured in all subjects before and after the exercise program. IGFBP-3 levels were significantly decreased in the PO middle aged and NO young groups whereas IGF-1 levels were statistically increased in NO young group after the exercise treatment. Contrary to the results observed in young people, middle aged PO and NO groups had a tendency to have better insulin and GH responses to exercise. In the light of the findings, it could be suggested that the middle aged group's response to exercise on the base of GH/IGF-1 system was more advantageous than the young group, although it is not significantly important.

Keywords: Exercise, pre-obese, middle aged, sedentary, GH/IGF-1 system

INTRODUCTION

Physical exercise has a major role in sustaining a healthy life. As a result of the facilities provided by technological advancements, people have abandoned most of their physical exercise. Therefore, the idea of reintroducing physical activity to people's lives has been implemented by the governments. This implementation is mainly associated with the scientific fact that physical exercise not only enables a sustainable healthy life but also prevents the formation of numerous diseases.

Physical inactivity resulting from industrialization and the modern lifestyle can affect individuals at any age. Moreover, a sedentary lifestyle may lead to serious health problems including hypertension, obesity, muscle weakness, postural disorders, increased risk of diabetes and coronary artery disease. It has been suggested that regular exercise prevents and even treats so many diseases associated with sedentary lifestyle (1, 2).

It has been reported that acute physical exercise increases GH secretion, thereby regulating the expression of IGF-1 and insulin-like growth factor binding protein 3 (IGFBP-3). Some other studies have suggested that regular physical exercise can improve health-related quality of life in elderly people since it increases the IGF-1 concentration in circulation (3). However, it is reported that the extent of health benefits achieved through physical activity is associated with each individual's age at the time of exercise (4).

Although the importance of the GH/IGF-1 system and insulin sensitivity in sustaining a long and healthy life has been extensively documented in the literature (5), there have been rather limited number of studies reporting the effects of submaximal exercise on the GH/IGF-1 system and insulin sensitivity, particularly in sedentary non-obese and pre-obese middle-aged individuals. Present study aims to investigate the alterations in the GH/IGF-1 system and insulin sensitivity in sedentary young and middle-aged individuals who participated in regular submaximal running exercise program. It also aims to evaluate the effect of age and body weight on this system and to analyze probable alterations in the GH/IGF-1system in pre-obese participants.

MATERIALS AND METHODS

The twenty-four male participants were initially divided into two groups as young (20-25 years) and middle-aged (35-43 years) individuals and each group was subsequently divided into two subgroups as non-obese and pre-obese participants depending on their body weight and body mass index (BMI). The young group had twelve voluntary undergraduates studying at Van Yuzuncu Yil University who had no clinical complaint or finding. The middle-aged group included twelve voluntary healthy participants who did not have any regular exercise. The participants in both groups underwent general health screening at Van Yuzuncu Yil University Medical School Hospital for the assessment of fitness for exercise. The participants were requested to avoid any physical exercise the week before the exercise program. A 6-week exercise program was applied which included 30 minute running session/day, four days/week. Intravenous blood samples were collected both before and after the exercise program at fasted state. Blood samples were analyzed for the assessment of GH, IGF-1, IGFBP-3, and insulin at Van Yuzuncu Yil University Medical School Biochemical Laboratory.

Calculation of BMI for the Identification of Pre-obese Participants

Body mass index (BMI) is the most common measurement used for the assessment of obesity. BMI is calculated by dividing body weight in kilograms (kg) by the square of the body height in meters (m^2).

Table 1. Pre-exercise age, height, weight, and BMI values of the groups.

	Group	Age	Height (m)	Kg	BMI
20-25 Years	NON-OBESE	23	1.73	61	20.4
		22	1.78	65	20.5
		22	1.72	60	20.3
		23	1.75	60	19.6
		21	1.75	56	18.3
		22	1.70	60	20.7
35-43 Years	NON-OBESE	40	1.89	88	24.6
		37	1.70	71	24.5
		38	1.69	70	24.5
		38	1.83	81	24.2
		35	1.73	73	24.4
		35	1.65	66	24.2
20-25 Years	PRE-OBESE	24	1.85	87	25.4
		25	1.80	83	25.6
		21	1.75	77	25.1
		22	1.68	73	25.8
		21	1.76	78	25.2
		22	1.75	80	26.01
35 -43 Years	PRE-OBESE	36	1.65	74	27.2
		37	1.78	87	27.5
		36	1.78	87	27.5
		42	1.65	74	27.2
		35	1.64	70	26.1
		39	1.85	100	29.2

Blood Sampling and Analysis

Prior to exercise, 5 cc of blood was intravenously sampled from each participant at fasted state. The samples were studied for the assessment of the parameters defined in the study and the results were used as pre-exercise values. At the end of the 6-week program, second blood samples were collected using the same protocol and the results were accepted as post-exercise values. The alterations were calculated based on the pre- and post-exercise values. For the assessment of GH, IGF-1, IGFBP-3, and insulin levels, immunoassay test was performed using Immulite 2000 with commercially available Biodepc kits.

Statistical Analysis

Independent-samples t-test was performed for binary comparisons and paired-samples t-test was performed for comparing pre- and post-exercise values. For the variables with normal distribution, appropriate tests were performed. Kolmogorov-Smirnov test and the homogeneity of the variables were taken into consideration. The assumptions of parametric tests were fulfilled. $p \leq 0.05$ accepted as statistically significant.

RESULTS

In the non-obese young subgroup, IGFBP-3 significantly decreased and IGF-1 significantly increased ($p > 0.05$ and $p < 0.01$, respectively) (Figure 1 and Figure 2). On the other hand, although GH decreased (Figure 3) and insulin level increased (Figure 4), no significant change was observed. Table 2 presents the pre- and post-exercise values of the parameters in all participants.

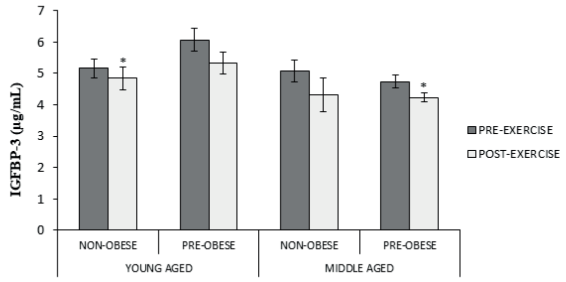

Figure 1. Comparison of pre- and post-exercise IGFBP-3 values in all participants.

* Statistically significant

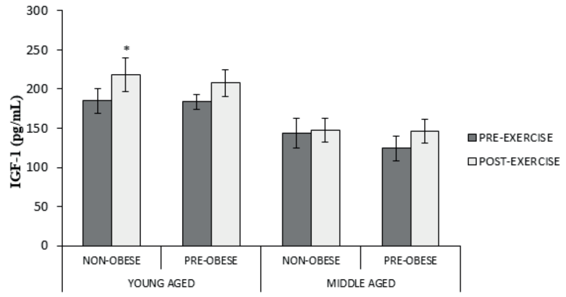

Figure 2. Comparison of pre- and post-exercise IGF-1 values in all participants.

* Statistically significant

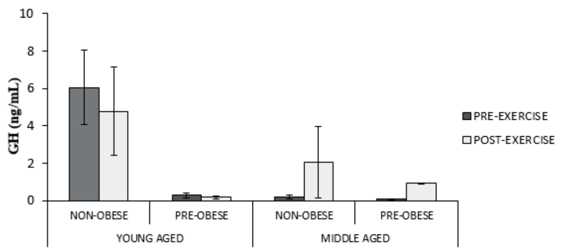

Figure 3. Comparison of pre- and post-exercise GH values in all participants.

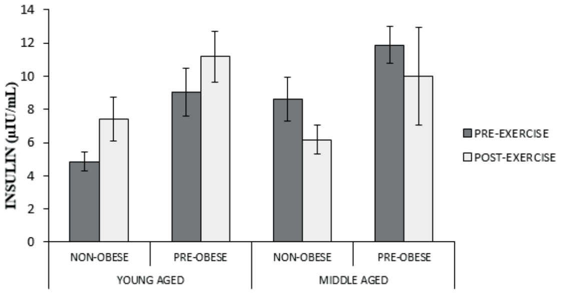

Figure 4. Comparison of pre- and post-exercise insulin values in all participants.

			PRE-EXERCISE				POST-EXERCISE			
		N	GH (ng/mL)	INSULIN (µIU/mL)	IGF-1 (pg/mL)	IGFBP-3 (µg/mL)	GH (ng/mL)	INSULIN (µIU/mL)	IGF-1 (pg/mL)	IGFBP-3 (µg/mL)
YOUNG AGED	NON-OBESE	6	6.04±1.99	4.86±0.56	184.83±15.61	5.16±0.3	4.76±2.36	7.43±1.31	218.17±22.02 [a]	4.84±0.36[b]
	PRE-OBESE	6	0.28±0.13	9.03±1.42	183.50±8.98	6.07±0.36	0.17±0.07	11.17±1.52	207.83±17.20	5.34±0.35
MIDDLE AGED	NON-OBESE	6	0.17±0.10	8.60±1.32	143.68±18.73	5.08±0.34	2.05±1.93	6.18±0.89	147.41±14.82	4.31±0.54
	PRE-OBESE	6	0.06±0.01	11.87±1.11	124.47±15.79	4.74±0.20	0.92±0.02	9.99±2.92	146.00±14.93	4.23±0.15[a]

Similarly, in the pre-obese young subgroup, although IGFBP-3 and GH were decreased, IGF-1 and insulin were increased, but these changes were not significant.

In the non-obese middle-aged subgroup, insulin and IGFBP-3 were decreased and, GH and IGF-1 were increased in the post-exercise period insignificantly.

In the pre-obese middle-aged subgroup, a significant decrease was found in IGFBP-3 (p<0.05), whereas no significant decrease was observed in insulin level. However, GH and IGF-1 increased insignificantly.

DISCUSSION

It is well-known that sedentary lifestyle could be accounted for many chronic diseases. Even though many studies are available on the effects of exercise young and elderly people, the age groups in between are mostly neglected. However, any kind of exercise interventions in these age groups might have a greater chance to prevent and reverse age-related deterioration of overall health as metabolic parameters do not change significantly at those age groups yet. GH/IGF-1 axis and insulin levels are regarded as important parameters for healthy aging (6, 7). The present study investigated the effect of regular submaximal running exercise on the alterations in the GH/IGF-1 system and on insulin and IGFBP-3 in sedentary non-obese and pre-obese young and middle-aged individuals.

Previous studies suggest that short-term exercise programs that last only for several weeks could not be sufficient for evaluating general health parameters since they can only change by long-term exercise programs that last for several months. It is also proposed that adaptation to any exercise program takes several weeks, particularly in middle-aged or older individual. Additionally, a minimum of 15-20 weeks are necessary to achieve health benefits of the exercise program (8). However, some other studies indicated that 4-6 weeks could be sufficient for evaluating the time-dependent effects of an exercise program, particularly after the adaptation period, and also for assessing the relative alterations in several parameters (9).

The GH/IGF-1 system has a direct effect on the glucose, lipid, and protein metabolism in human subjects. During physical exercise, the need for energy increases and a number of hormonal changes occur. It is also known that regular exercise alters the body composition depending on the type of the exercise performed. Moreover, acute changes are likely to occur in the GH/IGF-1 system in adults with GH deficiency (10), runners (11, 12), strength athletes (13), and in healthy volunteers (14). But these hormonal changes have not been reported in all studies. For example Grandys et al observed no changes in resting serum concentrations of GH, IGF-I, IGFBP-3, and IGF-I/IGFBP-3 ratio after the 20 weeks of endurance running training (12).

Thomas et al. evaluated 19 healthy volunteers including class 1 obese (BMI, 30.00-34.99), class 2 (BMI, 35-39.99)/ class 3 (BMI, ≥40) obese, and 9 lean men and reported that no increase was observed in the post-exercise insulin levels in all these groups (15). Gregory et al. evaluated non-obese women (mean age, 20.3 ± 0.3 years) and reported that GH, total IGF-1, and IGFBP-3 significantly increased (p<0.05) and free IGF-1 concentration decreased following endurance and resistance exercises (16). Mohajeri Tehrani et al. evaluated 20 middle-aged participants and reported that IGF-1 and IGFBP-3 increased significantly and insulin resistance decreased insignificantly following submaximal endurance training using a cycle ergometer (17). In the present study, insulin level increased and GH decreased, whereas IGFBP-3 decreased significantly ($p<0.05$) and IGF-1 value increased significantly ($p<0.01$) in non-obese young participants. Similarly, in pre-obese young participants, insulin level increased and GH decreased, whereas levels of IGFBP-3 and IGF-1 did not change.

Studies on physical exercise indicate that acute hormonal response to exercise is weakened with age and this occurrence can be explained by the lower exercise intensity in elderly women. It is also postulated that physical exercise has the capacity to affect the hormones as a result of changes in protein carriers and receptors. Therefore, the value and safety of hormone supplements should be carefully examined, particularly when used in combination with an exercise program (18). In the present study, the middle-aged individuals had higher positive hormone sensitivity to exercise compared to young individuals. However, another study reported that elderly participants (mean age, 65.5 years) exhibited similar hormonal response with young (mean age, 22.9 years) and middle-aged participants (mean age, 44.9 years) following an acute submaximal cycling training (19). Contrary to the findings of this study, the middle aged participants of our study showed a more effective response to exercise when compared to the young. This could be due to the longer duration and different types of exercise in the other study.

Poehlman and Copeland assessed serum concentrations in healthy non-obese young and elderly men, characterized for maximal aerobic capacity and energy expended in leisure-time physical activity, in order to investigate the hypothesis that a lower level of physical activity affects the age-related reduction in IGF-1. The authors concluded that the age-related decrease in IGF-1 can be affected by various factors but the reduction in IGF-1 in elderly men is partially associated with reduced physical activity (3). In the present study, IGF-1 significantly increased in non-obese young participants ($p<0.01$) but increased insignificantly in pre-obese young participants. Yamaguchi et al. evaluated 19 individuals aged 46-54 years with a BMI >25 kg/m^2 and reported that IGF-1 increased by 5.8% following the exercise and serum GH increased from 0.69±0.59 to 1.25±0.78 following the training (20). However, Kanaley et al. investigated the effect of submaximal exercise on IGF-1 activity in patients with GH-deficiency and healthy subjects and reported that no change was observed in IGFBP-3 and IGF-1 but the GH levels increased in healthy subjects (21). In our study, insulin levels tended to decrease, whereas GH levels tended to increase in pre-obese middle-aged participants. However, IGFBP-3 levels decreased significantly, and IGF-1 levels increased insignificantly in the same group. In another study, Chadan et al. evaluated healthy elderly women and reported that GH increased by 1.3-2.6 times ($p<0.05$) following physical activity but IGF-1 was not affected by physical activity (22). In our study, IGF-1 was found to be affected by physical exercise in middle-aged participants.

Studies show that plasma insulin levels may decrease by 35% following any type of physical activity including low- and high-intensity and short- and long-term exercise programs (21). Likewise, in this study, the plasma insulin levels after exercise decreased in the non-obese and pre-obese subgroups of the middle-age group.

In our study, the GH/IGF-1 system in the middle-aged group exhibited a more effective hormonal response to exercise both in non-obese and pre-obese participants compared to young participants and their insulin levels decreased and GH levels increased as well. Thomas et al. also reported that implementing certain exercise program variables can ameliorate attenuated GH response in obese people, although obesity has negative effect on circulating GH-IGF-1 axis (15). Under the lights of the present study and the others, it is likely that the GH/IGF1 system has a dynamic activity in which changes occur with age and sexual maturation, and is affected by body composition and other factors (10). However, the IGFBP-3 and IGF-1 levels in the young group exhibited a more effective response in non-obese participants. It was also revealed that the young and middle-aged groups exhibited different responses to the same exercise intensities. Moreover, the results also indicated that the pre-obese participants had the initial signs of obesity.

Results of the present study reveal hormonal responses of middle-aged non-obese and pre-obese subjects have increased GH and IGF-1 levels and also decreased insulin levels. These finding suggest that normal age related deterioration in sedentary middle age groups could be improved through exercise intervention programs, by which disturbed metabolic processes could be diverted toward normal course. In another study, similar to the present findings, whole-body insulin sensitivity index was found to be increased after acute exercise in sedentary obese group but not in obese group who have regular physical activity (23). Acute exercise ameliorates differences in insulin resistance between physically active and sedentary overweight adults. The results obtained from pre-obese and non-obese young subjects were contrary to the expected outcome which could be explained by different metabolic activity levels between young and middle aged groups.

In conclusion, it could be said that it would not be too late for middle-aged individuals who had no regular exercise during early adolescence to start having regular exercise in middle age, in which the adverse effects of sedentary lifestyle on the health can be seen. Moreover, individuals with higher body weight, compared to non-obese individuals who are not classified as obese despite having metabolic signs of obesity, are more likely to reverse their situation by performing regular exercise. In particular, it seems that performing regular submaximal exercise with an intensity of 30 min session/day is essential for sustaining a healthier life especially for middle-age people. More research is needed to study the effects of different types of exercise in middle-age sedentary subjects with a larger number of groups.

REFERENCES

1. Utter AC, Whitcomb DC, Nieman DC, Butterworth DE. and Vermillion SS. 2000. Effects of exercise trainning on gallbladder function in an obese female population. Medicine Science in Sports Exercise. 32:141-145.

2. Pedersen BK, Saltin B. 2015. Exercise as medicine–evidence for prescribing exercise as therapy in 26 different chronic diseases. Scand J Med Sci Sports. 25(S3):1–72.

3. Poehlman ET and Copeland KC. 1990. Influence of physical activity on insulin-like growth factor-1 in healthy younger and older men. J Clin Endocrinol Metab. 82:2177-2181.

4. Mitchell JH, Tate C, Raven P, Cobb F, Kraus W, Moreadith R, O'Toole M, Saltin, B and Wenger N. 1992. Acute response and chronic adaptation to exercise in women. Med Sci Sports Exerc. 24:258-265.

5. Lalia AZ, Dasari S, Johnson ML, et al. 2016. Predictors of whole-body insulin sensitivity across ages and adiposity in adult humans. J Clin Endocrinol Metab. 101:626-634.

6. Byrne H, Caulfield B, De Vito G. 2018. Self-directed exercise programmes in sedentary middle-aged individuals in good overall health; a systematic review. Prev Med.114:156-163.

7. Byrne H, Caulfield B, De Vito G. 2017. Effects of Self-directed Exercise Programmes on Individuals with Type 2 Diabetes Mellitus: A Systematic Review Evaluating Their Effect on HbA1c and Other Metabolic Outcomes, Physical Characteristics, Cardiorespiratory Fitness and Functional Outcomes. Sports Med. 47(4):717-733.

8. Seals DR, Hagberg JM, Hurley BF, Ehsani AA. and Holloszy JO. 1984. Endurance training in older men and women, I. Cardiovascular responses to exercise. J Appl Physiol. 57:1024-1029.

9. American College of Sports Medicine Position Stand. 1998. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. Med Sci Sports Exerc. 30:975-991.

10. Mukherjee A, Shalet SM. 2009. The value of IGF1 estimation in adults with GH deficiency. Eur J Endocrinol. 161(1):33-9.

11. Sartorio A, Morpurgo P, Cappiello V, Agosti F, Marazzi N, Giordani C, Rigamonti AE, Muller EE, Spada A. 2008. Exercise-induced effects on growth hormone levels are associated with ghrelin changes only in presence of prolonged exercise bouts in male athletes. J Sports Med Phys Fitness. 48(1):97-101.

12. Grandys M, Majerczak J, Kuczek P, Sztefko K, Duda K, Zoladz JA. 2017. Endurance training-induced changes in the GH-IGF-I axis influence maximal muscle strength in previously untrained men. Growth Horm IGF Res. 32:41-48.

13. Ahtiainen JP, Pakarinen A, Kraemer WJ, Häkkinen K. 2004. Acute hormonal responses to heavy resistance exercise in strength athletes versus nonathletes. Can J Appl Physiol. 29(5):527-43.

14. Sheikholeslami-Vatani D, Ahmadi S, Salavati R. 2016. Comparison of the Effects of Resistance Exercise Orders on Number of Repetitions, Serum IGF-1, Testosterone and Cortisol Levels in Normal-Weight and Obese Men. Asian J Sports Med. 7(1):30503.

15. Thomas GA, Kraemer WJ, Comstock, BA, Lewis CD, Volek JS, Denegar CR. and Maresh CM. 2012. Effects of resistance exercise and obesity level on ghrelin and cortisol in men. Metabolism. 61:860-868.

16. Gregory SM, Spiering BA, Alemany JA, Tuckow AP, Rarick KR, Staab JS, Hatfield DL, Kraemer WJ, Maresh CM and Nindl BC. 2013. Exercise-induced insulin-like growth factor I system concentrations after training in women. Med Sci Sports Exerc. 45:420-8.

17. Mohajeri Tehrani MR, Tajvidi M, Kahrizi S and Hedayati M. 2015. Does endurance training affect IGF-1/IGFBP-3 and insulin sensitivity in patients with type 2 diabetes. J Sports Med Phys Fitness. 55:1004-12.

18. Copeland JL, Chu SY and Tremblay MS. 2004. Aging, physical activity, and hormones in women-a review. J Aging Phys Act. 12:101-16.

19. Silverman HG and Mazzeo RS. 1996. Hormonal responses to maximal and submaximal exercise in trained and untrained men of various ages. J Gerontol A Biol Sci Med Sci. 51:30-7.

20. Yamaguchi T, Saiki A, Endo K, Miyashita Y and Shirai K. 2011. Effect of exercise performed at anaerobic threshold on serum growth hormone and body fat distribution in obese patients with type 2 diabetes**.** Obesity Research & Clinical Practice. 5:9-16.

21. Kanaley JA, Frystyk J, Moller N, Dall R, Chen JW, Nielsen SC, Christiansen JS, Jorgensen JO and Flyvbjerg A. 2005. The effect of submaximal exercise on immuno- and bioassayable IGF-I activity in patients with GH-deficiency and healthy subjects. Growth Horm IGF Res.15:283-90.

22. Chadan SG, Dill RP, Vanderhoek K and Parkhouse WS. 1999. Influence of physical activity on plasma insulin-like growth factor-1 and insulin-like growth factor binding proteins in healthy older women. Mech Ageing Dev. 109:21-34.

23. Nelson RK, Horowitz JF. 2014. Acute exercise ameliorates differences in insulin resistance between physically active and sedentary overweight adults. Appl Physiol Nutr Metab. 39(7):811-8.