New Approaches in Exercise Physiology (NAEP), Vol 3, No 6, 99-110, December 2021

Effects of 8 Weeks of Combined Training (Resistance and Endurance) on the Serum Vaspin Level in Obese Girls

Batoul Jalali-Kahnooj*
M.Sc., Department of Sport Sciences, University of Sistan and Baluchestan, Zahedan, Iran

Mohammad Reza Batavani**
Assistant Professor of Sport Physiology, Faculty of Center of Physical Education, Isfahan University of Technology, Isfahan 84156–83111, Iran

Mohsen Ghofrani***
Associate Professor, Department of Sport Sciences, University of Sistan and Baluchestan, Zahedan, Iran

Received: November 17, 2018; **Accepted:** March 16, 2019
doi: 10.22054/nass.2019.9860

Abstract

Background: Vaspin is an adipokine secreted from fatty tissues that has serious effects on adipose tissues, muscles, liver, and inflammation. **Purpose:** The study aimed at determining the effects of 8 weeks of combined training (resistance and endurance) on the serum vaspin level in obese girls. **Method:** The examinees consisted of 25 obese female students (BMI> 30) from Sistan-Baluchestan University in 2016-17 academic years who voluntarily participated in the research. Samples were divided randomly into two groups: Training (n = 13) and Control (n = 12). Combined training group had both resistance training (5 stations of foot press, Lat pulldown, biceps curl, knee flexion and knee extension for 75-70 minutes) and; endurance was running on the treadmill; in the 2 first weeks, with 60% HR_{max} for 25 minutes, in the 3-6th weeks with 75-65% HR_{max} for 35 minutes, and in the 6-8th weeks with 75 -85% HR_{max} for 40 minutes, continuously, for 3sessions each week. Also 10 minutes at the beginning and at the end of the training were warm up and cool down for athletes. It should be noted that during this period the control group did not participate in any kind of sports activities. After receiving the consent forms, the examinees were given enough information regarding the research procedure and their blood samples were obtained in a standard position, collected in pipes containing EDTA, and centrifuged 24 and 48 hours before and after the first and last training sessions, respectively. The obtained plasmas were kept at -80 $^{\circ}$C and their serum vaspin concentrations were measured by ELISA method using the special Human Vaspin kit. To analyze the data, the paired and independent t-test and SPSS-21 Software were performed; the meaningfulness level p was considered to be less than 0.05 ($p < 0.05$). **Results:** Results showed that after 8 weeks of combined training, the vaspin levels, weight, BMI, WHR, and %BF decreased meaningfully in the training Group compared to the control Group ($P < 0.05$). **Conclusions:** considering the meaningful vaspin reduction in this study, it seems that combined training (resistance and endurance) is beneficial to obese and overweighed people.

Keywords: Combined training, Obese girls, Vaspin

Author's e-mails: *kahnoujjalali@gmail.com **(Corresponding Author),**
**batavani@cc.iut.ac.ir, ***m_ghofrani2000@ped.usb.ac.ir

INTRODUCTION

Recent studies have shown that although hereditary factors can affect obesity, it can also occur due to lifestyle even without inheritance; physical activity is effective in both losing and maintaining weight. Over 25% of the adult population is overweighed. An inert, motionless life can increase the risk of obesity and diabetes and although neither of the two alone can cause death, both are associated with a number of such complications as hypertension, coronary disease, and cancer all of which increase the mortality rate (Wilmore, Castill, & Kenney, 2017).

The terms "overweight" and "obesity" are often used interchangeably, but technically, they have different meanings; "overweight" is more than the normal and standard weight considering a person's height and size, but "obesity" is a condition wherein the body has excess fat. Body Mass Index (BMI), obtained through dividing the weight (kg) by the square of height (m2), is a measure widely used to estimate obesity. It depends on the body composition; for people with BMI < 24 kg/m2, the risk of diabetes is at the lowest level, but it rises and becomes 40 times as the BMI increases and reaches about 35 kg/m2. Reports show that the diabetes probability in people with moderate obesity is ten times higher than that in normal people and 80% of the diabetic people are obese (Bouchard, 2012). Research results show that exercise activities can reduce appetite, increase fat recall from adipose tissues, and increase the resting metabolism a trifle after exercise (Khademosharie, Amiri Parsa, Hamedinia, & Hosseini-Kakhk, 2014).

Adipose tissues are currently considered as active endocrine organs that besides adjusting the fat mass and homeostasis of nutriments, secrete many bioactive mediums (adipokines) that regulate hemostasis energy, blood pressure, glucose and fat metabolism, cell survival, reproduction, inflammation, and, most importantly, cardiovascular function (Trujillo & Scherer, 2005). The white adipose tissue, stored as triglyceride, is the main place of energy storage in mammals. Over the past few decades, theories about the white adipose tissue have progressed considerably and besides its role as the main place of energy storage, it is considered as a gland that secretes various hormones. The white adipose tissue and its main components secrete several proteins that have many biological functions. Adipocytes secrete more than 50

different proteins called adipokines among which leptin, adiponectin, apelin, amentyn, visfatin, vaspin, and chemerin are well known (Lago, Gómez, Gómez-Reino, Dieguez, & Gualillo, 2009).

Vaspin was first identified and observed in white fat cells in adipose tissues in 2000. It is a protein with a molecular mass of 47kD secreted from adipose tissues and consists of 414,412, and 415 amino acids in rats, mice, and human beings, respectively. It has also been shown that it follows adipokines and is mostly a product of visceral adipose tissues that are related to resistance to insulin, blood glucose level, sex hormones (women at higher levels than men), and nutritional conditions (Hida et al., 2005). Vaspin secretion disruption is observed in many patients suffering from the polycystic ovary syndrome, insulin resistance, obesity (mainly visceral), and glucose intolerance. The increased serum vaspin concentration is related to obesity, insulin sensitivity disruption, and physical fitness level (Trujillo & Scherer, 2005), and vaspin levels relate to weight loss and many other factors such as the relation between obesity and metabolic disorders (Hida et al., 2005). However, findings about the role of vaspin are controversial and more research is needed to clarify the role of this adipokine in obese women, metabolic patients, and especially in patients with polycystic ovary syndrome.

The long-term dietary intervention usually causes a rapid weight loss which follows either the weight stability or a complete weight gain even with continued diet (Aronne, Wadden, Isoldi, & Woodworth, 2009). Researchers conducted a vaspin-related study for two years on 322 participants who were prescribed a low-fat, low-carbohydrate diet for weight loss to check if vaspin could have useful effects on weight control (Shai et al., 2008). It was noteworthy that during the research, vaspin played an important role in weight loss. Vaspin dynamism can reflect a consistent response in favor of a change in the pattern of healthy diet (Koiou et al., 2011).As findings show, vaspin levels reduced significantly in obese people in a short-term, 12-week weight-loss program (Chang et al., 2010). According to the dietary intervention data, the weight loss after an obesity surgery caused the amount of the serum vaspin to decrease considerably and the changes in the serum concentration were significantly related to the reduction in the circulation levels of leptin, insulin, and improved sensitivity to insulin

(Handisurya et al., 2010); this supports the idea that vaspin can be a factor for showing the body fat mass.

Researchers have shown, through numerous studies, that vaspin circulation, sensitivity to insulin, and obesity parameters are related (Mourad & Jeune, 2008). A recent study on the Korean women has shown that the vaspin expression in SAT (subcutaneous adipose tissue) in subcutaneous fat type is significantly higher compared to the visceral fat and, interestingly, it is significantly correlated with fasting insulin, HOMA-IR, and the ratio of vaspin expression in VAT (Visceral adipose tissue) to vaspin expression in SAT (Lee et al., 2011). Regarding the effects of physical activities, Safarzadeh, Gharakhanlou, Hedayati, & Talebi (2012) showed, in a study on investigating the effects of 4 weeks resistance training on vaspin level and some inflammatory indices in rats' serums, that resistance training in non-diabetic rats meaningfully reduced the vaspin level in the serum while it was increased in the diabetic training group compared to the diabetic control group. Contrary to the above results, Hejazi, Nezamdoust, and Saghebjoo (2014) showed, in a study on middle-aged obese women, that 12 weeks of aerobic exercise had no meaningful effects on their serum vaspin levels. Khademosharie et al. (2014) too showed, in a study on diabetic women, that a five-week daily and 10-week every other day aerobic exercise did not significantly affect their serum vaspin concentrations.

They answered this meaninglessness in vaspin level variations by the vaspin relation with sensitivity to insulin and showed that this meaninglessness could be an indication of an increase in the sensitivity to insulin in these patients. Although this increase too was not meaningful, the small improvement could be related to the performance of unknown proteases that altered vaspin levels independent of glucose levels. When studying the relation between physical activities with new adipokines in type 2 diabetic patients in inert and active groups, Kadoglou et al. (2011) found that the active group patients showed lower visfatin and higher apelin and adiponectin levels compared to the inert group patients and there was no significant difference in vaspin levels and other parameters between the two groups. Considering what was stated, there are many contradictions about the effects of exercise on the vaspin level variations. Interestingly, serum vaspin

concentrations were lower in slim examinees and competitive athletes with high exercise backgrounds, but they increased as a result of the reduction in the body mass with exercise programs. Hence, this study aims at studying the effects of 8 weeks of combined training (resistance and endurance) on serum vaspin levels in obese girls so as to propose suitable methods for weight control, desirable body composition, and better fat tissue efficiency by appropriate fitness exercises.

METHOD

Participants

The present study is of the applied and semi-experimental type with pre- and post-test plans and the statistical population includes all 20-25 year-old obese girl students who have completed the physical education course in the 2016-17 educational term. Based on sample size estimation rules and using the simple stochastic method, 25 examinees (with BMI > 30) were selected as the statistical samples and were randomly divided into two groups: Training (n = 13) and Control (n = 12).

Exercise Protocol

Combined training group had both resistance training and endurance training continuously, for 3sessions each week. Progressive resistance training included of (5 stations of foot press, Lat pull down, biceps curl, knee flexion and knee extension for 75-70 minutes), 3 sets, for 8-12 repeats. The rest time between each set was 1 minute that it prolonged to 3 minutes for start the next station. 1 Repetition Maximums for each athlete were measured and the intense of resistance training was 60-80 %1RM who increased smoothly and progressively. Endurance training was running on treadmill, in the 2 first weeks, with 60% HR_{max} for 25 minutes, in the 3-6^{th} weeks with 75-65% HR_{max} for 35 minutes, and in the 6-8^{th} weeks with 75 -85% HR_{max} for 40 minutes. The maximum heart rate was calculated by equation below for each person:

$$HR_{max} = 220 - Age$$

Heart rate was evaluated using a finger-speed pacemaker. Also 10 minutes at the beginning and at the end of the training were warm up and cool down for athletes. It should be noted that during this period the control group did not participate in any kind of sports activities.

Procedure

The data collection tools were included as Table 1:

Table 1: The tools were used in this survey

Tool	Usage
PAR-Q	Physical Activity Readiness Questionnaire
Written consent letters	Health status and consent letters
Germany-made SECA standard medical scale	To measure weight
Digital height meter	To measure the height
British-made Yagami caliper with a precision of 0.2 mm	To measure body composition
Germany-made finger pulse meter	To measure HR
Lab kit	To measure blood sample

Blood samples were taken 24 before the first training sessions and 48 hours after the last one. The amount of 8 cc blood were taken from anterior veins of samples in morning at 8 o'clock, at sitting and comfortable position, collected in tubes containing EDTA anticoagulant, and rapidly centrifuged for 10 minutes at 3000 rpm; the plasma was stored at -80 °C. The serum vaspin concentrations were measured by ELISA method using the special human Vaspin Kit of EASTIBIOPHARM Company through its instructions. All samples did not take tobacco, alcohol, caffeine supplement, food supplements and medication from one week before the beginning of the training program until the end of eight weeks.

Data Analyses

Data were analyzed descriptively and inferentially using the SPSS-23 Software; the descriptive statistics were used to evaluate the mean and standard deviation of the research variables-related data. Kolmogorov-Smirnov's Explore test was used to check the data distribution were normal. Since data were normal, the paired t-test was used for the difference between the pre-test and post-test and independent t-test was used for the groups' homogeneity. The statistical meaningfulness level P was taken to be less than 0.05 ($P < 0.05$); and to draw the charts and tables, we used from Excel (2010) software.

RESULTS

Table 2 shows the research findings on such anthropometric and physiological features of the samples as the weight, height, age, BMI, WHR, and % BF. The results showed BMI, WHR, and % BF in pre and post-tests in both groups were different, significantly (p<0/05).

Table 2: Examinees' anthropometric variables (mean ± standard deviation) before and after training interventions

Variables	**Control group**		**Experiment Group**	
Age (yrs.)	21/42 ± 1/67		20/62 ± 1/26	
Height (cm)	155/75 ± 6/09		185/92 ± 6/78	
	Post-test	**Pre-test**	**Post-test**	**Pre-test**
Weight,(kg)	76/66 ± 8/53	74/83 ± 7/59	72/70 ± 10/59	76/06 ± 10/40
BMI (kg/m2)	31/64 ± 3/08	30/92 ± 3/08	28/86 ± 4/26	30/20 ± 4/22
WHR	0/96 ± 0/45	0/95 ± 0/065	0/90 ± 0/043	0/93 ± 0/057
BF%	35/75 ± 4/11	34/93 ± 4/09	32/52 ± 2/50	34/28 ± 2/61

All data are expressed as the mean±SD.

Table 3 shows a comparison between the effects of 8 weeks of combined exercises in the studied groups. The independent t-test results show a meaningful vaspin difference in post-test stages of two groups (P = 0.044, t = 2.24, df=12).

Table 3: Pre- and post-test serum comparison in studied groups

Variable	**Group**	**Mean SD of Post-test**	**Mean SD of Pre-test**	**Independent t-test**	
Vaspin	Experiment	3/48 ±4/07	1/09 ± 0/52	**P-value**	**T=2/24**
	Control	3/46 ±2/94	3/38 ± 2/95	df=12	0/044

DISCUSSION

The results of this study emphasized, once again, the very effective role of the physical exercise in reducing fat without any muscle mass loss in overweighed individuals and showed that this effective weight loss method can replace hard diets and expensive medicines with various detrimental side-effects and causes people to enjoy such benefits as improved secretion of adipokines, reduced insulin resistance, improved physical fitness, and healthy body organs.

On the other hand, the new combined training method (instead of tiring weight loss exercises) can reduce the monotony of the physical exercises that are often accompanied with people's despair, particularly in obese/relatively obese individuals who are mostly inert. Despite having the same volume and intensity as other training models, it has the highest effect on weight loss through decreasing the feeling of fatigue caused by repetitive exercises. This combined (endurance-resistance) method meaningfully reduced the serum vaspin level in 20-25 year old obese girls.

Results of this study on vaspin reduction were agree to the findings of Askari, Ravasi, Gaieni, Hedayati, and Hamedinia (2015), Barzegari and Mahdirejei (2014) and Oberbach et al. (2010) but were not agree by Hida et al. (2005). Askari et al. (2015) examine the effects of a combined endurance-resistance training program on some adipokines, growth hormone and lipid profiles in overweighed girls and Oberbach et al. (2010) who have reported that the reduced serum vaspin levels after 4 weeks of exercise is an adaptation to glucose metabolism and Anti-oxidative enzyme activities due to physical activities. Also the study of Barzegari and Mahdirejei (2014) showed that after an 8-week of resistance training, resistance group had reductions in vaspin (330.50±82.51 ng/ml vs. 251.62±107.28 ng/ml, $p=0.03$).

However, the result from the current study is in agreement with the recently reported studies that have found a decrease in vaspin concentration after lifestyle modification in adults. It seems that the differences between the results found in the present study and those reported unagreement results may be related to the type of exercise (resistance vs. endurance) and this suggests that vaspin serum concentrations decreased by exercise-induced oxidative stress is confirmed in the present study (Barzegari and Mahdirejei, 2014). Also,

it seems that it can be due to the difference in the age of participants in the different studies. Different growth stages could affect the levels of growth hormone (GH). It has been reported that GH levels strongly influence vaspin regulation and its circulating levels (Gonzalez et al., 2009). Knowing that most of our subjects are adult men and large variation in levels of GH is expected, this may explain the large variation of vaspin levels between the two groups.

Vaspin is a protease inhibitor observed as an adipocytokine with the highest fat weight and increased blood insulin concentration (from rats' adipose tissues) simultaneously. Hida et al. (2005) have reported that when rats were at the peak of obesity, weight gain, and insulin resistance, their serum concentrations increased, but it reduced after their diabetes got worse. Ahmadizad, Khodamoradi, Ebrahim, and Hedayati (2010) have shown that obese people have higher vaspin levels due to their higher body fat content because of a close relationship between serum vaspin and such anthropometric indices as weight, percent body fat, and BMI. Therefore, by performing combination training that reduces the fat percent/weight in the experimental group samples, vaspin reduction is both expectable and justifiable, so there is a meaningful relationship between vaspin levels and such anthropometric components as sex, insulin sensitivity, and glucose metabolism. Exercise is effective in reducing insulin resistance, reducing fat accumulation and, hence, preventing the consequent overweight, and improving the profile and lipid metabolism (Hughes et al., 1993). Improved body composition, increased insulin sensitivity, and regulated metabolism are among the useful physiological changes due to endurance, resistance and, recently, combined endurance-resistance training. Combined exercises are interfering factors in the proper effectiveness of each exercise alone and they have been recently proposed as effective training methods for improving body function and reducing the insulin resistance index; a combination of pedaling and swimming has led to a change in the release of adipokines and a decrease in the insulin resistance in diabetic women.

CONCLUSIONS

Results of this study emphasize the effective role of exercise in reducing the fat weight and show that this weight loss method can replace hard diets and expensive drugs and let people enjoy, besides

preventing the possible side effects of weight loss drugs, the improved secretion of adipokines, reduced insulin resistance, improved physical fitness factors, and health of various body organs.

Acknowledgements

This study was supported by the office of vice chancellor for research and technology of the University of Sistan and Baluchestan.

REFERENCES

Ahmadizad, S., Khodamoradi, A., Ebrahim, K., & Hedayati, M. (2010). [Effects of resistance exercise intensity on adipokines and insulin resistance index]. *Iranian Journal of Endocrinology and Metabolism, 12*(4). 427-434. Retrieved from http://ijem.sbmu.ac.ir/article-1-824-en.html [In Persian]

Aronne, L. J., Wadden, T., Isoldi, K. K., & Woodworth, K. A. (2009). When prevention fails: Obesity treatment strategies. *The American Journal of Medicine, 122*(4 Suppl 1), 24-32. doi:10.1016/j.amjmed.2009.01.005

Askari, R., Ravasi, A., Gaieni, A., Hedayati, M., & Hamedinia, M. (2015). Effect of combined and endurance exercise training on Adipokines, GH and lipid profiles in overweight females. *Journal of Sport Biosciences, 6*(4): 399-413. doi:10.22059/jsb.2015.53211

Barzegari, A., & Mahdirejei, H. A. (2014). Effects of 8 weeks resistance training on plasma vaspin and lipid profile levels in adult men with type 2 diabetes. *Caspian journal of internal medicine, 5*(2), 103-108. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3992237/

Bouchard, C, Blair S. N., Haskell, W. (2012). *Physical activity and obesity* (2nd ed.). Champaign, IL: Human Kinetics Europe. 253-254.

Chang, H. M., Lee, H. J., Park, H. S., Kang, J. H., Kim, K. S., Song, Y. S., & Jang, Y. J. (2010). Effects of weight reduction on serum vaspin concentrations in obese subjects: modification by insulin resistance. *Obesity, 18*(11), 2105-2110. doi:10.1038/oby.2010.60

Gonzalez, C. R., Caminos, J. E., Vázquez, M. J., Garces, M. F., Cepeda, L. A., Angel, A., . . . Bravo, S. B. (2009). Regulation of visceral adipose tissue-derived serine protease inhibitor by nutritional status, metformin, gender and pituitary factors in rat white adipose tissue. *The Journal of physiology, 587*(14), 3741-3750. doi:10.1113/jphysiol.2009.172510

Handisurya, A., Riedl, M., Vila, G., Maier, C., Clodi, M., Prikoszovich, T., . . . Kautzky-Willer, A. (2010). Serum vaspin concentrations in relation to insulin sensitivity following RYGB-induced weight loss. *Obesity Surgery, 20*(2), 198-203. doi:10.1007/s11695-009-9882-y

Hejazi, M., Nezamdoust, Z., & Saghebjoo, M. (2014). Effect of twelve weeks of aerobic training on serum levels of leptin, vaspin and some indicators of oxidative stress in obese middle-aged women. *Iranian Journal of Endocrinology and Metabolism (IJEM)*, *16*(2), 111-8. Retrieved from http://ijem.sbmu.ac.ir/article-1-1664-en.html

Hida, K., Wada, J., Eguchi, J., Zhang, H., Baba, M., Seida, A., . . . Shikata, K. (2005). Visceral adipose tissue-derived serine protease inhibitor: a unique insulin-sensitizing adipocytokine in obesity. *Proceedings of the National Academy of Sciences, 102*(30), 10610-10615. doi:10.1073/pnas.0504703102

Hughes, V. A., Fiatarone, M. A., Fielding, R. A., Kahn, B. B., Ferrara, C. M., Shepherd, P., . . . Evans, W. J. (1993). Exercise increases muscle GLUT-4 levels and insulin action in subjects with impaired glucose tolerance. *American Journal of Physiology-Endocrinology and Metabolism*, *264*(6), e855-e862. Retrieved from https://doi.org/10.1152/ajpendo.1993.264.6.E855

Kadoglou, N. P., Vrabas, I. S., Kapelouzou, A., Lampropoulos, S., Sailer, N., Kostakis, A., & Liapis, C. D. (2011). Impact of atorvastatin on serum vaspin levels in hypercholesterolemic patients with moderate cardiovascular risk. *Regulatory Peptides*, *170*(1-3), 57-61. doi:10.1016/j.regpep.2011.05.008

Khademosharie, M., Amiri Parsa, T., Hamedinia, M. R., & Hosseini-Kakhk, S. A. R. (2014). Effects of two aerobic training protocols on Vaspin, Chemerin and lipid profile in women with type 2 diabetes. *ISMJ, 17*(4), 571-581. Retrieved from http://ismj.bpums.ac.ir/article-1-573-en.html

Koiou, E., Tziomalos, K., Dinas, K., Katsikis, I., Kalaitzakis, E., Delkos, D., . . . Panidis, D. (2011). The effect of weight loss and treatment with metformin on serum vaspin levels in women with polycystic ovary syndrome. *Endocrine Journal*, *58*(4), 237-246. doi:10.1507/endocrj.K10E-330

Lago, F., Gómez, R., Gómez-Reino, J. J., Dieguez, C., & Gualillo, O. (2009). Adipokines as novel modulators of lipid metabolism. *Trends in biochemical sciences*, *34*(10), 500-510. doi:10.1016/j.tibs.2009.06.008

Lee, J. A., Park, H. S., Song, Y. S., Jang, Y. J., Kim, J. H., Lee, Y. J., & Heo, Y. S. (2011). Relationship between vaspin gene expression and abdominal fat distribution of Korean women. *Endocrine Journal*, *58*(8), 639-646. doi:10.1507/endocrj.K11E-073

Mourad, J. J., & Le Jeune, S. (2008). Blood pressure control, risk factors and cardiovascular prognosis in patients with diabetes: 30 years of progress. *Journal of Hypertension, 26*, 7-13. doi:10.1097/01.hjh.0000334072.97080.33

Oberbach, A., Kirsch, K., Lehmann, S., Schlichting, N., Fasshauer, M., Zarse, K., . . . Kovacs, P. (2010), Serum vaspin concentrations are decreased after exercise-induced oxidative stress. *Obesity Facts, 3*(5), 328-331. doi:10.1159/000321637

Safarzadeh, A., Gharakhanlou, R., Hedayati, M., & Talebi, G. E. (2012). The effect of 4 weeks resistance training on serum vaspin, Il-6, CRP and TNF-A concentrations in diabetic rats. *Iranian Journal of Endocrinology and Metabolism (IJEM), 14*(1), 68-74. doi:http://ijem.sbmu.ac.ir/article-1-1244-en.html [In Persian]

Shai, I., Schwarzfuchs, D., Henkin, Y., Shahar, D. R., Witkow, S., Greenberg, I., . . . Tangi-Rozental, O. (2008). Weight loss with a low-carbohydrate, Mediterranean, or low-fat diet. *New England Journal of Medicine, 359*(3), 229-241. doi:10.1056/NEJMoa0708681

Trujillo, M. E., & Scherer, P. E. (2005). Adiponectin-journey from an adipocyte secretory protein to biomarker of the metabolic syndrome. *Journal of internal medicine, 257*(2), 167-175. doi:10.1111/j.1365-2796.2004.01426.x

Wilmore, J. H., Castill, E., & Kenney, W. L. (2009). *Physiology of Physics* (Zia Moeini, Farhad Rahmani Nia, Hamid Rajabi, Hamid Agha Alinejad, Fatemeh Salami, Trans.) (Vol. 1, pp. 51-57). Mobtakeran: Tehran. (Original work published 2015). [In Persian]