Jurnal Gizi Indonesia (The Indonesian Journal of Nutrition)
Vol. 10, No. 1, December 2021 (21-27)
Submitted: 15 January 2021, Accepted: 28 September 2021
Tersedia Online di https://ejournal.undip.ac.id/index.php/jgi

Correlation of dietary intake and physical activity with nutritional status, body composition and hand grip strength in elderly

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ABSTRACT

Background: *Increased life expectancy has both positive and negative impacts. Elderly group are prone to nutritional issues and body function disorder such as sarcopenia. Factors including dietary intake and physical activity are contributors of sarcopenia.*

Objectives: *The purpose of this study is to analyze the correlation of dietary intake and physical activity with nutritional status, body composition and hand grip strength (HGS) in elderly.*

Materials and Methods: *The study was held on July-October 2020 at the Panti Wredha Dharma Bakti Surakarta. This was a cross-sectional study of 54 elderly subjects. Subjects were selected by purposive sampling method. The data included height was measured using microtoise, while weight and body composition was measured using Bioelectrical Impedance Analyzer (BIA). Dietary intake was obtained through comstock observation. Physical activity was measured by the International Physical Activity Questionnaire. Hand grip strength values was measured by hand grip dynamometer. Data normality analyzed by Kolmogorov-Smirnov test. Bivariate test analyzed by Rank Spearman test.*

Results: *Energy, carbohydrate and fat intake had no correlation with nutritional status, total body fat percentage, subcutaneous fat percentage and skeletal muscle mass percentage (p value > 0.05), but there was a relationship between energy (p value = 0.33), carbohydrate (p value = 0.016) and fat intake (p value = 0.047) with visceral fat percentage. Physical activity had relation with nutritional status (p = 0.048) but had no relationship with total body fat percentage, visceral fat percentage, subcutaneous fat percentage and skeletal muscle mass percentage. Protein intake also had no relationship with HGS value (p value> 0.05).*

Conclusions: *Dietary intake only correlated with visceral fat percentage, but had no correlation with other body composition parameters. Physical activity correlated with nutritional status, but had no correlation with all of body composition parameters. Protein intake also had no correlation with HGS.*

Keywords: *Nutritional status; dietary intake; body composition; HGS; physical activity*

BACKGROUND

Globally, Indonesia has the fifth-largest elderly population in the world. Population projection data in 2019 shows 27.5 million elderly or 10.3% from the whole population and predicted to grow into 57 millions in 2045 or 17.9% from total population in Indonesia.[1] Central Java is province with the second-largest elderly population after Yogyakarta Special Region. In 2015, elderly population in Central Java reached 11.7% and grows to 12.59% in 2017.[2] This shows the increasing life expectancy of the elderly population in the world, including Indonesia.[3] According to population projection data in 2010-2035, Indonesia will experience an ageing period, where 10% of Indonesian population will be 60 years old. In 2004 to 2015 there was an increased life expectation rate in Indonesia from 68.6 to 70.8 years old and projected to be 72.2 years old in 2030-2035.[4]

The growing number of elderly populations has both positive and negative impact. Elderly will make positive contribution if they are healthy, physically active, and productive. While the negative impacts are when elderly has deteriorating health condition and chronic diseases.[2] The age-related decline in metabolic rate will make elderly more prone to diseases.[5,6] Elderly are specific population prone to nutritional status abnormality (over or undernutrition) and body composition changes.[7]

Ageing will affect changes in energy intake due to impaired glucose homeostasis, hormonal, gustatory and olfactory system.[8] Basal metabolic rate (BMR) studies in elderly shows a 1-2% decline yearly and substantially 5% less than younger age.[9] All of the above contributes to nutritional status changes in elderly.

Increasing age is associated with the loss of muscle mass which occurs continuously and consistently, also the gain of body fat composition. In adult, muscle mass makes up 45% of total body weight, while in elderly decreases to 27%. This will

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e-ISSN : 2338-3119, p-ISSN: 1858-4942

attributes to the decreased energy requirement for 5% every 10 years.[10] Moreover, ageing in elderly will affect clinically to body function, such as the increasing risk of sarcopenia. Sarcopenia is a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength and it is strictly correlated with age, gender and physical activity.[11]

Nutritional issues in elderly should be addressed by adequate nutrition intake and focusing on physical activity as the body function are declining. Increased physical activity will improve health outcomes, while inactivity will impose elderly to diseases.[5] Gerontologists and geriatricians stated that nutrition holds 30-50% role in achieving and maintaining optimum health condition in elderly. Certain nutrient needs are increased due to rapidly occurring degradation process.[6] Several studies shows there is a significant correlation between energy intake consumption with nutritional status in elderly. In elderly, body protein need is not decreased, even higher than adults. But several studies shows most of elderly experiencing protein consumption deficit.[10] Based on mentioned above background, authors are interested in identifying correlation between dietary intake and physical activity with nutritional status, body composition and hand grip strength value in elderly.

MATERIALS AND METHODS

This study was performed in July to October 2020 in Panti Wredha Dharma Bakti Surakarta. This is an observational-analytic study with cross-sectional design. Sample size for this study was calculated using population proportion estimation with minimum 50 subjects sample size. Subjects were pre-screened, then 54 subjects eligible to inclusion criteria was chosen using purposive sampling method. Inclusion criteria of this study are elderly living in Panti Wredha Dharma Bakti Surakarta from July to October 2020 >60 years old, able to communicate effectively, and gave consent to participate. Exclusion criteria for this study is if subject resigns when the study took place. This study had been approved by Health Research Ethics Committee of Medical Faculty Diponegoro University Number 55/EC/KEPK/FK-UNDIP/V/2020.

Independent variables in this study are dietary intake (energy, fat, carbohydrate, protein) and physical activity. Dietary intake data was obtained from Comstock visual observation converted to *ukuran rumah tangga* (URT), then analyzed using Nutrisurvey 2007. Energy, fat, protein, and carbohydrates requirement was calculated from Recommended Daily Allowance (RDA) 2019 adjusted by age group.[12] Dietary intake was considered 'adequate' when intake was meeting 80-110% requirement, considered 'more' if surpass 110% and 'less' if not meeting 80% requirement. Physical activity data was obtained from calculated daily physical activity including last 7 days exercise. Physical activity was scored using International Physical Activity Questionnaire (IPAQ). Physical activity score was calculated according to IPAQ scoring protocol. Physical activity score was classified as 'low' if under 600, 'moderate' if 600-2999 and 'high' if $\geq$ 3000.

Dependent variable in this study are body mass index (BMI), hand grip strength (HGS) and body composition parameters consist of percent fat mass, visceral fat, subcutaneous fat, and skeletal muscle mass. Body mass index value was obtained from weight divided by square height. Body mass index is categorized as underweight if <18.5 kg/m^2, normal if 18.5-22.9 kg/m^2, overweight if 23-24.9 kg/m^2, obesity grade I if 25-29.9 kg/m^2, obesity grade II if $\geq$ 30 kg/m^2. Body composition measured by OMRON (Karada Scan) model HBF 375. All procedures were carried out according to manufacturer instructions. Percent fat mass is categorized as normal if 20-30 % for women and 20 % for man. Visceral fat is categorized as normal if 0.5-9.5 %. Subcutaneous fat is categorized as normal if 20-29.9 % for women and 10-19.9 % for men. Skeletal muscle mass is categorized as normal if 23.9-29.9% for women and 32.9-38.9 % for men.

Hand grip strength is a measure of muscular strength or the maximum force/tension generated by one's forearm muscles. Hand grip strength value was measured by hand grip dynamometer. Univariate data analysis in this study was used to describe each study variables characteristic. Data normality was analyzed by Kolmogorov-Smirnov test. Bivariate data analysis was done using Spearman Rank test. Bivariate analysis was used to identify correlation between each variable in this study.

RESULTS

Subjects characteristic

Subjects characteristic table shows average of subjects age is 71.96 years old. Subjects' nutritional status by BMI is 23.37 kg/cm^2, there was underweight elderly subject with BMI 15.08 kg/cm^2 and obese elderly subject with BMI 36.86 kg/cm^2.

The result of this study shows that most of the subjects has normal nutritional status (37%) but 50% of them has obesity and are overweight. While based on percent fat, there are 63% subjects are overweight

and obese. Most subjects (66.7%) has low physical activity score, only 1 subjects was found to be highly active. More than half subjects (66.7%) has low hand grip strength (HGS) value. Most of the subjects hare normal visceral and subcutaneous fat, but all subjects have low skeletal muscle mass. Majority of the subjects (72.2%) has adequate dietary intake.

Correlation of dietary intake and physical activity and body composition

Fat percentage in this study has no correlation with energy, carbohydrate, fat intake and physical activity. Instead, energy, fat, and carbohydrate intake has positive correlation in the same direction, just physical activity alone has negative correlation direction. After analysis, visceral fat has significant correlation with dietary intake irrespective of energy, fat, or carbohydrate intake, while physical activity has no correlation with visceral fat. In this study, dietary intake (energy, fat, carbohydrate) has no significant correlation with subcutaneous fat and skeletal muscle mass ($p > 0.05$).

Correlation of dietary intake and physical activity with BMI and HGS

This study shows that BMI has no significant correlation with energy intake, but correlates in positive direction for 0.259. Inversely, this study shows a significant correlation between BMI and fat and carbohydrate intake, and physical activity. Handgrip strength value also does not significantly correlate with protein intake, but correlates in positive direction for 0.235.

Table 1. Subjects Characteristic

Variable	Min	Max	Mean ±SD
Age (years)	59	92	71.90±8.44
Weight (kgs)	28.30	101.20	56.30±13.55
Height (cm)	137.68	169	153.41±6.50
Body Mass Index (kg/cm^2)	15.08	36.86	23.30±4.16
Physical activity (score)	120	3986	1100.10±871.17
HGS (kg)	2.60	34.60	16.60±6.78
Percent Fat (%)	13.60	49.20	33.40±8.02
Percent Visceral Fat (%)	0.50	30	8.50±5.37
Percent Subcutaneous Fat (%)	10.60	37.20	25.10±5.95
Percent Skeletal Muscle Mass (%)	13	31.10	22.90±3.71
Energy intake (kcal)	1489	1887	1610±110
Carbohydrate intake (g)	265	313	270.90±11.31
Fat intake (g)	30	47	35.70±5.06
Protein intake (g)	41	74	50.7±9.01

Table 2. Distribution and Frequency of BMI, Physical Activity, HGS, Body Composition and Dietary Intake

Characteristic	N	%
BMI		
Underweight	7	13
Normal	28	37
Overweight	10	18.50
Obese I	14	25.90
Obese II	3	5.60
Physical activity		
Low	36	66.70
Moderate	17	31.50
High	1	1.90
HGS		
Normal	18	33.30
Low	36	66.70
Percent fat		

Ideal	20	37

Characteristic	N	%
Overweight	25	46.30
Obese	9	16.70
Percent visceral fat		
Normal	36	66.70
High	15	27.80
Very High	3	5.60
Percent subcutaneous fat		
Low	8	14.80
Normal	26	48.10
High	7	13
Very hight	13	24.10
Percent skeletal muscle mass		
Low	54	100
Energy intake		
Low	1	1.90
Adequate	39	72.20
High	14	25.90
Fat intake		
Low	2	3.70
Adequate	18	33.30
High	34	63
Protein intake		
Low	22	40.70
Adequate	27	50
High	5	9.30
Carbohydrate intake		
Low	29	53.70
Adequate	25	46.30

Table 3. Correlation of Dietary Intake and Physical Activity with Body Composition Parameters

Variable	R	P Value*
Percent Fat		
Energy intake	0.188	0.174
Fat intake	0.239	0.081
Carbohydrate intake	0.017	0.901
Physical activity	-0.036	0.796
Percent Visceral Fat		
Energy intake	0.291	0.033*
Fat intake	0.272	0.047*
Carbohydrate intake	0.328	0.016*
Physical activity	0.242	0.078
Percent Subcutaneous Fat		
Energy intake	0.009	0.947
Fat intake	-0.023	0.872
Carbohydrate intake	-0.105	0.450
Physical activity	0.161	0.246
Percent Skeletal Muscle Mass		
Energy intake	-0.151	0.275
Fat intake	-0.219	0.111
Carbohydrate intake	0.110	0.429
Physical activity	0.179	0.195

Rank Spearman Test *Significant ($p<0.05$)

Table 4. Correlation of Dietary Intake and Physical Activity with Nutritional Status and HGS

Variable	R	P Value*
BMI		
Energy intake	0.259	0.059
Fat intake	0.275	0.044*
Carbohydrate intake	0.289	0.034*
Physical activity	0.270	0.048*
HGS		
Protein intake	0.235	0.087

Rank Spearman test *Significant (p<0.05)

DISCUSSION

Subjects of this study are 54 elderly in Panti Wredha Dharma Bakti Surakarta. Result of this study shows 50% BMI of the subjects are overweight and obese. Thirteen percent elderly are underweight, and the rest are within normal weight. Other studies on elderly in Semarang also shows 50% elderly are overweight, 7.5% are underweight and 42.5% are normal.[13] Based on percent total fat, there are 63% elderly with obesity and overweight. Other study on elderly in Puskesmas Sukawati also shows 77.8% subjects are obese. Overweight or obesity is predominantly caused by excess calories from eating more than energy requirement and the lack of physical activity.[14]

This study shows 66.7% elderly has low score of physical activity, 31.5% elderly has moderate score and only 1.9% elderly has high score. Low physical activity in elderly is caused by limited daily activities in the environment. A study on elderly in Karangjati also shows 70.6% of the subjects has low activity level. Elderly over 70 years of age indeed engaged in less physical activity as much as 64.8%.[15] Low or moderate physical activity is associated with declining cognitive function, especially memory and language function. Physical activity are known to improve executive function, directing attention, thinking speed, working memory, and short/long term memory.[16]

Handgrip strength value for most of the elderly (66.7%) were low, only 33.3% of the subjects has normal HGS value with average 16.61±6.78 kg. A study on elderly in Semarang also shows 63.8% subjects has low grip strength. Hand grip strength is one of important indicator in diagnosing sarcopenia in elderly.[17] Decreased grip strength in ageing is associated with muscle type transformation, muscle fiber composition changes, and excitation-contraction (EC) process, genetic factor, and oxidative stress (increased IL-6 and pro-apoptosis cytokine TNF-α).[18] Decreased type II muscle fiber which plays role in anaerobic metabolism is main mechanism in lower grip strength in elderly. Less neurotropic factor as serotonergic, cholinergic, adrenergic, dopaminergic, acid-aminobutyric, and glutaminergic system caused hypo excitability in the cortex, decreased motoric coordination and cortical plasticity which affect motoric work.[19] Based on the European Working Group on Sarcopenia in Older People (EWGSOP), grip strength is a valid and reliable parameter of measuring muscle strength in diagnosing sarcopenia.[20] Sarcopenia is a geriatric condition which characterized with the loss of muscle mass and declining muscle function caused by less physical activity, caloric intake, more fibrotic progressivity, muscle metabolic changes, inflammation and oxidative stress.[21]

Bivariate analysis in this study shows BMI is significantly correlates with fat and carbohydrate intake but not with energy intake. A study on 214 elderly in Yogyakarta shows dietary intake (energy, carbohydrate, fat, protein) correlates with nutritional status.[22] Dietary intake is a direct factor in determining one's nutritional status.[23] If an elderly consume more than 3500 kcal of energy, the excess of calories will produce 0.45 kg of fat. Excess calories of 1000 kcal per day will add 1 kg of fat per week. Chronic excess calories will result in weight gain.[24] One with inadequate dietary intake will have 3.2 times higher risk of being malnourished, compared to subjects with adequate dietary intake.[25] A study on elderly in Puskesmas Rambung Kota Binjai in 2019 also shows BMI significantly correlated with energy intake. Although inversely correlated, this study also has positive correlation with the value of 0.259. Inadequate energy intake occurs overtime will caused decreased body weight while excess energy intake will increased body fat deposit and weight gain.[26]

Energy, fat, and carbohydrate intake in this study is significantly correlated with percent visceral fat. A study on 624 elderly in Japan shows different result where energy, fat, carbohydrate and protein do not have significant correlation with visceral fat accumulation.[17] A study in 81 elderly in Puskesmas Jagir Surabaya also shows same result. Elderly does not likely to be obese and centrally obese. Visceral fat is body fat deposited in the middle of the body and covering internal organs. A study shows that obese people tend to have more visceral fat.[27]

This result shows that dietary intake does not correlate with body composition parameters (percent body fat, subcutaneous fat, and skeletal muscle mass). Dietary intake positively correlated with body fat percentage. Body fat percentage will be lower if the dietary intake is subsided and energy expenditure is increased through physical activity.[28] Although the result of this study is not correlated significantly but energy, carbohydrate and fat intake has correlation in positive direction with percent body fat. A study in 167 subjects also show similar result, energy, carbohydrate and fat intake are not correlated with subcutaneous fat tissue.[29]

Hand grip strength value in this study does not have significant correlation with protein intake. This result is similar to a study on 4123 elderly in the States, where dietary intake with ≥25 gram and ≥30 gram protein does not correlates with grip strength. Nevertheless, a high protein consumption correlates positively with grip strength in female subjects.[22] Although not correlates significantly, protein intake and HGS has correlation in positive direction (r=0.235).

In this study, physical activity correlates significantly with BMI. Physical activity is one of important determinants of BMI. Excess energy intake if not accompanied by balanced energy expenditure through physical activity will results in weight gain. Lifestyle changes also influence population eating pattern that will refer to high dense calorie, fat, cholesterol and sedentary activity also play role.[30] Most elderly subjects in this study has low physical activity which contributes to the high number of overweight and obesity in BMI.

This study showed that physical activity was not significantly correlated with body composition parameters (percent body fat, visceral fat, subcutaneous fat and skeletal muscle mass). A study in 60 scholar subjects also showed a similar result. This result is different with previous study, which physical activity in working days correlates with BMI and body fat. The higher one's physical activity, the better the nutritional status. Based on the literature, physical activity is more influential to body composition than weight loss. The average loss of visceral fat is 44%.[31] Physical activity is able to increase fatty acids oxidation in skeletal muscle mass, mitochondrial volume, and adipocytes lipolysis to fatty acids, and fatty acids transport into cells. Besides, physical activity yields more energy contribution from fatty acids deposited in adipocytes.[32]

CONCLUSIONS

Dietary intake only correlates with visceral fat percentage, but has no correlation with other body composition parameters. Physical activity correlates with nutritional status, but has no correlation with all of body composition parameters. Protein intake also has no correlation with HGS

ACKNOWLEDGMENTS

The authors thank the dharma bhakti home nurse that participated in the observations

REFERENCES

1. Heri l. Info Demografi Lansia. Jakarta. Badan Kependudukan dan Keluarga Berencana Nasional. 2019. p. 4.
2. Kementrian Kesehatan RI. Analisis Lansia di Indonesia. Jakarta Selatan: Pusat Data dan Informasi, Kementrian Kesehatan RI; 2019.
3. Kementrian kesehatan RI. Situasi dan Analisis lanjut Usia. Jakarta Selatan: Pusat Data dan Informasi, Kementrian Kesehatan RI; 2014. 1-6 p.
4. Kementrian Kesehatan RI. Situasi Lanjut Usia (LANSIA) di Indonesia. Jakarta: Pusat Data dan Informasi, Kementrian Kesehatan RI; 2016. 1-9 p.
5. Ismayanti N, Solikhah. Hubungan antara Pola Konsumsi dan Aktivitas Fisik dengan Status Gizi pada Lansia di Panti Sosial Tresna Werdha Unit Abiyoso Yogyakarta. KES MAS. 2012;6(3):144–211.
6. Ibrahim H. Hubungan Faktor-faktor yang Mempengaruhi Kebutuhan Gizi dengan Status Gizi Lanjut Usia di UPTD Rumoh Seujahtera Geunaseh Sayang Banda Aceh. Idea Nurs J. 2012;III(2):51–62.
7. Leslie W, Hankey C. Aging, Nutritional Status and Health. Healthcare. 2015;3(3):648–58.
8. Roberts SB, Rosenberg I. Nutrition and aging: Changes in the regulation of energy metabolism with aging. Physiol Rev. 2006;86(2):651–67.
9. Keys A, Taylor HL, Grande F. Basal metabolism and age of adult man. Metabolism. 1973;22(4):579–87.
10. Jannah M, Rohmawati N. Tingkat Konsumsi , Tingkat Aktivitas Fisik , dan Status Gizi pada Lansia Anggota dan Bukan Anggota Karang Werda (Consumption Level , Level of Physical Activity , and Nutritional Status of elderly. 2015;1–7.

11. Santilli V, Bernetti A, Mangone M, Paoloni M. Clinical definition of sarcopenia. Clin Cases Miner Bone Metab. 2014;11(3):177–80.
12. Peraturan Menteri Kesehatan Republik Indonesia Nomor 28 Tahun 2019 tentang Angka Kecukupan Gizi yang dianjurkan untuk Masyarakat Indonesia. Menteri Kesehatan Republik Indonesia. 2019. p. 1–33.
13. Karunia ANA. Hubungan Indeks Masa Tubuh dan Asam Lemak Jenuh dengan Serum Rasio LDL/HDL Lansia. 2015;1–27.
14. Novia RT. Hubungan Asupan Energi, Karbohidrat dan Lemak dengan Status Obesitas pada Lansia di Posyandu Lansia Wedra Utama Purwosari. 2017;1–16.
15. Mulyadi A, Anisa Fitriana L, Rohaedi S. Gambaran Aktivitas Fisik Pada Lansia Demensia Di Balai Perlindungan Sosial Tresna Wreda Ciparay Bandung. J Keperawatan Olahraga. 2020;9(1):1–11.
16. Sauliyusta M, Rekawati E. Aktivitas Fisik Mempengaruhi Fungsi Kognitif Lansia. J Keperawatan Indones. 2016;19(2):71–7.
17. Caniago MR, Ngestiningsih D, Fulyani F. Hubungan antara Kadar Vitamin D dengan Kekuatan Genggaman Tangan Lansia. J Kedokt Diponegoro. 2019;8(1):300–12.
18. Clark BC, Manini TMClark BC MT. Sarcopenia Dynapenia. 2008;63(8):29–34.
19. Riviati N, Setiati S, Laksmi PW AM. Factors Related with Handgrip Strength in Elderly Patients. Acta Med Indones. 2017;49(3):215–9.
20. Schaap LA, Fox B, Henwood T, Bruyère O, Reginster JY, Beaudart C, et al. Grip strength measurement: Towards a standardized approach in sarcopenia research and practice. Eur Geriatr Med [Internet]. 2016;7(3):247–55.
21. Papadopoulou SK. Sarcopenia: A contemporary health problem among older adult populations. Nutrients. 2020;12(5):1–20.
22. Mishra S, Goldman JD, Sahyoun NR, Moshfegh AJ. Association between dietary protein intake and grip strength among adults aged 51 years and over : What We Eat in America , National Health and Nutrition Examination Survey 2011-2014. PLoS One. 2018;1–12.
23. Saniawan I. Status gizi pada lanjut usia pada Banjar Paang Tebel di Desa Peguyangan Kaja Wilayah Kerja Puskesmas III Denpasar Utara. J Ilm Keperawatan. 2009;2(1):45–9.
24. Fatimah. Gizi Usia Lanjut. Jakarta: Erlangga; 2010.
25. Dwiyanti D, Hadi H, Susetyowati. Pengaruh asupan makanan terhadap kejadian malnutrisi di rumah sakit. J Gizi Klin Indones. 2004;1(1):1–7.
26. Lubis DV. Hubungan Asupan Energi dan Protein dengan Status Gizi Lansia di Puskesmas Rambung Kota Binjai Tahun 2019. 2019;
27. Sofa IM. Kejadian Obesitas , Obesitas Sentral , dan Kelebihan Lemak Viseral pada Lansia Wanita. 2018;228–36.
28. Rachmawati PA, Murbawani EA. Hubungan Asupan Zat Gizi, Aktivitas Fisik, dan Persentase Lemak Tubuh dengan Gangguan Siklus Menstruasi pada Penari. J Nutr Coll. 2015;4(1):39–49.
29. Tayyem RF, Al-radaideh AM, Hammad SS, Al-hajaj S, Allehdan SS, Agraib LM. Subcutaneous and visceral fat volume measured by MRI and its relationship with nutrients intake among adults. Asia Pasific J Clin Nutr ·. 2019;28(2):1–12.
30. Delimasari A. Hubungan Pola Aktivitas Fisik dengan Status Gizi pada Mahasiswa Prodi DIV Bidan Pendidik Universitas Aisyiyah Yogyakarta. 2017.
31. Boudou P, Sobngwi E, Mauvais-Jarvis F, Vexiau P, Gautier JF. Absence of exercise-induced variations in adiponectin levels despite decreased abdominal adiposity and improved insulin sensitivity in type 2 diabetic men. Eur J Endocrinol. 2003;149(5):421–4.
32. Talanian JL, Galloway SDR, Heigenhauser GJF, Bonen A, Spriet LL. Two weeks of high-intensity aerobic interval training increases the capacity for fat oxidation during exercise in women. J Appl Physiol. 2007;102(4):1439–47.