Article

Physical activity, exercise habits, and body mass index of adults

Ratna Candra Dewi,[1,2] Bambang Wirjatmadi[3]

[1]Doctoral Program of Public Health Faculty, Universitas Airlangga, Surabaya, Indonesia; [2]Faculty of Sport Science, Universitas Negeri Surabaya, Surabaya, Indonesia; [3]Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia

Abstract

Introduction: The risk of degenerative diseases begins to appear in adulthood. Physical activity and exercise habits prevent the incidence of obesity which is a risk factor for degenerative diseases' emergence. Therefore, this study aims to examine the relationship between physical activity, exercise habits, body mass index, and fat mass percentage.

Design and Methods: This study used an analytic observational cross-sectional design and 32 office workers in Surabaya aged 28-56 years were selected by simple random sampling technique. The data collected included measurements of physical activity, exercise habits, anthropometry, and body composition, which were analyzed using Spearman's rank correlation test.

Results: The results showed that 46.9% of participants had moderate activity, 43.8% exercised 1-2x a week, 56.3% exercised for 20-60 minutes, 56.30% had a low exercise intensity, 62.50% had an overweight body mass index, and 71.9% had overfat mass percentage. Spearman's rank test showed a significant relationship between energy intake, physical activity, exercise frequency, duration and intensity, and body mass index as well as between energy intake, physical activity, exercise intensity, and body fat percentage.

Conclusions: Increased physical activity and exercise habits were associated with decreased BMI and body fat percentage.

Introduction

Physical Activity (PA) and exercise habits help to prevent and manage chronic disease, due to their beneficial effects on clinical endpoints in various diseases.[1] High levels of PA show a relationship with better health and life quality.[2,3] In contrast, low PA is associated with negative health outcomes, including obesity, type 2 diabetes mellitus, and death.[4] Physical activity, exercise, and nutrition work together to maintain body weight at the desired level.[2] Although diet contributes more to short-term weight loss, exercise appears to be important in maintaining the desired body weight.[3]

Decreased PA due to Lifestyle changes initiates obesity, while light PA performed during leisure time such as sitting relaxed, watching television, and playing computer, decreases bodily-produced energy, causing an imbalance between energy generated from food and the amount expended for physical activity. This leads to fatty tissue accumulation that increases the risk of obesity, especially in adulthood.[5]

Obesity in adulthood (26-45 years) which has the highest level of productivity compared to other age groups, directly increases the economic burden. Hence, elevation in medical expenses and absenteeism at work due to diseases caused by obesity is used to measure a country's productivity decline. Obese employees require more time to complete tasks and have limited ability to work physically. Their counterparts with a normal body weight lack or only have a few related health disorders.[6]

Physical activity that prevents obesity can be conducted with moderate intensity for at least 150-250 minutes per day. Additionally, there is a need to limit excess food, rest sufficiently (6-8 hours in adults) and reduce stress.[7] Moderate-intensity PA done regularly maintains a balance of expended and consumed energy.[8] PA in adulthood includes sports or planned exercises, as well as leisure activities (such as walking, dancing, gardening, swimming), household chores (such as washing, cooking, sweeping), on-site work, and play which are carried out routinely.

Body Mass Index (BMI) is a method that uses height and weight data to determine whether a person is healthy, overweight, or obese, but its disadvantage is the inability to provide accurate information about body composition. This aspect led some authors to define "the obesity paradox" as a situation in which obese individuals do not appear to be at a higher risk for hypertension, dyslipidemia, type II diabetes, or cardiovascular disease compared to their lean counterparts.[2]

A recent study on total body fat shows that adiposity is a significant risk marker for evaluating unhealthy weight. Furthermore, body fat is a more accurate indicator than BMI for predicting obesity.[3] There is ample evidence regarding the importance of physical activity in weight loss programs to maintain a healthy weight and prevent long-term weight gain. Increased PA has also been reported to provide comprehensive health benefits and reduce mortality associated with any cause, regardless of BMI. Specifically, this study aims to analyze the relationship between physical activity, exercise habits, body mass index, and body fat percentage.

Significance for public health

An unbalanced diet and lack of physical activity increase the risk of non-communicable diseases. Meanwhile physical activity has several benefits including reducing the risk of coronary heart disease, stroke, diabetes, hypertension, colon cancer, breast cancer, and depression. It is also the key to energy expenditure which balances energy and controls body weight to facilitate a normal BMI and body fat percentage.

Design and Methods

An analytic observational cross-sectional design was used, while the population selected by simple random sampling technique were 32 office workers in Surabaya aged 25-55 years. Anthropometric measurements included the assessment of height using a microtoise. Bodyweight, body fat percentage, and BMI were measured by bioimpedance using a Tanitamulti frequency analyzer (Tanita Corporation, Tokyo, Japan). Furthermore, consumption intake was determined with a 2x24 hour recall method and analyzed using NutriSurveysoftware, while the GPAQ (Global Physical Activity Questionnaire) method was used for PA. In this study, exercise habits were divided into frequency, duration, and intensity of exercise. All data were analyzed with SPSS version 22 and descriptive statistics were calculated to determine consumption intake percentage, body fat percentage, BMI, physical activity, and exercise habits. Rank Spearman Correlation Test was used to analyze relationships between variables, where α (two-sided) = 0.05 and Power of study = 95%. Before data collection, all participants were provided with information about the study and the right to withdraw at any time, then they filled out informed consent.

Results and Discussions

Characteristics of participants

Table 1 shows that most of the participants were male (78.1%), 46.9% had an energy intake of 2500-2999 kcal, 46.9% did a moderate physical activity, 62.5% had overweight BMI, 71.9% had excess body fat percentage, 43.8% exercised at a frequency of 1-2 times/week, 56.3% had an exercise duration of 20-60 minutes, and 56.3% did low-intensity exercise.

Table 2 shows a significant relationship (<0.05) between energy intake, physical activity, exercise frequency, duration and intensity, and BMI, as well as between energy intake, physical activity, exercise intensity, and body fat percentage. The energy intake coefficient is positive, meaning a greater coefficient value tends to increase BMI and body fat percentage. On the other hand, the coefficients of exercise frequency, duration and intensity, and physical activity are negative, meaning a greater value reduces BMI and body fat percentage.

This study aimed to analyze the relationship between energy intake, physical activity, exercise frequency, duration and intensity, BMI, and percentage body fat in adults aged 28-56 years. Bodyweight and composition are the sums of many factors that regulate and influence the "intake" and "output" sides of the energy balance equation.[1] In weight management and obesity prevention, the role of diet and PA is not simply 'eat less' or 'exercise more', but understanding the synergies and interrelated nature of both factors.[9] Diet influences energy balance and health more than just providing energy. For example, daily energy expenditure is affected by total energy intake (e.g., kcal or kJ consumed), plus food macronutrient composition (percentage of energy from protein, fat, carbohydrates, and alcohol),[4,10] its energy density (kcal or kJ per g of food),[10,11] and timing of intake.[12] These dietary factors also change the food's thermic effect and the type of substrate stored or used for fuel during PA.[13-15]

Physical activity and exercise affect the balance of energy more than just its expenditure. The energy amount expended and

Table 1. Variables of the participant's characteristics.

Characteristics	N	%
Sex		
Male	25	78.1
Female	7	21.9
Energy Intake		
2000 – 2499 kcal	4	12.5
2500 – 2999 kcal	15	46.9
3000 – 3499 kcal	10	31.2
>3500	3	9.4
Minimum:	2000	
Maximum:	3500	
Mean:	2787.50	
SD:	421.02	
Physical Activity		
Low (< 600 MET-minutes a day)	13	40.6
Moderate (600 - <1500 MET-minutes a day)	15	46.9
High (1500 - <3000 MET-minutes a day)	4	12.5
Body Mass Index		
Underweight (BMI ≤ 18.4)	1	3.1
Normal (BMI 18.5-25)	11	34.4
Overweight (BMI ≥ 25.1)	32	62.5
Body Fat Percentage		
Lean	0	0
Optimal	9	28.1
Overfat	23	71.9
Exercise frequency		
No exercise	5	15.6
1-2x/week	14	43.8
3-5x/week	8	25.0
>5x/week	5	15.6
Exercise duration		
<20 minutes	7	21.9
20-60 minutes	18	56.3
>60 minutes	7	21.9
Exercise intensity		
Low	18	56.3
Moderate	13	40.6
High	1	3.1

Remark: MET= Metabolic equivalents; BMI= Body Mass Index.

Table 2. The relationship between explanatory variables, body mass index, and body fat percentage.

Variables	BMI		Body Fat Percentage	
	R	Sig.	r	Sig.
Energy Intake	0.522	0.002	0.479	0.006
Physical Activity	-0.415	0.018	-0.418	0.017
Exercise Frequency	-0.396	0.025	-0.255	0.159
Exercise Duration	-0.375	0.034	-0.315	0.079
Exercise Intensity	-0.628	0.000	-0.528	0.002

the fuel used are affected by the type, intensity, and duration of PA. For example, 30 minutes of running consumes more energy than walking at that same time. PA also alters appetite and its-regulating hormones by promoting appetite suppression or hunger, which in turn changes total energy intake.[16-19] This in addition to regular and frequent exercise jointly increases energy flux, namely energy conversion rate after absorption from food into body tissues for use in metabolism or the conversion into energy stores.[20] Higher energy flux levels augment the body's ability to match energy intake with expenditure thereby making weight management easier.[20,21] PA and proper exercise increase muscle mass and strength,[22,23] as well as elevate or maintain bone mass.[23] These factors improve body composition and health as well as increase an individual's ability to maintain an active lifestyle and reduce the risk of obesity and chronic disease.[11,24]

According to Shook et al., the group with low activity levels had high body weight and BMI. They also discovered that weight differences were entirely attributable to differences in fat mass, with the low PA group having the highest fat mass (30.9 kg or 68 lb) versus the greatest PA group (14.2 kg or 32 lb).[25] One year later, another study reported that the two lowest PA groups had a 1.82 to 3.80 times greater risk of gaining >3% body fat than the group participating in medium or higher PA, meaning a low PA level is a risk factor for weight gain.

Physical activity reduces energy intake by changing appetite, and its effect on appetite is influenced by PA type and intensity, environmental temperature, and characteristics of the exerciser. PA tends to create a negative energy balance, depending not only on its direct effect on the ability to increase expenditure but also indirectly on the potential to modulate appetite and/or energy intake.

Based on a study, the type and intensity of exercise or PA affect changes in appetite. High-intensity exercise has a greater propensity to suppress hunger or food intake after being performed than moderate or light exercise.[26,27] Appetite is suppressed for 15-60 minutes after exercise and potentially delays the next meal. The type of exercise also affects appetite suppression. Another study shows that running, rope jumping, or high-intensity exercise interval workouts tend to suppress appetite than swimming and walking which rather stimulate appetite and/or food intake. Additionally, running has a stronger effect on appetite suppression than strength training.[28-33]

The environmental temperature during or after exercise also affects appetite. Increased hunger and/or food intake can be caused by a cold environment while hunger is suppressed by hotness. It was reported that exercising for 45 minutes in 20◦C water elevates food intake by an average of 44% more after 1 hour of exercise compared to 32◦C.(34,35) Differences in environmental or body temperature show that swimming increases hunger compared to other types of exercise.[35] The limitations of this study are related to body composition measurements that only BMI and body fat percentage. There need to be other measurements such as muscle mass and bone mass. This is to determine the role of physical activity, exercise habits and diet on body composition.

Conclusions

Based on the results, increased physical activity and exercise habits were associated with decreased BMI and body fat percentage. Regular physical activity and exercise, as well as a healthy and balanced diet will create a healthy body composition.

Correspondence: Ratna Candra Dewi, Faculty of Public Health, Universitas Airlangga, Jl. Dr. Ir. H. Soekarno, Mulyorejo, Surabaya, Indonesia 60115, Tel.: +62315920948, Fax: +62315924618, E-mail: ratna.can.dewi-2017@fkm.unair.ac.id

Key words: Physical activity, exercise habits, Body Mass Index, body fat percentage

Acknowledgment: The authors are grateful to the Faculty of Public Health Universitas Airlangga for the support and encouragement provided during this study.

Contributions: All authors read and approved the final manuscript.

Conflict of interest: The authors declare no conflict of interest.

Funding: This study was funded by the Faculty of Public Health, Universitas Airlangga.

Availability of data and materials: All data generated or analyzed during this study are included in this published article.

Informed consent: Written informed consent was obtained from a legally authorized representative(s) for anonymized patient information to be published in this article.

Conference presentation: Part of this paper was presented at the 2nd International Nursing and Health Sciences Symposium that took place at the Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia.

Received for publication: 3 December 2021.
Accepted for publication: 10 May 2022.

Healthcare in Low-resource Settings 2023; 11(s1):11197
doi:10.4081/hls.2023.11197

References

1. Sparling PB, Franklin BA, Hill JO. Energy balance: the key to a unified message on diet and physical activity. J Cardiopulm Rehabil Prev 2013;33:12–5.
2. Hall KD, Heymsfield SB, Kemnitz et al. Energy balance and its components: implications for body weight regulation 1-3. Am J Clin Nutr 2012;95:989–94.
3. Shook RP, Hand GA, Blair SN. Top 10 research questions related to energy balance. Res Q Exerc Sport 2014;85:49–58.
4. Galgani J, Ravussin E. REVIEW Energy metabolism, fuel selection and body weight regulation. Int J Obes 2008;32:109–19.
5. Elder BL, Ammar EM, Pile D. Sleep Duration, Activity Levels, and Measures of Obesity in Adults. Public Health Nurs 2016;33:200–5.
6. Sanchez Bustillos A, Gregory Vargas III K, Gomero-Cuadra R. Journal of Epidemiology and Global Health Work productivity among adults with varied Body Mass Index: Results from a Canadian population-based survey Work productivity among adults with varied Body Mass Index: Results from a Canadian

population-based survey. J Epidemiol Glob Health 20155:191–9.
7. Hruby A, Hu FB. The Epidemiology of Obesity: A Big Picture. Pharmacoeconomics 2015;33:673–89.
8. Swift DL, Johannsen NM, Lavie et al. The Role of Exercise and Physical Activity in Weight Loss and Maintenance. Prog Cardiovasc Dis 2014;56:441–7.
9. Flatt JP. Issues and misconceptions about obesity. Obesity (Silver Spring) 2011;19:676–86.
10. Ledikwe JH, Rolls BJ, Smiciklas-Wright, et al. Reductions in dietary energy density are associated with weight loss in overweight and obese participants in the PREMIER trial 14. Am J Clin Nutr 2007;85:4754403
11. Madjd A, Taylor MA, Delavari A et al. Beneficial effects of replacing diet beverages with water on type 2 diabetic obese women following a hypo-energetic diet: A randomized, 24-week clinical trial. Diabetes, Obes Metab 2017;19:125–32.
12. Hawley JA, Burke LM, Phillips SM, et al. Nutritional modulation of training-induced skeletal muscle adaptations [Internet]. J Appl Physiol 1985;110:34–45.
13. Hawley JA, Burke LM. Carbohydrate availability and training adaptation: Effects on cell metabolism. Exerc Sport Sci Rev 2010;38:152–60.
14. Manore M, Meyer NL, Thompson J. Sport Nutrition for Health and Performance. Human Kinetics; 2009. Available from: https://books.google.vg/books?id=UAWJVHHTM2QC.
15. Stensel D. Exercise, appetite and appetite-regulating hormones: Implications for food intake and weight control. Ann Nutr Metab 2011;57:36–42.
16. Hagobian TA, Braun B. Physical activity and hormonal regulation of appetite: Sex differences and weight control. Exercise and Sport Sciences Reviews. Exerc Sport Sci Rev 2010;38:25–30.
17. King JA, Garnham JO, Jackson AP, Al E. Appetite-regulatory hormone responses on the day following a prolonged bout of moderate-intensity exercise. Physiol Behav 2015;141:23–31.
18. Thackray AE, Deighton K, King JA, Stensel DJ. Exercise, Appetite and Weight Control: Are There Differences between Men and Women? Nutrients 2016;8:583.
19. Hill JO, Wyatt HR, Peters JC. Energy Balance and Obesity. Circulation 2012;126:126–32.
20. Melby CL, Paris HL, Foright RM, Peth J. Attenuating the Biologic Drive for Weight Regain Following Weight Loss: Must What Goes Down Always Go Back Up? Nutrients. 2017;9:468.
21. Ramírez-Vélez R, Correa-Bautista JE, Lobelo F, et al. High muscular fitness has a powerful protective cardiometabolic effect in adults: influence of weight status. BMC Public Health 2016;16:1012.
22. Kohrt WM, Bloomfield SA, Little KD et al. Physical activity and bone health. Med Sci Sports Exerc 2004;36:1985–96.
23. Hupin D, Roche F, Gremeaux V, et al. Even a low-dose of moderate-to-vigorous physical activity reduces mortality by 22% in adults aged ≥60 years: A systematic review and meta-analysis. Br J Sports Med 2015;49:1262-7.
24. Shook RP, Hand GA, Drenowatz C, et al. Low levels of physical activity are associated with dysregulation of energy intake and fat mass gain over 1 year 1,2. Am J Clin Nutr 2015;102:1332–40.
25. Ueda S-Y, Yoshikawa T, Katsura Y et al. Comparable effects of moderate intensity exercise on changes in anorectic gut hormone levels and energy intake to high intensity exercise. J Endocrinol 2009;203:357–64.
26. Imbeault P, Saint-Pierre S, And NA et al. Acute effects of exercise on energy intake and feeding behaviour. Br J ofNufrifion 2021;77:51–2.
27. Deighton K, Karra E, Batterham et al. Appetite, energy intake, and PYY3-36 responses to energy-matched continuous exercise and submaximal high-intensity exercise. Appl Physiol Nutr Metab 2013;38:947–52.
28. Larson-Meyer DE, Palm S, Bansal A, Austin KJ, Hart AM, Alexander BM. Clinical study influence of running and walking on hormonal regulators of appetite in women. J Obes 2012;2012:15.
29. Kawano H, Mineta M, Asaka M et al. Effects of different modes of exercise on appetite and appetite-regulating hormones. Appetite 2013;66:26–33.
30. King JA, Wasse LK, Stensel DJ. The Acute Effects of Swimming on Appetite, Food Intake, and Plasma Acylated Ghrelin. J Obes 2011;2011.
31. Verger P, Lanteaume MT, Louis-Sylvestre J. Human intake and choice of foods at intervals after exercise. Appetite 1992;18:93–9.
32. Broom DR, Batterham RL, King JA et al. Influence of resistance and aerobic exercise on hunger, circulating levels of acylated ghrelin, and peptide YY in healthy males. Am J Physiol Integr Comp Physiol 2009;296:R29–35.
33. Crabtree, Daniel R.Blannin AK. Effects of Exercise in the Cold on Ghrelin, PYY, and Food Intake in Overweight Adults. Med Sci Sport Exerc 2015;47:49–57.
34. White LJ, Dressendorfer RH, Holland E et al. Increased caloric intake soon after exercise in cold water. Int J Sport Nutr Exerc Metab 2005;15:38–47.
35. Halse RE, Wallmann KE, Guelfi KJ. Postexercise Water Immersion Increases Short-Term Food Intake in Trained Men. Med Sci Sport Exerc 2011;43:632–8.