



Original
Artículo inglés

Exercise and Body Mass Index: are those two parameters related in adults?

Ejercicio e Índice de Masa Corporal: ¿están relacionados estos dos parámetros en adultos?

Ismael San Mauro Martín¹, Elena Garicano Vilar¹, Victor Paredes Barato¹

¹ Grupo CINUSA. Paseo de la Habana, 43. 28036, Madrid, España.

Abstract

Introduction. Theories linking physical activity and body fat or weight have long suggested the presence of an inverse relationship between the two variables.

Aim. The aim was to evaluate the association between exercise and Body Mass Index (BMI) in adults.

Methods. 318 subjects aged 17-62 years were recruited from different sport clubs in Madrid (Spain). Anthropometric measurements and information on exercise-related physical activity were obtained. Statistical analyses were performed using IBM SPSS v.20.0.

Results. There was no statistically significant difference in exercise minutes between the different BMI groups ($\chi^2 = 0.750$, $p = 0.750$). After a Spearman's correlation was run to determine the possible monotonic relationship between BMI and exercise, the null hypothesis tested ("there's no association between the two variables") could not be rejected (Spearman's $Rho = 0.001$; $p = 0.991$).

Conclusion. This trial brings to light no association between hours of exercise per week and BMI.

KEYWORDS

Physical activity; Body Mass Index; obesity; body fat.

Resumen

Introducción. Las teorías que relacionan la actividad física y la grasa corporal o peso han sugerido desde hace tiempo la presencia de una relación inversa entre las dos variables.

Objetivo. El presente estudio tiene por objetivo evaluar la asociación entre las horas de ejercicio realizadas a la semana y el Índice de Masa Corporal en adultos.

Métodos. 318 sujetos con edades entre 17-62 años fueron reclutados de diferentes clubes deportivos en Madrid (España). Se obtuvieron mediciones antropométricas e información sobre la actividad física relacionada con el ejercicio. Los análisis estadísticos se realizaron con IBM SPSS v.20.0.

Resultados. No hubo diferencia estadísticamente significativa entre los minutos de ejercicio y los diferentes grupos de IMC ($\chi^2 = 0,750$, $p = 0,750$). Después de llevar a cabo la correlación de Spearman para determinar la posible relación monotónica entre el IMC y el ejercicio, la hipótesis nula de la prueba ("no hay asociación entre las dos variables") no pudo ser rechazada (Rho de Spearman = 0,001; $p = 0,991$).

Conclusiones. Este estudio pone de manifiesto la no asociación entre las horas de ejercicio y el Índice de Masa Corporal en adultos.

PALABRAS CLAVE

Actividad física; Índice de Masa Corporal; obesidad; grasa corporal.

CONTRIBUTION TO SCIENTIFIC LITERATURE

Increase in non-sedentary activity is related to a decrease in body mass index, and numerous articles show that the prevalence of overweight is inversely related to the level of physical activity. However, in this study carried out in Spain, statistically significant differences between these parameters cannot be observed. This suggests the need for further studies in this regard, given the importance that is currently taking the control of obesity as a strategy for the prevention of associated diseases.

* Autor para correspondencia.

Correo electrónico: research@grupocinusa.com (Ismael San Mauro Martín).

Recibido el 24 de mayo de 2016; aceptado el 25 de mayo de 2016.



Los artículos publicados en esta revista se distribuyen con la licencia:
Articles published in this journal are licensed with a:
Creative Commons Attribution 4.0.
<https://creativecommons.org/licenses/by-nc-nd/4.0/>
La revista no cobra tasas por el envío de trabajos,
ni tampoco cuotas por la publicación de sus artículos.

INTRODUCTION

Theories linking physical activity and body fat or weight have long suggested the presence of an inverse relationship between the two variables ⁽¹⁾. The relationship between physical activity and body fat or weight is derived from the assumption that a normal-weight person's energy intake is equal or nearly equal to their energy expenditure ⁽¹⁾. That is, a person becomes overweight or obese if the energy intake is greater than the energy expenditure ⁽¹⁾, and one way of maintaining the energy balance is by getting rid of the extra calories by performing physical activity ⁽²⁾. If physical activity is not sustained, even an individual with a healthy weight could easily regain some or all of it ⁽³⁾.

Body Mass Index (BMI) is an easily-administered and inexpensive tool to monitor weight status. Although it is commonly used in a health-setting to classify humans as underweight, normal weight, overweight and obese ⁽⁴⁾, its application in sport populations has been questioned, because it is associated with fat mass, as well as with fat free mass ⁽⁵⁾. Independently from this limitation, it still can evaluate athlete's body weight for a given stature, and thus, contribute to weight control.

Although it is well established in Western populations that increasing purposeful or leisure-time physical activity is associated with reduced rates of obesity ⁽⁶⁾, recent evidence, also from Western countries, suggests that sedentary activities, such as watching television or using a computer, are associated with increasing obesity, independent of purposeful physical activity ⁽⁷⁾. That means, the effect of physical activity may be offset by other factors or habits and may not imply that the more hours of exercise will become lower BMI.

This paper examines in detail the relationships between obesity and exercise-related physical activity in adults, with particular emphasis on the interaction between these factors.

AIM

Our aim was to verify whether more exercise hours is associated with a lower BMI in adults.

METHODS

Sample size:

318 adults aged 17-62 years, recruited from different sport clubs, gyms and sports centres, completed an ad-hoc questionnaire, including data on height, weight, waist circumference, body fat, visceral fat, muscle and basal metabolic rate. Weight and height were used to calculate participants' BMI, as their weight in kilograms, divided by the square of their height in metres.

Information on exercise-related physical activity was obtained through a question asking: "During a typical week (7-day period), how many times on average do you exercise, for how long each session and under which intensity (strenuous, moderate and walking)?" The following information on demographics factors was collected: age, gender and nationality.

Where possible, questionnaire items that had been standardised and validated were used. Data were collected by trained and formed nutritionists and dieticians, standardizing the data collection protocol and monitoring the study.

Height was measured with a stadiometer SECA 216, range from 3.5 to 230 cm with an accuracy of 1 mm. Body composition was determined through an electrical bioimpedance, four-pole, multi-frequency (20 to 100 kHz), InBody Model 230. For waist circumference a flexible non-elastic, metallic measuring tape, ranged from 0.1mm to 150cm was used

Inclusion criteria: analysis was restricted to men and women aged 18-65 years old, who were physically active, had sufficient level of understanding to conceive their participation in the study and accepted a voluntary participation after signing an informed consent.

Exclusion criteria: individuals were excluded from the analyses if they were nonage, had not provided complete responses to follow-up questionnaires, did not perform any exercise or presented any diseases that could alter activity level and/or weight.

Variables and study factors:

International cut-off points of BMI were employed to classify adult participants as underweight (<18.5 kg/m²), normal (18.5-24.9 kg/m²), overweight (25-30 kg/m²) or obese (>30 kg/m²) (WHO, 1995). Time dedicated to physical activity was divided into two groups (<150min/week and ≥150 min/week), according to the WHO recommendation of exercise for adults between 18 and 64 year old ⁽⁸⁾.

Statistical analysis:

Statistical analyses were performed using IBM SPSS v.20.0. Data were expressed as mean and standard deviations of the mean (SD). Normal distribution could not be assumed, so non-parametric tests were used. Association between hours of physical activity, and BMI was examined using Pearson's Chi-square test, together with Kruskal-Wallis test to compare the mean ranks of exercise time between groups. Spearman's rho was used to look for correlations between BMI and minutes of exercise per week. The level of significance was set at α=0.05 and a 95% confidence interval.

RESULTS

A total of 318 participants (181 men and 137 women) aged 17-62 years (mean 35 ± 11,04 years) joined the cohort. The baseline characteristics of participants are summarized in Table 1.

Table 1: Descriptive statistics of the participants

	Total (n=318)	Males (n=181)	Females (n=137)
	Mean ± SD	Mean ± SD	Mean ± SD
Age (years)¹	35,96 ± 11,04	36,06 ± 10,66	35,81 ± 11,66
Weight (kg)	70,07 ± 12,24	76,34 ± 10,18	60,50 ± 8,32
Height (m)	1,71 ± 0,09	1,76 ± 0,06	1,63 ± 0,06
BMI (Kg/m²)	23,79 ± 3,02	24,48 ± 2,84	22,73 ± 2,99
Waist circumference (cm)	77,56 ± 16,17	81,37 ± 17,80	71,74 ± 11,09
Body fat (%)	20,74 ± 8,45	16,35 ± 6,01	27,43 ± 7,15
Visceral fat (kg)	7,91 ± 7,27	7,12 ± 6,09	9,12 ± 8,67
Muscle (kg)	30,94 ± 7,50	35,94 ± 4,41	23,32 ± 4,00
Basal metabolic rate (kcal)	1568,50 ± 269,96	1730,80 ± 209,87	1320,68 ± 122,98
Physical activity (minutes/week)	421,45 ± 266,36	446,64 ± 262,15	383,00 ± 269,54

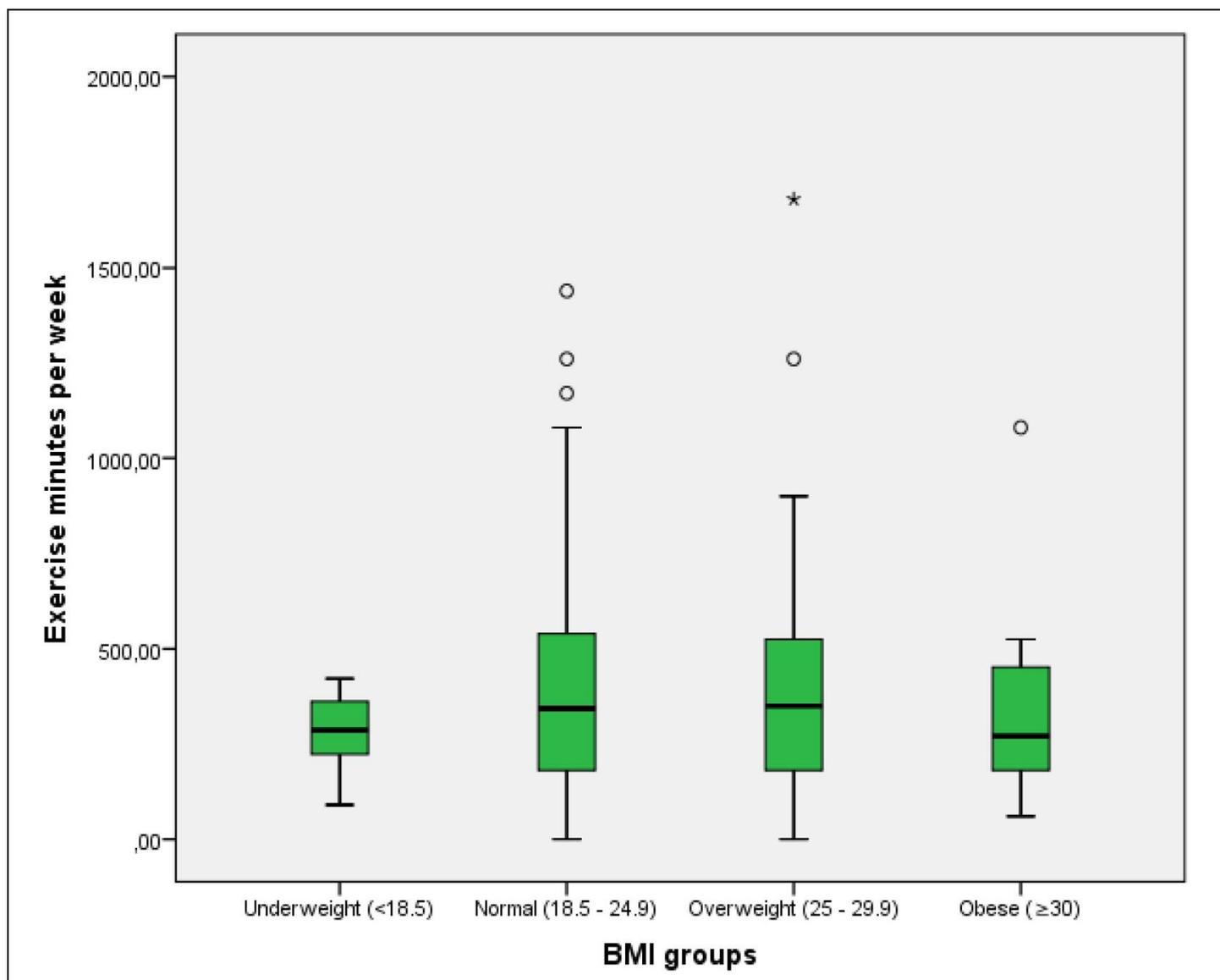
¹: No statistically significant differences between both groups were found.

Overall, 9,6 % of participants were obese, with a substantially greater prevalence in men (10,4%) than women (9,4%). Inverse associations between being obese and total weekly sessions of exercise-related physical activity, as awaited, were not observed (Table 2).

Table 2: Percentage of participants according to BMI and exercise recommendations.

	Underweight	Normal weight	Overweight	Obese	Chi ²
<150min/week exercise (%)	2	64.7	31.4	2	0.678
≥150 min/week exercise (%)	2	67.5	25.5	5.1	

After a Spearman's correlation was run to determine the possible monotonic relationship between BMI and exercise, the null hypothesis tested ("there's no association between the two variables") couldn't be rejected (Spearman's Rho = 0,001; p = 0,991) (Figure 1).



There was no statistically significant difference in exercise minutes between the different BMI groups ($\text{Chi}^2 = 0.750$, $p = 0.750$).
Figure 1. Boxplot representing BMI versus minutes of exercise per week.

DISCUSSION

In the present study we examined the correlations between BMI and time of physical activity and investigated whether more exercise minutes is associated with a lower BMI in adults. We found a negative correlation between BMI and time of exercise performance in our adult's sample. We interpret this finding to indicate that the excess of body mass does not interfere on time of performance.

Far more surprising was that the intensity of physical activity did not matter in lowering or maintaining BMI. One has to be careful, however, when interpreting such a result. For instance, respondents in this study might not have accurately described the intensity of their physical activities.

It has not been well clarified yet, how the inverse linear, logarithmic, or logistic models describe the relationship between physical activity and body fat or weight. In spite of that lack, there is evidence from research conducted chiefly on general young populations that BMI is associated with reduced physical fitness and the same has recently been shown on sport populations. The comparison between groups with different BMI has revealed that the groups with lower or normal BMI perform better in physical fitness than overweight/obese (higher BMI)⁽⁹⁾. In spite of this, a review reported that increasing cardiorespiratory fitness through exercise could reduce waist circumference and cardiometabolic risk, despite the lack of weight loss⁽¹⁰⁾.

Our findings did not come partially to terms with previous studies on general population. Results from linear regression analyses of Ching et al.⁽¹¹⁾ suggest that each additional hour of non-sedentary activity (assuming an expenditure of 5 METS during that hour) predicted a 0.015 decrease in body mass index.

In line with the aforementioned study, in the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System, prevalence of overweight was inversely related to physical activity level⁽¹²⁾. In the NHANES I Epidemiologic Follow-Up Study, recreational physical activity was inversely associated with body mass index, average 10-year weight change, and risk of developing clinical overweight; prospectively, change in activity level was inversely

related to change in weight. These findings suggest that low physical activity is both a cause and a consequence of weight gain⁽¹³⁾. Guðmundsdóttir et al.⁽¹⁴⁾ also revealed that more than half of adult in their sample were overweight or obese but the risk is halved among those who exercise at least five days per week, compared to those who exercise less frequently. Li et al. showed in the Nurses' Health Study that higher BMI and low physical activity levels are both linked to an increased CHD risk but physical activity by itself is not enough to overcome the negative effects of obesity⁽¹⁵⁾. A subsequent systematic review indicated that the risk for all-cause and CVD mortality was lower in those participants with higher BMI and good aerobic fitness, compared to those with a normal weight and poor fitness, so there are many discrepancies in the available evidence.

The results of the present study were in agreement with those of van Gemert et al.⁽¹⁶⁾ In the SHAPE study, for example, 189 healthy inactive and postmenopausal women participated in a one-year aerobic and strength exercise intervention to improve insulin, glucose and HOMA2 parameters. In this study, despite the increase in physical activity, weight loss was not achieved (nor aimed to it)⁽¹⁷⁾.

Although the body mass index (kg/m²) is widely used as a surrogate measure of adiposity, it is a measure of excess weight, rather than excess body fat, relative to height. The interpretation of BMI >25 as a measure of overweight is the assumption that the increase is mainly due to fat, wherein muscle mass also contributes as well as fat. The influence of large muscle mass on BMI in athletes and young adults may misclassify these individuals as overweight and obese by BMI. Therefore, the use of other techniques such as subcutaneous adipose tissue topography may be more effective than BMI in assessing obesity in physically active people and young adults⁽¹⁸⁾.

In contrast with the above mentioned studies, we did not find any difference. Potential explanations for this discrepancy include: the lack of homogeneous data between populations; the possibility that the proportion of total energy expenditure to leisure-related physical activity is lower in one population than another, differing types and intensities of leisure-related physical activity; and differences in measurement error.

CONCLUSION

More exercise hours has not been associated with a lower BMI in our adults sample. In this setting, programs to prevent and treat obesity through increasing general physical activity need to consider overall energy expenditure. The achievement of an optimal body mass just through more hours of training should be reconsidered. More experimental studies should delve into this issue.

References

1. Tiruneh G. The relationship between physical activity and body mass index: issues in model specification. *International Journal On Disability and Human Development* 2010; 8(3):267-75.
2. Esparza J, Fox C, Harper TI, Bennett HP, Schultz OL, Valencia EM, et al. Daily energy expenditure in Mexican and USA Pima Indians: low physical activity as a possible cause of obesity. *Int J Obes* 2000; 24:55-9.
3. Tate FD, Jeffery WR, Sherwood EN, Wing RW. Long-term weight losses associated with prescription of higher physical activity goals. Are higher levels of physical activity protective against weight loss? *Am J Clin Nutr* 2007; 85:954-9.
4. WHO. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Consultation. WHO Technical Report Series Number 854. Geneva: World Health Organization, 1995.
5. Ode J, Pivarnik JM, Reeves M, Knous JL. Body mass index as a predictor of percent fat in college athletes and nonathletes. *Med Sci Sports Exerc* 2007; 39:403-9.
6. Cameron A, Welborn T, Zimmet P, Dunstan D, Owen N, Salmon J, et al. Overweight and obesity in Australia: the 1999-2000 Australian Diabetes, Obesity and Lifestyle Study (AusDiab). *Med J Aust* 2003; 178:427-32.
7. Salmon J, Bauman A, Crawford D, Timperio A, Owen N. The association between television viewing and overweight among Australian adults participating in varying levels of leisure-time physical activity. *International Journal of Obesity* 2000; 24(5):600-6.
8. WHO. Physical activity and adults: recommended levels of physical activity for adults aged 18-64 years, WHO Global Strategy on Diet, Physical Activity & Health. Geneva: World Health Organization. Available at: http://www.who.int/dietphysicalactivity/factsheet_adults/en/
9. Nikolaidis PT, Ingebrigtsen J. The relationship between body mass index and physical fitness in adolescent and adult male team handball players. *Indian J Physiol Pharmacol* 2013; 57(4):361-71.
10. Ross R, Janiszewski PM. Is weight loss the optimal target for obesity-related cardiovascular disease risk reduction? *Can J Cardiol* 2008; 24(D):25-31D.
11. Ching PL, Willett WC, Rimm EB, Colditz GA, Gortmaker SL, Stampfer MJ. Activity level and risk of overweight in male health professionals. *Am J Public Health* 1996; 86(1):25-30.
12. DiPietro L, Williamson DF, Caspersen CJ, Eaker E. The descriptive epidemiology of selected physical activities and body weight among adults trying to lose weight: the Behavioral Risk Factor Surveillance System survey, 1989. *IntJObes* 1993; 17:69-76.
13. Williamson DF, Madans J, Anda RF, Kleinman JC, Kahn HS, Byers T. Recreational physical activity and ten-year weight change in a US national cohort. *Int J Obes* 1993; 17:279-86.

14. Guðmundsdóttir SL, Oskarsdóttir D, Franzson L, Indriðason OS, Sigurðsson G. The relationship between physical activity, body mass index, body composition and grip strength in an Icelandic population. *Laeknabladid*. 2004; 90(6):479-86.
15. Li TY, Rana JS, Manson JE, Willett WC, Stampfer MJ, Colditz GA, et al. Obesity as compared with physical activity in predicting risk of coronary heart disease in women. *Circulation* 2006; 113(4):499-506.
16. Fogelholm M. Physical activity, fitness and fatness: relations to mortality, morbidity and disease risk factors. A systematic review. *Obesity Rev* 2010; 11(3):202-21.
17. van Gemert WA, Monninkhof EM, May AM, Peeters PH, Schuit AJ. Effect of exercise on insulin sensitivity in healthy postmenopausal women: the SHAPE study. *Cancer Epidemiol Biomarkers Prev* 2015; 24(1):81-7.
18. Wallner-Liebmann SJ, Kruschitz R, Hübler K, Hamlin MJ, Schnedl WJ, Moser M, et al. A measure of obesity: BMI versus subcutaneous fat patterns in young athletes and nonathletes. *Coll Antropol* 2013; 37(2):351-7.