

Anthropometric measures: associated factors, and relationships with weight satisfaction in an adult population

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RESUMEN

Esta investigación tuvo como objetivo estudiar las medidas antropométricas, los factores asociados y su relación con la satisfacción con el peso, en una muestra de población formada por 507 adultos marroquíes. Los datos sobre las características sociodemográficas (edad, sexo, zona de residencia y nivel educativo) y la satisfacción con el peso se recopilaron mediante un cuestionario, completado con una entrevista. Las medidas antropométricas, especialmente el peso, la estatura, el índice de masa corporal (BMI), la circunferencia de la cintura (WC), la relación cintura-cadera (WHR), la masa grasa corporal (%FM) y la masa muscular del cuerpo (%MM), fueron tomadas con un equipo adecuado. Más de la mitad de la población estudiada (52%) tenía entre 20 y 39 años y el 52% eran mujeres. Los resultados de los análisis estadísticos mostraron que la edad tenía una asociación significativa y positiva con el IMC ($p<0,001$), la WC ($p<0,001$), la WHR ($p<0,001$) y el %FM ($p<0,001$); el grupo de edad de entre 20-29 años tuvo los valores más bajos en estas medidas y el de 50-59 años los más elevados. El sexo se asoció significativamente con el BMI ($p<0,001$), el %FM ($p<0,001$) y el %MM ($p<0,001$), con valores del BMI y del %MF más altos en las mujeres que en los hombres, mientras que el %MM fue mayor en estos últimos. Respecto a la satisfacción con el peso, los resultados mostraron que el BMI y la WC estaban asociados positivamente con el deseo de perder peso. Así, el aumento del BMI en una unidad aumentó este deseo en 1,21 veces, mientras que el incremento en una unidad de la WC lo aumentó en 1,06 veces. Estos resultados pueden ayudar a orientar las acciones de prevención y gestión del sobrepeso, la obesidad y las enfermedades cardiovasculares y metabólicas.

Palabras clave:

Antropometría
Composición corporal
Peso corporal
Satisfacción con el peso
Marruecos

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ABSTRACT

This research aimed to study anthropometric measures, their associated factors, and their relationships with weight satisfaction in an adult population. Thus, 507 Moroccan adults were studied. Data on socio-demographic characteristics (age, sex, area of residence, and education level) and weight satisfaction were collected by a questionnaire completed by interview. The anthropometric measures, notably weight, height, body mass index (BMI), waist circumference (WC), waist-hip ratio (WHR), body fat mass (%FM), and body muscle mass (%MM), were taken with suitable equipment. More than half of the population studied (52%) were aged between 20 and 39 years old, and were female (52%). The principal results of statistical analysis showed that age had a positive significant association with BMI ($p<0.001$), WC ($p<0.001$), WHR ($p<0.001$) and %FM ($p<0.001$). The age group of 20 - 29 years had the lowest values of these measures, by contrast, the age group [50 - 59] years had the highest values. Sex had a significant association with BMI ($p<0.001$), %FM ($p<0.001$), and %MM ($p<0.001$). The BMI and %FM values were higher in women than in the men's group; by contrast, the %MM was higher in men than in the women's group. Furthermore, in relationship with weight satisfaction, the statistical analysis showed that BMI and WC were associated positively with the desire to lose weight. Indeed, increasing the BMI of a unit increased this desire by 1.21 times, and increasing the WC of a unit increased this desire by 1.06 times. These results may help to guide actions for the prevention and management of overweight, obesity, and cardiovascular and metabolic diseases.

Keywords:

Anthropometry
Body composition
Body weight
Weight satisfaction
Morocco

Introduction

Nutritional status represents the health status of the body resulting from food intake, absorption, and utilization, as well as pathological factors (Saccoun, 2008). It is determined by biological analyzes, clinical signs, anthropometric measures, and body composition (Blondé-Cynober and Aussel, 2006; Campos del Portillo et al., 2015). The latter include body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and body composition in fat and lean mass (Oppert, 2003; Messiah, 2020). These different measures make it possible to qualify the weight status of an individual or a population by classifying them according to their degree of underweight, overweight, and obesity (Casadei and Kiel, 2020). Thus, BMI, calculated as weight/height^2 and expressed in kg/m^2 is an indicator of weight status, and WC is an indicator of abdominal adiposity (Oppert, 2003). In fact, it is recommended to calculate the BMI completed with the WC, which is a major indicator of cardiovascular and metabolic risk (Tsigos et al., 2008; De D, Danne and Sinoni, 2009; Jacobs et al., 2010). For its part, the WHR is an indicator of the distribution of adipose tissue between the upper and lower parts of the body, and therefore its increase could result from an increase in abdominal adiposity as well as a decrease in hip circumference (Han et al., 1997; Oppert, 2003).

In addition to these methods of anthropometric assessment, there are other methods assessing body composition by impedance measurement, including fat and lean mass or free fat mass (FFM) (Messiah, 2020; Holmes and Racette, 2021; Heymsfield et al., 2024). Fat-Free Mass includes muscle mass but also the weight of organs, bones, skin and body water, while muscle mass refers only to muscle weight (Holmes and Racette, 2021; Damluji et al., 2023). Unlike the measurement of free fat mass, which presents the risk of overestimation of muscle mass (Buckinx et al., 2018), the interest of the specific measure of muscle mass is that it is directly related to metabolic functions, mobility, and response to nutritional and physical interventions (Walowski et al., 2020).

Moreover, independently of the

anthropometric measures mentioned above, individuals may have a subjective perception of their body weight, which induces a satisfaction or a dissatisfaction with this weight. Thus, some people may perceive their weight status as normal while it is excess and do not adopt the appropriate attitude to correct it, namely a healthy diet and sufficient physical activity (Duncan et al., 2011; Blake et al., 2013), or they may perceive their weight status as excess and adopt weight-loss diets while they have a normal weight status (Gillen, 2015; Rounsefell et al., 2020) and thus find themselves in a state of undernutrition. This article aims to study anthropometric measures, their associated factors, and their relationships with weight satisfaction in an adult population from Morocco.

Methods

The data included in this work are part of a study that was conducted in the region of Rabat, Salé, Kenitra (RSK) in Morocco, and whose conceptual and methodological framework was previously validated (Barakat, Elayachi and Belahsen, 2022).

Data collection

Data on characteristics and weight satisfaction were collected on 507 adult subjects, using a questionnaire completed by interviews. The questionnaire aimed to collect information on socio-demographic characteristics (age, sex, area of residence and education level) and weight satisfaction. Anthropometric measures and body composition were measured with validated equipment, notably a Body Circumference Measuring Tape, a Stadiometer Mobile Scale (SECA), and an OMRON BF 214 impedancemeter, which measures fat mass (FM) and muscle mass (MM) (Omron Healthcare, 2020).

Variables studied

The socio-demographic characteristics collected were age, categorized in 1) [20 - 29], 2) [30 - 39], 3) [40 - 49], 4) [50 - 59], and 5) ≥ 60 years; sex, categorized in 1) male and 2) female; area of residence, categorized in 1) urban areas and 2) rural areas according to the Moroccan territorial

organization and, education level categorized in 1) none, 2) preschool and primary, 3) secondary school, 4) qualifying secondary and 5) higher education.

Anthropometric measures were body mass index (BMI), waist circumference (WC), waist/hip ratio (WHR), fat mass %FM, and muscle mass %MM. The BMI was categorized in 1) BMI < 18.50 kg/m² (underweight); 2) BMI of 18.50 to 24.99 kg/m² (normal); 3) BMI of 25 to 29.99 kg/m² (overweight); 4) BMI ≥ 30 kg/m² (obesity) (WHO, 2014; Weir and Jan, 2022). The WC, an indicator of cardiovascular and metabolic risk (CVMR), was categorized in 1) WC ≤ 94 cm (absence of CVMR); 2) 94 cm > WC ≤ 102 cm (moderate CVMR); 3) WC > 102 cm (high CVMR) for men, and in 1) WC ≤ 80 cm (no CVMR); 2) 80 cm > WC ≤ 88 cm (moderate risk); 3) WC > 88 cm (high CVMR) for women. The WHR is also an indicator of CVMR that was categorized for men in 1) WHR ≤ 1 (absence of CVMR) and 2) WHR > 1 (presence of CVMR), and for women in 1) WHR ≤ 0.85 (absence of CVMR) and 2) WHR > 0.85 (presence of CVMR) (WHO 2000; Oppert, 2003). The % FM and the % MM were categorized into 1) deficient; 2) normal; 3) excessive (Omron Healthcare, 2020).

Weight satisfaction was categorized in 1) "satisfied with weight status"; 2) "desire to lose weight" because they perceive themselves as overweight; 3) "desire to gain weight" because they perceive themselves as underweight.

Statistical analysis

Statistical analysis were performed using SPSS for Windows (Statistical Package for the Social Sciences) version 21. Associations between variables were studied by statistical tests with a threshold of significance p-value < 0.05. Thus, the student test and the one-way ANOVA test were used to study the associations of socio-demographic characteristics with anthropometric measures. The multinomial regression was used to study associations of anthropometric measures with weight satisfaction.

Ethics approval and consent to participate

This study was carried out under the aegis of the Department of Higher Education and

Scientific Research, particularly with the agreement of the Faculty of Science of the Chouaib Doukkali University of El Jadida in Morocco. It has been approved by the Wilaya and the Regional Directorate of Health and Social Protection of Rabat-Salé-Kenitra region's (RSK). Furthermore, the core ethical precepts that guide research conduct were honored, specifically providing participants with information about the study's subject matter, volunteering, maintaining participant confidentiality, and obtaining informed consent.

Results

Characteristics of the study population

More than half of the study population (52%) was between 20 and 39 years old which demonstrates the young character of this adult population. The majority of the population (70%) resided in urban environment which is characterized by both westernized food practices and the predominance of overweight and obesity compared to rural areas. More than half of the population (52%) were women. A proportion of 35% of the population had a higher education level that is supposed to promote access to proper nutritional information (Table 1).

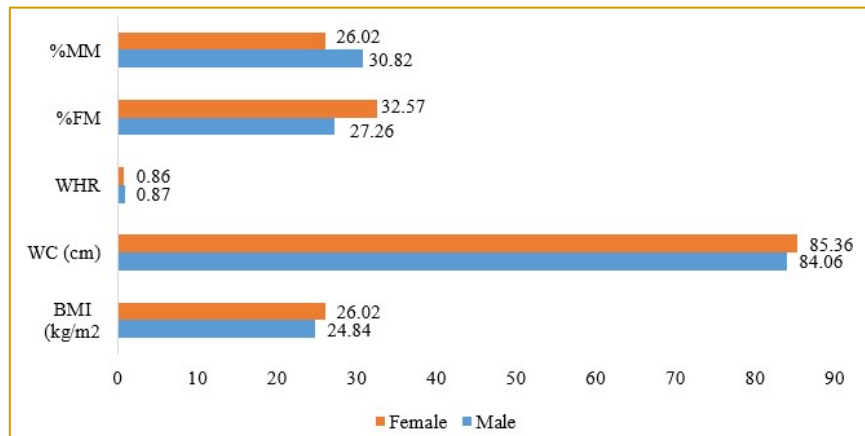
Anthropometric measures of the study population

Anthropometric measures showed that men have a normal BMI mean (24.84 kg/m²) while women have a BMI mean indicating overweight (26.02 kg/m²). The WC mean for men was 84.06 cm, indicating an absence of the CVMR while the WC mean for women was 85.36 cm, indicating the presence of a moderate CVMR. The WHR mean of men was 0.87, indicating an absence of CVMR, while for women it was 0.86, indicating the presence of CVMR. The %FM mean was 27.6% in men which is considered an excessive value, whereas the %FM mean was 32.57% among women indicating a normal value. Finally, the %MM mean of men is 30.82%, which is considered a deficit value, whereas among women this %MM mean is 26.02%, considered a normal value (Figure 1).

Table 1. Socio-demographic characteristics of the study population (n=507).

Characteristics	Values	CI (95%)
Age groups* (years)	[20 - 29]	142 (28%) [23.9-32.0]
	[30 - 39]	121 (24%) [20.3-27.4]
	[40 - 49]	101 (20%) [16.6-23.3]
	[50 - 59]	80 (16%) [12.6-18.9]
	≥ 60	63 (12%) [9.5-15.4]
Sex*	Male	244 (48%) [43.6-52.3]
	Female	263 (52%) [47.7-56.4]
Area of residence*	Urban	355 (70%) [66.0-74.0]
	Rural	152 (30%) [26.0-33.0]
Professional activity *	Active	248 (49%) [44.6-53.1]
	Inactive	259 (51%) [46.9-55.4]
Education level*	Without	86 (17%) [13.6-20.5]
	Preschool and primary	84 (17%) [13.9-19.5]
	Secondary school	84 (17%) [13.2-19.7]
	Qualifying secondary	73 (14%) [11.6-17.4]
	Higher education	180 (35%) [31.2-40.0]

*: Expressed in size (%); CI: Confidence interval.

**Figure 1.** Distribution of the study population by anthropometric measures and sex (n=507).

BMI: Body Mass Index; WC: Waist circumference; WHR: Waist to Hip ratio; %FM: Percentage of fat mass; %MM: Percentage of muscle mass.

Weight satisfaction of the study population

The majority of the study population (69%) reported being satisfied with their weight, while a 31% reported being dissatisfied. Of these, 20% said they wanted to lose weight because they felt overweight, and 11% said they wanted to gain weight because they thought they were underweight (Figure 2). These statements reflect perceptions that may not correspond to actual weight status and could therefore lead to inappropriate eating practices and lifestyle. Hence the need for comparisons between these statements and the rational anthropometric measures presented below.

Associations between the socio-demographic characteristics of the studied population and its anthropometric measures

Age had a significant association with BMI ($p<0.001$), WC ($p<0.001$), WHR ($p<0.001$), and %FM ($p<0.001$). The age group [20-29] years old had the lowest BMI, WC, WHR, and %FM, respectively, of 24.34 kg/m², 79.90 cm, 0.84, and 28.56%; by contrast, the age group [50-59] years old has the highest BMI, WC, WHR, and %FM corresponding respectively to 27.14 kg/m², 90.46 cm, 0.89, and 32.95%. Sex had a significant association with BMI ($p<0.001$), %FM ($p<0.001$), and %MM ($p<0.001$). The BMI and %FM were

higher in women than men's group (26.02 vs 24.84 kg/m²) and (32.5 vs 27.26%) respectively; by contrast, the %MM was higher in men than in women (30.82% vs 26.02 %). A significant association was found between area of residence and WHR (p=0.01) and %FM (p=0.006), with higher values in urban compared to rural areas for both WHR (0.87 vs 0.85) and %FM (30.55% vs 28.76%),

respectively. Education level had a significant association with BMI (p<0.001), WC (p<0.001), WHR (p<0.001), %FM (p<0.001), and %MM (p<0.007). The population with a higher education level had the lowest BMI and WC and higher %MM, respectively, 24.58 kg/m², 81.67 cm, and 29.17% (Table 2).

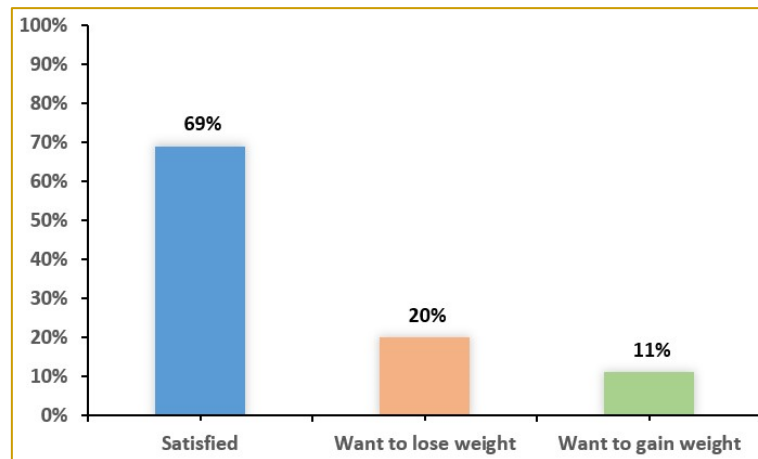


Figure 2. Distribution of the population according to satisfaction with its weight (n=507)

Table 2. Association of socio-demographic characteristics with anthropometric measures (n= 507).

Characteristics	BMI (kg/m ²)	WC (cm)	WHR	%FM	%MM
Age groups (years)					
[20 - 29]	24.34 (±3.29)	79.90 (±9.56)	0.84 (±0.08)	28.56 (±5.23)	28.64 (±5.82)
[30 - 39]	25.51 (±3.69)	82.88 (±12.73)	0.85 (±0.09)	28.64 (±6.18)	27.61 (±4.99)
[40 - 49]	25.48 (±3.24)	86.08 (±12.53)	0.87 (±0.09)	30.22 (±6.83)	29.24 (±5.77)
[50 - 59]	27.14 (±4.63)	90.46 (±14.26)	0.89 (±0.08)	32.95 (±7.85)	27.23 (±5.96)
≥ 60	25.66 (±4.78)	89.75 (±14.77)	0.88 (±0.07)	31.84 (±7.80)	28.97 (±7.02)
p ¹	<0.001***	<0.001***	<0.001***	<0.001***	0.08 NS
Gender					
Male	24.84 (±2.84)	84.06 (± 11.71)	0.87(±0.09)	27.26 (±4.59)	30.82 (±6.57)
Female	26.02 (±4.62)	85.36 (±14.11)	0.86 (±0.08)	32.57 (±7.44)	26.02 (±3.83)
p ²	0.001**	0.26 NS	0.1 NS	<0.001***	<0.001***
Area of residence					
Urban	25.57 (±4.17)	85.14 (±13.43)	0.87 (±0.08)	30.55 (±7.11)	28.58 (±6.39)
Rural	25.18 (±3.18)	83.78 (±11.98)	0.85 (±0.09)	28.76 (±5.71)	27.75 (±4.21)
p ²	0.3 NS	0.26 NS	0.01*	0.006**	0.14 NS
Education level					
Without	27.39 (±4.74)	94.98 (±12.80)	0.91 (±0.05)	34.23 (±7.97)	26.31 (±5.68)
Preschool and primary	26.22 (±4.31)	85.55 (±14.66)	0.86 (±0.11)	29.38 (±6.53)	28.48 (±5.65)
Secondary school	24.87 (±3.47)	82.39 (±11.60)	0.86 (±0.09)	30.15 (±7.28)	28.50 (±5.48)
Qualifying secondary	25.10 (±3.00)	81.99 (±10.21)	0.85 (±0.09)	28.12 (±5.43)	28.29 (±4.90)
Higher education	24.58(±3.40)	81.67 (±11.47)	0.86 (±0.08)	28.99 (± 5.64)	29.17 (±6.32)
p ¹	<0.001***	<0.001***	<0.001***	<0.001***	0.007**

Values expressed in mean (±standard deviation). 1: Student Test; 2: One Way Anova Test; significance level p<0.05; *: p<0.05, **: p<0.01, ***: p<0.001; NS: Not Significant; BMI: Body Mass Index; WC: Waist circumference; WHR: Waist to Hip ratio; %FM: Percentage of fat mass; %MM: Percentage of muscle mass.

Associations between anthropometric measures and weight satisfaction

Multinomial logistic regression showed that BMI and WC were associated with the desire to lose weight. Indeed, in reference to being satisfied with one's weight, a unit increase of the BMI

increases the desire by 1.21 times, and increasing the WC by a unit increases this desire by 1.06 times. Also, BMI was associated with the desire to gain weight since its increase of one unit protects against this weight gain (Table 3).

Table 3. Associations of anthropometric measures with weight satisfaction

Variables	Satisfied ¹	Want to lose weight			Want to gain weight		
		OR	CI 95%	P ²	OR	CI 95%	P ²
BMI (kg/m ²)	-	1.21	[1.11-1.32]	<0.001**	0.81	[0.71-0.92]	<0.001**
WC (cm)	-	1.06	[1.02-1.10]	0.003*	0.99	[0.94-1.03]	0.61 NS
WHR	-	0.36	[0.12-1.50]	0.3 NS	2.97	[0.19-3.69]	0.16 NS
%FM	-	0.95	[0.91-1.10]	0.072 NS	1.02	[0.95-1.08]	0.62 NS
%MM	-	1.03	[0.97-1.08]	0.347NS	0.97	[0.92-1.03]	0.38 NS

(n = 507). R²<1; p<0.001. 1: Reference of multinomial regression; 2: Multinomial regression with significance level p<0.05; *: p<0.01, **: p<0.001; NS: Not Significant; OR: Odds Ratio; CI: Confidence interval; BMI: Body Mass Index; WC: Waist circumference; WHR: Waist to Hip ratio; %FM: Percentage of fat mass; %MM: Percentage of muscle mass.

Discussion

This research aimed to study associated factors with anthropometric measures and their relationships with weight satisfaction in an adult population. The results revealed an association between some socio-demographic characteristics such as age, sex, area of residence, and level of education and some anthropometric measures such as BMI, WC, WHR, and body composition in FM and MM (percentages). This study revealed a significant association of age with BMI, WC, WHR, and %FM, whose averages were higher in older versus younger participants. Similarly, a study conducted in Saudi Arabia found that significant trends were observed for BMI, waist circumference and fat mass based on age (Azzeh et al., 2017). In addition, other studies have shown an increase in the percentage of fat mass with age in both sexes (Bosomworth, 2019). Similarly, other investigations show that the means of all anthropometric measures increased with age (Belahsen, Mziwira and Fertat, 2004; Msyamboza, Kathyola and Dzowela, 2013). This study also revealed a significant association of sex with BMI and %FM, which are higher in women than in men. These findings are similar to those of a study reporting that overweight and obesity are more common in women than men (Simo et al., 2021), and to another study that revealing that for the same

BMI, the percentage of fat mass is higher in women than in men (Schorr et al., 2018).

This research also showed that the area of residence has a significant association with WHR and %FM, which were higher in urban than in rural areas. These results are consistent with those previously reported, indicating that overweight and obesity predominate in urban areas more than in rural ones (MSPS, 2018; Daif et al., 2021). In addition, other studies showed that the means of all anthropometric measures were higher in urban areas than in rural areas (Belahsen, Mziwira and Fertat, 2004; Msyamboza, Kathyola and Dzowela, 2013). Another study conducted in Cameroon also found a higher prevalence of overweight and obesity among adults and children in urban areas compared to rural regions (Akob et al., 2023). The present study also revealed a significant association between education level and BMI and WC values, which were lower in participants with higher education level than in illiterate ones. This result is consistent with an American study that found that tertiary graduates are less likely than secondary school graduates to be obese (Cohen et al., 2013). However, this result is contradictory to that reported by another study that found that the probabilities of overweight and obesity were higher in people with higher education level (Simo et al., 2021).

Regarding weight satisfaction, the present study revealed that the majority (69%) of the surveyed population were satisfied with their weight, 20% reported wanting to lose weight, and 11% wanted to gain weight. These results are consistent with those obtained by a great survey conducted in Belgium, which revealed that the majority of the population aged 10 to 64 years (45%) tries to maintain a stable weight, a smaller proportion (28%) tries to lose weight, and only a minority (3%) wants to gain weight (ISP, 2016). Another study that involved adult Moroccans from the Souss region and the Casablanca metropolitan area assessed the participants' perceptions of their bodies by comparing their desired and current weight status silhouettes. According to this study, half of the participants misjudged their current weight (Hibbi et al., 2016). The statistical analysis showed that increases in BMI and WC significantly increase the desire to lose weight, indicating a concordance between the results of objective anthropometric measurements and the perception of population weight status. However, measurement of height and weight should be performed as much as possible to optimize measurements in clinical practice and clinical research (Haghighian Roudsari et al., 2015). The desire to lose weight generally motivates the efforts to adapt diet and physical activity and to adopt other medical or surgical therapies, as well as alternative medicine therapies (Sarwer and Polonsky, 2016). Therefore, the population must be able to adopt healthy practices and choose appropriate and safe therapies.

Conclusion

The reported data highlights an association of socio-demographic factors with different anthropometric measures in the study adult population. The identification of these factors is very useful for guiding actions in order to prevent and manage overweight, obesity, and cardiovascular and metabolic diseases. This research also showed that the satisfaction or not of the population with its weight and hence the adopted attitudes are not always consistent with rational and objective anthropometric measures. Indeed, apart from BMI

and WC, the other measures such as WHR, %FM, and %MM did not show a positive relationship with dissatisfaction with weight. Hence the importance of raising awareness to take these measures regularly.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

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