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ORIGINAL ARTICLE

Lifestyle factors associated with metabolically healthy obesity in adults at primary care level

Estilos de vida y factores asociados a obesidad metabólicamente sana en adultos en primer nivel de atención

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ABSTRACT: Background: Individuals with metabolically healthy obesity (MHO) may have a lower short-term cardiovascular risk; however, up to half may develop increased cardiovascular risk over the medium term. **Objective:** To determine the proportion of patients with MHO and the lifestyle factors associated with this condition among adults in primary care. **Material and methods:** An observational, cross-sectional, analytical, and prospective study was conducted in adults aged 18-50 years with a body mass index ≥ 30 kg/m². The FANTASTIC questionnaire was administered, and sociodemographic, clinical, anthropometric, and laboratory data were collected. Descriptive statistics, bivariate analyses, and binary logistic regression were used to identify factors associated with MHO. A value of $p < 0.05$ was considered statistically significant. **Results:** A total of 207 participants were included (mean age 39.4 ± 7.8 years; 71% women), 16.4% (n = 34) met criteria for MHO. Age was associated with MHO (35.8 ± 7.7 years vs. 40.1 ± 7.7 years, p = 0.003). A healthier lifestyle was also more frequent in the MHO group, classified as "excellent" or "very good" (61.8% vs. 41.9%, p = 0.01). Logistic regression analysis did not identify additional significant predictors. **Conclusions:** MHO was infrequent and occurred mainly in younger individuals, suggesting a potentially transient phenotype.

Keywords: Obesity. Primary health care. Lifestyle. Risk factors. Anthropometry.

RESUMEN: Antecedentes: Las personas con obesidad metabólicamente sana (OMSa) podrían tener un menor riesgo cardiovascular en el corto plazo, sin embargo, la mitad incrementan riesgos cardiovasculares a mediano plazo. **Objetivo:** Determinar la proporción de pacientes con OMSa y los factores de estilo de vida asociados a esta condición en adultos en primer nivel de atención. **Material y métodos:** Se realizó un estudio observacional, transversal, analítico y prolectivo en adultos de 18 a 50 años con IMC ≥ 30 kg/m². Se aplicó el cuestionario FANTASTIC, se registraron datos sociodemográficos, clínicos, antropométricos y de laboratorio. Se utilizó estadística descriptiva, análisis bivariado y regresión logística binaria para identificar factores asociados a OMSa. Un valor de $p < 0.05$ se consideró significativo. **Resultados:** 207 participantes (edad media 39.4 ± 7.8 años; 71% mujeres), de los cuales el 16.4% (n = 34) presentaron OMSa. La edad mostró asociación con OMSa (35.8 ± 7.7 años vs. 40.1 ± 7.7 años, p = 0.003). Así como el estilo de vida "excelente" o "muy bien" en el grupo OMSa (61.8% vs. 41.9%, p = 0.01). El análisis de regresión no identificó predictores significativos adicionales. **Conclusiones:** La OMSa es poco frecuente y se presenta principalmente en personas más jóvenes, lo que sugiere un posible carácter transitorio.

Palabras clave: Obesidad. Primer nivel de atención. Estilo de vida. Factores de riesgo. Antropometría.

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INTRODUCTION

Non-communicable diseases such as type 2 diabetes mellitus, cardiovascular diseases, and certain types of cancer are the leading causes of death and premature disability worldwide, accounting for more than 70% of global mortality[1]. Among the main risk factors for these conditions is obesity; despite being recognized as a chronic, progressive, and relapsing disease[2-4], most health systems still do not fully address obesity as such, which has limited early and effective management. Simultaneously, the global prevalence of obesity has increased dramatically over recent decades. In 2016, more than 650 million adults were living with obesity[5,6]. If current trends persist, obesity prevalence in Latin America is projected to reach 19.6% by 2030[7]. In Mexico, obesity has been described as an epidemic, ranking among the highest prevalence worldwide[8]. Beyond its clinical impact, obesity also affects quality of life and productivity, and contributes to social stigma and discrimination[2,3,9].

Historically, obesity has been considered to be associated with metabolic disturbances such as insulin resistance, dyslipidemia, and hypertension. However, some studies have identified a subgroup of individuals with obesity who do not present these metabolic abnormalities, a phenotype known as metabolically healthy obesity (MHO)[10,11]. This phenotype is characterized by normal blood pressure, a favorable lipid profile, preserved insulin sensitivity, and lower visceral fat, despite having a body mass index (BMI) ≥ 30 kg/m^2 [12,13]. Nevertheless, the reported prevalence of MHO varies widely depending on diagnostic criteria, study population, and sociodemographic factors, ranging from 4.2% to 35%[14].

In the Mexican context, information on MHO in adults remains limited. A cross-sectional study in a pediatric population reported a lower prevalence of MHO among Mexican children compared with European cohorts[15], suggesting potential genetic or lifestyle-related differences. Lifestyle has also been identified as a key determinant of health status. According to the World Health Organization, lifestyle includes behavioral patterns influenced by personal, social, and environmental factors[16]. Tools such as the FANTASTIC questionnaire have been validated to assess lifestyle in Mexican populations, allowing the identification of physical, psychological, and social domains relevant to the prevention and control of chronic diseases[17,18].

Although individuals with MHO may have a lower cardiovascular risk in the short term, the consistency of this phenotype remains debated, as up to half of these individuals develop metabolic abnormalities over the medium term[14]. Therefore, understanding the factors associated with this phenotype is essential to improve its detection and to define effective intervention strategies.

For this reason, the aim of the present study was to determine the proportion of patients with MHO and the lifestyle factors associated with this condition among adults in primary care.

MATERIALS AND METHODS

Study design

An observational, analytical, cross-sectional, and prospective study was conducted to estimate the proportion of adults living with MHO, defined as a BMI ≥ 30 kg/m^2 in the absence of type 2 diabetes mellitus, with fasting glucose ≤ 100 mg/dL, no hypertension (systolic blood pressure ≤ 130 mmHg and diastolic blood pressure ≤ 85 mmHg), fasting triglycerides ≤ 150 mg/dL, and total cholesterol < 200 mg/dL[11], without pharmacological treatment for dyslipidemia, diabetes, or hypertension, and with no evidence of cardiovascular disease. In addition, the study aimed to analyze lifestyle characteristics associated with this condition among adults receiving medical attention and follow-up at the primary health care level.

Study population

The study population consisted of men and women aged 18-50 years with a BMI ≥ 30 kg/m^2, affiliated to a family medicine unit in Santa Catarina, Nuevo León, Mexico, during January-December 2023 period. The inclusion criteria were individuals who met the age and BMI criteria, were affiliated with the family medicine unit, and voluntarily agreed to participate by signing an informed consent form. Participants were excluded if they had conditions that could significantly affect BMI, such as pregnancy, thyroid disease, cancer, or kidney disease, as well as those receiving weight-loss medications or who had followed a structured weight-loss diet within the previous year. Patients with severe hearing or visual impairment who lacked appropriate assistance to complete the questionnaire were also excluded. Finally, questionnaires that were incomplete or incorrectly filled out were removed from the analysis.

Ethical considerations

The study protocol was reviewed and approved by the local ethics committee (approval number R-2022-1904-204). Written informed consent was obtained from all participants, ensuring confidentiality and exclusive use of the data for research purposes. All participants were referred to their family physician for comprehensive clinical assessment and follow-up, and when indicated, initiation of nutritional or metabolic treatment. This ensured subsequent clinical care and the opportunity for early intervention.

Data collection

A non-probabilistic consecutive case sampling technique was used. Patients with BMI ≥ 30 kg/m^2 were identified in high-traffic areas of the clinic (outpatient consultation, pharmacy, preventive medicine, and emergency department). Eligible individuals were informed about the purpose of the study, and after signing informed consent, the FANTASTIC questionnaire was administered, and an identification form was completed.

The FANTASTIC questionnaire is a lifestyle assessment tool that evaluates multiple factors; the name is the acronym of the domains included in the questionnaire. It evaluates the following domains: family and friends; activity and associativity; nutrition; tobacco and toxics; alcohol and other substances; sleep, seatbelt, stress, and safe sex; type of behaviors; I = Insight; and C = Career[19]. The total score is reported on a 0-100 scale and was classified as follows: Excellent (85-100), Very Good (70-84), Good (55-69), Fair (35-54), and Needs Improvement (0-34).

Subsequently, laboratory tests (serum glucose, total cholesterol, and triglycerides) were requested through the treating physician. Blood pressure was measured by the interviewer, a family medicine resident, with the patient seated, with the arm extended and resting over the table; the blood pressure was measured twice, with the average being used for the study. Weight and height were measured using a calibrated Seca 700™ scale and a stadiometer (TAQ Sistemas Médicos, S.A. de C.V., Mexico City, Mexico) by the same resident, with the patient standing barefoot in a straight position. Laboratory results were retrieved from the institutional database. Based on the results, individuals were classified as MHO or non-MHO.

Sample size

To determine the association between lifestyle factors and MHO, a logistic regression sample size formula was applied, assuming 80% power, a 5% significance level, a minimum expected odds ratio (OR) of 2, and an event proportion of 13%[11]. The minimum required sample size was 171 participants.

Statistical analysis

Descriptive statistics were used to characterize the study population. Categorical variables were expressed as frequencies and

percentages, while continuous variables were summarized using measures of central tendency and dispersion after assessing their distribution. For bivariate analyses, the Chi-square test or Fisher's exact test was used for categorical variables. For continuous variables, Student's t-test or the Mann-Whitney U test was applied as appropriate. Finally, binary logistic regression was used to identify factors associated with the MHO phenotype, reporting results as ORs with 95% confidence intervals (CIs). A value of $p < 0.05$ was considered statistically significant.

RESULTS

Although the minimum required sample size was 171 participants, during recruitment, a larger number of eligible patients provided informed consent and had laboratory tests requested. Participants who completed the clinical and laboratory evaluation were included in the final analysis. A total of 207 individuals with obesity were included and analyzed, with a mean age of 39.45 years (standard deviation ± 7.87), consisting primarily of women (71.0%). Among the 207 participants included, 16.4% (n = 34) met the criteria to be classified as having the MHO phenotype, whereas 83.6% (n = 173) did not present a metabolically healthy profile.

Regarding occupational profile, manual labor workers and homemakers were the most common. In terms of educational level, nearly half of the participants had basic education, and regarding socioeconomic status, most were classified as having low family poverty status. No statistically significant differences were observed between groups for sex, marital status, occupation, or educational level. Full sample characteristics are available in table 1.

Regarding clinical and behavioral profiles, a substantial proportion of participants had systemic arterial hypertension, type 2 diabetes mellitus, or dyslipidemia. Approximately one-third reported engaging in physical activity. Sleep duration varied, with most participants reporting 6 h or less. Tobacco and alcohol consumption were also reported by a considerable proportion of participants. Finally, most participants had class I obesity. These characteristics are presented in table 2.

Among the 207 participants included, 16.4% (n = 34) met the criteria to be classified as having the MHO phenotype, whereas 83.6% (n = 173) did not present a metabolically healthy profile.

When comparing sociodemographic characteristics according to MHO status, a statistically significant difference in age was observed between participants with and without MHO (35.8 ± 7.7 years vs. 40.1 ± 7.7 years, respectively; $p = 0.003$). When clinical characteristics were analyzed, no statistically significant differences were found in physical activity, smoking status, or average sleep duration between groups. Diabetes and hypertension were exclusive to non-MHO patients, and thus, statistical significance cannot be correctly evaluated.

Lifestyle assessment using the FANTASTIC instrument showed a statistically significant association with the presence of the MHO phenotype ($p = 0.01$). Within the MHO group, 61.8% of participants rated their lifestyle as "excellent" or "very good," compared with 41.9% in the non-MHO group. Data on FANTASTIC scores are shown in table 3.

In the binary logistic regression model, age was the only variable significantly associated with metabolically healthy status. Specifically, for each additional year of age, the odds of not having MHO increased by 7.1% (OR = 1.071; 95% CI: 1.021-1.124; $p = 0.005$). Sex showed a non-significant trend, in which women had lower odds of being classified as non-MHO compared with men (OR = 0.520; 95% CI: 0.182-1.483; $p = 0.221$). Categories of the FANTASTIC questionnaire, which assesses lifestyle, were not significantly associated with MHO status ($p = 0.439$). Hypertension and type 2 diabetes mellitus were not included in the

Table 1. Sociodemographic characteristics of the study population according to metabolic status (MHO vs. non-MHO)

Variable	MHO (n = 34)	Non-MHO (n = 173)	Total (n = 207)	p
Age, mean (SD)	35.8 (7.7)	40.1 (7.7)	39.4 (7.8)	0.003
Sex, n (%)				0.14
Female	28 (82.4)	119 (68.8)	147 (71.0)	
Male	6 (17.6)	54 (31.2)	60 (29.0)	
Marital status, n (%)				0.79
Single	8 (23.5)	35 (20.2)	43 (20.8)	
Cohabiting	7 (20.6)	27 (15.6)	34 (16.4)	
Married	18 (52.9)	98 (56.6)	116 (56.0)	
Divorced	1 (2.9)	10 (5.8)	11 (5.3)	
Widowed	0 (0.0)	3 (1.7)	3 (1.4)	
Occupation, n (%)				0.21
Manual labor worker	13 (38.2)	102 (59.0)	115 (55.6)	
Administrative	6 (17.6)	23 (13.3)	29 (14.0)	
employee	12 (35.3)	42 (24.3)	54 (26.1)	
Homemaker	1 (2.9)	2 (1.2)	3 (1.4)	
Student	2 (5.9)	4 (2.3)	6 (2.9)	
Self-employed				
Education level, n (%)				0.54
Basic education	16 (47.1)	77 (44.5)	93 (44.9)	
High school	9 (26.5)	61 (35.3)	70 (33.8)	
Higher education	9 (26.5)	35 (20.2)	44 (21.3)	

Data are presented as mean (standard deviation) for continuous variables and as frequency (percentage) for categorical variables. Comparisons between groups (MHO vs. non-MHO) were performed using Student's t-test for continuous variables and the Chi-square test for categorical variables. A value of $p < 0.05$ was considered statistically significant.
MHO: metabolically healthy obesity; SD: standard deviation.

model because they were diagnostic criteria for classification as non-MHO (Table 4).

DISCUSSION

In the present study, we identified a prevalence of MHO of 16.4% among adults receiving medical attention and follow-up at the primary health care level. This proportion falls within the range reported in international literature, where the prevalence of MHO varies widely from 4.2% to 30%, depending on the diagnostic criteria used and the population profile evaluated[14,20]. Studies conducted in European, Asian, and Latin American populations have reported similar prevalence when strict definitions excluding diabetes, hypertension, and dyslipidemia are applied, confirming that MHO represents a minority subgroup within the population with obesity[15,16].

In the bivariate analysis, lifestyle assessed using the FANTASTIC questionnaire showed a statistically significant association with MHO. Approximately 20% more individuals with MHO reported a lifestyle classified as "excellent" or "very good" compared with those without MHO. This finding is consistent with previous studies reporting higher levels of physical activity, healthier dietary patterns, and overall healthier behaviors among individuals with MHO[21-23]. However, after adjusting for potential confounders in the multivariable analysis, this association lost statistical significance, and only age remained independently associated with metabolically healthy status.

The loss of significance of lifestyle in the multivariable analysis contrasts with some studies that have identified physical activity and diet as independent predictors of the MHO phenotype[22,23], but it is consistent with other reports indicating that these

Table 2. Comorbidities and clinical characteristics according to MHO

Variable	MHO (n = 34)	Non-MHO (n = 173)	Total (n = 207)	p
Hypertension, n (%)				-
Yes	0 (0.0)	84 (48.6)	84 (40.6)	
No	34 (100.0)	89 (51.4)	123 (59.4)	
Diabetes, n (%)				-
Yes	0 (0.0)	55 (31.8)	55 (26.6)	
No	34 (100.0)	118 (68.2)	152 (73.4)	
Other comorbidities, n (%)				-
Yes	0 (0.0)	7 (4.0)	7 (3.4)	
No	34 (100.0)	166 (96.0)	200 (96.6)	
Physical activity, n (%)				0.47
Yes	13 (38.2)	49 (28.3)	62 (30.0)	
No	21 (61.8)	124 (71.7)	144 (70.1)	
Sleep duration (hours), n (%)				0.33
≤ 6	15 (44.1)	92 (53.2)	107 (51.7)	
≥ 7	19 (55.9)	81 (46.8)	100 (48.3)	
Smoking, n (%)				0.59
Yes	6 (17.6)	24 (13.9)	30 (14.5)	
No	28 (82.4)	149 (86.1)	177 (85.5)	
BMI category, n (%)				0.78
Class I obesity	17 (50.0)	81 (46.8)	98 (47.3)	
Class II obesity	11 (32.4)	52 (30.1)	63 (30.4)	
Class III obesity	6 (17.6)	40 (23.1)	46 (22.2)	

Data are presented as frequency (percentage). Comparisons between groups with metabolically healthy obesity (MHO) and non-MHO were performed using the Chi-square test or Fisher's exact test, as appropriate. A $p < 0.05$ was considered statistically significant.
MHO: metabolically healthy obesity; HTN: hypertension; BMI: body mass index.

Table 3. Lifestyle assessment (FANTASTIC questionnaire) according to MHO

Variable	MHO (n = 34)	Non-MHO (n = 173)	Total (n = 207)	p
FANTASTIC questionnaire, n (%)				0.01
Excellent	1 (2.9)	1 (0.6)	2 (1.0)	
Very good	20 (58.9)	71 (41.3)	91 (44.2)	
Good	10 (29.4)	69 (40.1)	79 (38.3)	
Fair	2 (5.9)	31 (18.0)	33 (16.0)	
Needs improvement	1 (2.9)	0 (0.0)	1 (0.5)	

Data are presented as frequency (percentage). Comparisons between groups (MHO vs. non-MHO) are performed using the Chi-square test. A $p < 0.05$ was considered statistically significant.
MHO: metabolically healthy obesity.

associations may be attenuated when variables such as age, sex, or central adiposity are considered[17,18]. These discrepancies may be explained by methodological differences, including the use of global lifestyle assessment instruments such as the FANTASTIC questionnaire. Although these tools provide a comprehensive overview, they may lack sensitivity to capture specific metabolic determinants, such as physical activity intensity or dietary quality.

On the other hand, our results are consistent with evidence suggesting that non-behavioral factors, such as age, genetic predisposition, and adipose tissue distribution, play a key role in metabolic differentiation between individuals with and without MHO[21]. Multiple studies have shown that

Table 4. Binary logistic regression analysis for factors associated with MHO

Variable	B	p	OR (Exp(B))	95% CI (Lower)	95% CI (Upper)
Age (years)	0.069	0.005	1.071	1.021	1.124
Sex (female vs. male)	–0.654	0.221	0.52	0.182	1.483
FANTASTIC category*		0.439			
Very good	1.093	0.487	2.983	0.137	64.9
Good	1.642	0.302	5.164	0.229	116.36
Fair	2.24	0.195	9.396	0.318	277.42
Needs improvement	–22.787	0.99	0	0	-
Constant	–1.863	0.32	0.155	-	-

Binary logistic regression was performed to identify factors associated with MHO. Results are presented as regression coefficient (B), OR, and 95% CI. A $p < 0.05$ was considered statistically significant.
*Reference category for FANTASTIC: excellent.
MHO: metabolically healthy obesity; OR: odds ratio; CI: confidence intervals.

abdominal fat accumulation is independently associated with increased cardiovascular and metabolic risk, even among individuals with obesity and apparently normal metabolic parameters[24,25].

In this study, participants with MHO were, on average, approximately 5 years younger than those with metabolically unhealthy obesity. This finding supports the hypothesis that MHO may represent a transient state rather than a stable condition. Longitudinal studies, such as that by Bell et al., have shown that a considerable proportion of individuals with MHO progress to a metabolically unhealthy phenotype over a period of 5-10 years[26]. Similarly, recent analyses have identified increasing age as an independent factor associated with the transition from MHO to metabolically unhealthy obesity, even after adjustment for other clinical and behavioral factors[27].

Finally, although some individuals with obesity do not present metabolic dysfunction at the time of assessment, this does not imply the absence of long-term risk. Recent studies have demonstrated that abdominal obesity is independently associated with major adverse cardiovascular events, even among individuals classified as having moderate risk using traditional risk scales[28]. In this context, the findings of the present study reinforce the fundamental role of primary care in early detection and in the implementation of timely preventive strategies, even in individuals with apparently MHO.

Strengths and limitations

The cross-sectional nature of this study prevents causal inference and may partly explain the lack of significant associations between MHO and most of the evaluated variables. Direct measurements of body composition, fat distribution, and physical fitness were not performed. The latter has been identified by Ortega et al.[22] as a relevant factor in MHO, limiting a more comprehensive understanding of the phenotype. The use of self-reported questionnaires to assess lifestyle introduces the risk of recall bias and social desirability bias. In addition, the sample size and the selection of participants from the waiting areas of a primary care clinic may limit the generalizability of the findings.

Future longitudinal studies will be necessary to determine how many patients with MHO remain metabolically healthy over time, how many develop metabolic abnormalities, and which interventions may modify the inherent risk associated with obesity. Among the strengths of this study is its contribution of local evidence regarding the proportion of individuals with MHO and its potential associated factors in primary care, which remains scarce in the national literature.

CONCLUSION

MHO is a phenotype present in a minority of individuals with obesity, predominantly among younger adults. This condition may be transient and potentially modifiable. In primary care, the focus should not be limited to the detection of established disease, but should also include active prevention strategies, even among individuals who do not yet present evident metabolic abnormalities.

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The authors declare that this work was carried out with the authors' own resources.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

ETHICAL CONSIDERATIONS

Protection of human subjects and animals. The authors declare that no experiments on humans or animals were performed for this research.

Confidentiality, informed consent, and ethical approval. The authors have followed their institution's confidentiality protocols, obtained informed consent from all patients, and secured approval from the Ethics Committee. SAGER guidelines have been followed as applicable to the nature of the study.

Declaration on the use of artificial intelligence (AI). The authors declare that no generative artificial intelligence was used in the writing or creation of the content of this manuscript.

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