Journal of Racial and Ethnic Health Disparities
https://doi.org/10.1007/s40615-023-01829-6

Differences in Body Weight According to Skin Color and Sex in Mexican Adults

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Received: 12 July 2023 / Revised: 25 September 2023 / Accepted: 3 October 2023

Abstract

Objectives 1) To analyze the differences in body weight according to skin color in Mexican adults. 2) Identify mediator variables that could explain possible differences in body weight according to skin color.

Methods A nationally representative survey of Mexican adults was analyzed ($n = 12{,}021$). People with obesity were identified (body mass index, BMI > 30) based on self-reported weight and height. Skin color was measured by self-report using a chromatic scale. The mediator variables were socioeconomic level, height, neighborhood public services, public safety, and discrimination based on skin color.

Results Compared to white-skinned women, brown-skinned women had higher BMI and a higher probability of being obese. These differences in weight by skin color are related to the lower level of education and more discrimination experiences of brown-skinned women. In men, there were no differences in weight according to skin color.

Conclusions In Mexican women (but not in men), darker skin color was associated with a higher probability of being obese, and the examined social factors partially explained this disparity.

Keywords Discrimination · Skin pigmentation · Racism · Body Weight · Obesity · Socioeconomic disparity

Introduction

In Mexico, the combined prevalence of overweight and obesity for 2018 was 75.2% among adults [1]. Obesity increases morbidity and mortality due to cardiovascular and metabolic alterations. The care of these comorbidities can imply expenses to individuals, families, and governments.

In Mexico (as in other Spanish-speaking Latin American countries), diet and physical activity have been the most analyzed factors as causes of obesity in their population. However, social factors may also play a role in explaining weight gain. In the USA and Brazil, racialization has been one of the social processes documented to be related to body weight [2–4].

Within the American continent, body weight disparities associated with racialization have been documented in the United States of America (USA) and to a lesser extent in Brazil. African American women are heavier than those of European ancestry; in men, the differences are smaller [2].

In the case of Mexico, there is evidence that, compared to white people, brown ones report worse self-reported health [5] and have lower self-esteem and vitality [6]. Like other forms of prejudice and discrimination [7], racialization can affect different spheres of life. Therefore, it is necessary to know if there are differences according to skin color in other health events. Therefore, an exploratory study was carried out, and its main objective was to analyze the differences in body weight according to skin color in Mexican adults between 25 and 64 years of age. A secondary objective was to identify mediator variables (socioeconomic level, height, neighborhood public services, neighborhood safety, and discrimination based on skin color) that could explain possible differences in body weight according to skin color.

Racialization in Spanish-Speaking Latin American Countries

Racialization [8] occurs when social relationships are structured by the meanings associated with humans' phenotypic characteristics (facial features or skin color).

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Published online: 19 October 2023

These meanings result in defining and constructing groups or categories within a society. Most people have created stereotypes in which the phenotype (skin color or facial features) is equated with geographic ancestry (ancestors come from America, Europe, or Africa), and with this, the differences are thought to be innate. The phenotypic variations are used as markers to create social categories which, in turn, are used to include (those perceived to be part of the in-group) or exclude (those in the out-group).

In the case of Spanish-speaking Latin American countries, racialization has its origin in the colonial period [9]. During the Spanish colonization of America, to justify the economic exploitation of indigenous people and Afro-descendants, a system of hierarchical categories ("caste" system) was developed [10]. In the caste system, the Spanish population was located at the top of the stratification and indigenous nations and Afro-descendants (who were brought to America as slaves) were at the base. From the colony to the present day, the phenotypic traits associated with European ancestry (white skin color) have been positively valued, while physical characteristics associated with indigenous (brown skin color) and African (black skin color) ancestries have been viewed in negative terms [9]. Throughout the history of Latin America, discourses have been constructed and circulated that justify or assume the supposed biological and cultural inferiority of indigenous nations and people of African descent [11].

In Latin America, skin color is a dimension of racialization that cannot be subsumed under traditional notions of race and ethnicity [12]. In the USA and Brazil, geographical ancestry serves as the basis for many people to create an ethnic or racial identity. However, ordinary Mexican people do not use these labels to define themselves. In the Mexican context, studying "brown" or "white" people is problematic because they are not a social group with a common origin and/or identity. Therefore, it is useful to think that skin color serves as a marker to create sociocultural categories so that people receive certain treatment and have similar experiences based on that characteristic, despite not identified as part of a group [13].

Mediating Variables

In the Brazilian population, the relationship between racialization and BMI is modified by sex and socioeconomic level [4]. The evidence from the USA also makes it possible to identify possible processes that explain such disparities. In African Americans, having been discriminated is associated with a higher probability of being obese [3]. Experiences of discrimination can generate stress, which, in turn, has been linked to eating patterns [14] that are linked to weight gain. Spatial segregation may also be a contributing factor to differences in weight between racialized groups [15].

Brown-skinned people could be heavier since they tend to have a low socioeconomic level [9, 16] which may imply purchasing affordable and energy-dense foods [17]. Lower socioeconomic level is a barrier to do recreational physical activity [18]. Brown-skinned people tend to be concentrated in neighborhoods of low socioeconomic status [5, 19]. In these areas, it is more likely that there is public insecurity and less infrastructure for sports practice, both determinants of physical activity and adiposity [20, 21]. Short stature may be more common among brown-skinned people and has been linked to a higher risk of obesity [22].

Materials and Methods

The database of the ESRU Survey of Social Mobility in Mexico (ESRU-EMOVI by its abbreviators in Spanish: *Encuesta de Movilidad Social*) was analyzed [23]. The ESRU Survey was carried out in 2017 by the *Centro de Estudios Espinosa Yglesias* of the *Fundación Espinosa Rugarcía* and examined the socioeconomic changes of people throughout their lives, and from parents to children. The sample was obtained probabilistically with a two-stage, stratified, and cluster design. The sample included 17,665 participants distributed nationwide. The primary sampling units were constituted by census tracts. In this study, people with a body mass index (BMI) < 12 kg/m^2 or > 50 kg/m^2, pregnant women, and people over 60 years of age were excluded. The final sample was 12,021 people.

To assess skin color, participants were asked to choose the color closest to their face using an eleven-tone color scale [24]. This variable was classified into four groups: dark brown (colors A to F of the scale), brown (color G), light brown (color H), and white (colors I to K) people. The presence of discrimination based on skin color was asked with one item.

Height and weight were obtained by self-report. For both measurements, correction equations for Mexican Americans were applied [25]. From the corrected measurements, the BMI was calculated, and it was defined that a person had obesity when their BMI ≥ 30 kg/m^2 [26]. Short stature was defined as a height lower than the 3rd percentile for an individual of 18 years and 11 months old [27].

The socioeconomic level was determined by the participant's education which was categorized as primary or less (kindergarten and primary options), junior high school (technical secondary and general secondary), high school (technical high school, general high school, technical or commercial with junior high school, and normal basic), and professional (technical or commercial with high school,

normal undergraduate, bachelorette, and postgraduate). In addition, a dichotomous variable was created to identify those with a bachelor's degree or more.

To assess the availability of public services in the neighborhood where the participant lived, a scale with 9 items was applied. Three factors emerged in an exploratory factorial analysis of the scale. In the first factor, the following services were included: schools or libraries, health centers, recreation facilities, and adequate transportation. This factor was called "access to public services," explained 21.1% of the variance, and was categorized into low (two or fewer services), medium (three), and high (four). The second factor included functional public lighting, low crime, and street cleanliness. This factor was named "public safety," which explained 18.0% of the variance, and was categorized into low (one or less), medium (two), and high (three). The third factor only included two items (there are stores that illegally sell alcohol, and there are abandoned terrains, dwellings, bridges, or tunnels) and was discharged. The reason for this discharging is that when a factor includes less than 3 items there is less probability of replicating its structure [28].

Whether the participant's mother and father spoke any indigenous language was asked. This variable was categorized into two groups: none versus at least one parent who spoke an indigenous language. Marital status was categorized into four groups: separated or divorced, widowed, single, and common-law or married. The geographical regions were determined by grouping the states where participants lived into four categories: north, southeast, center, and west. According to locality size, a distinction was made between rural (500–2500 inhabitants) and urban (more than 2500 inhabitants).

In the statistical analysis, the *survey* commands of the STATA software version 14.0 were used. With these commands, estimates for complex design samples (i.e., with weights, strata, and clusters) are obtained. All analyses were performed stratifying by sex since the social factors associated with obesity differ between men and women [4, 29]. The distribution of sociodemographic characteristics stratified by skin color was estimated.

A mediator must meet certain premises [30]: a) be more frequent in the exposed group (i.e., brown people), b) be associated with the health outcomes studied, and c) when incorporated into a regression model, it should result in a decrease in the estimates of the associations between the exposure (color of skin) and the outcome (adiposity). To evaluate the first premise, we explored whether there were differences in socioeconomic characteristics and discrimination based on skin color. For the second premise, the average BMI and the prevalence of obesity were estimated according to sociodemographic characteristics and skin color. For these bivariate analyses, a modified version of the ANOVA test (comparison of means) or the chi-square test (comparison of proportions) was estimated.

For the third premise, the *khb* command for STATA [30] was used, which consists of a decomposition method based on regression models. This command has the following capabilities: it can model continuous (regress function) or categorical (Poisson function) variables, it allows adjusting for confounders, the sample weights are considered for the estimates, standard errors are adjusted for the existence of clusters, and it provides estimates without bias of the contribution of the mediating variables. We estimated Poisson regression model because for cross-sectional survey data is more appropriate than other association measurements such as logistic regression [31]. Reduced models were adjusted for participant age, whether parents spoke an indigenous language, geographic region, locality size, and marital status. In the complete models, the mediating variables that met the first two previously described premises were included. The reference group was white people. The level of significance used was a $p\text{-}value < 0.050$.

Results

Most participants had a partner, were 25 to 35 years old, and lived in urban areas or in the central region (Table 1). In both sexes, the darker the skin color, the greater the proportions of people residing in the southeast or in rural areas, but fewer of those residing in the north. In men, as the skin was darker, it was more frequent that they were in the older group and that they had a partner.

In both sexes, as skin color was darker, the prevalence of the following indicators was higher: discrimination based on skin color, low education, short stature, having at least one of their parents speak an indigenous language, and low level of public security (Table 2). In men, as skin color was darker, the prevalence of having less access to public services was higher.

In men, those who were taller tended to have a higher BMI, although the differences were no significant (Table 3). The prevalence of obesity in men tended to be higher in those who were darker or with short stature. However, the differences by skin color were not significant. In women, the BMI was higher as the skin color was darker, the education was lower, or they had less access to public services, although the differences for the latter were not significant. Those who experienced discrimination based on skin color had a higher BMI. In addition, women with darker skin, less education, or short stature had a higher prevalence of obesity.

In both the reduced and full models, dark brown, brown, and light brown women had higher BMI than white women (Table 4). The difference between the

Table 1 Sociodemographic characteristics according to sex and skin color in Mexican adults, 2017

Characteristics	Men					Women				
	W	LB	B	DB	*p*	W	LB	B	DB	*p*
	%, SE	%, SE	%, SE	%, SE		%, SE	%, SE	%, SE	%, SE	
Age (years)										
25–35	46.6, 0.1	48.4, 1.9	43.0, 1.8	36.9, 2.1	< 0.001	41.2, 2.9	45.7, 1.5	40.8, 1.8	38.9, 2.2	0.135
36–45	35.8, 2.7	31.7, 1.6	32.3, 1.6	34.4, 1.9		30.1, 2.7	30.8, 1.3	33.1, 3.3	33.6, 1.9	
46–59	17.5, 2.1	19.9, 1.2	24.6, 1.4	28.7, 1.6		28.7, 2.9	23.5, 1.3	26.1, 1.3	27.5, 1.6	
Marital status										
Had a partner	63.7, 3.1	65.1, 2.1	70.1, 1.7	72.0, 1.6	< 0.001	69.9, 2.5	73.6, 1.1	72.7, 1.8	73.6, 1.7	0.411
Singles	28.8, 3.1	28.8, 1.8	20.6, 1.3	19.1, 1.6		20.0 2.2	16.5, 0.9	17.0, 1.7	14.8, 1.5	
Separated	6.7, 1.4	5.2, 0.7	7.5, 1.0	7.4, 0.7		7.6, 1.0	7.7, 0.7	7.0, 0.8	8.4, 1.1	
Widowers	0.9, 0.3	0.9, 0.2	1.8, 0.6	1.5, 0.4		2.6, 0.9	2.3, 0.4	3.3, 0.6	3.1, 0.5	
Region										
North	28.4, 4.7	27.4, 2.9	23.4, 2.3	19.2, 2.1	0.028	27.5, 4.1	22.8, 2.2	21.5, 2.2	14.9, 1.8	< 0.001
Southeast	16.2, 3.4	19.2, 2.2	21.1, 2.0	28.2, 2.7		18.1, 2.8	23.0, 2.0	27.3, 2.3	33.8, 3.1	
Center	35.6, 5.5	29.8, 3.9	32.9, 3.8	32.4, 3.4		34.7, 5.1	31.9, 3.8	30.7, 3.6	34.0, 4.4	
West	19.8, 4.9	23.5, 3.2	22.6, 2.7	20.2, 2.3		19.7, 3.5	22.3, 3.0	20.5, 2.4	17.2, 2.1	
Locality size										
Urban	92.5, 2.0	91.2, 1.1	90.1, 1.0	83.4, 2.0	0.003	89.6, 1.9	87.0, 1.3	85.5, 1.5	79.2, 3.0	0.007
Rural	7.5, 2.0	8.8, 1.1	9.9, 1.0	16.6, 2.0		10.4, 1.9	13.0, 1.3	14.5, 1.5	20.8, 3.0	

W, white; *LB*, light brown; *B*, brown; *DB*, dark brown; *SE*, standard error

Table 2 Differences in the experience of discrimination and socioeconomic characteristics according to sex and skin color in Mexican adults, 2017

	Men					Women				
	W	LB	B	DB	*p*	W	LB	B	DB	*p*
	%, SE	%, SE	%, SE	%, SE		%, SE	%, SE	%, SE	%, SE	
Discrimination based on skin color	1.3, 0.5	0.8, 0.2	1.7, 0.4	4.6, 0.8	< 0.001	0.4, 0.3	1.1, 0.3	1.6, 0.4	5.7, 1.0	< 0.001
Education										
Primary or less	13.0, 2.1	16.4, 1.2	19.6, 1.4	23.8, 1.6	< 0.001	16.8, 2.2	22.5, 1.2	30.1, 1.7	36.3, 2.5	< 0.001
Junior high school	21.4, 3.1	26.6, 1.6	29.5, 1.8	34.6, 1.8		33.3, 3.6	33.0, 1.8	38.2, 1.8	38.0, 2.8	
High school	29.9, 3.2	26.6, 1.4	27.1, 1.7	26.0, 2.0		24.4, 2.2	25.4, 1.5	20.6, 1.7	17.2, 1.7	
Professional or more	35.7, 3.4	30.4, 1.8	23.8, 1.9	15.7, 1.5		25.5, 2.6	19.2, 1.7	11.0, 1.2	8.5, 1.2	
Height (percentile)										
< 3	15.5, 3.2	18.9, 1.5	21.8, 1.8	23.3, 2.0	< 0.001	8.1, 1.5	11.5, 1.2	14.5, 1.4	19.6, 1.8	< 0.001
3 a < 15	19.4, 2.9	22.1, 1.7	24.7, 1.6	26.6, 2.0		40.1, 3.1	45.8, 1.9	51.4, 1.8	50.7, 2.4	
15 a < 50	33.4, 3.0	38.4, 1.6	36.9, 1.8	34.5, 2.0		29.7, 2.6	24.8, 1.4	21.2, 1.4	19.4, 1.7	
≥ 50	31.7, 3.4	20.6, 1.7	16.6, 1.4	15.5, 1.5		22.2, 3.1	17.9, 1.7	12.9, 1.2	10.2, 1.3	
Parents spoke indigenous language	7.5, 1.6	10.1, 1.4	13.1, 1.4	16.2, 1.7	< 0.001	8.9, 1.7	12.2, 1.4	17.7, 1.7	21.3, 3.0	< 0.001
Access to public services										
Low	11.6, 2.3	14.3, 1.4	16.4, 1.7	19.0, 1.9	0.019	14.8, 2.4	17.0, 1.8	17.3, 1.6	19.0, 1.9	0.068
Medium	18.3, 2.4	24.7, 1.7	23.4, 1.7	22.9, 1.6		24.8, 3.6	24.3, 1.3	28.2, 1.7	31.2, 2.7	
High	70.2, 3.3	61.0, 2.2	60.2, 1.9	58.1, 2.2		60.4, 3.4	58.7, 2.2	54.5, 2.2	49.9, 2.7	
Public safety										
Low	23.5, 2.9	31.2, 2.0	35.3, 1.9	37.4, 2.1	0.003	32.0, 3.0	37.5, 2.8	39.3, 2.2	38.9, 2.4	0.030
Medium	30.7, 3.2	30.5, 1.9	28.5, 1.5	29.4, 1.7		26.4, 2.5	27.6, 1.6	29.9, 1.6	32.2, 1.9	
High	45.8, 3.5	38.3, 2.3	36.2, 1.8	33.3, 1.9		41.6, 3.6	34.9, 2.2	30.9, 1.9	28.9, 2.2	

W, white; *LB*, light brown; *B*, brown; *DB*, dark brown; *SE*, standard error

Table 3 Differences in body mass index (BMI) and prevalence of obesity according to skin color, discrimination, and socioeconomic characteristics in Mexican adults, 2017

	Men				Women			
	BMI		Obesity		BMI		Obesity	
	$\bar{x}$, SE	*p*	%, SE	*p*	$\bar{x}$, SE	*p*	%, SE	*p*
Skin color								
White	27.3, 0.3	0.119	17.3, 2.7	0.087	25.9, 0.3	0.002	17.6, 2.2	0.029
Light brown	27.5, 0.2		22.3, 1.6		26.4, 0.2		21.2, 1.4	
Brown	27.3, 0.2		21.7, 1.7		26.7, 0.2		23.4, 1.4	
Dark brown	27.8, 0.2		25.1, 2.0		27.1, 0.2		25.2, 1.6	
Discrimination based on skin color								
No	27.5, 0.1	0.991	22.3, 1.2	0.723	26.6, 0.1	0.006	22.2, 0.9	0.149
Yes	27.5, 0.5		24.1, 5.0		28.4, 0.6		30.2, 5.9	
Education								
Primary or less	27.3, 0.2	0.340	22.4, 1.7	0.258	27.6, 0.2	< 0.001	28.3, 1.6	< 0.001
Junior high school	27.5, 0.2		22.1, 1.6		26.7, 0.2		24.2, 1.5	
High school	27.8, 0.3		25.0, 2.6		25.9, 0.2		16.0, 1.3	
Professional or more	27.3, 0.2		19.7, 0.2		25.5, 0.2		16.6, 1.6	
Height (percentile)								
< 3	27.3, 0.2	0.052	27.1, 2.4	0.004	27.6, 0.3	< 0.001	21.8, 2.1	0.019
3 a < 15	27.3, 0.2		19.8, 1.5		26.5, 0.2		21.5, 1.2	
15 a < 50	27.4, 0.2		18.9, 1.7		26.1, 0.2		20.9, 1.4	
≥ 50	27.9, 0.2		21.9, 2.1		26.9, 0.2		28.1, 2.3	
Parents spoke indigenous language								
None	27.6, 0.1	0.463	22.4, 1.2	0.562	26.7, 0.1	0.181	22.7, 1.1	0.139
One or both	27.4, 0.3		23.8, 2.3		26.3, 0.2		19.8, 1.7	
Access to public services								
Low	27.5, 0.3	0.718	21.1, 2.6	0.769	27.0, 0.3	0.066	23.6, 2.4	0.690
Medium	27.4, 0.2		23.0, 1.8		26.3, 0.2		21.3, 1.6	
High	27.5, 0.1		22.4, 1.3		26.6, 0.1		22.4, 1.1	
Public safety								
Low	27.8, 0.2	0.159	24.1, 2.4	0.116	26.5, 0.2	0.317	22.0, 1.5	0.368
Medium	27.5, 0.2		24.1, 1.9		26.8, 0.2		24.0, 1.6	
High	27.3, 0.2		19.7, 1.3		26.5, 0.2		21.1, 1.3	

$\bar{x}$, average; *SE*, standard error

reduced and full model was significant in the case of dark brown women. In these cases, education was the main variable that explained the difference in BMI according to skin color (15.3% for brown women and 11.7% for dark brown women). Discrimination experience only explained 2.6% of the differences for brunettes and 5.4% for dark brunettes. The probability of having obesity did not differ between white and light brown or brown women. In both the reduced and full models, dark brown women were more likely to be obese than white ones. The differences between the models in dark brown and brown women were significant. Education contributed to the difference in the probability of presenting obesity between white and brown and dark brown women in 18.1% and 16.4%, respectively.

In men, after adjusting the models for confounders, there were no statistically significant differences on the probability of presenting obesity ($p = 0.147$ for light brown men, $p = 0.229$ for brown men, $p = 0.090$ for dark brown men).

Discussion

To the best of our knowledge, no previous studies have analyzed the relationship between skin color and body weight in the Mexican population or in other Spanish-speaking countries in Latin America. Dark brown women presented higher BMI values and a higher prevalence of obesity compared to white women. This relationship was maintained after adjusting for confounders. In men, the same trend was observed for the prevalence of obesity; however, after adjusting for confounders, the differences disappeared. These differences are like those observed according to racial groups and sex observed in the USA [2, 32] and Brazil [4]. The fact that

Table 4 Regression models to test the possible role of mediators in the relationship between skin color and body weight in Mexican women, 2017

	Women					
	BMI [a]			Obesity [b]		
	β, SE	95% CI	*p*	PR, SE	95% CI	*p*
Light brown[c]						
Reduced model	0.69, 0.28	0.14, 1.22	0.014	1.03, 0.02	0.99, 1.08	0.127
Complete model	0.64, 0.28	0.09, 1.19	0.022	1.03, 0.02	0.99, 1.08	0.148
Difference	0.04, 0.05	−0.06, 0.14	0.435	1.00, 0.00	1.00, 1.01	0.564
Contribution	%			%		
Discrimination based on skin color	2.1					
Professional degree or more	3.8			5.5		
Brown[c]						
Reduced model	0.72, 0.28	0.18, 1.26	0.009	1.04, 0.02	1.00, 1.09	0.066
Complete model	0.59, 0.28	0.03, 1.15	0.040	1.03, 0.02	0.99, 1.08	0.122
Difference	0.13, 0.06	−0.00, 0.26	0.059	1.01, 0.00	1.00, 1.01	0.030
Contribution	%			%		
Discrimination based on skin color	2.6					
Professional degree or more	15.3			18.1		
Dark brown[c]						
Reduced model	1.35, 0.31	0.74, 1.96	< 0.001	1.07, 0.03	1.01, 1.13	0.013
Complete model	1.12, 0.31	0.49, 1.74	< 0.001	1.00, 0.03	1.03, 1.11	0.031
Difference	0.23, 0.07	0.07, 0.39	0.005	1.01, 0.00	1.00, 1.02	0.005
Contribution	%			%		
Discrimination based on skin color	5.4					
Professional degree or more	11.7			16.4		

Reduced models are adjusted for age, indigenous language of parents, region, locality size, and marital status. The complete model includes—in addition to the previous ones—the mediating variables. Difference refers to the difference between reduced and complete models. Contribution refers to the percentage in which each mediator variable contributes to the difference between skin color groups. [a] Linear regression model having BMI (continuous variable) as the outcome. [b] Poisson regression model having obesity (dichotomous variable) as the outcome. [c]The reference group was white women. *PR*, prevalence ratio; *β*, regression coefficient; *95% CI*, 95% confidence interval; *SE*, standard error

differences are observed between women according to skin color but not in men can be attributed to the intersection of inequities. The effects of racialization on weight could be greater in dark brown women, given they are in charge of domestic and parenting work, which frequently end up being stressors [33]. Furthermore, from a sociocultural perspective, in women, physical appearance is more important [34], which may result in eating behaviors that promote weight gain [35].

To what extent can the observed differences in BMI according to skin color be attributed to biological factors (i.e. genetics associated with geographic ancestry) or to social processes (i.e. racialization)? Regarding the results of our study, body weight did not differ according to the indigenous condition of the participants' parents. In addition, differences in body weight according to skin color did not disappear after controlling for whether parents spoke any indigenous language, which, to some extent, is a proxy of indigenous ancestry. The study of the relationship of indigenous ancestry with body weight has been questioned since it implies assuming the existence of biologically defined "races" or groups [36]. Studies that have tried to document the effect of indigenous ancestry show that a significant proportion of the differences can be attributed to socioeconomic factors [29]. Furthermore, in Mexico, skin color is a poor indicator of continental ancestry assessed with genetic markers [37]. In other words, having light skin is not related to being of European descent or brown skin does not imply having indigenous ancestry.

We think that disparities in body weight associated with skin color and other findings observed in our study can be understood as an expression of racialization, i.e., the social stratification produced by the meanings and beliefs that assume that certain physical traits (skin color) are markers of geographical ancestry. For example, we observed that people with darker skin tended to have lower socioeconomic status and live in neighborhoods with fewer public services. These disparities are the product of the historical accumulation of disadvantages associated with belonging to indigenous groups or the perception that one belongs to them.

During the Spanish colony, indigenous people were unable to occupy jobs with high status and power, and they were segregated within the cities to keep them separated from the Spaniards [9]. These disadvantages have been reproduced, and nowadays, brown people face discriminatory practices to impede them from ascending social mobility and they tend to concentrate in impoverished neighborhoods [5, 19].

Another finding of our study was that experiences of discrimination based on skin color were more frequent among Mexican brown people. This result shows that social processes are operating to generate disparities among racialized categories in Mexico. In this context, skin color does not measure any biological attribute, rather it is a way of capturing how people perceive and signify certain physical qualities [9]. These perceptions and meanings, in turn, determine certain (mis)treatments and access to opportunities.

The postulated mediator variables explained a minimal proportion of the differences in weight by skin color. For example, the mediating variables (education, discrimination, and wealth index) only explained 16% of the differences in the probability of presenting obesity between white and dark brown women. In other words, 84% of the differences could not be attributed to the postulated mediating variables. However, before ruling out the role that mediating variables may have, better measurements of them are required in future studies, as indicated below.

One of the variables that were proposed as mediators was the socioeconomic level. In Mexico, as the skin color is darker, there is a greater probability of having a low socioeconomic level [9, 16]. Our results confirm these disparities, which were observed in both sexes. Additionally, in women, education was the main mediator in explaining the differences in weight according to skin color. It is possible that brown women, due to their low socioeconomic level, have less access to a healthy diet [17] or more barriers to physical activity [18]. Future studies could corroborate these explanations.

Consistent with the socioeconomic disparities, in the sample of Mexicans, it was observed that the darker the skin, the shorter the stature. Height is the product of the living conditions of the individuals and their parents [38]. However, height did not function as a mediator to explain the association between skin color and body weight.

In our study, brown people tended to live in neighborhoods with fewer public services and public security, which has been previously reported [5, 19]. This is linked to the low socioeconomic level that is more frequent among brown people [9, 16]. These trends suggest the existence of spatial segregation; that is, brown people tend to concentrate in localities with worse living conditions. However, neither of these two variables acted as a mediator between skin color and body weight. Unfortunately, the variables that we analyzed are not adequate measures of spatial segregation. In the USA, studies have been carried out on the segregation of racialized groups using geographic information systems [15]. However, to conduct these types of studies, it is required that the censuses register indicators of racialization other than ethnicity, which still does not occur in Mexico.

In both sexes, the experiences of discrimination were more frequent as the skin color was darker. In women, these experiences contributed minimally to explaining the differences in weight according to skin color. In African American women, experiences of discrimination have been linked to weight gain [32]. One problem with this finding is that the experience of discrimination was assessed with a question about differential treatment based on skin color. This evaluation has the disadvantage that people may not identify when they have been discriminated against or may not be able to determine if some form of mistreatment can be attributed to racism. For this reason, it is more convenient to use scales with several items on differential treatment without the interviewees attributing it to a certain characteristic. In this regard, in Mexican university students, the experiences of discrimination did contribute to the differences in mental health according to skin color when the former was evaluated with a scale with the aforementioned characteristics [6].

One limitation of the study is that it is a cross-sectional survey, so causal inferences cannot be made. Since skin color is a feature that is not modified or changes minimally, it is unlikely that the relationship is inverse to that proposed here. Another limitation of the study was that weight and height were self-reported. To reduce the effect of self-report, specific equations were used to reduce misclassification into BMI categories [25]. Misclassification is more problematic when the BMI is close to the category cut-off points. Therefore, in addition to analyzing the BMI as a continuous variable, a dichotomous variable was created to identify people with obesity. Future studies could use objective measures of adiposity. On the contrary, a strength of the study is that it was based on a representative sample of the Mexican adult population.

In summary, this study found that Mexican brown women are more likely to be obese, which can be explained by their low socioeconomic status and, to a lesser extent, by experiences of discrimination. In men, no differences were observed between white and brown ones. If what was observed in this study is confirmed, it would imply considering obesity not only as a product of women's lifestyle but also as a manifestation of racialization. This would be relevant for research and public policies for the prevention of obesity. In the future, the relationships explored herein could be analyzed in detail using quantitative and qualitative research. It could also be evaluated whether the prevalence of cardiometabolic diseases in the Mexican population varies according to skin color, as has been documented in the USA regarding the differences between racialized groups

[3]. This could be done by including the color palette in national health surveys. We believe that our study is a contribution to the incipient research on the effects of racialization on the health and well-being of the Mexican population and other Spanish-speaking countries in Latin America.

Funding The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Declarations

Ethics Approval The ethical aspects of the analysis reported in the manuscript have been approved by the Research Ethics Committee of the Divisional Council of Biological and Health Sciences of the *Universidad Autónoma Metropolitana Xochimilco*.

References

1. Shamah-Levy T, Rivera-Dommarco J, Bertozzi S. Encuesta Nacional de Salud y Nutrición 2018–19: análisis de sus principales resultados. Salud Pública de México. 2020;62(6):614–7.
2. Min J, Goodale H, Xue H, Brey R, Wang Y. Racial-ethnic disparities in obesity and biological, behavioral, and sociocultural influences in the United States: a systematic review. Adv Nutr. 2021;12(4):1137–48. https://doi.org/10.1093/advances/nmaa162.
3. Agbonlahor O, DeJarnett N, Hart JL, Bhatnagar A, McLeish AC, Walker KL. Racial/ethnic discrimination and cardiometabolic diseases: a systematic Review. J Racial Ethn Health Disparities. 2023;1–25. https://doi.org/10.1007/s40615-023-01561-1.
4. Araujo MC, Baltar VT, Yokoo EM, Sichieri R. The association between obesity and race among Brazilian adults is dependent on sex and socio-economic status. Public Health Nutr. 2018;21(11):2096–102. https://doi.org/10.1017/S1368980018000307.
5. Ortiz-Hernández L, Ayala-Guzmán CI, Pérez-Salgado D. Health inequities associated with skin color and ethnicity among Mexican adults. Lat Am Caribb Ethn Stud. 2020;15(1):16. https://doi.org/10.1080/17442222.2020.1714846.
6. Ortiz-Hernandez L, Compean S, Verde E, Flores MN. Racism and mental health among university students in Mexico City. Salud Publica Mex. 2011;53(2):125–33.
7. Krieger N. Methods for the scientific study of discrimination and health: an ecosocial approach. Am J Public Health. 2012;102(5):936–44. https://doi.org/10.2105/AJPH.2011.300544.
8. Barot R, Bird J. Racialization: the genealogy and critique of a concept. Ethn Racial Stud. 2001;24(4):601–18. https://doi.org/10.1080/01419870120049806.
9. Ortiz-Hernandez L, Ayala-Guzmán CI, Pérez-Salgado D. Posición socioeconómica, discriminación y color de piel en méxico. Perf Latinoam. 2018;26(51):215–39. https://doi.org/10.18504/pl2651-009-2018.
10. Morner M. History of race relations in Latin-America - comments on state of research. Lat Am Res Rev. 1966;1(3):17–44.
11. Nutini HG. Class and ethnicity in Mexico: somatic and racial considerations. Ethnology. 1997;36(3):227–38. https://doi.org/10.2307/3773987.
12. Telles E, Flores DR. A Comparative analysis of ethnicity, race, and color in Latin America based on PERLA findings. In: Telles E, editor. Pigmentocracies Ethnicity, race, and color in Latin America. 1st ed. Chapel Hill, NC: University of North California Press; 2014. p. 218–36.
13. Aguilar R. Los tonos de los desafíos democráticos. El color de la piel y la raza en México. Polít Gob. 2013;2013:25–55.
14. Kazmierski KFM, Gillespie ML, Kuo S, Zurita T, Felix D, Rao U. Stress-induced eating among racial/ethnic groups in the United States: a systematic review. J Racial Ethn Health Disparities. 2021;8(4):912–26. https://doi.org/10.1007/s40615-020-00849-w.
15. Corral I, Landrine H, Hall MB, Bess JJ, Mills KR, Efird JT. Residential segregation and overweight/obesity among African-American adults: a critical review. Front Public Health. 2015;3:169. https://doi.org/10.3389/fpubh.2015.00169.
16. Villarreal A. Stratification by skin color in contemporary Mexico. Am Sociol Rev. 2010;75(5):652–78. https://doi.org/10.1177/0003122410378232.
17. Valencia-Valero RG, Ortiz-Hernandez L. Food availability according to food security-insecurity among Mexican households. Salud Publica Mex. 2014;56(2):154–64.
18. Ortiz-Hernandez L, Ayala-Hilario C, Ayala- GC. Prevalence of sports practice among Mexican adults in 2002 and 2014. SPORT TK-Rev EuroAmericana Cienc Deporte. 2020;9(1):8.
19. Low SM. Unlocking the gated community. Moral minimalism and social (dis)order in gated communities in the United States and Mexico. In: Glasze G, Webster C, Frantz K, editors. Private cities: global and local perspectives. Routledge studies in human geography. New York, USA: Routledge; 2006;43–60.
20. Ortiz-Hernandez L, Janssen I. Social disorder, physical activity and adiposity in Mexican adults: evidence from a longitudinal study. Health Place. 2014;30:13–9. https://doi.org/10.1016/j.healthplace.2014.08.001.
21. Romo-Aviles M, Ortiz-Hernández L. Desigualdades socioespaciales en infraestructura deportiva en áreas metropolitanas de México. In: Martínez MA, Staines G, Lara NL, Tamez S, Correa E, editors. La salud y su atención, investigación y experiencias. Ciudad de México: Universidad Autónoma Metropolitana Xochimilco; 2019. p. 28.
22. Castano LS, Restrepo AE, Rueda JD, Aguirre CC, Lopez LP. The effects of socioeconomic status and short stature on overweight, obesity and the risk of metabolic complications in adults. Colomb Med (Cali). 2013;44(3):146–54.
23. Centro de Estudios Espinosa Yglesias: Encuesta de la "Fundación Espinosa Rugarcía" de movilidad Social 2017. Available on https://ceey.org.mx/contenido/que-hacemos/emovi/. Accessed 15 Nov 2022.
24. Project on Ethnicity and Race in Latin America: PERLA Color Palette. Available on https://perla.princeton.edu/perla-color-palette/. Accessed 15 Nov 2022.
25 Mozumdar A, Liguori G. Corrective equations to self-reported height and weight for obesity estimates among U.S. adults: NHANES 1999–2008. Res Q Exerc Sport. 2016;87(1):47–58. https://doi.org/10.1080/02701367.2015.1124971.
26. Organización Mundial de la Salud: obesidad y sobrepeso. Available on https://www.who.int/es/news-room/fact-sheets/detail/obesity-and-overweight. Accessed 24 Feb 2023.
27. de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. Bull World Health Organ. 2007;85(9):660–7. https://doi.org/10.2471/blt.07.043497.
28. Lloret-Segura S, Ferreres-Traver A, Hernández-Baeza A, Tomás-Marco I. El análisis factorial exploratorio de los ítems: una guía práctica, revisada y actualizada. An Psicol. 2014;30(3):1151–69. https://doi.org/10.6018/analesps.30.3.199361.
29. Ruderman A, Perez LO, Adhikari K, Navarro P, Ramallo V, Gallo C, et al. Obesity, genomic ancestry, and socioeconomic variables in Latin American mestizos. Am J Hum Biol. 2019;31(5):e23278. https://doi.org/10.1002/ajhb.23278.

30. Karlson K, Holm A, Breen R. Comparing regression coefficients between models using logit and probit: a new method. Sociol Methodol. 2012;42:286–313.
31. Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. BMC Med Res Methodol. 2003;3:21. https://doi.org/10.1186/1471-2288-3-21.
32. Cunningham TJ, Berkman LF, Kawachi I, Jacobs DR Jr, Seeman TE, Kiefe CI, et al. Changes in waist circumference and body mass index in the US CARDIA cohort: fixed-effects associations with self-reported experiences of racial/ethnic discrimination. J Biosoc Sci. 2013;45(2):267–78. https://doi.org/10.1017/S0021932012000429.
33. Hernández E, Pérez-Salgado D, Ortiz-Hernández L. Consecuencias alimentarias y nutricionales de la inseguridad alimentaria: la perspectiva de madres solteras. Rev Chil Nutr. 2013;40(4):7.
34. Moreno MG. Historically-rooted transnationalism: slightedness and the experience of racism in mexican families. J Intercultural Stud. 2008;29(3):283–97.
35. Dulloo AG, Jacquet J, Montani JP, Schutz Y. How dieting makes the lean fatter: from a perspective of body composition autoregulation through adipostats and proteinstats awaiting discovery. Obes Rev. 2015;16(Suppl 1):25–35. https://doi.org/10.1111/obr.12253.
36. Saldaña-Tejeda A. Mitochondrial mothers of a fat nation: race, gender and epigenetics in obesity research on Mexican mestizos. BioSocieties. 2018;13(2):434–52. https://doi.org/10.1057/s41292-017-0078-8.
37. Ruiz-Linares A, Adhikari K, Acuna-Alonzo V, Quinto-Sanchez M, Jaramillo C, Arias W, et al. Admixture in Latin America: geographic structure, phenotypic diversity and self-perception of ancestry based on 7,342 individuals. PLoS Genet. 2014;10(9):e1004572. https://doi.org/10.1371/journal.pgen.1004572.
38. Batty GD, Shipley MJ, Gunnell D, Huxley R, Kivimaki M, Woodward M, et al. Height, wealth, and health: an overview with new data from three longitudinal studies. Econ Hum Biol. 2009;7(2):137–52. https://doi.org/10.1016/j.ehb.2009.06.004.