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Prevalence of self-reported obesity among diverse Latino adult populations in New York City, 2013–2017

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Abstract

Introduction: Latinos in the United States represent a heterogeneous population disproportionally impacted by obesity. Yet, the prevalence of obesity by specific Latino group is unclear. Using the New York City Community Health Survey (2013–2017), this study compared self-reported obesity in the city's largest Latino adult populations (Puerto Ricans, Mexicans, Dominicans, Ecuadorians, and Colombians).

Methods: Age-standardized prevalence using the 2000 Census and prevalence ratios (PRs) for self-reported obesity (BMI ≥ 30 kg/m^2) by country of origin were estimated using weighted multivariable logistic regression adjusting for socio-demographic characteristics, health status, and behaviors.

Results: Obesity prevalence among Mexicans (36.8%; 95% CI [31.5, 42.4]) and Puerto Ricans (36.3%; 95% CI [31.7, 41.3]) was significantly higher than that among Colombians (23.8%; 95% CI [18.8, 29.5]), Ecuadorians (24.2%; 95% CI [20.7, 28.1]), and Dominicans (27.0%; 95% CI [25.0, 29.1]). After adjusting for covariates, compared to Mexicans, the PRs of obesity remained significantly lower for Colombians (PR = 0.80; 95% CI [0.64, 1.00]), Ecuadorians (PR = 0.72; 95% CI [0.61, 0.86]) and Dominicans (PR = 0.75; 95% CI [0.65, 0.85]). There was no significant difference between Mexicans and Puerto Ricans.

Conclusion: Obesity prevalence differs by country of origin, suggesting that clustering of Latinos in public health research may obscure unique risks among specific groups. Despite group differences, all Latino groups exhibit high prevalence of obesity and warrant renewed efforts tailored to the specific context and culture of each group to prevent and reduce obesity.

KEYWORDS
adult, hispanics, obesity

1 | INTRODUCTION

Latinos are the largest and fastest growing ethnic group in the United State (U.S.).[1] In 2016, the U.S. Latino population reached over 58 million (18% of the total national population) accounting for half of the national population growth since 2000.[1] Latinos are disproportionately impacted by the obesity epidemic in the U.S.[2] National reports have shown that adult Latinos have higher age-adjusted prevalence of obesity compared to non-Latino Whites (47% vs. 38%).[2] This pattern also holds in large urban areas such as New York

City (NYC), where Latinos represent one-third of the city's population and have a higher prevalence of obesity compared with non-Latino New Yorkers (29% vs. 20%).[3]

Although Spanish-speaking Latinos are considered one ethnic group in the U.S., they represent a heterogeneous mix of genetic ancestry, culture, immigration history, and environmental exposures from 20 different countries in Latin America and the Caribbean.[1,4,5] The prevalence of obesity by specific Latino group is unclear as the majority of obesity research ignores the country of origin or has primarily involved Mexican Americans.[2,6-8] A limited number of obesity studies have started to report on country-of-origin differences for some Latino groups (e.g., Mexicans, Puerto Ricans, Cubans, and Dominicans) and combined regional groups (i.e., Central American and South American).[3,6,8-22] According to these studies, Latinos of all backgrounds experience high rates of obesity.[3,6,8-11,13-18] Comparisons by country of origin have shown that Puerto Ricans and Mexicans have a higher prevalence of obesity, whereas South Americans have the lowest prevalence of obesity.[3,6,8,9,11,14,18] However, the latter studies still combined data from five different Central America and nine different South American countries into homogenous regional groups for comparisons, making it difficult to understand the obesity disparities within regional groups.

Indeed, emerging evidence suggests that country of origin is an important factor to understand obesity.[3,6-22] Recent studies suggest that some Latino immigrants may no longer be arriving with healthy weight status to the U.S. because Latin American countries are undergoing epidemiologic[23,24] and nutrition transitions.[25,26] For example, Mexico has some of the highest obesity and overweight prevalence in the world currently.[27-29] These studies are encouraging more research to limit overgeneralization of Latinos in the U.S. and further explore the heterogeneity of Latinos in terms of socio-demographic characteristics, diet, physical activity (PA), obesity and comorbid conditions.[3,6,8-22] The present study responded to this call by examining and comparing the prevalence of obesity in a large and diverse sample of Latino immigrants born in Latin America but residing in NYC. Specifically, this study compared self-reported obesity in NYC's five largest Latino adult populations (Puerto Ricans, Mexicans, Dominicans, Ecuadorians, and Colombians). The present study is the first to disaggregate South American data by country of origin to compare prevalence of obesity and risk factors of Colombians and Ecuadorians with other Latino groups in NYC.

2 | METHODS

This study was conducted using the 2013–2017 NYC Community Health Survey (CHS), which has been administered annually by the NYC Department of Health and Mental Hygiene since 2002.[30] The NYC CHS is a random telephone-call, cross-sectional survey of approximately 10,000 non-institutionalized adults (≥18 years old), sampled within 34 neighborhood strata in NYC.[30] The survey was administered in English, Spanish, Russian, Cantonese, and Mandarin to selected respondents with land lines telephones and cell phones

(since 2009).[30] The survey questions were based on the national Behavioral Risk Factor Surveillance System (BRFSS) and provided population-representative estimates of health conditions and risk factors.[31] The institutional ethics review committee at the City University of New York deemed this study exempt from review.

2.1 | Participants

The pooled NYC CHS data from 2013 to 2017 included adult individuals from the five largest Latino populations in NYC and who accounted for 84% of the Latino population of NYC.[32] Specifically, the participants selected for this study reported being born in Mexico ($n = 1216$), Puerto Rico ($n = 1608$), Dominican Republic ($n = 4022$), and two South American countries, Ecuador ($n = 962$) and Colombia ($n = 503$).

2.2 | Measures

This study assessed the relationship between the prevalence of obesity and several risk factors: socio-demographic characteristics (i.e., country of origin, age, sex, education, employment status, marital status, presence of children in the household, household size, and household income)[33,34]; health status (i.e., diagnosis of Type 2 Diabetes [T2D] and Hypertension [HTN], and self-perception of health)[33-35]; and lifestyle behaviors (i.e., daily consumption of sugar-sweetened beverages [SSB] and physical activity [PA] in the past 30 days).[34-36]

Body Mass Index (BMI, kg/m²) was calculated from self-reported height and weight. Obesity was defined as BMI ≥30 kg/m² (yes/no) and overweight was defined as BMI ≥ 25–29.9 kg/m² (yes/no). Country of origin was self-reported (i.e., *Where were you born? Please tell me the country*). Age was categorized as 18–24, 25–44, 45–64, and 65+ years. Sex was self-identified as male or female. Education was dichotomized as less than high school versus high school or more. Employment was categorized as employed, unemployed and not in the labor force (i.e., homemakers, students, retired or unable to work). Marital status was dichotomized as married or living together versus divorced, widowed, separated or never married. Presence of children in the household was defined as having one or more children <18 years old living in the home (yes/no). Household size was dichotomized as households with five or fewer people versus six or more people. Household income was dichotomized as <200% Federal Poverty Level (FPL) versus ≥200% FPL.

Comorbidities included in the analysis were self-reported diagnosis of HTN and T2D. The T2D diagnosis question did not distinguish between type 1, type 2 and gestational diabetes. Therefore, women who had diabetes only while pregnant are included in the "no" category. The prevalence of type 1 diabetes among Latinos in the U.S. is well under 1% according to recent estimates.[37] Self-perception of general health was measure using a question from the Healthy Days core questions (i.e., *Would you say that in general your*

health is excellent, very good, good, fair or poor?).[38] Lifestyle factors such as PA was dichotomized (i.e., *during the past 30 days, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?* yes/no); and consumption of SSB was defined as none or <1 serving per day versus ≥1 serving per day.

2.3 | Analysis

Weighted prevalence was estimated to account for potential nonresponse bias and selection probability. Survey weights were created using iterative proportional fitting to be representative of the NYC adult population based on sex, race/ethnicity, age, phone type and borough of residence based on the 2015 American Community Survey.[31] Proportional differences in the distribution of socio-demographic characteristics, health status and lifestyle factors across each Latino group were assessed using Pearson's χ² test and followed by a pairwise comparison using the *t*-test. The prevalence of overweight and obesity was age-standardized by the direct method referencing the 2000 projected U.S. population by age group (18–24 years, 25–44 years, 45–64 and ≥65 years) and stratified by sex. Prevalence ratios (PRs) for obesity by country of origin were estimated using weighted multivariable logistic regression adjusting for socio-demographic characteristics, health status or comorbidities and lifestyle across Latino subgroups. PR represented the ratio of predicted probabilities calculated from logistic regression models, using the PREDMARG and PRED_EFF statements in SUDAAN.[39] To compare group differences between estimates, subsequent multivariable logistic regression models were conducted for all five groups with Mexicans as the referent. Mexicans were chosen as the referent group for comparisons as the prevalence of obesity for this group has been well documented in the literature.[2,6-8,40] The sequence of regression models (parallel models with obesity as the outcome) is as follows. Model 1 examined the relationship between country of origin and obesity, adjusting for age, sex, education, employment status, marital status, presence of children in the household, household size, household income, HTN and T2D status, and self-perception of general health. Models 2 examined the relationship between country of origin and obesity, adjusting for variables in Model 1 plus consumption of SSB and PA in the last 30 days. Subsequent logistic regression models included an interaction term (i.e., country of origin by sex) and were used to identify sex-specific associations between obesity and independent variables in Models 1 and 2. All statistical tests were two-sided at a significance level of 0.05. Analyses were performed using SAS Enterprise Guide (version 7.1) and SAS-callable SUDAAN (version 11.0, RTI).

3 | RESULTS

Table 1 provides descriptive statistics for each Latino group. The 8311 eligible participants represented a weighted sample of

1,040,952 adults from Colombia, Dominican Republic, Ecuador, Puerto Rico, and Mexico residing in NYC. The five groups were significantly different for all characteristics (all *p* < 0.001) based on a Pearson's χ² test. Results of a pairwise *t*-test comparison show that most participants from Colombia, Dominican Republic, Ecuador, and Mexico were between the ages of 25–64 years (78%, 72%, 71%, and 89%, respectively). However, Puerto Ricans had higher percentage of people who reported being ≥65 years old (40%). Women represented the majority of the sample for Colombians (60%), Dominicans (59%) and Puerto Ricans (60%) but not for Ecuadorians (46%) and Mexicans (50%). Colombians had higher percent of people who completed more than high school (69%) compared to Dominicans (52%), Ecuadorians (48%), Puerto Ricans (47%), and Mexicans (39%). Most Latino groups reported being employed except for Puerto Ricans who were mostly not in the labor force (68%). Mexicans (70%) were more likely to be married or living with a partner than Ecuadorians (59%), Colombians (52%), Dominicans (49%) and Puerto Ricans (36%). Compared to the other groups, Mexicans and Ecuadorians were more likely to have children <18 years in their household and to live in households with six or more individuals. The majority of respondents in all groups reported an annual household income at <200% FPL. Puerto Ricans and Dominicans were more likely to report a diagnosis of HTN (55% and 41%, respectively) and T2D (34% and 19%, respectively) compared to the other groups. Self-perception of heath differed in the sample as the majority of Ecuadorians (65%), Mexicans (63%), and Colombians (62%) rated their health "very good or good"; however, close to half of Puerto Ricans (47%) and Dominicans (41%) rated their health as "fair or poor". Compared to other groups, most Colombians (76%), Ecuadorians (74%) and Mexicans (71%) reported exercising in the past 30 days. A higher percentage of Mexicans reported drinking one or more servings of SSB per day, compared to Colombians, Dominicans and Ecuadorians.

Figure 1 shows the age-standardized prevalence of obesity and overweight by sex for all Latino groups. The prevalence of obesity among Mexicans (36.8%; 95% CI [31.5, 42.4]) and Puerto Ricans (36.3%; 95% CI [31.7, 41.3]) was significantly higher than Colombians (23.8%; 95% CI [18.8, 29.5]), Ecuadorians (24.2%; 95% CI [20.7, 28.1]), and Dominicans (27.0%; 95% CI [25.0, 29.1]). On the other hand, Ecuadorians had significantly higher prevalence of overweight (44.0%; 95% CI [39.7, 48.3]) compared to Colombians (33.7%; 95% CI [28.1, 39.8]), Dominicans (39.0%; 95% CI [36.8, 41.2]), and Puerto Ricans (35.2%; 95% CI [30.7, 40.0]). There were also differences by sex for some groups. Dominican women (46.2%; 95% CI [42.5, 49.96]) had significantly higher prevalence of obesity compared to Dominican men (33.9%; 95% CI [31.3, 36.5]). Ecuadorian men (50.3%; 95% CI [44.4, 56.2]) had significantly higher prevalence of overweight compared to Ecuadorian women (37.0%; 95% CI [31.0, 43.3]). Overall, Mexicans had the highest prevalence of obesity and overweight combined (75.1%; 95% CI [69.0, 80.2]) and Colombians had the lowest prevalence of obesity and overweight combined (57.4%; 95% CI [50.9, 63.7]) among the five Latino groups (see Table S1).

Table 2 shows the association of obesity with socio-demographic characteristics, health status and lifestyle behaviors by

T A B L E 1 Participant characteristics from the NYC Community Health Survey (2013–2017)[a]

Country of birth Sample size[b] Population size[c]	Colombia n = 503 n = 66,684 %	Dominican Republic n = 4022 n = 464,370 %	Ecuador n = 962 n = 150,656 %	Puerto Rico/U.S. n = 1608 n = 148,674 %	Mexico n = 1216 n = 210,566 %
Age					
18–24	6	11	9	5	10
25–44	32	33	52	16	70
45–64	46	39	29	39	19
65+	16	16	10	40	1
Sex					
Male	40	41	54	40	50
Female	60	59	46	60	50
Education					
Less than high school	31	48	52	53	61
More than high school graduate	69	52	48	47	39
Employment status					
Employed	54	51	63	27	64
Unemployed	10	9	10	6	6
Not in labor force	35	39	27	68	30
Marital status					
Married or living together	52	49	59	36	70
Divorced, widowed, separated, never married	48	51	41	64	30
Presence of children in household					
Yes	31	47	54	23	72
No	69	53	46	77	28
Household size					
5 or less	92	88	80	95	69
6 or more	8	12	20	5	31
Annual household income					
≥200% Federal poverty level	35	19	22	26	14
<200% Federal poverty level	65	81	78	74	86
Ever been told you have hypertension					
Yes	30	41	21	55	15
No	70	59	79	45	85
Ever been told you have diabetes					
Yes	9	19	10	34	8
No	91	81	90	66	92
General health					
Excellent	11	12	7	10	10
Very good	23	11	14	12	8
Good	39	37	51	31	55
Fair	21	28	20	28	21
Poor	6	13	8	19	6

TABLE 1 (Continued)

Country of birth Sample size[b] Population size[c]	Colombia n = 503 n = 66,684 %	Dominican Republic n = 4022 n = 464,370 %	Ecuador n = 962 n = 150,656 %	Puerto Rico/U.S. n = 1608 n = 148,674 %	Mexico n = 1216 n = 210,566 %
Exercise in the past 30 days					
Yes	76	68	74	66	71
No	24	32	26	34	29
Average soda & sugar sweetened drinks per day					
None or <1/day	76	77	74	70	68
≥1/day	24	23	26	30	32

[a]The table shows weighted percentages. All weighted proportions reflect New York City population counts from the 2015 American Community Survey.

[b]Sample size were based on unweighted data.

[c]Population size were based on weighted data.
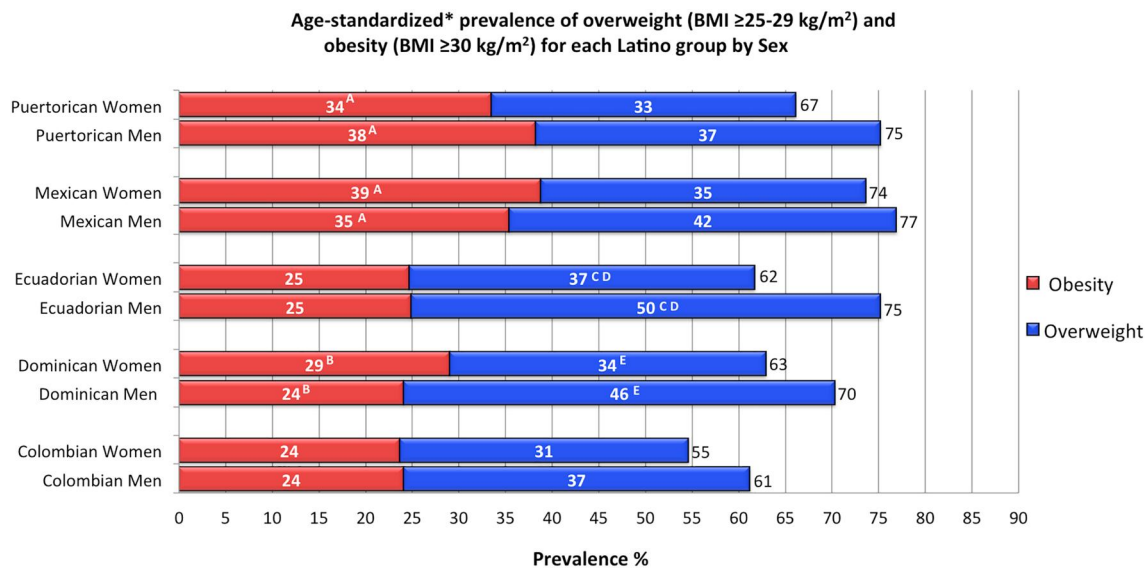
FIGURE 1 *Age-standardized by the direct method to the 2000 projected U.S. population using age groups 18–24 years, 25–44 years, 45–64 and 65+ years. Full results with confidence intervals are available in a Table S1.(A) Mexican and Puerto Ricans had significant higher age-standardized prevalence of obesity compared to Colombians, Dominicans, and Ecuadorians ($p < 0.01$).(B) Dominican women had significant higher age-standardized prevalence of obesity compared Dominican men ($p < 0.05$).(C) Ecuadorian had significant higher age-standardized prevalence of overweight compared to Colombians, Dominicans, and Puerto Ricans ($p < 0.05$).(D) Ecuadorian men had significant higher age-standardized prevalence of overweight compared Ecuadorian women ($p < 0.05$).(E) Dominican men had significant higher age-standardized prevalence of overweight compared Dominican women ($p < 0.01$)

Latino group. Some notable differences in the correlates of obesity were noted across Latino groups. For example, compared to Dominican men, the prevalence of obesity was 23% greater for Dominican women (PR = 1.23; 95% CI [1.05, 1.43]). In further sex-specific analyses for obesity, the effects of interaction between country of origin and sex ($p < 0.001$) were statistically significant (see results in Tables 4 and 5 for more details). The prevalence of obesity was 16% higher for Dominicans who completed less than high school (PR = 1.16; 95% CI [1.00, 1.35]) when compared to Dominicans who completed high school or more. The prevalence of obesity was 29% higher for Dominicans who were not in the labor force (e.g., homemaker, student) (PR = 1.29; 95% CI [1.08, 1.54]) and two-fold greater for Colombians who reported being unemployed (PR = 2.45; 95% CI [1.57, 3.81]), when compared to their national counterparts who were employed. The prevalence of obesity was higher for Ecuadorians (PR = 1.41; 95% CI [1.03, 1.95]) and Mexicans (PR = 1.32; 95% CI [1.08, 1.63]) who lived with six or more occupants in their homes, compared to their national counterparts who lived with fewer occupants in their homes. The prevalence of obesity was 35% higher for Mexicans (PR = 1.35; 95% CI [1.03, 1.76]) and 27% higher for Puerto Ricans (PR = 1.27; 95% CI [1.03, 1.57]) who reported the presence of

TABLE 2 Adjusted prevalence ratios (PR) of obesity (BMI ≥30 kg/m^2) by Latino background (men and women combined)

Country of Birth Population size (weighted N) Risk factors	Colombia n = 64,211 NYC CHS PR (95% CI)	Dominican Republic n = 438,294 NYC CHS PR (95% CI)	Ecuador n = 139,641 NYC CHS PR (95% CI)	Puerto Rican/U.S. n = 139,284 NYC CHS PR (95% CI)	Mexico n = 191,710 NYC CHS PR (95% CI)
Age					
18–24	Referent	Referent	Referent	Referent	Referent
25–44	0.69 (0.29, 1.65)	1.35 (0.96, 1.89)	1.37 (0.68, 2.77)	2.12 (0.86, 5.22)	1.39 (0.82, 2.37)
45–64	0.80 (0.34, 1.88)	1.15 (0.80, 1.64)	1.06 (0.51, 2.21)	1.56 (0.64, 3.79)	1.32 (0.75, 2.29)
65+	0.81 (0.31, 2.12)	0.84 (0.55, 1.28)	1.09 (0.49, 2.39)	1.25 (0.52, 3.03)	1.34 (0.56, 3.23)
Sex[a]					
Male	Referent	Referent	Referent	Referent	Referent
Female	0.92 (0.62, 1.36)	1.23 (1.05, 1.43)**	0.97 (0.71, 1.29)	0.97 (0.81, 1.18)	1.24 (0.95, 1.62)
Education					
More than high school graduate	Referent	Referent	Referent	Referent	Referent
Less than high school	0.76 (0.47, 1.25)	1.16 (1.00, 1.35)*	1.19 (0.90, 1.57)	1.08 (0.89, 1.31)	1.15 (0.93, 1.43)
Employment status					
Employed	Referent	Referent	Referent	Referent	Referent
Unemployed	2.45 (1.57, 3.81)***	1.08 (0.83, 1.41)	1.33 (0.84, 2.10)	0.87 (0.57, 1.35)	1.07 (0.73, 1.56)
Not in labor force	0.81 (0.40, 1.62)	1.29 (1.08, 1.54)**	1.15 (0.79, 1.68)	0.97 (0.76, 1.25)	1.12 (0.84, 1.50)
Marital status					
Divorced, widowed, separated, never married	Referent	Referent	Referent	Referent	Referent
Married or living together	1.26 (0.85, 1.85)	1.06 (0.92, 1.23)	0.81 (0.60, 1.09)	1.08 (0.90, 1.30)	1.05 (0.85, 1.30)
Household size					
5 or less	Referent	Referent	Referent	Referent	Referent
6 or more	0.66 (0.32, 1.35)	1.19 (0.94, 1.50)	1.41 (1.03, 1.95)*	0.93 (0.53, 1.61)	1.32 (1.08, 1.63)**
Presence of children in household					
No	Referent	Referent	Referent	Referent	Referent
Yes	0.92 (0.60, 1.43)	0.90 (0.76, 1.06)	1.39 (0.99, 1.97)	1.27 (1.03, 1.57)*	1.35 (1.03, 1.76)*
Annual household income					
≥200% Federal poverty level	Referent	Referent	Referent	Referent	Referent
<200% Federal poverty level	0.82 (0.55, 1.24)	0.89 (0.74, 1.07)	1.76 (1.15, 2.68)**	1.11 (0.90, 1.38)	1.03 (0.75, 1.42)
Ever been told you have hypertension					
No	Referent	Referent	Referent	Referent	Referent
Yes	1.29 (0.86, 1.93)	1.56 (1.29, 1.88)***	1.78 (1.32, 2.41)***	1.29 (1.02, 1.62)	1.35 (1.08, 1.68)**
Ever been told you have diabetes					
No	Referent	Referent	Referent	Referent	Referent
Yes	1.15 (0.69, 1.89)	1.45 (1.20, 1.76)***	1.19 (0.80, 1.77)	1.49 (1.22, 1.82)***	1.59 (1.26, 2.00)***
General health					
Excellent	Referent	Referent	Referent	Referent	Referent
Very good	1.21 (0.51, 2.86)	0.98 (0.66, 1.46)	1.26 (0.60, 2.64)	0.98 (0.63, 1.53)	1.17 (0.72, 1.90)
Good	1.46 (0.73, 2.95)	1.22 (0.88, 1.70)	1.28 (0.68, 2.38)	0.88 (0.62, 1.26)	1.08 (0.77, 1.52)

TABLE 2 (Continued)

Country of Birth Population size (weighted N) Risk factors	Colombia n = 64,211 NYC CHS PR (95% CI)	Dominican Republic n = 438,294 NYC CHS PR (95% CI)	Ecuador n = 139,641 NYC CHS PR (95% CI)	Puerto Rican/U.S. n = 139,284 NYC CHS PR (95% CI)	Mexico n = 191,710 NYC CHS PR (95% CI)
Fair	2.06 (0.99, 4.30)*	1.19 (0.83, 1.70)	1.13 (0.57, 2.25)	1.16 (0.81, 1.65)	1.25 (0.88, 1.78)
Poor	4.39 (2.17, 8.87)***	1.26 (0.84, 1.89)	2.10 (1.03, 4.25)*	1.05 (0.71, 1.54)	0.98 (0.61, 1.58)
Exercise in the past 30 days					
Yes	Referent	Referent	Referent	Referent	Referent
No	1.19 (0.74, 1.91)	1.02 (0.88, 1.18)	1.11 (0.81, 1.53)	1.20 (1.00, 1.45)	1.14 (0.94, 1.39)
Average soda & sugar sweetened drinks per day					
None or <1/day	Referent	Referent	Referent	Referent	Referent
≥1/day	0.85 (0.53, 1.35)	1.30 (1.10, 1.54)***	0.77 (0.55, 1.10)	1.16 (0.94, 1.43)	1.22 (0.99, 1.49)

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

[a]The effects of interaction between country of origin and sex ($p < 0.001$) were statistically significant.

children (<18 years of age) in their home compared those who did not. The prevalence of obesity was 76% higher for Mexicans who reported an annual income of <200% FPL (PR = 1.76; 95% CI [1.15, 2.68]) than those who made above that threshold.

Also shown in Table 2, the prevalence of obesity was significantly higher for Dominicans (PR = 1.56; 95% CI [1.29, 1.88]), Mexicans (PR = 1.35; 95% CI [1.08, 1.68]), and Ecuadorians (PR = 1.78; 95% CI [1.32, 2.41]) who reported being diagnosed with HTN compared to their national counterparts without HTN. The prevalence of obesity was significantly higher for Dominicans (PR = 1.45; 95% CI [1.20, 1.76]), Mexicans (PR = 1.59; 95% CI [1.26, 2.00]), and Puerto Ricans (PR = 1.49; 95% CI [1.22, 1.82]) who reported being diagnosed with T2D compared to their respective counterparts without T2D. The prevalence of obesity was two-fold greater for Ecuadorians (PR = 2.10; 95% CI [1.03, 4.25]) and four-fold greater for Colombians (PR = 4.39; 95% CI [2.17, 8.87]) who self-rated their general health as poor compared to their national counterparts who self-rated their health as excellent. Compared to Dominicans who consumed less than one SSB per day, the prevalence of obesity was 30% higher for Dominicans who reported drinking one or more SSBs per day (PR = 1.30; 95% CI [1.10, 1.54]). Age, marital status, and PA in the past 30 days were not significant correlates of obesity for any Latino group.

Table 3 shows two models on the association of obesity with country of origin, adjusting for different socio-demographic characteristics, health status and lifestyle behaviors (Model 2 included all Model 1 covariates plus PA and SSB intake). Results for Models 1 and 2 are similar. In Model 2, compared to Mexicans, the prevalence of obesity remained 20% lower for Colombians (PR = 0.80; 95% CI [0.64, 1.00]), 28% lower for Ecuadorians (PR = 0.72; 95% CI [0.61, 0.86]), and 25% lower for Dominicans (PR = 0.75; 95% CI [0.65, 0.85]). There was no significant difference between Mexicans and Puerto Ricans in either model. Tables 4 and 5 show sex-specific associations between obesity and all independent variables in Models 1 and 2. These analyses by sex revealed that age was associated with

obesity among Colombian and Dominican males and Colombian and Puerto Rican females. Interestingly, unemployment was associated with obesity only among males. It is worth noting that unemployment in males was significant correlated with an annual household income at <200 % FPL; which may explain this association. The presence of children was associated with obesity among Ecuadorian and Puerto Rican females, and among Mexican males. Hypertension and diabetes were associated with obesity among both, female and male, Dominicans, Mexicans, and Puerto Ricans, and among Ecuadorian females. General perception of health was associated with obesity only among Colombian men.

4 | DISCUSSION

There has been limited literature on how obesity impacts Latinos immigrants in the U.S. from different countries of origin. This is the first obesity study to disaggregate South American data by country of origin in NYC and to compare the prevalence of self-reported obesity and risk factors among the largest Latino populations in NYC (all five groups are also among the 10 largest Latino groups throughout the U.S.). Consistent with previous studies, the present study found that Latinos in NYC, regardless of their country of origin, had high age-standardized prevalence of obesity.[3] Independent of covariates, this study is among the first to show that the prevalence of obesity was 20%–28% lower among Colombians, Ecuadorians and Dominicans compared to Mexicans. That Mexicans and Puerto Ricans appeared to have the highest prevalence of obesity was consistent with prior research.[3,8,14]

This is the first study to document the prevalence of obesity and overweight in relation to socio-demographic characteristics, health status, and lifestyle behaviors among Colombians and Ecuadorians in the U.S.; these are the two largest South American populations in NYC and the U.S.[32,41] That the two South American

TABLE 3 Adjusted prevalence ratios (PR) of obesity (BMI ≥30 kg/m^2) comparing Latino subgroups

Population size[a] Risk factors	Model 1[b] n = 981,004 NYC CHS PR (95% CI)	Model 2[c] n = 973,140 NYC CHS PR (95% CI)
Country of birth		
Mexico	Referent	Referent
Colombia	0.80 (0.64, 1.00)*	0.80 (0.64, 1.00)*
Dominican Republic	0.74 (0.65, 0.84)***	0.75 (0.65, 0.85)***
Ecuador	0.72 (0.60, 0.85)***	0.72 (0.61, 0.86)***
Puerto Rico/U.S.	0.89 (0.76, 1.05)	0.88 (0.75, 1.04)

[a]Population sizes are based on weighted data.

[b]Adjusted for age, sex, education, employment status, marital status, presence of children in the household, household size, household income, HTN and T2D status, and self-perception of general health. Analyses were weighted to reflect NYC population estimates.

[c]Adjusted for age, sex, education, employment status, marital status, presence of children in the household, household size, household income, HTN and T2D status, self-perception of general health, PA in the past 30 days and daily consumption of SSB. Analyses were weighted to reflect NYC population estimates.

***$p < 0.001$;   *$p < 0.05$.

groups had the lowest prevalence of obesity is consistent with other obesity studies using combined South American samples in the U.S.,[3,6,8-11,13-18] suggesting biological and socio-cultural factors that may be protective against obesity among South Americans compared to Latinos from Mexico or the Caribbean. The mechanisms explaining such differences warrant further research. Note, however, that while Ecuadorians had a lower prevalence of obesity than other non-South American groups, they also had a high prevalence of overweight. This may imply that there is simply a lag in the population shift toward obesity but requires further investigation over time. Ecuadorian men, in particular, had a significantly higher age-standardized prevalence of overweight than Ecuadorian women or their male counterparts among the other Latino groups. The difference by sex was not found for Colombians; which emphasizes the importance of avoiding homogeneous treatment of Latinos who come from the same region in Latin America. Indeed, Ecuadorian and Colombian populations are highly diverse in terms of genetic ancestry and characterized by a complex and different history of migration to the U.S. For example, a study looking at genetic ancestry admixture from Africa, Europe and Native America found that Colombians and Ecuadorians showed extensive variation in European and Native American ancestry when compared to Puerto Ricans and Dominicans.[42] The study further investigated the extent of subcontinental ancestry and found that Ecuadorians and Mexicans have the highest Native American proportions and that Colombians showed greater European ancestry contribution.[42] In terms of migration history to the U.S., Colombians and Ecuadorians are different. Colombian migration first started in the 1940s with a substantial increased between 1980 and 1990s due to ongoing domestic armed conflict, encompassing illegal armed groups and drug-related violence, combined with economic recession.[43,44] Most Colombian immigrants were women of working age (20–49 years) from high and middle-income households in urban areas in Colombia.[43,44] On the other hand, in the 1950s and 1960s, when the Panama hat trade declined, many young and male Ecuadorians started to migrate to New York.[44] Ecuador experienced economic growth in the 1970s, but in the early 1980s, oil prices collapsed, causing an increase in inflation and a decrease in wages.[44] This economic crisis disproportionally impacted low-income Ecuadorian farmers, thousands of whom opted to emigrate to the U.S. Subsequent economic reforms in the 1990s and 2000s only worsened conditions, driving more people to emigrate from Ecuador to the U.S., Spain and Italy.[44] Recent research on Latinos living in NYC showed that Colombian and Ecuadorian immigrants are different in terms of education attainment, household size, fertility rates/birth rates, and annual household income.[32,45] These studies also reported that Colombian immigrants in NYC have more favorable socio-demographic characteristics than Dominicans, Mexicans and Puerto Ricans residing in the city.[32,45] The present study found that Colombians reported healthier lifestyle behaviors and more positive self-perceptions of their health than other groups.

Similar to other studies, this study also suggests that female migration is more common for Colombians, Dominicans, and Puerto Ricans while male migration is more common for Ecuadorians and Mexicans in NYC.[32,44] Studies have suggested that among Latinos, women may have a higher prevalence of obesity compared to men.[2,6] This study detected such sex difference among Dominicans only. Additionally, this study found that age, presence of children in the household, a diagnosis of hypertension and diabetes, and general perception of health was associated with obesity for both sexes overall. Among traditional socio-economic factors (e.g., education and employment), other studies have found that Latinos who have completed more than high school and who are employed are less likely to be affected by obesity.[11] This study found an association of low education levels with obesity among Dominicans and of unemployment with obesity among Ecuadorians, Colombians and Puerto Rican males. Contrary

TABLE 4 Adjusted prevalence ratios (PR) of obesity (BMI ≥30 kg/m²) among women by Latino background

Country of Birth Population size (weighted N) Risk factors	Colombia n = 38,300 NYC CHS PR (95% CI)	Dominican Republic n = 255,974 NYC CHS PR (95% CI)	Ecuador n = 64,851 NYC CHS PR (95% CI)	Puerto Rican/U.S. n = 82,900 NYC CHS PR (95% CI)	Mexico n = 94,494 NYC CHS PR (95% CI)
Age					
18–24	Referent	Referent	Referent	Referent	Referent
25–44	1.53 (0.38, 6.21)	1.18 (0.76, 1.84)	1.46 (0.57, 3.73)	0.91 (0.60, 1.37)*	1.71 (0.70, 4.17)
45–64	1.60 (0.39, 6.56)	1.18 (0.74, 1.88)	1.10 (0.40, 3.01)	0.77 (0.51, 1.15)*	1.76 (0.74, 4.20)
65+	2.11 (0.48, 9.38)	0.80 (0.47, 1.35)	0.93 (0.30, 2.92)	0.62 (0.39, 0.99)*	0.89 (0.25, 3.10)
Education					
Less than high school	Referent	Referent	Referent	Referent	Referent
More than high school graduate	0.57 (0.30, 1.06)	1.25 (1.04, 1.51)*	1.24 (0.87, 1.77)	1.17 (0.92, 1.47)	1.02 (0.79, 1.32)
Employment status					
Employed	Referent	Referent	Referent	Referent	Referent
Unemployed	2.25 (1.25, 4.04)*	1.03 (0.75, 1.41)	1.04 (0.55, 1.96)	1.27 (0.79, 2.04)	1.03 (0.62, 1.72)
Not in labor force	0.93 (0.48, 1.81)	1.24 (1.01, 1.53)*	0.91 (0.60, 1.39)	1.10 (0.79, 1.53)	1.10 (0.79, 1.52)
Marital status					
Divorced, widowed, separated, never married	Referent	Referent	Referent	Referent	Referent
Married or living together	1.12 (0.69, 1.82)	1.11 (0.94, 1.32)	0.98 (0.66, 1.46)	1.17 (0.93, 1.48)	1.03 (0.77, 1.38)
Presence of children in household					
No	Referent	Referent	Referent	Referent	Referent
Yes	1.03 (0.64, 1.66)	0.96 (0.78, 1.18)	1.55 (1.01, 2.38)*	1.34 (1.03, 1.76)*	1.14 (0.81, 1.61)
Household size					
5 or less	Referent	Referent	Referent	Referent	Referent
6 or more	0.87 (0.37, 2.05)	1.17 (0.86, 1.58)	0.93 (0.57, 1.54)	0.73 (0.39, 1.37)	1.27 (0.99, 1.62)
Annual household income					
≥200% Federal poverty level	Referent	Referent	Referent	Referent	Referent
<200% Federal poverty level	0.92 (0.56, 1.53)	1.02 (0.81, 1.28)	1.38 (0.79, 2.40)	1.04 (0.81, 1.34)	1.04 (0.66, 1.64)
Ever been told you have hypertension					
No	Referent	Referent	Referent	Referent	Referent
Yes	1.24 (0.75, 2.05)	1.42 (1.16, 1.75)*	2.03 (1.39, 2.97)*	1.01 (0.77, 1.32)	1.16 (0.84, 1.59)
Ever been told you have diabetes					
No	Referent	Referent	Referent	Referent	Referent
Yes	0.96 (0.53, 1.76)	1.41 (1.15, 1.74)*	0.89 (0.49, 1.64)	1.59 (1.26, 2.02)*	1.57 (1.20, 2.07)*
General health					
Excellent	Referent	Referent	Referent	Referent	Referent
Very good	35.08 (4.03, 305.62)	1.22 (0.75, 1.97)	0.67 (0.27, 1.64)	1.23 (0.65, 2.34)	0.87 (0.46, 1.66)

(Continues)

TABLE 4 (Continued)

Country of Birth Population size (weighted N) Risk factors	Colombia n = 38,300 NYC CHS PR (95% CI)	Dominican Republic n = 255,974 NYC CHS PR (95% CI)	Ecuador n = 64,851 NYC CHS PR (95% CI)	Puerto Rican/U.S. n = 82,900 NYC CHS PR (95% CI)	Mexico n = 94,494 NYC CHS PR (95% CI)
Good	32.43 (4.09, 256.98)	1.42 (0.96, 2.09)	0.76 (0.37, 1.53)	1.26 (0.73, 2.15)	1.04 (0.66, 1.64)
Fair	41.74 (5.09, 342.28)	1.42 (0.95, 2.14)	0.76 (0.33, 1.73)	1.57 (0.92, 2.66)	1.30 (0.82, 2.05)
Poor	95.27 (11.90, 762.57)	1.49 (0.95, 2.33)	1.70 (0.82, 3.51)	1.46 (0.83, 2.56)	1.29 (0.76, 2.22)
Exercise in the past 30 days					
Yes	Referent	Referent	Referent	Referent	Referent
No	1.27 (0.77, 2.11)	1.12 (0.94, 1.33)	1.05 (0.72, 1.54)	1.13 (0.91, 1.41)	1.10 (0.86, 1.41)
Average soda & sugar sweetened drinks per day					
None or <1/day	Referent	Referent	Referent	Referent	Referent
≥1/day	0.73 (0.33, 1.59)	1.01 (0.81, 1.26)	0.68 (0.42, 1.11)	1.10 (0.86, 1.42)	1.57 (1.23, 2.01)*

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

to prior reports, this study did not find an association between obesity and marital status.[35] The presence of children, low household income (i.e., <200% FPL) and large household size (i.e., living with six or more occupants) were significantly associated with obesity only for Mexicans, Ecuadorians and Puerto Ricans. This study is the first to document these results for Ecuadorians in NYC, but prior research documented similar findings for Mexicans and Puerto Ricans.[6,35]

Consistent with others studies, individuals from Dominican Republic and Puerto Rico reported previous diagnosis of T2D and HTN more frequently than other groups.[8,46] This may partly explain why Dominicans and Puerto Ricans self-rated their health as poor more than other groups. Obesity was associated with a previous diagnosis of T2D and HTN for all groups except for Colombians. Even so, Colombians who self-rated their health as "fair or poor" had a greater prevalence of obesity than Colombians who self-rated their health as excellent. Lastly, this study found that daily consumption of SSB was significantly associated with high prevalence of obesity for Dominicans only.

Several limitations of this study are important to note. As with any cross-sectional study, results from this study are not intended to prove causation.[47] In addition, self-reported data may introduce measurement error due to recall and social desirability biases.[47] Studies suggest that self-reported body weight is typically under-reported, biasing the estimates towards the null.[48,49] However, there is consistent evidence that Latino individuals are less likely to under-report BMI compared to non-Latino Whites regardless of sex.[49-51] A study of a diverse population-based sample of Latinos found that Latino men over-reported their weight more often than females. Additionally, the study found that Mexicans and Puerto Ricans over-reported their weight more often than other groups such as Central Americans.[52] The characteristics of the Latino population living in the US are changing constantly; therefore, the findings of this study are specific to NYC and may be not generalizable to other Latino populations in the US. Despite these limitations, however, this study is unique given the diversity of the Latino sample and is one of the largest obesity studies to date comparing obesity differences among Latino subgroups from South America.

5 | CONCLUSION

All Latino groups exhibit high prevalence of obesity and warrant renewed effort and novel research strategies tailored to the specific context and culture of each group to prevent and reduce obesity. Furthermore, this study points to the pitfall of combining all Latino populations into one category or regional group categories for research. Depending on the country of origin, significant differences among Latinos subgroups exist in both the prevalence and correlates of obesity. Specifically, this study found that obesity was significantly correlated with sex, low education level, unemployment, living in a household with six or more individuals, presence of children in the house, poverty, previous diagnosis of hypertension and diabetes, negative self-perception of general health, and drinking one or more SSBs per day. However, these factors were not consistent across all groups, Further research is needed to understand the underlying mechanisms of these differences, including biological and social risk profiles and experiences of racial discrimination, acculturation, migration history, and structural barriers (e.g., policies that restrict services to some Latino groups but not others), among others.[3,36] Health disparities related to obesity persist among Latinos in the U.S. and the lack of understanding of subgroup differences hampers the ability to tailor prevention and treatment strategies. This study strongly suggests the necessity to disaggregate Latinos into distinct cultural groups in future obesity and related health research.

TABLE 5 Adjusted prevalence ratios (PR) of obesity (BMI ≥30 kg/m^2) among men by Latino background

Country of Birth Population size (weighted N) Risk factors	Colombia n = 26,356 NYC CHS PR (95% CI)	Dominican Republic n = 182,320 NYC CHS PR (95% CI)	Ecuador n = 74,790 NYC CHS PR (95% CI)	Puerto Rican/U.S. n = 56,384 NYC CHS PR (95% CI)	Mexico n = 97,216 NYC CHS PR (95% CI)
Age					
18–24	Referent	Referent	Referent	Referent	Referent
25–44	0.36 (0.17, 0.76)*	1.56 (0.97, 2.52)*	1.12 (0.43, 2.95)	1.80 (0.84, 3.86)	0.94 (0.54, 1.63)
45–64	0.42 (0.22, 0.81)*	0.99 (0.58, 1.70)	0.97 (0.36, 2.60)	1.17 (0.56, 2.44)	0.79 (0.41, 1.52)
65+	0.19 (0.05, 0.77)*	0.94 (0.48, 1.82)	1.28 (0.43, 3.79)	0.94 (0.43, 2.07)	1.40 (0.47, 4.18)
Education					
Less than high school	Referent	Referent	Referent	Referent	Referent
More than high school graduate	1.35 (0.69, 2.67)	0.98 (0.76, 1.26)	1.04 (0.70, 1.53)	0.95 (0.68, 1.33)	1.19 (0.85, 1.66)
Employment status					
Employed	Referent	Referent	Referent	Referent	Referent
Unemployed	2.51 (1.30, 4.85)*	1.26 (0.83, 1.92)	1.83 (1.09, 3.08)*	0.42 (0.18, 1.00)*	1.19 (0.66, 2.14)
Not in labor force	0.83 (0.26, 2.71)	1.32 (0.95, 1.82)	1.42 (0.74, 2.71)	0.89 (0.61, 1.31)	1.19 (0.51, 2.77)
Marital status					
Divorced, widowed, separated, never married	Referent	Referent	Referent	Referent	Referent
Married or living together	1.44 (0.82, 2.54)	1.04 (0.81, 1.35)	0.80 (0.53, 1.22)	1.04 (0.76, 1.42)	1.11 (0.79, 1.56)
Presence of children in household					
No	Referent	Referent	Referent	Referent	Referent
Yes	0.75 (0.40, 1.40)	0.87 (0.66, 1.14)	1.22 (0.76, 1.95)	1.29 (0.91, 1.81)	1.46 (1.00, 2.14)*
Household size					
5 or less	Referent	Referent	Referent	Referent	Referent
6 or more	0.45 (0.14, 1.45)	1.15 (0.81, 1.64)	2.20 (1.48, 3.28)*	1.15 (0.57, 2.29)	1.34 (0.97, 1.85)
Annual household income					
≥200% Federal poverty level	Referent	Referent	Referent	Referent	Referent
<200% Federal poverty level	0.72 (0.43, 1.21)	0.76 (0.57, 1.01)	2.33 (1.25, 4.35)*	1.17 (0.82, 1.69)	1.07 (0.68, 1.68)
Ever been told you have hypertension					
No	Referent	Referent	Referent	Referent	Referent
Yes	1.41 (0.78, 2.57)	1.87 (1.35, 2.58)*	1.46 (0.96, 2.23)	1.76 (1.25, 2.47)*	1.53 (1.10, 2.12)*
Ever been told you have diabetes					
No	Referent	Referent	Referent	Referent	Referent
Yes	1.23 (0.52, 2.89)	1.55 (1.13, 2.13)*	1.48 (0.85, 2.57)	1.32 (0.95, 1.84)	1.53 (1.01, 2.30)
General health					
Excellent	Referent	Referent	Referent	Referent	Referent
Very good	0.39 (0.15, 1.00)*	0.84 (0.48, 1.48)	3.06 (0.84, 11.22)	0.84 (0.48, 1.47)	1.47 (0.75, 2.88)
Good	0.72 (0.37, 1.39)	1.14 (0.70, 1.87)	2.53 (0.76, 8.43)	0.65 (0.39, 1.08)	1.21 (0.72, 2.05)
Fair	0.97 (0.45, 2.09)	1.07 (0.61, 1.87)	2.30 (0.66, 8.01)	0.96 (0.58, 1.56)	1.19 (0.68, 2.09)
Poor	2.64 (1.54, 4.51)*	1.14 (0.61, 2.13)	2.69 (0.69, 10.43)	0.82 (0.47, 1.42)	0.77 (0.32, 1.83)

(Continues)

TABLE 5 (Continued)

Country of Birth Population size (weighted N) Risk factors	Colombia n = 26,356 NYC CHS PR (95% CI)	Dominican Republic n = 182,320 NYC CHS PR (95% CI)	Ecuador n = 74,790 NYC CHS PR (95% CI)	Puerto Rican/U.S. n = 56,384 NYC CHS PR (95% CI)	Mexico n = 97,216 NYC CHS PR (95% CI)
Exercise in the past 30 days					
Yes	Referent	Referent	Referent	Referent	Referent
No	0.93 (0.49, 1.74)	0.89 (0.68, 1.16)	1.22 (0.78, 1.91)	1.28 (0.94, 1.75)	1.28 (0.94, 1.73)
Average soda & sugar sweetened drinks per day					
None or <1/day	Referent	Referent	Referent	Referent	Referent
≥1/day	0.90 (0.49, 1.66)	1.72 (1.34, 2.21)*	0.94 (0.60, 1.47)	1.00 (0.78, 1.48)	0.93 (0.67, 1.29)

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

AUTHOR CONTRIBUTIONS

All authors were contributed to the conception of the manuscript, analysis and interpretation of data, and preparation of the manuscript. All authors were involved in writing the paper and had final approval of the submitted and published versions.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.