RACIAL DISPARITIES IN THE RISK OF DEVELOPING OBESITY-RELATED DISEASES: A CROSS-SECTIONAL STUDY

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Objectives: Analyze racial/ethnic disparities in the prevalence of obesity and its related diseases in Massachusetts and assess disparities in the risk of developing diseases related to overweight and obesity.

Design: Cross-sectional analysis of survey data.

Setting: Community-based US population.

Subjects: 63,235 non-institutionalized adults in Massachusetts.

Main Outcome Measures: BMI, overweight and obesity prevalence and prevalence of obesity-related- diseases, odds of developing obesity-related diseases. Participants were considered hypercholesterolemic, diabetic, hypertensive, or having a cardiovascular disease if they reported that a health professional told them that they had such a disease. Behavioral characteristics of respondents included fruit and vegetable consumption, alcohol drinking, smoking, and physical activity. Demographic variables included sex, age, marital status, employment status, household income, region of residence, and educational status.

Results: Blacks (OR=1.97) and Hispanics (OR=1.81) had higher odds of obesity as compared to Whites. Blacks had higher odds of high blood pressure (OR=1.88), heart attack (OR=1.40) and stroke (OR=2.14) than Whites. Hispanics were more likely to have high blood pressure (OR=1.34), high cholesterol (OR=1.56), stroke (OR=1.71), and heart attack (OR=1.54) than Whites. Hispanics (OR=2.71) and Blacks (OR=2.58) had the highest odds of diabetes.

Conclusions: Minority groups share a disproportionate risk of obesity and obesity-related diseases. Hispanics and Blacks have significantly higher odds of obesity and its related diseases. Continued emphasis on racial/ethnic groups at greatest risk of obesity remains critical. (*Ethn Dis.* 2012;22[3]:308–316)

Key Words: Racial Disparities, Obesity, Obesity Co-morbidities, Underserved, Minority Health

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INTRODUCTION

The overweight and obesity epidemic is a growing public health concern in the United States. In 2008, 36.5% of US adults were overweight and 26.7% were obese.[1] Obesity prevalence varies according to racial/ethnic group, age, gender, education, and socioeconomic status.[2–4]

Obesity is an independent risk factor for hypercholesterolemia, type 2 diabetes, and cardiovascular diseases (CVD). In 2008, 37.6% of US adults had hypercholesterolemia and 8.3% had diabetes.[1] Obesity is also associated with an increased risk of hypertension, coronary heart disease (CHD), myocardial infarction, and stroke. In 2008, 37.1% of the US population had one or more types of CVD; 27.8% of adults had hypertension, 4.3% had angina or CHD, 2.6% had a stroke, and 4.2% were told by a health care professional they had a myocardial infarction.[1,5] The risk of CVD increases with increasing body mass index (BMI).[6] Obesity-related diseases are also associated with an increased risk of mortality.[7] Obesity and obesity-related diseases also increase health care utilization and cost.[8,9]

The obesity epidemic is reflected in all racial and ethnic groups but is particularly prevalent among minority populations. The prevalence of obesity is significantly higher among Blacks, Hispanics and American Indians/Alaska Natives (AI/AN) compared to Whites.[2] In 2007, the obesity prevalence in the United States was highest for Blacks (36.7%) followed by Hispanics (26.6%), in contrast with a prevalence of 25.6% found in Whites.[1]

There are also significant differences among racial/ethnic groups for the risk of developing obesity-related diseases. Hypercholesterolemia is more prevalent in Whites compared to Blacks or Hispanics. In 2007, White adults (38.9%) had the highest rate of hypercholesterolemia compared to Blacks (33.3%) and Hispanics (31.8%).[1] Meanwhile, minority groups in the US population have higher rates of type 2 diabetes than Whites.[1,5] The prevalence of type 2 diabetes is highest among AI/ANs followed by Blacks, Hispanics, and Whites.[10] In 2007, 7.6% of Whites, 12.6% of Blacks, and 7.2% of Hispanics were told by a doctor that they had diabetes.[1]

Cardiovascular diseases are partly responsible for persisting disparities in life expectancy and overall health among racial and ethnic groups. The prevalence of hypertension is higher among Blacks compared to Whites and lower among Hispanics and Asians. In 2007, 27.9% of White adults in the United States were told by a health care professional they had hypertension compared to 36.9% of Blacks and 17.3% of Hispanics.[1] Racial and ethnic disparities in CHD and angina are also well-documented. The prevalence of heart disease is higher in Blacks compared to Whites and lower in Hispanics

Table 1. Prevalence of overweight and obesity by demographic characteristics (95% Cl), Massachusetts; 2005–2008

	Underweight (BMI<18.5)	Normal weight (18.5≥BMI< 25)	Overweight (25≥BMI<30)	Obese (30≥BMI<35)	Morbidly Obese (BMI≥35)	Total
Sex						
Male	0.63% (0.46–0.79)	32.25% (31.24–33.26)	44.26% (43.24–45.28)	16.02% (15.26–16.77)	6.85% (6.35–7.34)	48.07% (47.42–48.73)
Female	2.60% (2.30–2.91)	49.78% (48.94–50.62)	28.27% (27.54–28.99)	12.23% (11.71–12.75)	7.12% (6.71–7.53)	51.93% (51.27–52.58)
Total	1.62% (1.44–1.79)	41.07% (40.41–41.73)	36.20% (35.57–36.84)	14.11% (13.65–14.56)	6.98% (6.66–7.30)	
Age						
Age 18–24	3.28% (2.15–4.41)	57.42% (54.29–60.56)	23.47% (20.84–26.10)	11.34% (9.21–13.46)	4.49% (3.24–5.74)	11.23% (10.60–11.87)
Age 25–34	1.82% (1.38–2.26)	43.60% (41.74–45.46)	34.77% (32.94–36.60)	12.74% (11.51–13.98)	7.06% (6.11–8.01)	16.17% (15.64–16.70)
Age 35–44	1.22% (0.96–1.48)	40.84% (39.54–42.14)	36.40% (35.10–37.70)	13.89% (12.96–14.82)	7.65% (6.94–8.35)	21.68% (21.17–22.19)
Age 45–54	1.24% (0.96–1.52)	36.10% (34.87–37.32)	38.22% (36.95–39.50)	16.26% (15.28–17.25)	8.18% (7.49–8.86)	18.98% (18.53–19.43)
Age 55–64	0.89% (0.67–1.12)	33.62% (32.31–34.92)	40.09% (38.73–41.45)	16.51% (15.52–17.51)	8.89% (8.12–9.65)	14.10% (13.73–14.47)
Age 65 or older	1.84% (1.56–2.13)	39.55% (38.40–40.69)	39.97% (38.82–41.12)	13.50% (12.72–14.28)	5.14% (4.64–5.64)	17.84% (17.44–18.24)
MA geographic region						
I-Western	1.50% (1.03–1.98)	40.13% (38.29–41.97)	35.47% (33.71–37.24)	14.83% (13.53–16.14)	8.06% (6.99–9.13)	6.42% (6.18–6.65)
II-Central	1.28% (0.88–1.68)	33.47% (31.40–35.54)	36.24% (34.17–38.31)	18.04% (16.43–19.66)	10.96% (9.75–12.18)	2.72% (2.61–2.84)
III-North East	1.57% (1.04–2.09)	33.47% (31.40–35.54)	37.61% (35.57–39.65)	15.79% (14.26–17.33)	8.89% (7.72–10.07)	2.96% (2.84–3.09)
IV-Metro West	1.61% (1.24–1.97)	33.47% (31.40–35.54)	37.24% (35.82–38.67)	16.22% (15.16–17.27)	9.57% (8.76–10.38)	3.85% (3.73–3.96)
V-South East	1.68% (1.18–2.18)	33.47% (31.40–35.54)	37.27% (35.86–38.68)	17.20% (16.11–18.29)	9.81% (8.97–10.65)	4.19% (4.06–4.31)
VI-Boston	1.64% (1.43–1.86)	33.47% (31.40–35.54)	36.11% (35.35–36.88)	13.60% (13.05–14.15)	6.42% (6.04–6.80)	79.87% (79.50–80.23)
Marital status						
Married	1.14% (0.98–1.31)	38.83% (38.04–39.63)	39.63% (38.83–40.43)	14.37% (13.80–14.94)	6.02% (5.65–6.40)	58.37% (57.72–59.03)
Divorced	1.76% (1.25–2.26)	37.31% (35.57–39.04)	35.32% (33.62–37.02)	14.88% (13.72–16.04)	10.73% (9.47–11.99)	8.25% (7.97–8.53)
Widowed	2.87% (2.24–3.50)	40.73% (39.06–42.41)	35.05% (33.43–36.68)	13.84% (12.62–15.06)	7.50% (6.43–8.58)	6.90% (6.67–7.13)
Separated	1.63% (0.83–2.42)	36.64% (32.68–40.59)	33.52% (29.33–37.71)	17.33% (14.30–20.36)	10.89% (8.15–13.62)	2.03% (1.86–2.19)
Never married	2.47% (1.84–3.10)	48.32% (46.41–50.24)	28.72% (27.05–30.39)	12.82% (11.55–14.10)	7.66% (6.81–8.52)	20.25% (19.61–20.89)
A member of an unmarried couple	1.80% (0.79–2.80)	46.77% (43.06–50.48)	30.34% (27.04–33.63)	13.91% (11.38–16.44)	7.19% (5.57–8.80)	4.20% (3.91–4.49)
Education level						
Less than high school	2.49% (1.45–3.53)	33.04% (30.54–35.55)	35.22% (32.79–37.65)	18.67% (16.77–20.57)	10.58% (9.19–11.97)	7.22% (6.86–7.57)
High school graduate	1.68% (1.35–2.00)	37.92% (36.55–39.29)	35.92% (34.65–37.19)	16.01% (15.03–16.99)	8.47% (7.78–9.16)	25.49% (24.90–26.08)
Some college or more	1.51% (1.31–1.71)	43.13% (42.33–43.92)	36.44% (35.67–37.20)	12.89% (12.36–13.43)	6.03% (5.66–6.40)	67.29% (66.65–67.93)
Employment status						
Employed for wages	1.24% (1.02–1.46)	40.16% (39.25–41.08)	37.37% (36.48–38.27)	14.69% (14.03–15.35)	6.53% (6.11–6.95)	55.90% (55.27–56.54)
Self-employed	0.92% (0.59–1.26)	40.45% (38.35–42.56)	40.82% (38.68–42.96)	12.70% (11.30–14.09)	5.11% (4.16–6.06)	8.51% (8.16–8.85)

Table 1. Continued

	Underweight (BMI<18.5)	Normal weight (18.5≥BMI< 25)	Overweight (25≥BMI<30)	Obese (30≥BMI<35)	Morbidly Obese (BMI≥35)	Total
Out of work for more than 1 year	2.98% (1.14–4.81)	36.98% (32.75–41.21)	31.73% (27.51–35.96)	18.95% (15.04–22.86)	9.36% (7.31–11.41)	2.08% (1.90–2.26)
Out of work for less than 1 year	2.08% (1.04–3.13)	42.19% (37.94–46.45)	32.41% (28.71–36.10)	13.92% (11.48–16.35)	9.40% (7.16–11.64)	2.87% (2.64–3.10)
Homemaker	3.17% (2.27–4.07)	52.69% (50.23–55.16)	27.26% (25.11–29.41)	10.33% (8.86–11.79)	6.54% (5.14–7.95)	5.95% (5.68–6.23)
Student	3.22% (1.58–4.86)	61.73% (57.34–66.12)	21.90% (18.33–25.48)	9.65% (6.90–12.40)	3.50% (2.06–4.93)	4.55% (4.15–4.95)
Retired	1.62% (1.33–1.91)	38.67% (37.45–39.89)	40.07% (38.84–41.30)	13.71% (12.88–14.54)	5.93% (5.36–6.50)	15.60% (15.23–15.98)
Unable to work	3.19% (2.25–4.13)	26.64% (24.28–29.01)	30.12% (27.72–32.53)	18.49% (16.56–20.43)	21.55% (19.02–24.08)	4.54% (4.30–4.77)
Income level						
Less than $10,000	2.84% (1.56–4.12)	38.65% (35.03–42.26)	33.07% (29.82–36.32)	14.78% (12.54–17.01)	10.67% (8.76–12.57)	3.37% (3.14–3.60)
Less than $15,000 ($10,000 to less than $15,000)	2.79% (1.63–3.95)	32.85% (29.56–36.15)	35.10% (31.77–38.43)	16.08% (13.75–18.41)	13.18% (10.47–15.88)	3.68% (3.44–3.93)
Less than $20,000 ($15,000 to less than $20,000)	1.83% (1.21–2.45)	34.45% (31.83–37.07)	33.49% (30.89–36.08)	18.66% (16.23–21.09)	11.58% (9.96–13.19)	5.27% (4.99–5.55)
Less than $25,000 ($20,000 to less than $25,000)	2.22% (1.14–3.30)	39.93% (37.33–42.53)	33.93% (31.56–36.31)	14.69% (13.10–16.27)	9.23% (7.75–10.70)	7.32% (6.97–7.68)
Less than $35,000 ($25,000 to less than $35,000)	1.96% (1.36–2.56)	40.02% (37.47–42.57)	35.04% (32.75–37.33)	14.66% (13.03–16.29)	8.32% (7.11–9.52)	8.93% (8.52–9.34)
Less than $50,000 ($35,000 to less than $50,000)	1.03% (0.72–1.34)	39.15% (37.27–41.04)	37.07% (35.27–38.87)	14.72% (13.42–16.02)	8.02% (7.03–9.02)	12.72% (12.28–13.17)
Less than $75,000 ($50,000 to less than $75,000)	1.22% (0.83–1.61)	38.67% (37.00–40.35)	38.92% (37.26–40.58)	14.08% (12.96–15.20)	7.11% (6.24–7.99)	17.19% (16.67–17.71)
$75,000 or more	1.23% (0.99–1.48)	42.33% (41.22–43.44)	37.23% (36.16–38.31)	13.83% (13.02–14.64)	5.38% (4.88–5.87)	41.51% (40.83–42.20)
Reported health status						
Excellent	24.79% (20.37–29.20)	32.86% (31.85–33.86)	23.95% (23.02–24.88)	13.95% (12.72–15.18)	9.31% (7.79–10.83)	24.94% (24.38–25.51)
Very good	25.59% (20.85–30.32)	36.32% (35.27–37.37)	38.30% (37.24–39.36)	34.01% (32.35–35.66)	22.49% (20.51–24.47)	35.36% (34.73–35.98)
Good	31.93% (26.20–37.65)	21.85% (20.94–22.75)	26.01% (25.07–26.95)	35.54% (33.84–37.24)	40.12% (37.77–42.46)	26.98% (26.41–27.56)
Fair	10.98% (8.37–13.59)	6.57% (6.09–7.05)	8.88% (8.28–9.48)	12.93% (11.81–14.06)	20.68% (18.86–22.50)	9.53% (9.18–9.89)
Poor	6.73% (4.84–8.61)	2.41% (2.12–2.70)	2.86% (2.54–3.18)	3.57% (3.02–4.12)	7.40% (6.29–8.51)	3.18% (2.99–3.38)
Moderate physical activity						
Meet recommendations for moderate physical activity	45.99% (38.22–53.76)	58.09% (56.56–59.62)	52.81% (51.22–54.40)	45.22% (42.69–47.76)	35.83% (32.47–39.19)	51.99% (51.04–52.94)
Insufficient activity to meet moderate recommendations	38.41% (30.14–46.68)	31.85% (30.42–33.28)	35.72% (34.18–37.25)	41.14% (38.65–43.63)	41.36% (37.85–44.87)	35.50% (34.59–36.41)
No physical activity	15.60% (10.84–20.36)	10.06% (9.11–11.00)	11.47% (10.52–12.43)	13.64% (12.03–15.24)	22.82% (19.71–25.92)	12.51% (11.89–13.14)
Consumed five or more servings of fruits & vegetables						
Consume <5 times per day	70.90% (64.59–77.22)	67.70% (66.27–69.13)	74.42% (73.11–75.73)	76.19% (74.07–78.30)	78.23% (75.64–80.82)	72.09% (71.27–72.91)

Table 1. Continued

	Underweight (BMI<18.5)	Normal weight (18.5≥BMI< 25)	Overweight (25≥BMI<30)	Obese (30≥BMI<35)	Morbidly Obese (BMI≥35)	Total
Consume 5 or more times per day	29.10% (22.78–35.41)	32.30% (30.87–33.73)	25.58% (24.27–26.89)	23.81% (21.70–25.93)	21.77% (19.18–24.36)	27.91% (27.09–28.73)
Heavy alcohol consumption						
No	91.15% (87.37–94.93)	93.26% (92.70–93.81)	93.55% (92.96–94.13)	94.53% (93.64–95.42)	94.04% (92.54–95.54)	93.77% (93.43–94.11)
Yes	8.85% (5.07–12.63)	6.74% (6.19–7.30)	6.45% (5.87–7.04)	5.47% (4.58–6.36)	5.96% (4.46–7.46)	6.23% (5.89–6.57)
Smoking status						
Current smoker - now smokes every day	19.22% (15.23–23.20)	13.25% (12.50–14.01)	11.55% (10.85–12.25)	12.18% (10.88–13.47)	14.08% (12.27–15.88)	12.59% (12.14–13.04)
Current smoker - now smokes some days	4.35% (2.44–6.26)	4.81% (4.29–5.32)	4.98% (4.41–5.55)	3.98% (3.34–4.61)	3.56% (2.66–4.46)	4.56% (4.25–4.86)
Former smoker	20.40% (16.61–24.19)	24.06% (23.25–24.88)	31.05% (30.10–32.00)	31.64% (30.11–33.17)	31.77% (29.64–33.91)	28.02% (27.48–28.55)
Never smoked	56.03% (50.75–61.31)	57.88% (56.83–58.92)	52.42% (51.34–53.49)	52.21% (50.46–53.95)	50.59% (48.22–52.96)	54.84% (54.20–55.47)

Moderate physical activity defined as 30 or more minutes per day for 5 or more days per week.
BMI, Body mass index; CI, confidence intervals.

compared to Blacks or Whites.[11] Likewise, the prevalence of angina is higher in Whites and Blacks compared to Hispanics.[12] In 2007, 4.3% of Whites in the United States were told by a doctor they had had angina pectoris compared to 3.3% of Blacks and 3.0% of Hispanics.[1] There is also an effect of race/ethnicity on the relative risk for acute myocardial infarction (MI) and stroke. In 2007, 4.3% of White adults in the United States were told by a health professional they had had a heart attack compared to 3.7% of Blacks and 2.5% of Hispanics.[1] In the same year, 3.6% of Black and 1.4% of Hispanic adults in the United States were told by a doctor they had had a stroke compared to 2.5% of White adults.[1] Studies also found greater stroke severity and recurrence in Blacks than in Whites.[13]

The objectives of our study were: 1) to assess racial/ethnic disparities in the prevalence of obesity and its related diseases in Massachusetts during 2005–2008; and 2) to estimate the attributable risk of developing obesity-related diseases by racial/ethnic group and BMI category.

METHODS

Data and Study Measures

We used data derived from the Massachusetts Behavioral Risk Factor Surveillance System (BRFSS) for the period 2005–2008. The BRFSS is a state-based system of health surveys that collects information on health risk behaviors, preventive health practices, and health care access. BRFSS data are collected monthly in all 50 states and territories. The BRFSS is a cross-sectional telephone survey conducted by state health departments. The BRFSS database contains self-reported data of non-institutionalized adults (ie, aged ≥18 years) in Massachusetts.

Body mass index of subjects was classified into four weight categories: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥ 30.0 kg/m^2). Respondents were categorized as non-Hispanic White (White), non-Hispanic Black (Black), Hispanic or multiracial non-Hispanic (multiracial) if they identified themselves as such during the BRFSS interview. This study assessed main overweight- and obesity-related diseases: hypercholesterolemia, diabetes, hypertension, heart attack, coronary heart disease, and stroke. The BRFSS does not elicit information on diabetes type therefore this study includes participants with type 1 and 2 diabetes. Participants were considered hypercholesterolemic, diabetic, hypertensive, or having a cardiovascular disease if they reported that a health professional ever told them that they had such a disease. Behavioral characteristics of respondents assessed in the study include fruit and vegetable consumption, alcohol drinking, smoking, and physical activity.

Statistical Analyses

Univariate analyses, prevalence estimates, and 95% confidence intervals (CI) were used to examine the demographics and selected health risk behaviors. Individual variables were compared across racial/ethnic groups using the

Pearson's chi-square test or analysis of variance (ANOVA) to determine the relationship of each independent variable with BMI. In the univariate analysis, categorical variables were compared by chi-square test.

Multivariate logistic regression analyses were conducted to model the association between independent variables and BMI while adjusting for age, gender and sex. Logistic regression models were used to obtain multivariate adjusted odds ratios (ORs) and 95% CIs. All statistical tests were based on a two-sided α significance level of $P<.05$. Parameter estimates were obtained by maximum likelihood techniques and 95% CIs were based on the standard error of model coefficients. The means and standard deviations were computed based on BRFSS sampling weights. Statistical analyses were performed with SASv9.0 (SAS Institute Inc; Cary, NC) statistical software to accommodate the complex sample design.

RESULTS

The study sample, excluding 485 pregnant women, totaled 63,235 BRFSS respondents.

Disparities in the Prevalence and Risk of Obesity

During the study period, 36.20% (CI 35.57–36.84) of respondents were overweight and 14.11% (CI 13.65–14.56) were obese (Table 1). Among men, 44.26% (CI 43.24–45.28) were overweight and 16.02% (CI 15.26–16.77) were obese. The prevalence of obesity was significantly higher among adults aged 55–64 years, separated or divorced, with low income and low education level. Obesity prevalence was highest among respondents who lived in Central Massachusetts (18.04%, CI 16.43–19.66) and it was lowest among respondents who lived in Boston (13.60%, CI 13.05–14.15). Obesity was more prevalent among individuals who were physically inactive (13.64%, CI 12.03–15.24), smoked every day (12.18%, CI 10.88–13.47), drank alcohol (5.47%, CI 4.58–6.36), and consumed less than five servings of fruits and vegetables per day (76.19%, CI 74.07–78.30).

We found large disparities in the odds of obesity. Females had statistically significant lower odds of being obese (OR=0.46; $P<.0001$) than males. Older adults were more likely to be obese than their younger counterparts. Being aged 55–64 years was significantly associated with higher odds of obesity (OR=2.83; $P<.0001$) as compared to respondents aged 18–24 years. On the other hand, having a college degree was significantly associated with lower odds of obesity (OR=0.55; $P<.0001$) compared with high school graduates. Respondents who had an annual household income of $15,000 to $20,000 had higher odds (OR=1.64; $P<.0001$) of obesity as compared to those with incomes of $50,000 to $75,000. There was a positive association between obesity and being out of work for more than one year (OR=1.40; $P=0.02$) compared with being employed for wage income. There were also disparities associated with the responder's region of residence in Massachusetts. Individuals living in Central Massachusetts (OR =1.53), North East (OR=1.37), South East (OR=1.61), and Metro West (OR=1.37), had statistically significant ($P<.0001$) higher odds of obesity than those living in Boston. There was a negative association between the daily consumption of fruits and vegetables (OR=0.72; $P<.0001$), meeting physical activity recommendations (OR=0.60; $P<.0001$) and the odds of being obese; while the association between being a former smoker and obese was positive (OR=1.29; $P<.0001$). The negative association between alcohol consumption and risk of obesity was also statistically significant (OR=0.81; $P=.04$). (data not shown)

Racial/ethnic Disparities in the Prevalence and Risk of Obesity

The prevalence of obesity was higher among Blacks 18% (CI 15.66–20.34) and Hispanics 17.58% (CI 15.59–19.58) than among Whites (Table 2). Disparities among racial/ethnic groups were also found in the odds of obesity; being Black was significantly associated with higher adjusted odds of overweight (OR=1.63; $P<.0001$) and obesity (OR=1.97; $P<.0001$) as compared to being White. Likewise, being Hispanic was significantly associated with an increased risk of overweight (OR =1.53; $P<.0001$) and obesity (OR =1.81; $P<.0001$).

Disparities in the Prevalence and Risk of Developing Obesity-related Diseases, by BMI Category

During the study period, 35.85% (CI 34.96–36.73) of respondents reported being told by a health care professional that they had high cholesterol, 25.76% (CI 25.02–26.50) high blood pressure, and 6.89% (CI 6.62–7.15) diabetes. Overall, 3.98% (CI 3.77–4.19) of respondents were diagnosed with a heart attack, 3.97% (CI 3.77–4.18) with a CHD, and 2.03% (CI 1.88–2.17) with a stroke (Table 3). Overweight and obesity were associated with increased odds of obesity related-diseases. Referenced to respondents with normal weight, the adjusted ORs of obesity-related diseases increased with BMI. Obesity was associated with an increased risk of diabetes (OR=3.72; $P<.0001$), high blood pressure (OR =3.56; $P<.0001$) and high cholesterol (OR=2.03; $P<.0001$). Obesity was also associated with an increased risk of having a heart attack (OR=1.44; $P<.0001$) and coronary heart disease (OR=1.76 $P<.0001$) (Table 3).

Racial/ethnic Disparities in the Prevalence and Risk of Developing Obesity-related Diseases

Statistically significant differences in the prevalence and risk of developing obesity-related diseases were found among racial/ethnic groups. The prevalence of diabetes (10.74%, CI 9.24–12.24) and

Table 2. Prevalence and odds ratios of overweight and obesity by race/ethnic group (95% CI), Massachusetts; 2005–2008

Massachusetts 2005–2008	Normal weight (18.5≥BMI< 25)	Underweight (BMI<18.5)		Overweight (25≥BMI<30)		Obese (30≥BMI<35)		Morbidly Obese (BMI≥35)	
	Prevalence (CI)	Prevalence (CI)	Odds ratio (CI)	Prevalence (CI)	Odds ratio (CI)	Prevalence (CI)	Odds ratio (CI)	Prevalence (CI)	Odds ratio (CI)
White only, Non-Hispanic	41.65% (40.93–42.37)	1.57% (1.38–1.77)		36.15% (35.46–36.83)		13.96% (13.46–14.46)		6.67% (6.33–7.02)	
Black only, Non-Hispanic	29.38% (26.48–32.28)	1.13% (0.55–1.72)	0.984 (0.563–1.719)	38.73% (35.63–41.82)	1.633** (1.384–1.927)	18.00% (15.66–20.34)	1.97** (1.614–2.406)	12.75% (10.52–14.99)	2.917** (2.303–3.695)
Hispanic	34.26% (31.63–36.89)	1.50% (0.98–2.02)	1.056 (0.702–1.589)	37.54% (34.93–40.16)	1.536** (1.33–1.774)	17.58% (15.59–19.58)	1.811** (1.524–2.151)	9.11% (7.75–10.48)	1.933** (1.585–2.357)
Other race only, Non-Hispanic	53.08% (49.79–56.37)	3.08% (1.94–4.23)	1.669* (1.099–2.534)	32.11% (29.06–35.15)	0.693** (0.591–0.813)	8.00% (6.24–9.77)	0.441** (0.339–0.573)	3.72% (2.66–4.78)	0.446** (0.326–0.611)
Multiracial, Non-Hispanic	36.22% (28.58–43.86)	1.84% (0.00–4.12)	1.211 (0.324–4.524)	35.02% (27.99–42.06)	1.236 (0.84–1.818)	16.26% (10.27–22.26)	1.49 (0.883–2.516)	10.66% (6.46–14.86)	2.076*** (1.263–3.413)

Normal weight (18.5≥BMI< 25) and White only, Non-Hispanic are the reference categories. Odds ratios are adjusted by age and sex.
Note. CI, confidence interval; BMI, Body mass index.
*$P < .01$; **$P < .0001$; ***$P < .004$; Derived from 2-tailed tests.

high blood pressure (29.99%, CI 25.97–34.01) was highest among Blacks, followed by Hispanics. The prevalence of having high cholesterol was higher among Hispanics (38.51%, CI 33.75–43.28) than among any other racial/ethnic group (Table 4).

Hispanic ethnicity and Black race were also significantly associated with an increased risk of developing obesity-related diseases. The highest odds of diabetes were found in Hispanics and Blacks while the lowest odds were observed in the multiracial group. Diabetes was associated with 2.71 and 2.58 increased odds among Hispanics and Blacks, respectively. Blacks also had higher adjusted odds of high blood pressure (OR=1.88; $P<.0001$) and stroke (OR=2.14; $P<.01$) than any other racial/ethnic group. Hispanics were more likely to have high blood pressure (OR=1.34; $P<.01$), stroke (OR=1.71; $P<.01$), high cholesterol (OR=1.56; $P<.0001$), and heart attack (OR=1.54; $P<.001$) than Whites (Table 4).

DISCUSSION

The purpose of our study was to assess racial and ethnic disparities in the prevalence of obesity and its related diseases and in the risk of developing obesity related diseases. This study provides evidence that overweight and obesity are associated with low socioeconomic status, region of residence and behavioral risk factors related with physical activity, food and alcohol consumption and smoking. Obesity is significantly more prevalent among male adults, aged 55–64 years, separated or divorced, with low education and income, unable to work or that have been out of work for more than one year and that live in Central Massachusetts. As expected, obesity is more prevalent among physically inactive individuals who drink alcohol, smoke every day and consume less than five servings of fruits and vegetables per day.

Table 3. Prevalence and odds ratios of obesity-related diseases by BMI category (95% CI), Massachusetts; 2005–2008

Massachusetts, 2005–2008	Diabetes		High blood pressure		High cholesterol	
	Prevalence (CI)	Odds ratio (CI)	Prevalence (CI)	Odds ratio (CI)	Prevalence (CI)	Odds ratio (CI)
Normal weight (18.5≥BMI< 25)	3.20% (2.88–3.52)		16.18% (15.20–17.15)		27.19% (25.85–28.54)	
Underweight (BMI<18.5)	2.60% (1.48–3.72)	0.861 (0.545–1.362)	15.83% (11.73–19.92)	0.984 (0.701–1.38)	25.94% (19.37–32.51)	1.01 (0.707–1.444)
Overweight (25≥BMI<30)	6.44% (6.01–6.87)	1.764** (1.554–2.003)	27.61% (26.33–28.90)	1.823** (1.637–2.031)	40.43% (38.89–41.960	1.616** (1.462–1.786)
Obese (30≥BMI<35)	11.64% (10.72–12.57)	3.724** (3.238–4.284)	38.29% (35.98–40.59)	3.569** (3.108–4.1)	45.10% (42.63–47.57)	2.034** (1.793–2.307)
Morbidly Obese (BMI≥35)	20.50% (18.79–22.21)	8.556** (7.327–9.99)	45.20% (41.79–48.61)	5.939** (4.928–7.158)	42.13% (38.76–45.51)	2.019** (1.713–2.38)
Total	6.89% (6.62–7.15)		25.76% (25.02–26.50)		35.85% (34.96–36.73)	
Massachusetts, 2005–2008	**Heart attack**		**Coronary heart disease**		**Stroke**	
	Prevalence (CI)	Odds ratio (CI)	Prevalence (CI)	Odds ratio (CI)	Prevalence (CI)	Odds ratio (CI)
Normal weight (18.5≥BMI< 25)	2.89% (2.59–3.19)		2.71% (2.43–3.00)		1.70% (1.49–1.92)	
Underweight (BMI<18.5)	4.13% (2.72–5.55)	1.67* (1.13–2.467)	2.56% (1.52–3.60)	1.054 (0.682–1.63)	2.01% (0.98–3.04)	1.18 (0.678–2.054)
Overweight (25≥BMI<30)	4.52% (4.14–4.90)	1.211* (1.04–1.41)	4.52% (4.15–4.89)	1.343** (1.162–1.552)	2.13% (1.89–2.37)	1.055 (0.879–1.265)
Obese (30≥BMI<35)	4.83% (4.23–5.43)	1.441** (1.204–1.725)	5.27% (4.60–5.95)	1.769** (1.47–2.129)	1.94% (1.60–2.28)	1.012 (0.803–1.274)
Morbidly Obese (BMI≥35)	6.08% (5.12–7.05)	2.289** (1.854–2.827)	6.45% (5.44–7.46)	2.72** (2.212–3.345)	3.49% (2.50–4.48)	2.226** (1.592–3.112)
Total	3.98% (3.77–4.19)		3.97% (3.76–4.18)		2.03% (1.88–2.17)	

Normal weight (18.5≥BMI< 25) is the reference category. Odds ratios are adjusted by age, race and sex.
Note. CI, confidence interval; BMI, Body mass index.
*P<.01; **P<.0001; ***P<.004.

Studies have found that obesity prevalence is higher among Blacks, Hispanics and American Indians/Alaska Natives (AI/AN) compared to Whites.[1,2] Studies also have found that minority groups in the United States have higher rates of hypercholesterolemia, type 2 diabetes, and cardiovascular diseases.[5,10–12] Our study supports and expands on the current body of literature by estimating the risk of developing obesity-related diseases by racial/ethnic group and BMI category. Our results show significant disparities in the prevalence of obesity and in the risk of developing obesity-related diseases among racial/ethnic groups in Massachusetts. Hispanics and Blacks have significantly higher odds of being overweight and obese. Likewise, Hispanic ethnicity and Black race is associated with a 2-fold risk of diabetes. Both minority groups also have a statistically significant higher risk of stroke, high blood pressure, high cholesterol, and heart attack.

This study provides evidence that overweight and obesity are associated with low socioeconomic status, region of residence and behavioral risk factors related with physical activity, food and alcohol consumption and smoking.

Additionally, this study estimates the odds of developing cardiovascular risk factors by BMI category and racial/ethnic group. A novel finding in this study was that racial/ethnic disparities also exist among the underweight. Results of the study show that the prevalence and odds of being underweight are highest among the non-Hispanic population group.

Novel findings of this study also show that health disparities in Massachusetts are not fully explained by the demographic, socioeconomic and lifestyle variables included in the analysis. We found that respondents in all race/ethnic groups reported worse health status as BMI increases, with the exception of Hispanics (although the differences for Hispanics between the BMI categories were not statistically significant).

Table 4. Prevalence and odds ratios of obesity-related diseases by race/ethnic group (95% CI), Massachusetts; 2005–2008

Massachusetts, 2005–2008	Diabetes		High blood pressure		High cholesterol	
	Prevalence (CI)	Odds ratios (CI)	Prevalence (CI)	Odds ratios (CI)	Prevalence (CI)	Odds ratios (CI)
White only, Non-Hispanic	6.46% (6.18–6.75)		26.63% (25.82–27.44)		36.35% (35.41–37.29)	
Black only, Non-Hispanic	10.74% (9.24–12.24)	2.586** (2.181–3.067)	29.99% (25.97–34.01)	1.887** (1.506–2.363)	30.69% (26.27–35.10)	0.859 (0.697–1.059)
Hispanic	8.74% (7.71–9.77)	2.71** (2.329–3.154)	21.85% (19.02–24.67)	1.349* (1.112–1.636)	38.51% (33.75–43.28)	1.56** (1.242–1.96)
Other race only, Non-Hispanic	6.62% (4.01–9.24)	1.719** (1.344–2.199)	27.01% (18.14–35.88)	0.732* (0.564–0.950)	34.09% (23.77–44.42)	0.830 (0.662–1.041)
Multiracial, Non-Hispanic	7.09% (5.62–8.56)	1.613**** (1.045–2.49)	14.40% (11.50–17.31)	1.751**** (1.020–3.007)	27.31% (23.07–31.56)	1.270 (0.783–2.059)
Total	6.86% (6.59–7.12)		25.77% (25.03–26.52)		35.85% (34.96–36.74)	
	Heart attack		**Coronary heart disease**		**Stroke**	
	Prevalence (CI)	Odds ratios (CI)	Prevalence (CI)	Odds ratios (CI)	Prevalence (CI)	Odds ratios (CI)
White only, Non-Hispanic	4.07% (3.84–4.29)		4.18% (3.94–4.41)		2.01% (1.86–2.16)	
Black only, Non-Hispanic	3.64% (2.65–4.63)	1.409**** (1.036–1.917)	3.06% (2.20–3.92)	1.122 (0.819–1.536)	2.73% (1.47–4.00)	2.142* (1.3–3.528)
Hispanic	3.04% (2.34–3.75)	1.549*** (1.193–2.011)	2.54% (2.02–3.06)	1.235 (0.971–1.571)	1.73% (1.23–2.22)	1.716* (1.251–2.354)
Other race only, Non-Hispanic	5.58% (2.78–8.39)	1.512* (1.076–2.126)	4.18% (2.05–6.31)	1.336 (0.888–2.009)	2.25% (0.50–4.00)	1.705* (1.149–2.529)
Multiracial, Non-Hispanic	3.71% (2.61–4.82)	2.227**** (1.232–4.026)	3.34% (2.15–4.54)	1.568 (0.880–2.795)	1.92% (1.23–2.61)	1.778 (0.767–4.124)
Total	3.96% (3.75–4.17)		3.96% (3.75–4.17)		2.01% (1.87–2.16)	

White only, Non-Hispanic is the reference category. Odds ratios are adjusted by age and sex.
Note. CI, confidence interval.
*$P<.01$; **$P<.0001$; ***$P<.001$; ****$P<.05$, derived from 2-tailed tests.

Some limitations must be taken into account in the interpretation of results from our study. The BRFSS contains self-reported data. Less accurate estimates may result because respondents tend to overestimate their height and underestimate their weight. Thus, the actual overweight and obesity prevalence estimates may be underestimated.

The BRFSS questionnaire is available only in English and Spanish therefore non-English-speaking persons are likely underrepresented in this study. The BRFSS is a telephone-based survey and therefore excludes persons without a landline telephone. Telephone surveys tend to oversample certain subpopulations such as women and older persons. However, weighting adjustments used for the BRFSS data minimize the impact of differences in noncoverage, undercoverage, and nonresponse at the state level. BRFSS post-stratification adjustments include age, race, sex and ethnicity. To ensure sufficient sample sizes and the precision of the prevalence estimates, multiple years of data were aggregated. Still, the small sample size in some racial/ethnic groups and the relatively limited sample size of the underweight category could impact the results of the study.

The BRFSS data are cross-sectional; thus, directionality of the associations cannot be clearly established. A related issue in cross-sectional studies is that, strictly speaking, population-attributable risks apply only to incident cases of disease, not prevalent ones.

In conclusion, this study provides further evidence that obesity and its related diseases affect racial/ethnic groups differently. Obesity is a preventable disease and a major public health problem in the United States. Obesity is likely to continue to increase and soon become the leading cause of morbidity if no effective public health approaches to controlling it are implemented.[2] Some population groups will be more seriously affected. Our findings suggest that lessening the burden of the disease and its related diseases requires further efforts on the part of public health programs toward the implementation of prevention strategies among those populations disproportionately affected.

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