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THE PREVALENCE OF OBESITY AND OBESITY-RELATED HEALTH CONDITIONS IN A LARGE MULTIETHNIC COHORT OF YOUNG ADULTS IN CALIFORNIA

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Abstract

Purpose—To identify population groups that are most susceptible to obesity-related health conditions at young age.

Methods—For this population-based cross-sectional study, measured weight and height, diagnosis, laboratory, and drug prescription information were extracted from electronic medical records of 1,819,205 patients aged 20–39 years enrolled in two integrated health plans in California 2007–2009.

Results—Overall, 29.9% of young adults were obese. Extreme obesity (BMI ≥ 40 kg/m²) was observed in 6.1% of women and 4.5% of men. The adjusted relative risk for diabetes, hypertension, dyslipidemia, and the metabolic syndrome increased sharply for those individuals with a BMI ≥ 40 , with the sharpest increase in the adjusted relative risk for hypertension and metabolic syndrome. The association between weight class and dyslipidemia, hypertension and metabolic syndrome but not diabetes was stronger among 20.0–29.9 year olds compared to 30.0–39.9 year olds (*p* for interaction: <0.05). For example, compared to their normal weight counterparts of the same age group, young adults with a BMI of 40.0–49.9, 50.0–59.9, and ≥ 60 kg/m² had a relative risk for hypertension of 11.73, 19.88, and 30.47 (95%-CI 26.39–35.17) at age 20–29 years, and 9.31, 12.41, and 15.43 (95%-CI 14.32–16.63) at age 30–39 years.

Conclusion—While older individuals were more likely to be extremely obese, the association between obesity-related health conditions was stronger in younger individuals. Hispanics and

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Conflict of interest:

Lawrence Kushi: (Relevant Relationship) Employment (other than primary affiliation, e.g., consulting) $<10,000$ - Adjunct Professor, UC Davis Medical School

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Blacks are also more likely to be obese, including extreme obesity, putting them at an elevated risk for premature cardiovascular disease and some cancers relative to non-Hispanic whites.

Keywords

Obesity; Type 2 Diabetes Mellitus; Hypercholesterolemia; Metabolic Syndrome X; Hypertension; Young Adult

INTRODUCTION

It is estimated that there are nearly 5 million young adults (6%) with extreme obesity (BMI ≥ 40 kg/m²) in the U.S. (1). Young adults with extreme obesity experience serious chronic diseases that normally occur in much older adults. These diseases include diabetes, dyslipidemia, and hypertension, each potentially leading to premature disability and death with enormous costs to the individual and the society (2–5). For the first time in two centuries, life expectancy may decline due to the rapidly increasing prevalence of obesity (6).

The prevalence of obesity and obesity-related chronic health conditions vary by sex, age group, and race/ethnicity (4, 7, 8). To understand the health consequences of obesity, especially extreme obesity in young adults, will be critical to identify populations at highest risk that may benefit from surveillance programs and prevention strategies (9). However, limited information exists regarding the health consequences of obesity, especially of extreme obesity in young adults. Most population-based studies combine younger and older adults and have limited information regarding obesity class 3 and higher (Body mass index, BMI ≥ 40 kg/m²). Young adults represent a distinctive age group that may experience obesity-related health risks that differ from those observed in older adults, as shown for ischemic heart disease (10).

The overall goal of the present cross-sectional study is to address several knowledge gaps regarding the consequences of obesity in young adults. First, we investigated the prevalence of obesity including obesity class 3 and higher in young adults and how it differed for defined population subgroups. Second, we investigated the prevalence of the consequences of obesity such as diabetes, dyslipidemia, hypertension, and the metabolic syndrome and how they differed for defined population subgroups. The current study was conducted within the framework of the National Cancer Institute (NCI)-funded Cancer Research Network (CRN), and a consortium of 14 health care organizations that participate in innovative population-based cancer research (11). The CRN focuses on cultivating multi-site collaborative efforts that address knowledge gaps in cancer-related research ranging from health care delivery and utilization to epidemiology of cancer and other associated health conditions.

METHODS

Study setting, design, and subjects

Two Cancer Research Network (CRN) sites participated in this project. The Northern and Southern California Divisions of Kaiser Permanente (KPNC and KPSC, respectively), jointly provided medical coverage for approximately 6.3 million members as of Dec. 31st 2009. From these more than 6 million KPNC and KPSC health plan current members, we identified 2,285,278 young adults aged 20–39 years who were members and had at least one medical encounter between January 1, 2007 and December 31, 2009. After excluding members with missing BMI or sex information (n=355,808) and pregnant women (n=110,265), the final analytic population comprised of 1,819,205 young adults that were

used for the present cross-sectional analysis. The study population covers 84.4% of KP California members aged 20–39 years and represents about 18.2% of the State of California population in this age group. The study protocol was approved by the Institutional Review Boards (IRB) of KPNC and KPSC.

Body mass Index (BMI)

Based on a validation study including data from over 21 million medical encounters from 2.4 million adults and a manual review of 35,000 medical encounters from 1,026 adults, we removed biologically implausible values for weight and height. For this study an approach combining descriptive analysis of data distribution with stepwise manual review of medical charts was chosen to determine thresholds. Briefly, a height <4 feet or 7 feet, 2 inches was considered implausible and excluded from the analysis. Weight data were excluded if weight was <30 lbs or 1000 lbs. Because implausible combinations of weight and height may be missed by the procedures described above, we additionally excluded BMI values <5 kg/m² or 100 kg/m² as implausible. The overall error rate before cleaning was <1% of all encounters.

BMI was calculated using the first plausible height and weight measurements in KP's electronic health record system between January 1st 2007 and December 31st 2009 as weight (kg) divided by the square of height (m²). The first BMI available after January 1st 2007 was used to assemble and characterize this population as only limited weight and height data were available in the KP electronic medical records before this date.

Obesity-related health conditions

Electronic health records were used to obtain the measurements of obesity-related health conditions of interest: Type-2 diabetes mellitus, dyslipidemia, hypertension, and the metabolic syndrome. Algorithms were developed to extract the various outcome measures from the electronic health record system. The algorithms were created based on the definitions of the selected health outcomes. Electronic laboratory data, pharmacy data, and diagnosis data were used to obtain the assorted measures. Records were searched between the dates January 1st, 2007 and December 31st, 2009. However, no information was used that preceded the date of study enrollment (first BMI measurement).

Type-2 diabetes mellitus was defined as (1) elevated glucose levels (fasting glucose >126 mg/dL or random glucose 200 mg/dL) measured on two separate occasions; (2) elevated HbA1C (>7.0%); (3) two or more outpatient visits with ICD-codes (250.XX) for diabetes mellitus; (4) one or more diabetes-related hospital discharge codes; or (5) one or more fills for oral or injected diabetes-specific medications excluding Metformin or any Thiazolidinedione if no other criterion was met. Patients who were pregnant during the enrollment period were only considered diabetic if they met the criterion outside of the pregnancy time period.

Dyslipidemia was defined as (1) at least one prescription for lipid-lowering medication plus an outpatient diagnosis of dyslipidemia (ICD-9 272.0–272.4); (2) at least two outpatient diagnoses of dyslipidemia; (3) at least one prescription for lipid-lowering medication plus at least one elevated LDL cholesterol (>160 mg/dL); or (4) at least one outpatient diagnosis of dyslipidemia plus at least one elevated LDL cholesterol.

Hypertension was defined as: (1) at least one prescription for an antihypertensive medication plus an outpatient diagnosis of hypertension (ICD-9 401–404); (2) at least two outpatient diagnoses of hypertension; (3) at least one prescription for an antihypertensive medication plus at least one elevated outpatient blood pressure reading (>140 mm Hg [systolic] or >90 mm Hg [diastolic]); or (4) at least one outpatient diagnosis of hypertension plus at least one

blood pressure reading of ≥ 140 mm Hg (systolic) or ≥ 90 mm Hg (diastolic) when no indication of a body temperature ≥ 100.4 F degrees on the day of the measurement was present.

Metabolic syndrome was defined by three or more of the following health conditions: (1) BMI ≥ 30 kg/m²; (2) any triglycerides ≥ 150 mg/dL; (3) any HDL <40 mg/dL for men and <50 mg/dL for women; (4) at least one elevated glucose value (fasting glucose >126 mg/dL or random glucose ≥ 200 mg/dL); (5) any existing diabetes diagnosis; (6) if hypertension criterion was met (12).

Demographic information

All demographic information such as age, sex, and race/ethnicity was retrieved from administrative health records. Individual member's education and household income were not available from electronic medical records. As measures of socioeconomic status, we used neighborhood household income and neighborhood education through linkage of a member's address with U.S. census tract information via geocoding (13) which have to be interpreted as area-based measures of socioeconomic status. Therefore, these measures do not necessarily reflect each individual's income or education but have been shown to be strongly associated with disparities in obesity rates (14). Neighborhood household income was classified as likelihood of an individual's household income of $< \$15,000$, $\$15,000$ to $\$34,999$, $\$35,000$ to $\$49,999$, $\$50,000$ to $\$74,999$, $\$75,000$ to $\$99,999$, $\$100,000$ to $\$149,999$, $\$150,000$ or more. Neighborhood education was categorized as and individual's likelihood of an education less than high school, high school, some college or associate degree, or Bachelor degree or higher.

Statistical analysis

Weight class was defined as follows: underweight (<18.5 kg/m²), normal weight (18.5 – 24.9 kg/m²), overweight (25–29.9 kg/m²); moderate obesity stratified as class 1 (30.0–34.9 kg/m²) and class 2 (35.0–39.9 kg/m²); and extreme obesity stratified as class 3 (40.0–49.9 kg/m²), class 4 (50.0–59.9 kg/m²), and class 5 (≥ 60 kg/m²).

Log-binomial regression models were used to estimate the association between weight class (BMI <18.5 kg/m², 18.5–24.9 kg/m²=reference, 25.0–29.9 kg/m², 30.0–34.9 kg/m², 35.0–39.9 kg/m², 40.0–49.9 kg/m², 50.0–59.9 kg/m², ≥ 60 kg/m²) and health conditions of interest. Covariates included in the models included sex, age group (20.0–24.9 years=reference, 25.0–29.9 years, 30.0–34.9 years, 35.0–39.9 years), mutually-exclusive race/ethnicity categories (non-Hispanic White=reference, Hispanic, Black, Asian/Pacific islanders, Others, Unknown), likelihood of education less than 9th grade, and likelihood of household income below $\$10,000$ simultaneously. The associations were expressed as relative risk (RR) and their corresponding 95% confidence intervals (CI). In order to assess whether, and to what extent the relationship between weight class and health conditions was modified by age group, we tested for interaction between age group and weight class in models adjusted for the covariates listed above. Based on these models, we report adjusted RR for all health conditions stratified by age group. All analyses were conducted using SAS release 9.1 (SAS Institute, Cary, NC).

RESULTS

A total of 1,819,205 young adults were included in this cross-sectional analysis. Racial/ethnic minorities constituted about 50% of the study population and were mostly of Hispanic origin (Table 1). Demographics characteristics were comparable between men and women with the exception that women were slightly younger than men.

Prevalence of Overweight, Obesity, and Extreme Obesity

Overall, 61.5% of young adults had a BMI ≥ 25.0 kg/m², with 31.6% of young adults classified as overweight, and 29.9% classified as obese (class 1 to 5, Table 2). The prevalence of overweight or obesity was higher in men than in women (71.7% and 53.1% respectively). Obesity was prevalent in 32.9% of men and 27.4% of women (class 1 to 5). Conversely, extreme obesity (classes 3 to 5) affected a higher percentage of women (6.1%) compared to men (4.5%). Overweight and obesity prevalence increased with age; 79.2% of men and 60.0% of women aged 30.0–39.9 years were overweight or obese compared to 63.6% of men and 46.9% of women in the group of 20.0–29.9 years olds. The prevalence of extreme obesity increased from 3.9% in the age group of 20 to 25 years of age to 6.1% in the group of 35 to 39 years of age. While Hispanic young adults have the highest overall prevalence of overweight and obesity, Black young adults had the highest prevalence of extreme obesity class 3–5. Asian/Pacific Islanders had the lowest prevalence of overweight, obesity, and extreme obesity.

Prevalence of Diabetes, Dyslipidemia, Hypertension, and the Metabolic Syndrome

Overall, men had higher adjusted RR for diabetes, dyslipidemia, hypertension, and the metabolic syndrome than women. This finding was consistent for adults aged 20 to 29 years and 30 to 39 years. The adjusted odd ratios for any of these health conditions increased with age and varied slightly by race and ethnicity. The most striking difference in prevalence of these health conditions among racial/ethnic groups was observed in the for hypertension, which was highest in Black young adults, especially those aged 30.0–39.9 years of age, with 13.1% having hypertension compared to 5.0% of non-Hispanic Whites.

The adjusted RR of diabetes, dyslipidemia, hypertension and metabolic syndrome increased with increasing weight class. The adjusted RR of these health conditions increased sharply for those individuals with a BMI ≥ 40 , with the sharpest increase in the adjusted RR for hypertension and metabolic syndrome. The association between weight class and obesity-related health conditions such as dyslipidemia, hypertension and metabolic syndrome was modified by age with a stronger association among 20.0–29.9 year olds compared to 30.0–39.9 year olds (p for interaction by age <0.001 for dyslipidemia, hypertension, and metabolic syndrome). For diabetes, however, the association with obesity was slightly stronger among 30.0–39.9 year olds than among 20.0–29.9 year olds.

DISCUSSION

This study was consistent with previous findings showing a high prevalence of overweight and obesity in young adults in the U.S., with over 30% of the population in KP having a BMI of 30 kg/m² or greater. With the large study population and availability of clinical data, a key finding of this population-based cross-sectional study of almost two million young adults is that the risk for obesity-related health conditions increases disproportionately in individuals who are extremely obese with a BMI > 40 kg/m². But while the prevalence of extreme obesity was higher in older individuals, the association between obesity and obesity-related health conditions was stronger in younger individuals.

Between 1980 and 2008, the prevalence of obesity (BMI ≥ 30 kg/m²) among U.S. adults more than doubled from 15% to approximately 34% (1, 7, 15) although it may have stabilized in recent years at this alarming rate (1). Additional reports based on the NHANES indicate that about 28% to 34% of young adults aged 20 to 39 years are classified as obese, with approximately 5% of the surveyed population categorized as extremely obese (BMI ≥ 40 kg/m²) (1, 7, 16, 17). These estimates are comparable to the present study with 5.4% of young adults classified as extremely obese.

Consistent with the present study, the prevalence of obesity varied markedly by sex. Previous studies identified differences in the prevalence of obesity among different adult population subgroups. Nationwide, more men (63%) than women (55%) are at least overweight (16, 18). However, obesity is more prevalent among women (27%) than among men (21%) (18). The proportion of extremely obese individuals is more than double in women (8.0%) than men (3.1%) (7). Studies focusing on young adults are scant. Recent studies estimated that approximately 7% of women between 20 and 39 years are extremely obese (1). The present study suggests that 4.5% of men and 6.1% of women aged 20–39 years are extremely obese, with 3.9% of men and 5.0% of women in the group of 20–29 year olds compared to 5.0% of men and 7.2% of women in the group of 30–39 year olds.

Consistent with other studies, the prevalence of obesity varied by race/ethnicity. Blacks have the highest prevalence of obesity, reaching rates as high as 50% in Black women (4, 18). Nationwide, obesity class 2 and 3 are most frequent in Black women with approximately 11% and 8% respectively (18). Based on the NHANES 2003–2004, Black women aged 20–39 years have the highest prevalence of extreme obesity with 15.7%, followed by Mexican-American women at 8.6%, Black men at 7.1%, White women at 6.4%, White men at 3.2% and Mexican-American men at 1.9% (7).

Obesity is a known risk factor for diabetes (3, 4, 16, 19–22), dyslipidemia (16), hypertension (16, 23), and metabolic syndrome (16, 24–27). Past reports identified individuals with a BMI ≥ 40 kg/m² as the weight class group with the highest prevalence of hypertension (52.3%), diabetes (14.2%), and metabolic syndrome (39.2%); while individuals with a BMI of 30–39 kg/m² had the highest prevalence rate of dyslipidemia (20.6%). Adults aged 18–29 years with a BMI ≥ 40 kg/m² had the following prevalence rates: hypertension (19.8%), diabetes (0.8%), dyslipidemia (18.2%) and metabolic syndrome (14.9%) (16). Adults aged 30–49 years with a BMI ≥ 40 kg/m² had the following prevalence rates: hypertension (47.2%), diabetes (10.8%), dyslipidemia (14.3%) and metabolic syndrome (31.8%). Although dyslipidemia was more prevalent in obese persons compared to normal weight individuals, the prevalence did not increase with increasing weight class beyond the group of individuals with a BMI of 30.0–34.9 kg/m² in that study (18). In contrast, a study on the association of hypertension, diabetes, dyslipidemia and metabolic syndrome with obesity from NHANES 1999 to 2004 determined that the odds of chronic health conditions increased as BMI increased. The findings indicated that the prevalence of diabetes was more than five times higher in individuals with a BMI ≥ 40 kg/m² compared to normal weight individuals (16). Additionally, the study found that individuals with a BMI ≥ 40 kg/m² were more than twice as likely as normal weight individuals to have a diagnosis of hypertension, dyslipidemia or metabolic syndrome (16). Similar to some but not all previous reports, findings of our study the prevalence of related-health conditions including dyslipidemia incline steadily with increasing BMI. Young adults with a BMI ≥ 60 kg/m² showed the highest prevalence of obesity-related health conditions.

Findings from NHANES 1999–2004 suggested that the association between obesity and some adverse health outcomes was stronger in adults aged 18 to 29 years than in adults aged 30–49 years and ≥ 50 years (16). In that study, the difference in the prevalence of hypertension, dyslipidemia and metabolic syndrome between normal weight and obese adults was most pronounced in the younger age group while the difference was lowest in the oldest age group (≥ 50 years) (16). In contrast, the prevalence difference of diabetes between normal weight and obese adults was higher in 30–49 year old adults than in 18–29 year old adults (16). This is consistent with findings from our study suggesting that young adults aged 20 to 29 years who are extremely obese are more likely to have hypertension, dyslipidemia and metabolic syndrome than 30 to 39 years olds when compared to their normal weight counterparts of the same age – even though the absolute prevalence was

higher in older adults than in younger adults. This, however, was not observed for diabetes where the relative risks for very obese individuals was comparable for 20–29 year olds and 30 to 39 years olds compared to their normal weight counterparts of the same age.

Our study benefited from an extremely large multi-ethnic population, using data from two large integrated health care delivery systems. These populations represent over 18% of young adults in California. The large population notwithstanding, it is possible that there is a bias in ascertainment of BMI, as these were obtained from electronic medical records. Those individuals who are more likely to seek medical care may also be more overweight or obese, and the prevalence estimates may therefore be overestimated. This is a likely explanation for the larger proportion of women in the study population, as women are likely to undergo more routine care in this age group due to prenatal and postnatal care, and recommended screenings, such as for pap smears. However, height and weight are recorded routinely for the vast majority of visits and not just those related to weight-related health conditions, and the prevalence estimates were similar to those from other studies as described above, albeit with smaller populations. Because of routine recording of height and weight, it is also unlikely that the relative risks observed for the association of BMI and various health conditions are biased due to the health care setting.

In our definition of the metabolic syndrome, BMI $>30 \text{ kg/m}^2$ (28) had to be used instead of waist circumference which is a better estimate of intra-abdominal visceral adipose tissue and worsened cardiovascular outcomes (12). The inclusion of BMI in the definition of the metabolic may result in an overestimation of relative risks for weight classes.

Because of the cross-sectional design of this study, our findings should be interpreted with care. Both exposure and outcome have been assessed at approximately the same time period, and therefore, no inferences pertaining to causality can be made directly from the observations in this study. Moreover, biological relevance of the differences between groups has to be considered. However, several mechanisms have been suggested to explain the association between obesity and diabetes, dyslipidemia, hypertension and the metabolic syndrome. Obesity is an established risk factor for these health conditions in adults and one of the possible features of the metabolic syndrome (12). Obesity is considered a chronic low-grade inflammatory state and is associated with adipocyte dysfunction which leads to abnormalities in lipid metabolism (29). Chronic inflammation is also often cited as key etiologic factor in the development of the metabolic syndrome (30), insulin resistance and diabetes (31), dyslipidemia (32), and hypertension (33–36).

In conclusion, the current study indicates that the impact of extreme obesity on various health conditions known to be associated with adiposity is higher in the younger age group. Hispanics and Blacks are also more likely to be obese, including extreme obesity, putting them at an elevated risk for premature cardiovascular disease and some cancers relative to non-Hispanic whites. Given the marked elevated associations with increasing obesity class for the health conditions examined in this study, greater attention may need to be directed at preventive screening recommendations and treatment decisions among the extremely obese for these aggravated health conditions.

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Abbreviations

CI	confidence interval
BMI	Body mass index
CRN	Cancer Research Network
ICD-9	International Classification of Disease, 9 th modification
KP	Kaiser Permanente
NCI	National Cancer Institute
RR	Relative Risk

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Table 1

Demographic characteristics of young adults in California by weight status

Weight class: BMI range (kg/m ²):	Under weight			Normal weight			Overweight			Obesity					Total
	18.5	18.5-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-49.9	50.0-59.9	60.0	Class 1 30.0-34.9	Class 2 35.0-39.9	Class 3 40.0-49.9	Class 4 50.0-59.9	Class 5 60.0		
n	32,984	668,204	574,044	308,117	138,523	81,883	12,927	2,523	308,117	138,523	81,883	12,927	2,523	1,819,205	
Sex, %															
Male	18.8	33.5	55.0	54.6	46.0	37.9	34.2	36.9	54.6	46.0	37.9	34.2	36.9	44.8	
Female	81.2	66.5	45.0	45.4	54.0	62.1	65.8	63.1	45.4	54.0	62.1	65.8	63.1	55.2	
Age Group (years), %															
20.0-24.9	45.3	33.5	22.0	18.9	19.4	19.2	16.5	16.9	18.9	19.4	19.2	16.5	16.9	25.7	
25.0-29.9	25.2	25.5	23.8	23.0	23.1	23.4	23.7	22.8	23.0	23.1	23.4	23.7	22.8	24.3	
30.0-34.9	16.9	21.0	25.4	26.6	26.6	27.0	28.3	29.0	26.6	26.6	27.0	28.3	29.0	24.0	
35.0-39.9	12.5	20.0	28.8	31.5	30.9	30.4	31.5	31.3	31.5	30.9	30.4	31.5	31.3	26.0	
Race/Ethnicity, %															
Non-Hispanic White	27.0	29.4	24.8	23.0	23.5	24.2	23.8	23.0	23.0	23.5	24.2	23.8	23.0	26.1	
Black	4.5	4.4	5.4	6.9	9.0	11.5	15.6	19.1	6.9	9.0	11.5	15.6	19.1	5.9	
Hispanic	21.6	26.9	37.6	43.1	43.1	41.6	39.2	36.1	43.1	43.1	41.6	39.2	36.1	34.9	
Asian/Pacific Islander	21.6	14.1	8.5	5.5	4.0	2.8	2.1	2.2	5.5	4.0	2.8	2.1	2.2	9.6	
Others	2.1	1.8	1.6	1.5	1.6	1.7	1.8	2.3	1.5	1.6	1.7	1.8	2.3	1.7	
Unknown	23.3	23.4	22.2	20.1	18.9	18.2	17.5	17.3	20.1	18.9	18.2	17.5	17.3	21.8	
Neighborhood education, * %															
Less than High school	19.3	19.9	23.6	26.0	27.0	27.7	29.0	29.4	26.0	27.0	27.7	29.0	29.4	23.1	
High school graduate	19.5	19.5	20.8	21.7	22.2	22.5	22.8	22.9	21.7	22.2	22.5	22.8	22.9	20.6	
Some college or associate degree	31.2	30.9	30.7	30.7	30.7	30.6	30.2	30.1	30.7	30.7	30.6	30.2	30.1	30.8	
Bachelor degree or higher	30.1	29.7	24.9	21.6	20.2	19.1	18.0	17.5	21.6	20.2	19.1	18.0	17.5	25.5	
Neighborhood income, * %															
< \$15,000	10.2	10.3	11.0	11.5	11.9	12.5	13.3	13.9	11.5	11.9	12.5	13.3	13.9	11.0	
\$15,000 to \$34,999	17.8	18.1	19.5	20.5	21.2	21.8	22.6	23.0	20.5	21.2	21.8	22.6	23.0	19.4	
\$35,000 to \$49,999	14.0	14.1	14.8	15.3	15.5	15.8	15.9	16.0	15.3	15.5	15.8	15.9	16.0	14.7	
\$50,000 to \$74,999	19.9	20.0	20.3	20.5	20.4	20.4	20.3	20.0	20.5	20.4	20.4	20.3	20.0	20.3	

Weight class:	Under weight		Normal weight		Overweight		Obesity					Total
	18.5	18.5–24.9	25.0–29.9	30.0–34.9	35.0–39.9	40.0–49.9	Class 1	Class 2	Class 3	Class 4	Class 5	
BMI range (kg/m²):												
\$75,000 to \$99,999	14.1	14.0	13.7	13.3	13.1	12.8	12.3	12.1	13.6			
\$100,000 to \$149,999	14.6	14.3	13.2	12.4	11.9	11.3	10.7	10.2	13.3			
\$150,000 or more	9.5	9.1	7.5	6.4	5.9	5.4	4.9	4.7	7.7			

* Neighborhood household income and neighborhood education are area-based measures retrieved through linkage of a member's address with U.S. census track

Table 2

Prevalence of overweight and obesity in young adults overall and by age group

Weight class: BMI range (kg/m ²):	Overweight					Obesity					Total			
	Class 1 25.0-29.9	Class 2 30.0-34.9	Class 3 35.0-39.9	Class 4 40.0-49.9 ²	Class 5 50.0-59.9	Class 1 60.0	Class 2 60.0	Class 3 60.0	Class 4 60.0	Class 5 60.0	n	%		
Age 20-29.9 y	n	%	n	%	n	%	n	%	n	%	n	%		
	262,702	53.4	128,952	26.2	58,866	12.0	34,888	7.1	5,200	1.1	1,002	0.2	491,610	100.0
Sex														
Male	139,314	53.0	67,045	52.0	26,213	44.5	13,158	37.7	1,787	34.4	397	39.6	247,914	50.4
Female	123,388	47.0	61,907	48.0	32,653	55.5	21,730	62.3	3,413	65.6	605	60.4	243,696	49.6
Race/Ethnicity														
Non-Hispanic White	66,724	25.4	29,215	22.7	13,161	22.4	7,807	22.4	1,162	22.3	198	19.8	118,267	24.1
Black	14,590	5.6	8,643	6.7	4,879	8.3	3,763	10.8	770	14.8	186	18.6	32,831	6.7
Hispanic	96,075	36.6	54,934	42.6	25,900	44.0	15,138	43.4	2,111	40.6	390	38.9	194,548	39.6
Asian/Pacific Islander	19,348	7.4	7,069	5.5	2,501	4.3	1,053	3.0	116	2.2	17	1.7	30,104	6.1
Others	4,188	1.6	1,862	1.4	950	1.6	590	1.7	93	1.8	26	2.6	7,709	1.6
Unknown	61,777	23.5	27,229	21.1	11,475	19.5	6,537	18.7	948	18.2	185	18.5	108,151	22.0
Age 30-39.9 y	n	%	n	%	n	%	n	%	n	%	n	%	n	%
	311,342	49.7	179,165	28.6	79,657	12.7	46,995	7.5	7,727	1.2	1,521	0.2	626,407	100.0
Sex														
Male	176,601	56.7	101,120	56.4	37,529	47.1	17,912	38.1	2,634	34.1	534	35.1	336,330	53.7
Female	134,741	43.3	78,045	43.6	42,128	52.9	29,083	61.9	5,093	65.9	987	64.9	290,077	46.3
Race/Ethnicity														
Non-Hispanic White	75,378	24.2	41,627	23.2	19,339	24.3	11,983	25.5	1,912	24.7	382	25.1	150,621	24.1
Black	16,158	5.2	12,523	7.0	7,609	9.6	5,677	12.1	1,250	16.2	297	19.5	43,514	7.0
Hispanic	119,796	38.5	77,797	43.4	33,836	42.5	18,893	40.2	2,962	38.3	521	34.3	253,805	40.5
Asian/Pacific Islander	29,424	9.5	9,797	5.5	3,012	3.8	1,270	2.7	151	2.0	38	2.5	43,692	7.0
Others	4,790	1.5	2,745	1.5	1,211	1.5	808	1.7	136	1.8	31	2.0	9,721	1.6
Unknown	65,796	21.1	34,676	19.4	14,650	18.4	8,364	17.8	1,316	17.0	252	16.6	125,054	20.0

Table 3

Prevalence, relative risks (RR) and 95% confidence intervals (CI) of dyslipidemia in young adults overall and by age group

	All					Age 20-29.9 y					Age 30-39.9 y					
	n	%	RR	95% CI	n	%	RR	95% CI	n	%	RR	95% CI	n	%	RR	95% CI
All ages	33,975	1.9	--	--	5,218	0.6	1.00	--	28,757	3.2	--	--				
Sex																
Male	21,297	2.6	1.89	(1.85-1.93)	2,746	0.7	1.36	(1.29-1.44)	18,551	4.4	2.01	(1.96-2.06)				
Female	12,678	1.3	1.00	Ref.	2,472	0.5	1.00	Ref.			1.00	Ref.				
Age group, y																
20.0-24.9	1,811	0.4	1.00	Ref.												
25.0-29.9	3,407	0.8	1.77	(1.68-1.88)												
30.0-34.9	8,945	2.0	4.27	(4.06-4.49)												
35.0-39.9	19,812	4.2	8.40	(8.01-8.82)												
Race/Ethnicity																
Non-Hispanic White	8,329	1.8	1.00	Ref.	1,353	0.6	1.00	Ref.	6,976	3.0	1.00	Ref.				
Black	2,466	2.3	1.11	(1.06-1.16)	354	0.7	0.98	(0.87-1.10)	2,112	3.9	1.14	(1.08-1.19)				
Hispanic	13,792	2.2	1.06	(1.03-1.09)	2,096	0.7	0.97	(0.91-1.04)	11,696	3.6	1.07	(1.04-1.10)				
Asian/Pacific Islander	3,997	2.3	1.60	(1.54-1.66)	578	0.7	1.55	(1.41-1.71)	3,419	3.6	1.60	(1.54-1.67)				
Others	704	2.3	1.37	(1.27-1.48)	124	0.8	1.44	(1.20-1.73)	580	3.8	1.36	(1.25-1.47)				
Unknown	4,687	1.2	0.64	(0.62-0.66)	713	0.3	0.56	(0.51-0.61)	3,974	2.2	0.66	(0.63-0.68)				
BMI, kg/m²																
<18.5	96	0.3	0.55	(0.45-0.67)	39	0.2	0.72	(0.53-1.00)	57	0.6	0.48	(0.37-0.62)				
18.5-24.9	4,721	0.7	1.00	Ref.	955	0.2	1.00	Ref.	3,766	1.4	1.00	Ref.				
25.0-29.9	10,758	1.9	1.91	(1.84-1.98)	1,441	0.5	2.07	(1.91-2.25)	9,317	3.0	1.85	(1.78-1.92)				
30.0-34.9	9,091	3.0	2.88	(2.77-2.98)	1,266	1.0	3.68	(3.38-4.01)	7,825	4.4	2.71	(2.60-2.82)				
35.0-39.9	5,165	3.7	3.88	(3.73-4.04)	841	1.4	5.49	(5.00-6.03)	4,324	5.4	3.60	(3.44-3.76)				
40.0-49.9	3,429	4.2	4.64	(4.44-4.85)	541	1.6	6.10	(5.48-6.78)	2,888	6.1	4.36	(4.15-4.57)				
50.0-59.9	584	4.5	4.97	(4.57-5.40)	112	2.2	8.39	(6.90-10.19)	472	6.1	4.46	(4.06-4.89)				
60	131	5.2	5.58	(4.73-6.59)	23	2.3	8.82	(5.86-13.27)	108	7.1	5.10	(4.25-6.12)				

Table 4

Prevalence, relative risks (RR) and 95% confidence intervals (CI) of hypertension in young adults overall and by age group

	All				Age 20–29.9 y				Age 30–39.9 y			
	n	%	RR	95% CI	n	%	RR	95% CI	n	%	RR	95% CI
All ages	60,027	3.3	--	--	11,985	1.3	--	--	48,042	5.3	--	--
Sex												
Male	31,319	3.8	1.32	(1.30–1.34)	6,360	1.6	1.50	(1.45–1.56)	24,959	5.9	1.28	(1.26–1.31)
Female	28,708	2.9	1.00	Ref.	5,625	1.1	1.00	Ref.	23,083	4.8	1.00	Ref.
Age group, y												
20.0–24.9	4,293	0.9	1.00	Ref.								
25.0–29.9	7,692	1.7	1.68	(1.62–1.75)								
30.0–34.9	15,963	3.7	3.16	(3.06–3.27)								
35.0–39.9	32,079	6.8	5.43	(5.26–5.60)								
Race/Ethnicity												
Non-Hispanic White	17,108	3.6	1.00	Ref.	3,638	1.5	1.00	Ref.	13,470	5.8	1.00	Ref.
Black	8,683	8.1	1.59	(1.55–1.63)	1,579	3.0	1.46	(1.38–1.55)	7,104	13.1	1.63	(1.59–1.67)
Hispanic	18,597	2.9	0.69	(0.67–0.70)	3,782	1.2	0.63	(0.60–0.66)	14,815	4.5	0.70	(0.69–0.72)
Asian/Pacific Islander	5,937	3.4	1.31	(1.27–1.35)	1,033	1.3	1.11	(1.03–1.18)	4,904	5.1	1.35	(1.31–1.40)
Others	1,407	4.7	1.28	(1.22–1.34)	298	2.0	1.26	(1.12–1.41)	1,109	7.4	1.28	(1.21–1.36)
Unknown	8,295	2.1	0.59	(0.57–0.60)	1,655	0.8	0.48	(0.46–0.51)	6,640	3.6	0.62	(0.60–0.63)
BMI, kg/m²												
<18.5	240	0.7	0.87	(0.77–0.99)	127	0.5	1.28	(1.07–1.53)	113	1.2	0.66	(0.55–0.80)
18.5–24.9	6,627	1.0	1.00	Ref.	1,800	0.5	1.00	Ref.	4,827	1.8	1.00	Ref.
25.0–29.9	14,186	2.5	2.08	(2.02–2.14)	2,610	1.0	2.00	(1.88–2.13)	11,576	3.7	2.07	(2.00–2.14)
30.0–34.9	15,330	5.0	4.04	(3.92–4.16)	2,723	2.1	4.25	(4.00–4.51)	12,607	7.0	3.95	(3.82–4.08)
35.0–39.9	10,894	7.9	6.47	(6.28–6.67)	2,056	3.5	7.18	(6.74–7.65)	8,838	11.1	6.25	(6.04–6.47)
40.0–49.9	9,806	12.0	9.80	(9.50–10.10)	1,979	5.7	11.73	(11.01–12.51)	7,827	16.7	9.31	(8.99–9.64)
50.0–59.9	2,313	17.9	13.54	(12.97–14.12)	525	10.1	19.88	(18.11–21.82)	1,788	23.1	12.41	(11.82–13.03)
60	631	25.0	17.25	(16.20–18.37)	165	16.5	30.47	(26.39–35.17)	466	30.6	15.43	(14.32–16.63)

Table 5

Prevalence, relative risks (RR) and 95% confidence intervals (CI) of diabetes in young adults overall and by age group

	All					Age 20–29.9 y					Age 30–39.9 y					
	n	%	RR	95% CI	n	%	RR	95% CI	n	%	RR	95% CI	n	%	RR	95% CI
All ages	28,545	1.57	--	--	7,061	0.78	--	--	21,484	2.36	--	--				
Sex																
Male	13,802	1.69	1.14	(1.11–1.16)	3,118	0.80	1.05	(1.00–1.10)	10,684	2.52	1.16	(1.13–1.19)				
Female	14,743	1.47	1.00	Ref.	3,943	0.76	1.00	Ref.	10,800	2.22	1.00	Ref.				
Age group, y																
20.0–24.9	3,020	0.65	1.00	Ref.												
25.0–29.9	4,041	0.92	1.26	(1.20–1.32)												
30.0–34.9	7,577	1.73	2.16	(2.07–2.25)												
35.0–39.9	13,907	2.94	3.51	(3.37–3.65)												
Race/Ethnicity																
Non-Hispanic White	7,102	1.50	1.00	Ref.	2,171	0.90	1.00	Ref.	4,931	2.13	1.00	Ref.				
Black	2,727	2.54	1.24	(1.18–1.29)	715	1.35	1.19	(1.10–1.30)	2,012	3.71	1.26	(1.20–1.33)				
Hispanic	12,046	1.90	1.09	(1.06–1.13)	2,615	0.85	0.80	(0.75–0.84)	9,431	2.87	1.22	(1.18–1.26)				
Asian/Pacific Islander	2,935	1.68	1.50	(1.44–1.57)	583	0.74	0.96	(0.88–1.06)	2,352	2.44	1.77	(1.68–1.86)				
Others	675	2.24	1.47	(1.361.59)	194	1.28	1.37	(1.19–1.59)	481	3.19	1.51	(1.38–1.66)				
Unknown	3,060	0.77	0.53	(0.51–0.55)	783	0.37	0.40	(0.37–0.44)	2,277	1.24	0.59	(0.56–0.62)				
BMI, kg/m²																
<18.5	141	0.43	0.80	(0.68–0.95)	93	0.40	0.96	(0.78–1.18)	48	0.49	0.57	(0.43–0.76)				
18.5–24.9	4,022	0.60	1.00	Ref.	1,665	0.42	1.00	Ref.	2,357	0.86	1.00	Ref.				
25.0–29.9	6,532	1.14	1.63	(1.57–1.70)	1,676	0.64	1.48	(1.38–1.58)	4,856	1.56	1.77	(1.69–1.86)				
30.0–34.9	6,895	2.24	3.09	(2.97–3.22)	1,434	1.11	2.54	(2.37–2.73)	5,461	3.05	3.48	(3.31–3.65)				
35.0–39.9	5,287	3.82	5.36	(5.14–5.59)	1,038	1.76	3.99	(3.69–4.32)	4,249	5.33	6.20	(5.89–6.53)				
40.0–49.9	4,466	5.45	7.76	(7.43–8.10)	898	2.57	5.76	(5.31–6.25)	3,568	7.59	9.01	(8.55–9.49)				
50.0–59.9	977	7.56	10.48	(9.79–11.22)	201	3.87	8.39	(7.27–9.70)	776	10.04	11.93	(11.03–12.91)				
60	225	8.92	12.14	(10.69–13.78)	56	5.59	11.97	(9.24–15.51)	169	11.11	13.09	(11.30–15.16)				

Table 6

Prevalence, relative risks (RR) and 95% confidence intervals (CI) of Metabolic Syndrome in young adults overall and by age group

	All					Age 20–29.9 y					Age 30–39.9 y					
	n	%	RR	95% CI	n	%	RR	95% CI	n	%	RR	95% CI	n	%	RR	95% CI
All ages	76,468	4.20	--	--	18,399	2.02	--	--	58,069	6.38	--	--				
Sex																
Male	38,805	4.76	1.14	(1.12–1.15)	8,697	2.23	1.08	(1.05–1.12)	30,108	7.09	1.15	(1.14–1.17)				
Female	37,663	3.75	1.00	Ref.	9,702	1.87	1.00	Ref.	27,961	5.76	1.00	Ref.				
Age group, y																
20.0–24.9	6,881	1.47	1.00	Ref.												
25.0–29.9	11,518	2.61	1.41	(1.37–1.45)												
30.0–34.9	21,573	4.93	2.29	(2.23–2.35)												
35.0–39.9	36,496	7.72	3.32	(3.24–3.40)												
Race/Ethnicity																
Non-Hispanic White	20,131	4.25	1.00	Ref.	4,831	1.99	1.00	Ref.	15,300	6.60	1.00	Ref.				
Black	5,841	5.45	0.81	(0.79–0.83)	1,279	2.42	0.73	(0.69–0.77)	4,562	8.41	0.83	(0.81–0.86)				
Hispanic	33,416	5.26	0.96	(0.94–0.97)	8,299	2.70	0.91	(0.88–0.94)	25,117	7.65	0.97	(0.95–0.98)				
Asian/Pacific Islander	5,900	3.37	1.43	(1.39–1.46)	1,261	1.60	1.27	(1.19–1.34)	4,639	4.82	1.46	(1.42–1.50)				
Others	1,577	5.22	1.18	(1.121.23)	408	2.70	1.21	(1.10–1.34)	1,169	7.75	1.16	(1.10–1.23)				
Unknown	9,603	2.42	0.59	(0.57–0.60)	2,321	1.09	0.53	(0.51–0.56)	7,282	3.95	0.60	(0.59–0.62)				
BMI, kg/m²																
<18.5	49	0.15	0.65	(0.49–0.86)	30	0.13	1.34	(0.92–1.94)	19	0.20	0.40	(0.25–0.63)				
18.5–24.9	1,708	0.26	1.00	Ref.	384	0.10	1.00	Ref.	1,324	0.48	1.00	Ref.				
25.0–29.9	6,480	1.13	3.90	(3.70–4.12)	1,086	0.41	4.13	(3.67–4.64)	5,394	1.73	3.58	(3.37–3.80)				
30.0–34.9	30,010	9.74	32.93	(31.36–34.58)	6,742	5.23	51.94	(46.86–57.57)	23,268	12.99	27.16	(25.69–28.70)				
35.0–39.9	19,614	14.16	48.86	(46.51–51.33)	4,980	8.46	84.70	(76.34–93.96)	14,634	18.37	39.24	(37.10–41.50)				
40.0–49.9	14,840	18.12	63.45	(60.37–66.68)	4,060	11.64	117.59	(105.93–130.53)	10,780	22.94	49.98	(47.24–52.89)				
50.0–59.9	3,058	23.66	81.05	(76.62–85.73)	881	16.94	170.33	(151.55–191.44)	2,177	28.17	61.90	(58.05–66.02)				
60	709	28.10	92.79	(86.05–100.06)	236	23.55	237.86	(204.92–276.08)	473	31.10	67.10	(61.29–73.45)				