Risk Factors for Obesity in Children and Adults

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Objectives: The purpose of this study was to determine whether modifiable lifestyle factors such as eating habits, physical activity, and screen-viewing time, as well as ethnicity, sex, and family income level, were associated with obesity in children and adults and whether the associations differed across age groups.

Participants: The data were drawn from the National Health and Nutrition Examination Survey 2009–2010.

Results: Multivariable logistic regression analyses were used, with obesity (defined as a body mass index of >30 kg/m^2 for adults and ≥95th percentile for children of the same age and sex) as the outcome variable. For children, screen-viewing (TV/computer) time was the only significant factor; in contrast, for adolescents, eating habits were the only significant predictor. For young and middle-aged adults, lack of physical exercise and time spent in sedentary activities were the determinants of obesity, whereas for older adults, both eating habits and physical activity measures were related to obesity.

Conclusions: Distinct lifestyle factors have significant associations with obesity in different age groups, and this study underscores the need for age-specific intervention programs to address the obesity epidemic.

Key Words: Obesity, modifiable risk factor, screen viewing time, physical activity, dietary habits

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Obesity rates in the United States are among the highest in the world, with 36% of US adults and 18% of children classified as obese,[1] and obesity increases the risks for many health conditions, including coronary heart disease, type 2 diabetes, cancer, hypertension, stroke, liver diseases, breathing problems, arthritis, and reproductive problems.[2] Obesity can also cause premature death, with an estimated 300,000 deaths annually attributed to obesity. In addition, obesity has serious economic consequences[3] and significantly impacts the US health care system.[4] A recent study[5] forecast an additional $550 billion in health care spending from now to 2030 as a result of rising obesity rates.

Research has shown that obesity is linked to genetics.[6] In trying to address the problem of widespread obesity, however, it is important to focus on modifiable nongenetic risk factors for obesity. Among these are food and dietary habits, physical exercise, and time spent in sedentary activity, watching TV, and playing computer games and video games. It has been shown that consumption of meals not prepared at home contributes to obesity, because these meals tend to have a higher caloric capacity and more fat and sugar.[7] Studies have also shown that time spent staring at a screen is correlated to weight gain.[8] The link between obesity and physical exercise is well established,[9] and furthermore, it has been documented that physical activity declines with age, with 42% of children aged 6 to 11 years getting the recommended 60 minutes a day of physical activity, but only about 8% of adolescents aged 12 to 15 years and only 5% of adults achieving the same amount of exercise.[10] Although previous research has identified several risk factors for obesity independently, no study has examined all of them together to identify which of these risk factors are the most significant predictors of obesity so that appropriate intervention programs can be designed. In addition, because different risk factors may play a significant role in different age groups, it is critical to determine these risk factors as a function of age, so that obesity can be targeted more effectively by designing lifestyle intervention programs that are tailor-made for each age group. Furthermore, it is important to determine which lifestyle factors are most predictive of illnesses such as cardiovascular disease and diabetes in the obese group.

This study will therefore determine whether modifiable lifestyle factors such as eating habits, physical activity, and screen-viewing time, as well as ethnicity, sex, and family income level, were associated with obesity in children and adults and whether the associations differed across age groups. It will also examine, in the obese group, which of these risk factors are most predictive of medical problems such as diabetes and hypertension.

METHODS

Data were obtained from the National Health and Nutrition Examination Survey (NHANES) 2009–2010.[11] The NHANES 2009–2010 was used because it is the latest survey that had data for all lifestyle factors of interest. The demographics, body measurements, diabetes, hypertension, physical activity, diet, behavior, and nutrition data sets from NHANES Web site were used. The detailed questionnaires and survey methodology, as well as the data, are publicly available.[12]

Measures

Obesity was measured using body mass index (BMI). While BMI ignores fat distribution within the body and the relative fat-muscle-bone contributions to total body weight, it provides a relatively reliable indicator of body fatness and weight categories that may lead to health problems. Body mass index was calculated as weight in kilograms divided by height in meters squared. As recommended by the Centers for Disease Control and Prevention, for children and adolescents, obesity was defined as a BMI at or greater than the 95th percentile for subjects of the same age and sex, obtained from the Centers for Disease Control and Prevention growth charts.[13,14] For adults, obesity was defined as BMI of greater than 30 kg/m^2, the standard cut point. Obesity was used as the primary outcome measure of interest.

Screen time was measured as the number of hours per day of television and computer screen viewing. The number of meals per week from a fast-food place or a pizza place was used as a measure of eating habits. Participation in physical exercise was measured as the number of minutes per day that the participant engaged in vigorous or moderate physical activity.

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Sedentary activity levels were measured as the number of hours a day performing sedentary activities. All of these measures were obtained by self-report by NHANES and were used as the lifestyle risk factors in the analyses. Screen time data were available only for subjects younger than 12 years, and physical and sedentary activity levels were available only for subjects older than 12 years.

Age, sex, ethnicity, and income level of the family were also obtained by self-report and were used as covariates in the models.

Data Analysis

Respondents were classified into children (7–11 years), adolescents (12–18 years), young adults (19–30 years), middle-aged adults (31–50 years), older adults (51–65 years), and seniors (66–80 years). Logistic regressions were used to determine which lifestyle factors (screen time, fast-food meals, physical activity levels, sedentary activity levels) were associated with obesity, controlling for sex, ethnicity, and income level. Stratified analyses were performed within each age group. Interaction terms between the lifestyle factors and covariates noted above were examined in the logistic regressions and were not retained in the final models because none were significant. Correlations between all independent variables (both lifestyle factors and covariates) were also examined, but no correlation coefficient exceeded 0.15. All available lifestyle factors were retained in the final models. Results are presented in terms of adjusted odds ratios (ORs) and 95% confidence intervals (CIs). Frequency tables and χ^2 tests were used to determine the association of obesity with diabetes and hypertension. Logistic regressions were also used to determine the lifestyle risk factors for developing these medical problems within the obese group. All analyses were performed using SAS software (version 9.2; SAS Institute Inc., Cary, NC).

RESULTS

There were 7431 subjects who had data on the measures of interest in the NHANES database. There were 930 children, 1026 adolescents, 1149 young adults, 1850 middle-aged adults, 1277 older adults, and 1199 seniors (Table 1). Overall, 34.0% of subjects were classified as obese by BMI criteria, and within the various age groups, 23.9% of children, 22.2% of adolescents, 28.6% of young adults, 40.7% of middle-aged adults, 44.1% of older adults, and 36.3% of seniors were found to be obese.

Table 2 presents a summary of the risk factors for obesity for each of the age groups of interest. For children from 7 to 11 years old, logistic regression revealed that the number of hours per day spent watching television, videos, or a computer (hours of screen time) was a significant predictor of obesity ($P = 0.01$). For every 3-hour increase in daily screen time, the odds of obesity increased by 50% (adjusted OR, 1.5; 95% CI, 1.2–1.8).

For subjects 12 years or older, the number of meals that were from a fast-food place was a significant predictor of obesity. Those who consumed more than 3 such meals per week were 20% more likely to be obese compared with those who consumed fewer outside meals (OR, 1.2; 95% CI, 1.0–1.3; $P < 0.01$). Subjects who did not participate in vigorous or moderate activity were 1.2 times more likely to be obese compared with those who did for at least an hour each day (OR, 1.2; 95% CI, 1.1–1.3; $P < 0.0001$). In addition, those spending 8 hours a day performing sedentary activities were 1.3 times more likely to be obese compared with those who spent less time in these activities (OR, 1.3; 95% CI, 1.1–1.5; $P = 0.0001$). Females were more likely than males to be obese (OR, 1.2; 95% CI, 1.0–1.3; $P = 0.01$), and Hispanic/African American subjects were

TABLE 1. Demographic and Other Characteristics of the Study Subjects

	Children		Adolescents		Young Adults		Middle-Aged Adults		Older Adults		Seniors	
	Nonobese	Obese	Nonobese	Obese	Nonobese	Obese	Nonobese	Obese	Nonobese	Obese	Nonobese	Obese
Characteristic	**n = 708**	**n = 222**	**n = 798**	**n = 228**	**n = 820**	**n = 329**	**n = 1098**	**n = 752**	**n = 714**	**n = 563**	**n = 764**	**n = 435**
Sex												
Male	358 (50.6%)	118 (53.1%)	417 (52.3%)	124 (54.5%)	402 (49.0%)	143 (43.5%)	525 (47.8%)	344 (45.7%)	389 (54.5%)	255 (45.3%)	402 (52.6%)	198 (45.5%)
Female	350 (49.4%)	104 (46.9%)	381 (47.7%)	104 (45.6%)	418 (51.0%)	186 (56.6%)	573 (52.2%)	408 (54.3%)	325 (45.5%)	308 (54.7%)	362 (47.4%)	237 (54.5%)
Ethnicity												
White	259 (36.6%)	60 (27.0%)	289 (36.3%)	67 (29.4%)	374 (45.6%)	110 (33.4%)	560 (51.0%)	338 (45.0%)	344 (48.2%)	243 (43.2%)	492 (64.4%)	271 (62.3%)
Hispanic	270 (38.1%)	91 (41.0%)	283 (35.4%)	93 (40.8%)	258 (31.5%)	105 (31.9%)	303 (27.6%)	225 (29.9%)	192 (26.9%)	173 (30.7%)	124 (16.2%)	72 (16.6%)
African American	128 (18.1%)	56 (25.2%)	170 (21.3%)	56 (24.5%)	126 (15.4%)	101 (30.7%)	144 (13.1%)	157 (20.9%)	140 (19.6%)	135 (24.0%)	102 (13.4%)	85 (19.5%)
Other*	51 (7.2%)	15 (6.8%)	56 (7.0%)	12 (5.3%)	62 (7.5%)	13 (4.0%)	91 (8.3%)	32 (4.2%)	38 (5.3%)	12 (2.1%)	46 (6.0%)	7 (1.6%)
Family income ($)												
0–34,999	314 (44.4%)	119 (53.6%)	348 (43.6%)	117 (51.3%)	396 (48.3%)	181 (55.0%)	428 (39.0%)	343 (45.6%)	282 (39.5%)	242 (43.0%)	380 (49.7%)	225 (51.7%)
35,000–74,999	201 (28.4%)	60 (27.0%)	228 (28.6%)	67 (29.4%)	231 (28.3%)	91 (27.7%)	309 (28.1%)	225 (29.9%)	200 (28.0%)	174 (30.9%)	256 (33.5%)	146 (33.6%)
≥75,000	193 (27.2%)	43 (19.4%)	222 (27.8%)	44 (19.3%)	193 (23.5%)	57 (17.3%)	361 (32.9%)	184 (24.5%)	232 (32.5%)	147 (26.1%)	128 (16.8%)	64 (14.7%)

*Including multiracial.

TABLE 2. Adjusted ORs* for Predictors of Obesity by Age Group

	Children	Adolescents	Young Adults	Middle-Aged Adults	Older Adults	Seniors
Screen time‡	1.5 (1.2–1.8)†					
Eating habits§	0.9 (0.6–1.4)	1.6 (1.1–2.3)†	1.2 (0.5–1.6)	1.0 (0.8–1.2)	1.5 (1.1–1.9)†	1.2 (0.9–1.6)
Physical activity level¶		1.0 (0.9–1.1)	1.2 (1.0–1.4)†	1.2 (1.0–1.3)†	1.3 (1.1–1.6)†	1.2 (1.0–1.5)
Sedentary activity level**		1.1 (0.7–1.8)	1.6 (1.0–2.4)†	1.6 (1.2–2.1)†	1.8 (1.3–2.5)†	1.5 (1.0–2.1)†
Sex††	0.8 (0.6–1.2)	1.2 (0.8–1.6)	1.1 (0.8–1.5)	1.0 (0.8–1.2)	1.5 (1.1–1.8)†	1.3 (1.0–1.6)
Ethnicity‡‡						
Hispanic	1.2 (0.8–1.8)	1.8 (1.2–2.7)†	1.5 (1.0–2.1)†	1.2 (1.0–1.6)†	1.4 (1.0–1.8)†	1.1 (0.8–1.6)
African American	1.3 (0.8–2.1)	1.5 (0.9–2.3)	2.7 (1.9–4.0)†	1.8 (1.3–2.3)†	1.4 (1.0–1.9)†	1.5 (1.1–2.2)†
Other	1.2 (0.6–2.3)	1.3 (0.7–2.5)	0.6 (0.3–1.3)	0.6 (0.4–1.0)	0.3 (0.2-0.8)†	0.3 (0.1–0.7)†
Income level§§						
<$35,000	1.5 (1.0–2.4)	1.5 (1.0–2.3)	1.4 (1.0–2.0)	1.6 (1.3–2.0)†	1.4 (1.0–1.9)†	1.2 (0.8–1.8)
$35,000–$74,999	1.2 (0.8–2.0)	1.4 (0.9–2.3)	1.3 (0.9–2.0)	1.5 (1.1–1.9)†	1.4 (1.0–1.9)†	1.1 (0.8–1.6)

*Adjusted ORs (95% CIs) are presented. For children, the final model included screen time, eating habits, sex, ethnicity, and income levels as predictors; for all other subject groups, the final model included eating habits, physical and sedentary activity level, sex, ethnicity, and income level as predictors.

†$P < 0.05$.

‡Adjusted OR for every 3-hour increase in screen time.

§Reference group = subjects who ate less than 3 fast-food meals per week.

¶Reference group = subjects who participated in physical activity for less than an hour a day.

**Reference group = subjects who were sedentary for less than 8 hours a day.

††Reference group = male.

‡‡Reference group = white.

§§Reference group = $75,000 or greater.

more likely than whites to be obese (Hispanic: OR, 1.3; 95% CI, 1.1–1.5; African American: OR, 1.7; 95% CI, 1.4–1.9; $P < 0.0001$). Furthermore, those with an annual income less than $35,000 and from $35,000–$75,000 were more likely to be obese than those with income greater than $75,000 (OR, 1.3; 95% CI, 1.1–1.5; $P = 0.0005$).

Within the 12- to 18-year-olds, eating habits were the only significant predictor of obesity, with adolescents who consumed more than 3 fast-food meals weekly 1.6 times more likely to be obese (OR, 1.6; 95% CI, 1.1–2.3; $P = 0.03$). The physical activity levels were not significant. In contrast, for young and middle-aged adults, eating habits were not significant, but both lack of participation in exercise (young adults: OR, 1.2; 95% CI, 1.0–1.4; $P = 0.05$; middle-aged adults: OR, 1.2; 95% CI, 1.1–1.3; $P = 0.003$) and time spent in sedentary positions (young adults: OR, 1.6; 95% CI, 1.1–2.4; $P = 0.02$; middle-aged adults: OR, 1.6; 95% CI, 1.2–2.1; $P = 0.0004$) were significant.

For older adults, both eating habits and activity measures were significant predictors of obesity. Older adults who consumed more than 3 fast-food or pizza meals per week were more likely to be obese (OR, 1.5; 95% CI, 1.1–1.9; $P = 0.007$); those who did not exercise at least an hour a day were more likely to be obese (OR, 1.3; 95% CI, 1.1–1.6; $P = 0.003$), and those who spent more time in sedentary activities were also more likely to be obese (OR, 1.8; 95% CI, 1.3–2.5; $P = 0.0004$). However, for seniors 65 years or older, only sedentary activity was a significant risk factor for obesity (OR, 1.5; 95% CI, 1.0–2.1; $P = 0.03$).

The presence of serious medical problems was significantly associated with obesity. Nearly 1 in 5 obese subjects (17.7%) had diabetes, whereas among the nonobese, only 6.0% had diabetes ($\chi^2_1 = 252.2$, $P < 0.0001$). Almost half (49.4%) of the obese subjects had diagnosed hypertension, whereas 28.3% of the nonobese had this medical condition ($\chi^2_1 = 267.3$, $P < 0.0001$). Within the obese group, sedentary activity levels were a significant risk factor for both diabetes and hypertension (diabetes: OR, 1.5; 95% CI, 1.1–2.1; $P = 0.01$; hypertension: OR, 1.3; 95% CI, 1.0–1.6; $P = 0.05$). The other lifestyle factors did not reach significance (Table 3).

DISCUSSION

This is one of the first studies to examine the relationship of obesity to lifestyle factors, in addition to sex, ethnicity, and income levels, using a nationally representative sample. This study reveals that time spent in front of a screen (TV/computer) is the most important factor associated with obesity for children; in contrast, for adolescents, eating habits were the most significant predictor. For young and middle-aged adults, lack of physical exercise and time spent in sedentary activities were important determinants of obesity, whereas for older adults, both eating habits and physical activity measures were related to obesity.

Because screen time is the most important predictor for children, programs targeting obese children should focus on reducing time spent viewing TV or playing computer games. For adolescents, obesity prevention programs should center on healthier diet tips. Young and middle-aged adults should be encouraged to engage in more physical activities and take routine breaks from sedentary activities. For older adults, programs must target both exercise and diet for the optimal management of obesity. In diabetes treatment studies, lifestyle interventions involving diet and exercise have been shown to be successful.[15] Similar interventions, along the lines proposed above for the different age groups, can be offered for the obese population. The current challenge lies in using findings from research such as the current study to inform routine clinical practice and

TABLE 3. Adjusted ORs* for Predictors of Diabetes/ Hypertension in the Obese Group

	Diabetes	Hypertension
Eating habits‡	0.9 (0.7–1.2)	1.0 (0.8–1.3)
Physical activity level§	0.9 (0.8–1.0)	1.0 (0.9–1.1)
Sedentary activity level¶	1.5 (1.1–2.1)†	1.3 (1.0–1.6)†
Age**	1.7 (1.6–1.9)†	1.8 (1.7–2.0)†
Sex††	0.8 (0.6–1.0)†	0.8 (0.7–1.0)
Ethnicity‡‡		
Hispanic	2.0 (1.5–2.6)†	0.8 (0.6–1.0)
African American	1.9 (1.4–2.6)†	1.7 (1.3–2.2)†
Other	2.2 (1.1–4.4)†	1.4 (0.8–2.5)
Income level§§		
<$35,000	1.4 (1.0–2.0)	1.3 (1.0–1.6)
$35,000–$74,999	1.3 (0.9–1.8)	1.3 (1.0–1.7)

*Adjusted ORs (95% CIs) are presented. The final model included eating habits, physical and sedentary activity level, age, sex, ethnicity, and income level as predictors.

†$P < 0.05$.

‡Reference group = subjects who ate less than 3 fast-food meals per week.

§Reference group = subjects who participated in physical activity for less than an hour a day.

¶Reference group = subjects who were sedentary for less than 8 hours a day.

**Adjusted OR for every 10-year increase in age.

††Reference group = male.

‡‡Reference group = white.

§§Reference group = $75,000 or greater.

fashion public health efforts to improve the health of obese individuals.

It is interesting to note that, in general, the older age groups (excluding seniors) have more significant predictors of obesity compared with the younger age groups. The life course approach[16,17] attempts to explain health patterns by postulating that health is cumulative and longitudinal, that is, developed over a lifetime. It is possible that the present study's findings of a larger number of significant predictors of obesity for older adults indicate that lifestyle behaviors early in the life course may lead to long-term health consequences, as would be predicted by the life course approach. Although a longitudinal study is required to study this possibility, the current cross-sectional study's findings reinforce the importance of educating children, adolescents, and adults to take greater responsibility in preserving their health and mitigating future problems by practicing positive lifestyle behaviors.

Strengths of the present study are that the sample is representative of the US population, includes respondents from a range of age groups, and is large enough to provide meaningful results in different age groups. Furthermore, this is one of the first studies to examine several identified risk factors of obesity in a multivariable model to determine the most significant ones so that these can be addressed for immediate results. However, there are several limitations to this study. First, the NHANES survey is a cross-sectional survey; only associations, and not causations, can be determined. Also, potential biases could have been introduced by the self-report of screen time, levels of physical activity, and meals consumed outside the home. Finally, we used BMI to classify participants as obese, because other measures of obesity such as waist-to-hip ratio are not collected by NHANES.

Future analyses can investigate whether other factors such as sleep measures and mental and emotional well-being also contribute to obesity. Nevertheless, the major finding that obesity is independently associated with different lifestyle factors in different age groups can be used to develop evidence-based public health care policy and programs.

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