Overweight and Components of the Metabolic Syndrome in College Students

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There is very little information on, and hence an urgent need to better understand, obesity and metabolic dysfunctions among U.S. college students, particularly as obesity rates have increased most rapidly among 18- to 29-year-old individuals and those with some college education (1,2). The National College Health Risk Behavior Survey suggests that as many as 35% of college students may be overweight or obese (3). We previously reported that 21.6% of a predominantly white student sample was overweight or obese (4).

In addition to obesity, the metabolic syndrome affects >20% of U.S. adults (5). Dyslipidemia and hypertension, both part of the metabolic syndrome, have been reported as significant problems in the college population (6,7). However, other metabolic parameters, such as hyperinsulinemia and glucose tolerance, and their associations with adiposity have not been well studied in this group. Thus, we aimed to examine, in a sample of college students, the relationships between weight status and components of the metabolic syndrome. In addition, we examined clinical correlates of percent body fat and total fat mass.

RESEARCH DESIGN AND METHODS

— As part of an ongoing study at the Watkins Memorial Health Center at the University of Kansas (Lawrence, KS), 163 students (18–24 years) provided data on anthropometry, body composition, blood pressure, fasting blood chemistries, and an oral glucose tolerance test (OGTT).

Anthropometric variables included weight, height, BMI, and waist and hip circumferences (average of three measures). Overweight was defined as BMI ≥25 kg/m^2. Total fat mass (kilograms) and percent body fat were measured by bioelectric impedance analysis (Tanita 300A; Tanita, Arlington Heights, IL). Systolic and diastolic blood pressure were taken twice in a sitting position. Fasting blood measures included glucose, insulin, triacylglycerol, total cholesterol, HDL cholesterol, and leptin. LDL and VLDL cholesterol levels were calculated. A 2-h OGTT was administered using a 75-g glucose load, and 2-h glucose and insulin were measured. With the exception of glucose, which was analyzed on site, all other serum blood measurements were analyzed by the Laboratory Corporation of America (Kansas City, MO, and Burlington, NC).

Components of the metabolic syndrome included abnormal waist circumference (≥102 cm in men and ≥88 cm in women), impaired fasting glucose (fasting glucose 6.1–7.0 mmol/l and 2-h glucose <7.8 mmol/l), impaired glucose tolerance (fasting glucose <6.1 mmol/l and 2-h glucose 7.8–11.1 mmol/l), impaired fasting insulin (>104.18 pmol/l, as a proxy of insulin resistance), hypertriacylglycerolemia (≥2.26 mmol/l), low HDL cholesterol (<1.04 mmol/l), and high blood pressure (systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg). In addition, high total cholesterol was defined as ≥5.18 mmol/l and high LDL cholesterol as ≥3.37 mmol/l.

Statistical analysis

ANCOVAs were conducted to compare anthropometric and metabolic indicators between normal-weight and overweight students, adjusting for age, sex, ethnicity (white versus nonwhite), and current smoking status (yes/no). Because not many individuals in this group were expected to have three or more components of the metabolic syndrome, a dichotomous variable indicating high risk of the metabolic syndrome was created based on the presence of at least one component of the metabolic syndrome. Logistic regression was then performed to model risk of the metabolic syndrome on weight status, adjusting for age, sex, ethnicity, and current smoking status. Finally, stepwise linear regression analyses were conducted to identify the demographic, anthropometric, and metabolic factors described above that were most highly associated with percent body fat and total fat mass. All analyses were performed using SAS version 8.2 (Cary, NC), with an α value of 0.05.

RESULTS

— The subjects were 22.2 ± 1.7 years of age (means ± SD). Seventy percent were female, 81% were white, and 26% were current smokers. Twenty-seven percent of the students were overweight, and 27% had at least one component of the metabolic syndrome (25.2% with one component, 1.2% with two components, and 0.6% with three components). The prevalence of individual components of the metabolic syndrome was 1.8% for abnormal waist circumference, 1.8% for impaired fasting glucose, 4.3% for impaired glucose tolerance, 4.3% for impaired fasting insulin, 2.5% for hypertriacylglycerolemia, 13.5% for low HDL cholesterol, and 1.2%

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Abbreviations: OGTT, oral glucose tolerance test.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Anthropometric and metabolic indicators in normal-weight versus overweight students*

Indicator	Normal weight (BMI <25 kg/m^2)	Overweight (BMI ≥25 kg/m^2)	*P*
n	119	44	
Waist circumference (cm)	72.5 ± 0.5	88.1 ± 0.9	<0.001
Hip circumference (cm)	98.0 ± 0.5	108.9 ± 0.8	<0.001
Total body fat (kg)	30.7 ± 1.0	56.3 ± 1.7	<0.001
Percent body fat (%)	21.9 ± 0.4	31.8 ± 0.7	<0.001
Systolic blood pressure (mmHg)	108.6 ± 0.7	112.2 ± 1.2	<0.02
Diastolic blood pressure (mmHg)	67.6 ± 0.5	70.2 ± 0.8	<0.01
Fasting glucose (mmol/l)	4.97 ± 0.04	5.12 ± 0.07	<0.06
2-h glucose (mmol/l)	5.16 ± 0.12	5.42 ± 0.21	NS
Fasting insulin (pmol/l)	39.59 ± 2.78	69.45 ± 4.86	<0.001
2-h insulin (pmol/l)	205.57 ± 10.42	257.66 ± 18.75	<0.02
Total cholesterol (mmol/l)	4.14 ± 0.08	4.49 ± 0.13	<0.05
HDL cholesterol (mmol/l)	1.47 ± 0.03	1.34 ± 0.05	<0.06
LDL cholesterol (mmol/l)	2.26 ± 0.07	2.61 ± 0.11	<0.01
VLDL cholesterol (mmol/l)	0.41 ± 0.02	0.53 ± 0.03	<0.01
Triacylglycerol (mmol/l)	0.91 ± 0.04	1.15 ± 0.07	<0.01
Leptin (ng/ml)	12.8 ± 1.1	29.4 ± 1.9	<0.001

Data are means ± SE. Adjusted for age, sex, ethnicity, and smoking status.

for high blood pressure. Additionally, 11.7% of students presented high total cholesterol and 5.5% had high LDL cholesterol. No student had type 2 diabetes based on the OGTT.

Table 1 compares the anthropometric and metabolic characteristics of normal-weight and overweight students, after adjusting for age, sex, ethnicity, and smoking status. Compared with normal-weight students, overweight students had greater waist and hip circumferences and higher blood pressure, fasting and 2-h insulin, fasting total cholesterol, LDL cholesterol, VLDL cholesterol, triacylglycerol, and leptin levels.

Logistic regression showed that compared with normal-weight students, overweight students were 2.9 times more likely to have at least one component of the metabolic syndrome (95% CI 1.3–6.4). Finally, stepwise linear regressions found that percent body fat (total R^2 = 0.87) was most strongly related to leptin (R^2 = 0.52, $P < 0.001$), waist circumference (R^2 = 0.26, $P < 0.001$), sex (R^2 = 0.06, $P < 0.001$), hip circumference (R^2 = 0.03, $P < 0.001$), 2-h glucose (R^2 = 0.004, $P < 0.05$), and LDL cholesterol (R^2 = 0.003, $P < 0.05$). Total fat mass (total R^2 = 0.90) was most strongly related to hip circumference (R^2 = 0.69, $P < 0.001$), sex (R^2 = 0.12, $P < 0.001$), waist circumference (R^2 = 0.08, $P < 0.001$), leptin (R^2 = 0.01, $P < 0.001$), and LDL cholesterol (R^2 = 0.003, $P < 0.05$).

CONCLUSIONS — This is one of the first studies to examine the associations between overweight and components of the metabolic syndrome in U.S. college students. Over 10% of our sample had abnormal total or HDL cholesterol or both. While type 2 diabetes was not observed, >6% had pre-diabetes. Being overweight increased the risk for experiencing at least one component of the metabolic syndrome by approximately threefold. In addition, leptin, LDL cholesterol, and waist and hip circumferences are significant clinical correlates of body fat. Our results echo findings from other U.S. surveys (6–9) showing that overweight and metabolic dysfunctions, particularly dyslipidemia and abnormal glucose and insulin metabolism, constitute a major health threat even at this young age. Furthermore, our findings are particularly alarming given the predominantly white and seemingly low-risk profile of our student sample and indicate the great importance of early screening, even in the absence of apparent disease. Colleges and universities are an important setting for the surveillance, prevention, and intervention of obesity and the metabolic syndrome.

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References

1. Mokdad AH, Serdula MK, Dietz WH, Bowman BA, Marks JS, Koplan JP: The spread of the obesity epidemic in the United States, 1991–1998. *JAMA* 282: 1519–1522, 1999
2. Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS, Marks JS: Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA* 289:76–79, 2003
3. Lowry R, Galuska DA, Fulton JE, Wechsler H, Kann L, Collins JL: Physical activity, food choice, and weight management goals and practices among US college students. *Am J Prev Med* 18:18–27, 2000
4. Huang TT, Harris KJ, Lee RE, Nazir N, Born W, Kaur H: Assessing overweight, obesity, diet, and physical activity in college students. *J Am Coll Health* 52:83–86, 2003
5. Park YW, Zhu S, Palaniappan L, Heshka S, Carnethon MR, Heymsfield SB: The metabolic syndrome: prevalence and associated risk factor findings in the US population from the Third National Health and Nutrition Examination Survey, 1988–1994. *Arch Intern Med* 163: 427–436, 2003
6. Spencer L: Results of a heart disease risk-factor screening among traditional college students. *J Am Coll Health* 50:291–296, 2002
7. Sparling PB, Snow TK, Beavers BD: Serum cholesterol levels in college students: opportunities for education and intervention. *J Am Coll Health* 48:123–127, 1999
8. Anding JD, Suminski RR, Boss L: Dietary intake, body mass index, exercise, and alcohol: are college women following the dietary guidelines for Americans? *J Am Coll Health* 49:167–171, 2001
9. Debate RD, Topping M, Sargent RG: Racial and gender differences in weight status and dietary practices among college students. *Adolescence* 36:819–833, 2001