Obesity, Inactivity, and the Prevalence of Diabetes and Diabetes-Related Cardiovascular Comorbidities in the U.S., 2000–2002

PATRICK W. SULLIVAN, PHD[1]
ELAINE H. MORRATO, MPH[1,2]
VAHRAM GHUSHCHYAN, MS[1]
HOLLY R. WYATT, MD[3]
JAMES O. HILL, PHD[3]

OBJECTIVE — Obesity and physical inactivity are established risk factors for type 2 diabetes and cardiovascular comorbidities. Whether adiposity or fitness level is more important to health is controversial. The objective of this research is to determine the relative associations of physical activity and BMI with the prevalence of diabetes and diabetes-related cardiovascular comorbidities in the U.S.

RESEARCH DESIGN AND METHODS — The Medical Expenditure Panel Survey (MEPS) is a nationally representative survey of the U.S. population. From 2000 to 2002, detailed information on sociodemographic characteristics and health conditions were collected for 68,500 adults. Normal weight was defined as BMI 18.5 to <25 kg/m^2, overweight 25 to ≤30 kg/m^2, obese (class I and II) 30 to <40 kg/m^2, and obese (class III) ≥40 kg/m^2. Physical activity was defined as moderate/vigorous activity ≥30 min ≥3 days per week.

RESULTS — The likelihood of having diabetes and diabetes-related cardiovascular comorbidities increased with BMI regardless of physical activity and increased with physical inactivity regardless of BMI. Compared with normal-weight active adults, the multivariate-adjusted odds ratio (OR) for diabetes was 1.52 (95% CI 1.25–1.86) for normal-weight inactive adults and 1.65 (1.40–1.96) for overweight inactive adults; the OR for diabetes and comorbid hypertension was 1.71 (1.32–2.19) for normal-weight inactive adults and 1.84 (1.47–2.32) for overweight inactive adults.

CONCLUSIONS — Both physical inactivity and obesity seem to be strongly and independently associated with diabetes and diabetes-related comorbidities. These results support continued research investigating the independent causal nature of these factors.

Diabetes Care 28:1599–1603, 2005

The prevalence of diabetes has been significantly increasing in the U.S. (1). Current estimates suggest that 6–8% of adults have diabetes, with the true prevalence likely closer to 10% when undiagnosed diabetes is also considered (2–4). Importantly, the prevalence of diabetes has increased nearly 50% over the last decade; >5 million U.S. adults are newly suffering from the disease (1,3). The burden of diabetes is significant in terms of human and economic costs and is expected to increase in the future (2,5,6).

Obesity and physical inactivity are well-established risk factors for the development of type 2 diabetes (7–11). It is estimated that for every 1-kg increase in weight, the prevalence of diabetes increases by 9% (1). Physical inactivity is associated with increased insulin resistance and poorer glycemic control independent of body weight (12).

Evidence from randomized controlled trials on three continents has clearly demonstrated that maintenance of modest weight loss through diet and physical activity reduces the incidence of type 2 diabetes in high-risk individuals by ~40–60% over 3–4 years (13–16). Lifestyle improvements, including weight control and increased physical activity, are also the cornerstone of diabetes management (11,12).

However, despite the known association of obesity and inactivity with diabetes-related morbidity and mortality, there is limited national data reporting the independent association of each risk factor with the prevalence of diabetes and related cardiovascular comorbidities in the U.S. population. The objective of this study was to determine the relative prevalence of diabetes and related cardiovascular comorbidities among overweight and inactive adults in a nationally representative population.

RESEARCH DESIGN AND METHODS

Data source

The Medical Expenditure Panel Survey (MEPS) is cosponsored by the Agency for Healthcare Research and Quality and the National Center for Health Statistics. The MEPS Household Component (HC), a na-

From the [1]Department of Clinical Pharmacy, School of Pharmacy, Pharmaceutical Outcomes Research Program, University of Colorado Health Sciences Center, Denver, Colorado; the [2]Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland; and the [3]Center for Human Nutrition, University of Colorado Health Sciences Center, Denver, Colorado.

Address correspondence and reprint requests to Patrick W. Sullivan, PhD, University of Colorado Health Sciences Center, School of Pharmacy, 4200 East 9th Ave., C238, Denver, CO 80262. E-mail: patrick.sullivan@uchsc.edu.

Received for publication 7 March 2005 and accepted in revised form 19 April 2005.

Abbreviations: MEPS, Medical Expenditure Panel Survey; MEPS-HC, MEPS Household Component.

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

Table 1—*Prevalence of diabetes, obesity, and physical activity by selected characteristics (MEPS 2000–2002)*

Selected characteristics	Diabetes	Obese (BMI ≥30 kg/m^2)	Active
Total	6.3 ± 0.16	23.5 ± 0.31	56.0 ± 0.41
Sex			
Men	6.4 ± 0.22	23.0 ± 0.43	60.1 ± 0.49
Women	6.2 ± 0.20	24.0 ± 0.36	52.2 ± 0.48
Age-groups (years)			
18–29	0.8 ± 0.09	17.0 ± 0.51	64.0 ± 0.63
30–39	2.0 ± 0.15	24.3 ± 0.54	57.5 ± 0.69
40–49	4.2 ± 0.22	26.7 ± 0.53	55.5 ± 0.61
50–59	9.5 ± 0.41	27.9 ± 0.68	52.8 ± 0.73
60–69	14.5 ± 0.59	27.5 ± 0.80	54.4 ± 0.99
≥70	15.9 ± 0.58	19.5 ± 0.63	45.2 ± 0.86
Race/ethnicity			
White	5.9 ± 0.15	22.8 ± 0.32	56.9 ± 0.44
Black	9.3 ± 0.51	33.5 ± 0.88	51.6 ± 1.15
Hispanic	6.8 ± 0.35	25.9 ± 0.76	51.5 ± 0.91
Asian, Pacific Islander, Native Hawaiian	5.03 ± 0.62	7.3 ± 0.93	51.2 ± 1.81
Native American, Aleut, Eskimo	9.1 ± 1.58	34.2 ± 2.85	48.3 ± 3.08
Education levels			
Less than high school	9.5 ± 0.39	25.8 ± 0.58	47.8 ± 0.69
High school	6.0 ± 0.19	25.4 ± 0.39	55.9 ± 0.50
Some college (<4 years)	4.8 ± 0.50	25.4 ± 0.97	58.3 ± 1.04
College degree (4 years)	4.7 ± 0.31	18.0 ± 0.59	61.2 ± 0.65
Graduate degree (>4 years)	4.1 ± 0.42	15.2 ± 0.85	64.3 ± 1.09
Smoking status			
Not current	6.5 ± 0.18	24.2 ± 0.36	57.0 ± 0.44
Current	5.0 ± 0.25	20.1 ± 0.51	52.6 ± 0.69
BMI			
Normal (18.5–24.9 kg/m^2)	3.1 ± 0.14	—	62.5 ± 0.55
Overweight (25.0–29.9 kg/m^2)	6.0 ± 0.22	—	58.6 ± 0.50
Obese, class I and II (30.0–39.9 kg/m^2)	11.4 ± 0.37	—	46.0 ± 0.62
Obese, class III (≥40 kg/m^2)	19.5 ± 1.20	—	32.3 ± 1.35
Physical activity (moderate/vigorous)			
Active (≥3 times/week)	4.4 ± 0.15	18.4 ± 0.35	—
Inactive (<3 times/week)	8.7 ± 0.26	30.2 ± 0.38	—

Data are % ± SE.

tionally representative survey of the U.S. civilian noninstitutionalized population, collects detailed information on demographic characteristics, health conditions, health status, and use of medical care services and income and employment (17). The sampling frame for the MEPS-HC is drawn from respondents to the National Health Interview Survey. The National Health Interview Survey provides a nationally representative sample of the U.S. civilian noninstitutionalized population, with oversampling of Hispanics and blacks. The MEPS Medical Provider Component supplements and validates information on medical care and pharmacy events at the person level. Medical condition diagnoses are based on ICD-9 Clinical Modification codes (17). The sample design of the MEPS-HC survey includes stratification, clustering, multiple stages of selection, and disproportionate sampling (18). MEPS sampling weights incorporate adjustment for the complex sample design and reflect survey nonresponse and population totals from the current population survey.

Ascertainment of diabetes and cardiovascular comorbidities

The primary outcome was the prevalence of diabetes and comorbid heart disease, hypertension, or hyperlipidemia stratified by physical activity and BMI. The current analysis used self-reported information resulting from the MEPS-HC survey, in which respondents were asked the following: if they had ever been diagnosed as having diabetes (excluding gestational diabetes), if they had been told on two or more different medical visits that they had high blood pressure, if they had ever been diagnosed as having coronary heart disease, if they had ever been diagnosed as having angina or angina pectoris, if they had ever been diagnosed as having a heart attack or myocardial infarction, and if they had ever been diagnosed with any other kind of heart disease or condition. Individuals who responded positively to questions regarding coronary heart disease, angina, heart attack, or other heart disease were classified as having heart disease. In addition, MEPS

Table 2—*Prevalence of diabetes and cardiovascular comorbidities by BMI and physical activity (MEPS 2000–2002)*

		BMI			
Health condition	All adults*	Normal	Overweight	Obese, class I and II	Obese, class III
n	68,500	24,444	23,730	14,538	2,252
Diabetes	6.3 ± 0.16				
Active	4.4 ± 0.15	2.2 ± 0.16	4.6 ± 0.22	8.7 ± 0.45	14.1 ± 0.19
Inactive	8.7 ± 0.26	4.5 ± 0.28	8.0 ± 0.36	13.7 ± 0.55	22.1 ± 0.15
Diabetes and heart disease	2.2 ± 0.08				
Active	1.2 ± 0.08	0.7 ± 0.09	1.2 ± 0.13	2.5 ± 0.25	3.0 ± 0.75
Inactive	3.4 ± 0.14	1.8 ± 0.18	3.3 ± 0.22	5.3 ± 0.33	8.2 ± 0.92
Diabetes and hypertension	4.1 ± 0.12				
Active	2.5 ± 0.10	1.1 ± 0.10	2.5 ± 0.16	5.7 ± 0.36	9.1 ± 1.46
Inactive	5.8 ± 0.21	2.5 ± 0.20	5.1 ± 0.29	9.6 ± 0.45	15.3 ± 1.27
Diabetes and hyperlipidemia	1.8 ± 0.09				
Active	1.3 ± 0.09	0.6 ± 0.09	1.3 ± 0.11	2.7 ± 0.29	2.9 ± 0.77
Inactive	2.4 ± 0.14	0.9 ± 0.15	2.2 ± 0.21	4.4 ± 0.33	6.3 ± 0.80

Data are % ± SE. *Total equals all adults, including those underweight (BMI <18.5 kg/m^2).

mapped medical conditions to 3-digit ICD-9 codes based on medical and pharmacy utilization and self-report. Then, 259 mutually exclusive clinical classification categories were mapped from ICD-9 codes in order to provide clinically homogenous groupings. The ICD-9 to clinical classification categories crosswalk is available from www.meps.ahrq.gov (appendix 2) (17). The current research used clinical classification categories 053 "Disorders of Lipid Metabolism" to identify individuals with hyperlipidemia.

Assessment of BMI, physical activity, and other covariates

Self-reported information from the MEPS-HC survey was used for the assessment of BMI, physical activity, and other covariates. Respondents were asked to estimate their current body weight and height, if they engaged in moderate or vigorous physical activity for ≥30 min three or more times per week, and to report on current smoking status, age, sex, race, ethnicity, and years of schooling. The following formula (from the Centers for Disease Control and Prevention, available from http://www.cdc.gov/) was used to calculate the BMI for adults in MEPS based on reported height and weight: BMI = [weight in pounds/(height in inches)^2] × 703. Full documentation is provided on page 97 of the MEPS H60 documentation file (17). Normal weight was defined as BMI 18.5 to <25 kg/m^2, overweight 25 to <30 kg/m^2, obese (class I and II) 30 to <40 kg/m^2, and obese (class III) ≥40 kg/m^2 based on the National Heart, Lung, and Blood Institute classification scheme (19).

Data analysis

To incorporate adjustment for the complex sample design, the current research used MEPS person-level and variance adjustment weights, using STATA 8.1 in all analyses to ensure nationally representative estimates. Logistic regression analysis was used to estimate the adjusted odds of having diabetes and diabetes-related cardiovascular comorbidities.

RESULTS — The general prevalence of diabetes among U.S. adults was 6.3% (Table 1). Blacks, Hispanics, and Native Americans/Aleut/Eskimos were more likely and Asians/Pacific Islanders/Native Hawaiians less likely to have diabetes than whites. Overweight, obese, and inactive individuals, as well as those with less education and current nonsmokers, were more likely to have diabetes.

The pooled prevalence of obesity was 23.5%, affecting more women than men and disproportionately affecting those of middle age. Again, blacks, Hispanics, and Native Americans/Aleut/Eskimos were more likely and Asians/Pacific Islanders/Native Hawaiians less likely to be obese than whites. Inactive adults and those with less schooling were more likely while current smokers were less likely to be obese.

Approximately 56% of the U.S. population reported engaging in moderate to vigorous physical activity for ≥30 min three or more times per week. Men, younger adults, whites, individuals with more schooling, nonsmokers, and those with lower BMI were more likely to report engaging in physical activity. The unadjusted prevalence of diabetes, diabetes and hypertension, diabetes and hyperlipidemia, and diabetes and heart disease was higher for categories of increasing BMI and inactivity (Table 2).

After controlling for sociodemographic characteristics and smoking status, overweight, obesity, and inactivity were significantly and independently associated with increased likelihood of diabetes, diabetes and comorbid hypertension, diabetes and comorbid hyperlipidemia, and diabetes and comorbid heart disease (Table 3). For example, compared with normal-weight and active adults, the multivariate-adjusted odds of diabetes was 1.52 (95% CI 1.25–1.86) times greater for normal-weight inactive adults and 1.65 (1.40–1.96) times greater for overweight active adults. Whether active or inactive, extremely obese (class III) individuals had the greatest increased likelihood of diabetes and diabetes-related cardiovascular disease.

CONCLUSIONS — The current study shows an independent association between obesity and inactivity and diabetes and diabetes-related cardiovascular comorbidities in a nationally representative sample of the noninstitutionalized U.S. population. Previous research (13–

Table 3—*Likelihood of diabetes and cardiovascular comorbidities by BMI and physical activity (MEPS 2000–2002)*

	BMI			
Health condition	Normal	Overweight	Obese, class I and II	Obese, class III
Diabetes				
Active	1.00 (ref)	1.65 (1.40–1.96)	3.62 (2.95–4.43)	8.37 (5.81–12.07)
Inactive	1.52 (1.25–1.86)	2.62 (2.18–3.16)	5.10 (4.34–6.00)	11.00 (8.61–14.04)
Diabetes and heart disease				
Active	1.00 (ref)	1.32 (0.97–1.80)	3.22 (2.34–4.43)	6.15 (3.42–11.04)
Inactive	1.83 (1.32–2.54)	3.19 (2.42–4.22)	5.62 (4.22–7.47)	11.97 (7.92–18.10)
Diabetes and hypertension				
Active	1.00 (ref)	1.84 (1.47–2.32)	4.80 (3.69–6.25)	11.59 (7.59–17.69)
Inactive	1.71 (1.32–2.19)	3.32 (2.63–4.19)	6.85 (5.49–8.54)	14.57 (10.89–19.50)
Diabetes and hyperlipidemia				
Active	1.00 (ref)	1.69 (1.22–2.35)	3.84 (2.69–5.49)	5.16 (2.68–9.91)
Inactive	1.27 (0.85–1.90)	2.55 (1.79–3.65)	5.36 (3.77–7.62)	9.33 (5.98–14.55)

Data are OR (95% CI). ORs were obtained from multivariate logistic regression models adjusting for age, sex, educational level, race, ethnicity, and smoking status.

16) has shown that lifestyle improvements, including weight control and increased physical activity, reduce the incidence of obesity and type 2 diabetes.

These results directly address the "fitness versus fatness" debate that has been popularized by the media. This debate has centered on whether obesity is a major health problem once the level of physical activity is considered. Some have suggested in this debate that it is acceptable to be "fat" from a health risk standpoint as long as you are "fit" (20). The argument being that fitness level is more important to health than body fatness, and fit obese individuals are at less risk than unfit normal weight individuals. Interestingly, in this dataset, the likelihood of having diabetes increases with increasing BMI regardless of level of physical activity. For example inactive normal-weight individuals are at lower risk (OR 1.52 [95% CI 1.25–1.86]) than obese active individuals (3.62 [2.95–4.43]). As such, these data do not support the concept that fitness level overrides body fatness. Similarly, the likelihood of having diabetes increases with physical inactivity regardless of BMI. At any given BMI classification, it is better to be active than inactive. Both physical inactivity and obesity seem to be independently associated with diabetes and diabetes-related comorbidities. This finding is critically important since it highlights that interventions should target both fatness and fitness in improving the health of the general population.

There has been much debate regarding the relative importance of obesity and inactivity as causal factors in the development of diabetes and cardiovascular morbidity and mortality (20–25). It is important to note that the current analysis is an examination of the association between obesity and physical inactivity and diabetes and diabetes-related cardiovascular comorbidities in a nationally representative cross-sectional dataset and as such does not provide information on the direct causal nature of these relationships.

The diabetes, physical activity, and obesity prevalence estimates presented here are consistent with other survey-based national-level estimates in the U.S. (2–4,26). However, it is likely that the diabetes and obesity rates in this study are underestimates and physical activity rates are overestimates of national prevalence. First, similar to the National Health Interview Survey and the Behavioral Risk Factor Surveillance System, MEPS is based on self-report. There is evidence that self-reported conditions may be underreported in general (27) and that blacks, whites, and Hispanics differ in reporting of disease labeling and levels of illness and disability (28–30). Second, previous studies (31,32) have shown that overweight respondents tend to underestimate their weight and overestimate their height. In addition, respondents tend to overestimate their level of physical activity. Third, unlike the National Health and Nutrition Examination Survey, MEPS does not contain information on undiagnosed diabetes. Recent estimates suggest that ~35% of individuals with diabetes have not been diagnosed (33).

The dramatically increasing epidemics of obesity and diabetes are well-known threats to public health in the U.S. The consistent independent association between obesity and physical inactivity and increased prevalence of diabetes and diabetes-associated cardiovascular comorbidities seen in this nationally representative study is disturbing. It is important to focus national attention on these trends and combat them with weight management and physical activity interventions.

References

1. Mokdad AH, Ford ES, Bowman BA, Nelson DE, Engelgau MM, Vinicor F, Marks JS: Diabetes trends in the U.S.: 1990–1998. *Diabetes Care* 23:1278–1283, 2000
2. Engelgau MM, Geiss LS, Saaddine JB, Boyle JP, Benjamin SM, Gregg EW, Tierney EF, Rios-Burrows N, Mokdad AH, Ford ES, Imperatore G, Narayan KM: The evolving diabetes burden in the United States. *Ann Intern Med* 140:945–950, 2004
3. Harris MI, Flegal KM, Cowie CC, Eberhardt MS, Goldstein DE, Little RR, Wiedmeyer HM, Byrd-Holt DD: Prevalence of diabetes, impaired fasting glucose, and impaired glucose tolerance in U.S. adults. *Diabetes Care* 21:518–524, 1998
4. 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
5. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH: The disease burden associated with overweight and obesity. *JAMA* 282:1523–1529, 1999
6. Ford ES, Giles WH, Mokdad AH: Increas-

ing prevalence of the metabolic syndrome among U.S. adults. *Diabetes Care* 27: 2444–2449, 2004
7. U.S. Department of Health and Human Services: Surgeon General's report on physical activity and health [article online], 1996. Available from http://www.cdc.gov/nccdphp/sgr/sgr.htm. Accessed 15 January 2005
8. U.S. Department of Health and Human Services: *The Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity*. Rockville, MD, Public Health Service, Office of the Surgeon General, 2001
9. American Diabetes Association, National Institute of Diabetes, Digestive and Kidney Diseases: The prevention or delay of type 2 diabetes (Position Statement). *Diabetes Care* 26 (Suppl. 1):S62–S69, 2003
10. Franz MJ, Bantle JP, Beebe CA, Brunzell JD, Chiasson JL, Garg A, Holzmeister LA, Hoogwerf B, Mayer-Davis E, Mooradian AD, Purnell JQ, Wheeler M: Evidence-based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications (Review). *Diabetes Care* 25: 148–198, 2002
11. Klein S, Sheard NF, Pi-Sunyer X, Daly A, Wylie-Rosett J, Kulkarni K, Clark NG, the American Diabetes Association, the North American Association for the Study of Obesity, the American Society for Clinical Nutrition: Weight management through lifestyle modification for the prevention and management of type 2 diabetes: rationale and strategies: a statement of the American Diabetes Association, the North American Association for the Study of Obesity, and the American Society for Clinical Nutrition. *Diabetes Care* 27: 2067–2073, 2004
12. Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C: Physical activity/exercise and type 2 diabetes. *Diabetes Care* 27: 2518–2539, 2004
13. Centers for Disease Control and Prevention Primary Prevention Working Group: Primary prevention of type 2 diabetes mellitus by lifestyle intervention: implications for health policy. *Ann Intern Med* 140:951–957, 2004
14. Pan XR, Li GW, Hu YH, Wang JX, Yang WY, An ZX, Hu ZX, Lin J, Xiao JZ, Cao HB, Liu PA, Jiang XG, Jiang YY, Wang JP, Zheng H, Zhang H, Bennett PH, Howard BV: Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance: the Da Qing IGT and Diabetes Study. *Diabetes Care* 20: 537–544, 1997
15. Tuomilehto J, Lindstrom J, Eriksson JG, Valle TT, Hamalainen H, Ilanne-Parikka P, Keinanen-Kiukaanniemi S, Laakso M, Louheranta A, Rastas M, Salminen V, Uusitupa M, the Finnish Diabetes Prevention Study Group: Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *N Engl J Med* 344:1343–1350, 2001
16. Diabetes Prevention Program Research Group: Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med* 346:393–403, 2002
17. Agency for Healthcare Research and Quality (AHRQ): Puf documentation files. Available from http://www.meps.ahrq.gov/PUFFiles/H52/H52doc.htm. Accessed 10 November 2003
18. Agency for Healthcare Research and Quality: Computing standard errors for MEPS estimates [article online]. Available from www.meps.ahrq.gov. Accessed September 2003
19. Expert Panel on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: Executive summary of the clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. *Arch Intern Med* 158:1855–1867, 1998
20. Church TS, Cheng YJ, Earnest CP, Barlow CE, Gibbons LW, Priest EL, Blair SN: Exercise capacity and body composition as predictors of mortality among men with diabetes. *Diabetes Care* 27:83–88, 2004
21. Weinstein AR, Sesso HD, Lee IM, Cook NR, Manson JE, Buring JE, Gaziano JM: Relationship of physical activity vs. body mass index with type 2 diabetes in women. *JAMA* 292:1188–1194, 2004
22. Wessel TR, Arant CB, Olson MB, Johnson BD, Reis SE, Sharaf BL, Shaw LJ, Handberg E, Sopko G, Kelsey SF, Pepine CJ, Merz NB: Relationship of physical fitness vs. body mass index with coronary artery disease and cardiovascular events in women. *JAMA* 292:1179–1187, 2004
23. Blair SN, Church TS: The fitness, obesity, and health equation: is physical activity the common denominator? *JAMA* 292:1232–1234, 2004
24. Katzmarzyk PT, Church TS, Janssen I, Ross R, Blair SN: Metabolic syndrome, obesity, and mortality: impact of cardiorespiratory fitness. *Diabetes Care* 28:391–397, 2005
25. Hu FB, Willett WC, Li T, Stampfer MJ, Colditz GA, Manson JE: Adiposity as compared with physical activity in predicting mortality among women. *N Engl J Med* 351:2694–2703, 2004
26. U.S. Department of Health and Human Services: Healthy People 2010 Progress Review: physical activity and fitness. Available from http://www.healthypeople.gov/data/2010prog/focus22/. Accessed 23 February 2005
27. Edwards DS, Winn DM, Kuriantzik V: Evaluation of the National Health Interview Survey diagnostic reporting. *Vital Health Stat 2* 120:1–116, 1994
28. Berkanovic E, Telesky C: Mexican-American, black-American and white-American differences in reporting illnesses, disability and physician visits for illnesses. *Soc Sci Med* 20:567–577, 1985
29. Stewart AL, Napoles-Springer A: Health-related quality-of-life assessments in diverse population groups in the United States. *Med Care* 38 (Suppl. 9):II102–II124, 2000
30. Johnson TP, O'Rourke D, Chavez N, Sudman S: Cultural variations in the interpretation of health survey questions. In *Health Survey Research Methods*. Warnecke RB, Ed. Hyattsville, MD, National Center for Health Statistics, 1996, p. 57–62
31. Palta M, Prineas RJ, Berman R, Hannan P: Comparison of self-reported and measured height and weight. *Am J Epidemiol* 115:223–230, 1982
32. Rowland ML: Self-reported weight and height. *Am J Clin Nutr Dec* 52:1125–1133, 1990
33. Centers for Disease Control and Prevention: *National Diabetes Fact Sheet: General Information and National Estimates on Diabetes in the U.S., 2000*. Atlanta, GA, Centers for Disease Control and Prevention, 2002