Sporting Activity and Hyperglycemia in Middle-Aged Men

IVAN J. PERRY, MRCP
S. GOYA WANNAMETHEE, PHD
MARY K. WALKER, MA
A. GERALD SHAPER, FRCP

OBJECTIVE — To assess the relationship between self-reported frequency of participation in sporting activity and the prevalence of hyperglycemia (nonfasting glucose level ≥7.8 mM) in middle-aged men.

RESEARCH DESIGN AND METHODS — We used a cross-sectional study of 7617 British middle-aged men, drawn from 24 general practices in England, Wales, and Scotland, who were participants in the British Regional Heart Study. The response rate was 78%. Patients with diabetes (physician-diagnosed) were excluded from our analysis. Frequency of participation in sporting activity was determined by the respondents and reported as none (61%), occasionally (12%), or frequently (27%).

RESULTS — The age-adjusted prevalence odds ratio for hyperglycemia was 0.86 (95% confidence interval, 0.6–1.2) in those reporting occasional, and 0.62 (95% confidence interval, 0.4–0.85) in those reporting frequent sporting activity, compared with those reporting none. This effect of frequent sporting activity on the prevalence of hyperglycemia was independent of body mass index, occupational status, smoking status, systolic blood pressure, use of antihypertensive therapy, and time of sampling.

CONCLUSIONS — Frequent sporting activity in middle-aged men is associated with a reduced prevalence of hyperglycemia and may reduce the risk of NIDDM.

Physical activity may be associated with a reduced risk of NIDDM. The inverse relationship between level of physical activity and subsequent development of physician-diagnosed NIDDM in both U.S. former college students (1) and participants in the Nurses Health Study Cohort (2), suggests a causal relationship. In the Nurses Health Study Cohort, physical activity was assessed on the basis of frequency of participation in ". . . any regular activity similar to brisk walking, jogging, bicycling, etc., long enough to work up a sweat."

The BRHS, a large population-based study of cardiovascular disease in middle-aged men, included a question on frequency of participation in a similar range of activities (which we have characterized as sporting) (3,4). The BRHS physical activity index, which predicts major cardiovascular end points, was heavily weighted on this sporting-activity question.

We investigated the relationship between self-reported sporting activity and the prevalence of hyperglycemia at screening in the BRHS cohort. The data from previous cross-sectional studies, which have examined the relationship between physical activity and diabetes or hyperglycemia, are inconsistent (5,6).

RESEARCH DESIGN AND METHODS

In the BRHS, 7735 men, 40–59 yr of age, were selected at random from the age-sex registers of one group general practice in each of 24 towns in England, Wales, and Scotland. The criteria for selecting the towns, general practices, and patients and details of the respondents and data collection have been described (3). The overall response rate was 78%.

The exercise questions asked participants for the duration of their daily walking or cycling and for their rating (on a five-point scale) of weekend recreational activity (walking, gardening, and household repair work). The men also were asked: "Apart from these activities (daily walking or cycling and weekend activities) do you take active physical exercise, e.g., running, digging, swimming, tennis, golf, sailing, etc.?" Frequency of participation was determined by the respondents who answered no, occasionally, or frequently. Those reporting frequent sporting activity were asked to

FROM THE DEPARTMENT OF PUBLIC HEALTH AND PRIMARY CARE, THE ROYAL FREE HOSPITAL SCHOOL OF MEDICINE, ROWLAND HILL STREET, LONDON, UNITED KINGDOM.

ADDRESS CORRESPONDENCE AND REPRINT REQUESTS TO IVAN J. PERRY, MRCP, DEPARTMENT OF PUBLIC HEALTH AND PRIMARY CARE, THE ROYAL FREE HOSPITAL SCHOOL OF MEDICINE, ROWLAND HILL STREET, LONDON, UK NW3 2PF.

RECEIVED FOR PUBLICATION 29 JANUARY 1992 AND ACCEPTED IN REVISED FORM 19 NOVEMBER 1992.

BRHS, BRITISH REGIONAL HEART STUDY; CI, CONFIDENCE INTERVAL; BMI, BODY MASS INDEX; sBP, SYSTOLIC BLOOD PRESSURE; dBP, DIASTOLIC BLOOD PRESSURE; NIDDM, NON-INSULIN-DEPENDENT DIABETES MELLITUS; WHO, WORLD HEALTH ORGANIZATION; OR, ODDS RATIO.

Table 1—*Age-adjusted cardiovascular risk factors by level of self-reported sporting activity*

	Frequency of sporting activity		
	None	Occasional	Frequent
n (%)	4633 (60.8)	886 (11.6)	2092 (27.5)
Age (yr)	51.0 ± 0.08	49.7 ± 0.2	48.7 ± 0.1*
Glucose (mM)†	5.47 ± 0.01	5.42 ± 0.04	5.42 ± 0.02
BMI >28 kg/m² (%)	21.0 ± 0.6	17.6 ± 1.3	16.0 ± 0.8*
Heart rate/min	71.5 ± 0.2	70.9 ± 0.4	68.6 ± 0.3*
sBP (mmHg)	146.0 ± 0.3	143.6 ± 0.7	143.8 ± 0.5*
dBP (mmHg)	82.9 ± 0.2	81.2 ± 0.4	81.4 ± 0.3*
Manual workers (%)	68.0 ± 0.7	53.2 ± 1.1	41.2 ± 1.0*
Cigarette smokers (%)	46.7 ± 0.7	39.5 ± 1.6	30.2 ± 1.0*
Antihypertensive therapy (%)	5.9 ± 0.3	4.1 ± 0.7	2.5 ± 0.3*
Postprandial samples (%)‡	28.9 ± 1.3	30.9 ± 1.6	27.3 ± 1.0

Data are means ± SE.
*$P < 0.0001$ compared with no sporting-activity group.
†Geometric mean.
‡Between 0900–1000, 1400–1500, and 1800–1830.

specify the number of times a month, on average, such activity was undertaken. Responses ranged from 1 to >20 times/mo, with 82% of this group engaged in sporting activity at least 4 times/mo.

A physical activity index, with levels 1–6, was derived for each man (4). Levels 1–4 reflected increasing duration of daily walking or cycling, and the rating of weekend activity and sporting activity to a maximum of 3 times/mo. At level 5 the majority of men were engaged in sporting activity 4–11 times/mo, and at level 6, ≥12 times/mo. Because few men were engaged in physically demanding work, occupational activity was excluded from the physical activity index.

Nonfasting blood samples were obtained between 0830 and 1830. Glucose was analyzed in serum with a commercially available automated analyzer (Technicon SMA12 60, Tarrytown, NY). We defined hyperglycemia on the basis of a serum glucose level ≥7.8 mM, the WHO glucose tolerance test threshold for impaired glucose tolerance. This point lies between the 96th-97th percentile of the glucose distribution in our study sample and defines a group of 267 men. The data presented refer to a total of 7611 men. A group of 118 men with diabetes (self-reported, physician-diagnosed) were excluded from the analysis. Six men did not respond to the sporting-activity question.

We noted the time of day at which we took blood samples. Mean glucose levels increased marginally postprandially (0900–1000, 1400–1500, and 1800–1830), with a maximum peak trough difference of 0.4 mM (7%). The proportion of men classified as hyperglycemic was 3.1% in nonpostprandial and 4.6% in postprandial samples. Overall, <1% of the variance in serum glucose level could be attributed to time of sampling (7).

The prevalence OR for hyperglycemia at different levels of sporting activity, adjusted for potential confounding factors, was derived with multiple logistic regression. Age, BMI, and sBP were fitted as continuous variables in the regression model. Occupational status, smoking status, underlying ischemic heart disease, use of antihypertensive therapy, and time of sampling (postprandial or not) were fitted as categorical variables.

RESULTS — The majority of respondents, 4633 (60.8%) men, reported no participation in sporting activity, 886 (11.6%) reported occasional, and 2092 (27%) reported frequent sporting activity. Table 1 shows the characteristics of the three groups. Compared with those reporting no sporting activity, men engaged in frequent sporting activity were younger, less obese, and had significantly lower heart rates and blood pressures. A smaller proportion were receiving antihypertensive therapy. The prevalence of cigarette smoking and the proportion of men engaged in manual occupations also were lower in this group.

The geometric mean serum glucose level was similar in the three groups, as was the proportion of men from whom postprandial blood samples were obtained. The age-adjusted prevalence of hyperglycemia was 3.9, 3.4, and 2.4% in men reporting no, occasional, and frequent sporting activity, respectively. Compared with men reporting no sporting activity, the age-adjusted prevalence OR for hyperglycemia was 0.86 (95% CI, 0.6–1.2) in those reporting occasional and 0.62 (95% CI, 0.4–0.85) in those reporting frequent sporting activity. This significantly reduced risk of hyperglycemia associated with frequent sporting activity was not attenuated after adjustment for BMI, occupational status, and cigarette smoking (Table 2).

Adjustment for numerous additional potential confounding factors, including time of sampling, had minimal effect on the observed relationship (Table 2). The prevalence of hyperglycemia was similar across levels 1–4 of the physical activity index (3.9, 4.1, 3.7, and 3.9%), but decreased significantly at levels 5–6 (2.1 and 2.4%), reflecting largely the contribution of sporting activity. The effect of sporting activity was observed at a threshold frequency of 4–7 times/mo, or approximately weekly. Higher levels of sporting activity were not associated with lower prevalence of hyperglycemia.

CONCLUSIONS — We have found evidence of an independent, protective effect of sporting activity on the preva-

Table 2—*Adjusted relative odds (and 95% CIs) of glucose ≥7.8 mM by level of self-reported sporting activity*

Frequency of sporting activity	Adjusted*	Adjusted†
None	1.00 —	1.00 —
Occasional	0.92 (0.6–1.4)	0.96 (0.6–1.4)
Frequent	0.68 (0.5–0.94)	0.71 (0.5–0.99)

*Adjusted for age, BMI, occupational status (nonmanual, manual, and armed forces) and smoking.
†Additional adjustment for sBP, symptomatic ischemic heart disease (doctor diagnosis of ischemic heart disease, angina, or possible myocardial infarction on WHO/Rose questionnaire), use of antihypertensive medication, and time of sampling.

lence of hyperglycemia in a population-based sample of middle-aged men, excluding those known to have diabetes. The documented effects of exercise on insulin sensitivity provide a plausible mechanism for this association (8). Clearly, given the cross-sectional design of this study, we cannot establish a causal link between physical inactivity and hyperglycemia. However, these data from a representative sample of British middle-aged men, support and complement the findings from prospective studies of selected populations (1,2).

Although a single nonfasting serum glucose level provides an imprecise, unreliable measure of glucose tolerance, such imprecision could attenuate rather than exaggerate associations with life-style factors, such as physical inactivity. We found no evidence of bias in the association between sporting activity and hyperglycemia attributable to time of sampling.

The activities assessed in this study, which we have characterized as sporting type, clearly encompass a spectrum of exercise intensity. Hence, the data may be interpreted as suggesting that frequency of exercise is as important as intensity in determining glycemic status. Although exercise frequency and intensity clearly are intercorrelated, further work should examine this issue.

Acknowledgments— The British Regional Heart Study, conducted by the British Heart Foundation Research Group, received support from the Chest, Heart, and Stroke Association. I.J.P. was supported by the Wellcome Trust.

References

1. Helmrich SP, Ragland DR, Leung RW, Paffenbarger RS: Physical activity and reduced occurrence of non-insulin-dependent diabetes mellitus. *N Engl J Med* 325: 147–52, 1991
2. Manson JE, Rimm EB, Stampfer MJ, Colditz GA, Willett WC, Krolewski AS, Rosner B, Hennekens CH, Speizer FE: Physical activity and incidence of non-insulin-dependent diabetes mellitus in women. *Lancet* 338:774- 77, 1991
3. Shaper AG, Pocock SJ, Walker M, Cohen NM, Wale CJ, Thomson AG: The British Regional Heart Study: cardiovascular risk factors in middle- aged men in 24 towns. *Br Med J* 283:179–86, 1981
4. Shaper AG, Wannamethee G: Physical activity and ischaemic heart disease in middle-aged British men: *Br Heart J* 66: 384–94, 1991
5. Taylor R, Ram P, Zimmet P, Raper LR, Ringrose H: Physical activity and prevalence of diabetes in Melanesian and Indian men in Fiji. *Diabetologia* 27:578–82, 1984
6. Jarret RJ, Shipley MJ, Hunt R: Physical activity, glucose tolerance and diabetes mellitus: The Whitehall Study. *Diabetic Med* 3:549–51, 1986
7. Pocock SJ, Ashby D, Shaper AG, Walker M, Broughton PMG: Diurnal variations in serum biochemical and haematological measurements. *J Clin Path* 42:172–79, 1989
8. Soman VR, Koivisto VA, Deibert D, Felig P, DeFronzo RA: Increased insulin sensitivity and insulin binding to monocytes after physical training. *N Engl J Med* 301: 1200–204, 1979