Relationship of Locus of Control to Physical Activity Among People With and Without Diabetes

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OBJECTIVE — To examine the relationship between locus of control (LOC) (internal and external) and physical activity in Pima Indians and to determine whether this relationship is affected by the presence of diabetes.

RESEARCH DESIGN AND METHODS — A population-based sample of 580 Pima Indians was recruited from an ongoing research study. LOC was measured on a 1–40 modified Rotter scale, and past year total physical activity (leisure and work physical activity levels combined) was measured by interviewer-administered questionnaire.

RESULTS — Among both men and women without diabetes, individuals with an internal LOC (score 1–16) were significantly ($P < 0.01$) more active than those with an external (score 17–40) LOC (70 vs. 30 median metabolic equivalent [MET] hours per week for men; 12 vs. 5 median MET hours per week for women). Controlled for age and BMI, an internal LOC was significantly associated with a higher level of physical activity among men ($P = 0.04$) and women ($P = 0.001$) without diabetes, but not among those with diabetes.

CONCLUSIONS — Nondiabetic Pima Indians with an internal LOC are more physically active than those with an external LOC. Enhancing perceptions of internal control may influence physical activity and thus have implications for diabetes prevention.

The extent to which an individual perceives life events to be within his or her own control, termed locus of control (LOC), has been examined as a potential correlate of health behaviors (1–8). Individuals with an external LOC are more likely to believe that life events are determined by chance, other individuals, or other outside factors, but those with an internal LOC believe they have more control over what happens to them. Individuals with an internal LOC may be less likely to smoke (3), more likely to have had a recent pap smear or breast exam (1,8), and less likely to experience a future decline in functional status (9). However, studies have also reported that LOC is not predictive or is only weakly predictive of health behaviors (2,5–7).

LOC has been examined as a potential predictor of physical activity levels and adherence to physical activity programs (2,10–12). The results of these studies have been equivocal and suggest that the relationship between LOC and physical activity may not be consistent across various populations and activity levels. More recently, physical inactivity has emerged as an important risk factor for the development of NIDDM (13–16). This, along with other findings associating an internal LOC with diabetes self-management and control (17–19), raises the question of whether LOC is associated with physical activity levels in individuals with and without diabetes.

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LOC, locus of control; MET, metabolic equivalent.

The relationship between LOC and physical activity was examined in the Pima Indians of Arizona, a population with a high risk of NIDDM (20,21). It is hypothesized that people with an internal LOC will be more active than those with an external LOC and that this relationship may depend on whether a person has diabetes.

RESEARCH DESIGN AND METHODS

Study description

Subjects were 216 men and 364 women Pima Indians aged 15–59 years, recruited from an epidemiological study in the Gila River Indian Community in Arizona (20,21). A medical history, physical examination, height, weight, BMI, and waist-to-thigh circumference ratio were obtained. Diabetes was defined as a 2-h postload (75 g carbohydrate) plasma glucose ≥11.1 mmol/l (22) or a previous medical diagnosis of diabetes.

LOC was assessed using a modification of the Rotter scale developed by Nowicki and Strickland (23). This inventory of yes/no questions yields a score ranging from 0 to 40, where a score of 0 represents the extreme end of an internal LOC, indicating a belief that the subject has a high degree of control over what happens to him or her. A score of 40 represents the other extreme of an external orientation, or a feeling that life events are largely determined by factors beyond the individual's personal control. The Nowicki and Strickland scale (23) is a global measure that, compared with a health-specific scale, may be less influenced by attitudes related to a specific disease. This measure was chosen so that generalized expectations and their relationship to physical activity could be compared in people both with and without diabetes.

Work and leisure-time physical activity levels were measured with a Modifiable Activity Questionnaire, which has been shown to be reliable and appropriate in the Pima Indian population and inquires about physical activities requir-

Table 1—*Descriptive statistics of study population*

	Men		Women	
	No diabetes	With diabetes	No diabetes	With diabetes
n	153	63	252	112
Years of age	30 (25, 37)	43 (32, 51)*	30 (24, 38)	41 (33, 52)*
Weight (kg)	98.7 ± 27.1	96.5 ± 20.2	90.9 ± 21.3	98.9 ± 22.8*
BMI (kg/m²)	33.5 ± 8.5	32.5 ± 6.0	35.2 ± 7.6	38.2 ± 8.0*
Waist-to-thigh ratio	1.69 ± 0.2	1.82 ± 0.15*	1.66 ± 0.24	1.87 ± 0.25*
Total physical activity (MET hours/week)	52 (12, 136)	25 (4, 79)*	10 (2, 40)	6 (0, 16)*
Locus of control	14 (10, 20)	16 (12, 20)	16 (12, 20)	18 (14, 22)*
Fasting plasma glucose (mmol/l)	5.1 (4.9, 5.5)	12.8 (8.2, 14.4)*	5.1 (4.8, 5.4)	9.9 (6.4, 13.8)*
2-h plasma glucose (mmol/l)	5.4 (4.7, 6.6)	20.7 (15.7, 24.9)*	6.3 (5.4, 7.3)	18.3 (12.0, 22.5)*

Data are means ± SD or median (25th, 75th percentile). *Significant difference ($P < 0.05$) between individuals with and without diabetes.

ing energy expenditure greater than that of activities of daily living (24,25). By recording the frequency and duration of these activities and weighting each by its relative intensity (metabolic equivalent [MET]), an estimate of total physical activity (leisure plus occupational) was made and expressed in MET hours per week (24).

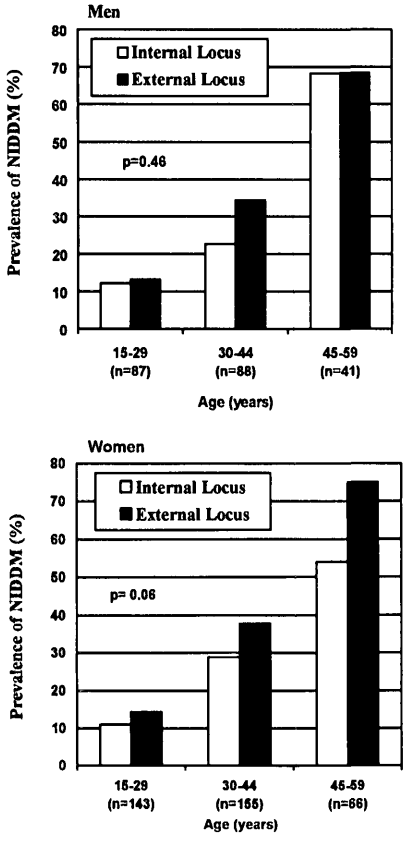

Figure 1—*Prevalence (%) of diabetes in men and women according to age and LOC groups.*

Statistical analyses

Student's *t* tests were used to evaluate differences in age, weight, BMI, waist-to-thigh ratio, total fasting, and 2-h plasma glucose and Wilcoxon tests were used to test differences in physical activity and LOC between individuals with and without diabetes. LOC was categorized as internal (0–16) and external (17–40), corresponding to a median split of participants and consistent with a categorization described by Nowicki and Strickland (23). Multiple logistic regression was used to evaluate differences in prevalence of diabetes between LOC groups, controlled for age and sex.

The relationship between LOC, physical activity, age, BMI, and waist-to-thigh ratio were examined separately for men and women with and without diabetes. Sex-specific Spearman partial correlations adjusted for age were calculated to assess associations between LOC, physical activity, BMI, and waist-to-thigh ratio for diabetic and nondiabetic subjects. Differences in physical activity between LOC groups were evaluated using Wilcoxon tests.

Multiple logistic regression was used to determine whether LOC score was related to physical activity level among diabetic and nondiabetic subjects independent of age and body composition. Physical activity values were dichotomized as high (≥ median) and low (< median) and treated as the dependent variable while LOC, age, and BMI were the continuous predictor variables.

RESULTS

Subject characteristics

As shown in Table 1, both men and women with diabetes were significantly older, less physically active, and had a higher waist-to-thigh ratio than those without diabetes ($P < 0.05$ for each). Additionally, women with diabetes had significantly higher weight, BMI, and a more external LOC than those without diabetes ($P < 0.05$). Men with diabetes had a higher LOC score (more external) than those without diabetes but this difference was not significant. Sex- and LOC-specific prevalence of diabetes, adjusted for age, are shown in Fig. 1. The odds of having diabetes for individuals with an external LOC compared with those with an internal LOC was 1.29 for men (95% CIs = 0.65, 2.55) and 1.61 for women (0.99, 2.64).

Among both men and women without diabetes, individuals with an internal LOC were more active than those with an external LOC (70 vs. 30 median MET hours per week total activity for men, $P = 0.003$; 12 vs. 5 median MET hours per week for women, $P = 0.009$) (Fig. 2). Among men and women with diabetes, median levels of physical activity were higher in those with an internal LOC than in those with an external LOC, but these differences were not statistically significant (Fig. 2).

Among men and women without diabetes, LOC was significantly, inversely correlated with total physical activity (age-adjusted Spearman $r = -0.18$ in men and $r = -0.19$ in women; $P < 0.05$ for each) and positively correlated with waist-to-thigh

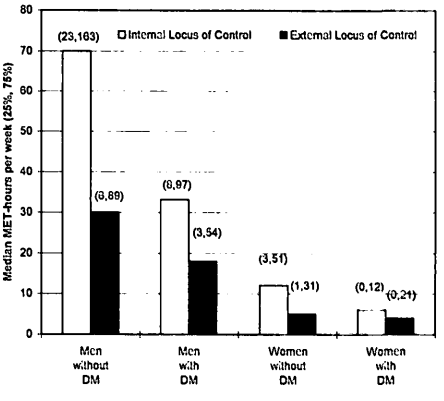

Figure 2—*Median MET hours per week expended in total physical activity among participants with and without diabetes according to LOC. The 25th and 75th percentiles are listed in parentheses.*

Table 2—*Spearman rank order partial correlations between LOC and age, physical activity, BMI, and waist-to-thigh ratio*

	Men without diabetes	Women without diabetes	Men with diabetes	Women with diabetes
n	153	252	63	112
Age (years)	−0.11	−0.12	0.29†	0.18
Physical activity (MET hours/week)	−0.18†	−0.19*	−0.21	−0.01
BMI (kg/m²)	0.01	0.07	−0.28†	−0.02
Waist-to-thigh ratio	0.19†	0.13†	−0.19	0.08

Correlations between LOC and physical activity, BMI, and waist-to-thigh ratio are adjusted for age. *$P < 0.01$; †$P < 0.05$.

ratio (r = 0.19 in men and r = 0.13 in women; $P < 0.05$ for each) (Table 2). Among men with diabetes, LOC was inversely correlated with physical activity ($r = -0.21$, $P = 0.11$) and BMI ($r = -0.28$, $P < 0.05$). LOC was not significantly associated with physical activity levels, BMI, or waist-to-thigh ratio in women with diabetes.

Multiple logistic regression analyses were conducted to determine whether the univariate relationships between LOC and physical activity levels were confounded by obesity and age. Among both men and women without diabetes, an internal LOC was significantly associated with higher physical activity, controlled for age and BMI (Table 3). LOC was not significantly associated with physical activity among those with diabetes. Younger age was associated with higher physical activity in women without diabetes and both men and women with diabetes. Two-way interactions were evaluated and did not significantly improve the fit of any of the models.

CONCLUSIONS

An internal LOC was associated with higher levels of physical activity among Pima Indian men and women without diabetes. Individuals who perceive life events to be largely within their own control may thus be more likely to engage in physically active lifestyles because they view it as a way to prevent diabetes and other diseases. Alternatively, the higher levels of physical activity may have influenced LOC in these individuals. While the extent to which long-term changes in LOC can occur within individuals is not clear, interventions such as biofeedback training have been related to at least a temporary shift in LOC (26). Since physical activity has been related to a variety of psychological benefits, including self-efficacy, self-esteem, and aspects of motivation, it may also alter LOC (27,28).

A significant relationship between LOC and physical activity did not exist among men or women with diabetes. The failure to find differences in physical activity between LOC groups in individuals with diabetes may be due to low statistical power. The magnitude of the LOC logistic regression coefficient and the Spearman correlation coefficient between LOC and physical activity were as high in men with diabetes as in other strata despite not being statistically significant. The sample size for diabetic men (n = 63), however, was smaller than in the other three groups. The lack of association in women with diabetes may be due to the extremely low levels of physical activity in this group, making it difficult to detect small differences in physical activity levels.

The observation that individuals with an external locus are more likely to have diabetes is consistent with previous research suggesting that an external LOC is related to worse health status and may be a response to disability (4,29). Since LOC has been related to a person's perceived susceptibility to disease and history of illness, it is possible that a diagnosis of diabetes could cause a more external orientation (29). If true, this could affect the relationship between LOC and physical activity, leading those with diabetes to be more external in their LOC control and less active physically.

Any influence of LOC in populations should be viewed in the context of other theories of health behavior, which focus on outcome expectations more specific to behaviors or situations. Self-efficacy, for example, represents an individual's confidence in the ability to perform a particular behavior (30). Fishbein and Ajzens' theory of reasoned action and the theory of planned behavior focus on behavior-specific attitudes, perceived control over behaviors, and related social factors as predictors of behavior (31). LOC, in contrast, is considered to be a more stable personality characteristic and refers to a more generalized set of expectations (32,33).

The identification of a relationship between LOC and physical activity may

Table 3—*Association of LOC with physical activity group (high/low) in 15- to 59-year-old Pima Indians with and without diabetes: multiple logistic regression*

Variable	*n*	Nonstandardized regression coefficient	SE	*P* value
Men without diabetes	152			
Locus of control*		−0.0548	0.0267	0.04
BMI (kg/m²)		−0.0353	0.0218	0.10
Age (years)		−0.0092	0.0193	0.63
Women without diabetes	250			
Locus of control*		−0.0740	0.0232	0.001
BMI (kg/m²)		−0.0101	0.0179	0.57
Age (years)		−0.0585	0.0148	0.0001
Men with diabetes	61			
Locus of control*		−0.0719	0.0550	0.19
BMI (kg/m²)		−0.0956	0.0537	0.08
Age (years)		−0.0637	0.0294	0.03
Women with diabetes	109			
Locus of control*		−0.0361	0.0360	0.31
BMI (kg/m²)		−0.0164	0.0276	0.55
Age (years)		−0.0499	0.0201	0.01

Dependent variable equals physical activity group. *LOC entered as continuous variable.

have implications for promoting physical activity among people at high risk for diabetes. Counseling at the primary care level may enhance perceptions of internal control and thus influence physical activity levels by emphasizing the role of the individual in affecting subsequent outcomes. Improvements in socioeconomic status or education, both suggested to be related to LOC (33), may also have beneficial effects on LOC orientation and physical activity. Whether these findings can be applied to community-wide interventions is a question for future research.

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References

1. Bundek NI, Marks G, Richardson JL: Role of health locus of control beliefs in cancer screening of elderly Hispanic women. *Health Psychol* 12:193–199, 1993
2. Calnan M: Control over health and patterns of health-related behavior. *Soc Sci Med* 29:131–136, 1989
3. Eiser JR, Eiser C, Gammage P, Morgan M: Health locus of control and health beliefs in relation to adolescent smoking. *Br J Addict* 84:1059–1065, 1989
4. Wallston KA, Wallston BS: Who is responsible for your health? The construct of health locus of control. In *Social Psychology of Health and Illness*. Sanders GS, Suls J, Eds. Hillsdale, NJ, Lawrence Erlbaum Associates, 1982
5. Oberle K: A decade of research in locus of control: what have we learned? *J Adv Nurs* 16:800–806, 1991
6. Schank MJ: Young adult women: lifestyle and health locus of control. *J Adv Nurs* 18:1235–41, 1993
7. Burgess C, Hamblett ML: Application of the Rotter scale of internal-external locus of control to determine differences between smokers, non-smokers and ex-smokers in their general locus of control. *J Adv Nurs* 19:699–704, 1994
8. Redeker NS: Health beliefs, health locus of control, and the frequency of practice of breast self-examination in women. *J Obstet Gynecol Neonatal Nurs* 18:45–51, 1989
9. Wallhagen, MI, Strawbridge WJ, Kaplan GA, Cohen RD: Impact of internal health locus of control on health outcomes for older men and women: a longitudinal perspective. *Gerontologist* 34:299–306, 1994
10. Oldridge NB, Streiner DL: The health belief model: predicting compliance and dropout in cardiac rehabilitation. *Med Sci Sports Exerc* 22:678–683, 1990
11. Slenker SE, Price JH, O'Connell JK: Health locus of control of joggers and nonexercisers. *Percept Mot Skills* 61:329–330, 1985
12. Dishman RK, Steinhardt M: Health locus of control predicts free-living, but not supervised, physical activity: a test of exercise-specific control and outcome-expectancy hypotheses. *Res Q Exerc Sport* 61:383–394, 1990
13. Helmrich SP, Ragland DR, Leung RW, Paffenbarger RS: Physical activity and reduced occurrence of non-insulin-dependent diabetes mellitus. *N Engl J Med* 325:147–152, 1991
14. 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* 338:774–778, 1991
15. Kriska AM, Laporte RE, Pettitt DJ, Charles MA, Nelson RG, Kuller LH, Bennett PH, Knowler WC: The association of physical activity with obesity, fat distribution and glucose intolerance in Pima Indians. *Diabetologia* 36:863–869, 1993
16. Regensteiner JG, Shetterly SM, Mayer EJ, Eckel RH, Haskell WL, Baxter J, Hamman RF: Relationship between habitual physical activity and insulin area among individuals with impaired glucose tolerance. *Diabetes Care* 18:490–497, 1995
17. Narayan KMV, Kriska AM, Pettitt D, de Courten M: Relationship between locus of control and glucose concentration in Pima Indians. *Diabetes* 43 (Suppl. 2):A831, 1994
18. Reynaert C, Janne P, Donckier J, Buysschaert M, Zdanowicz N, Lejeune D, Cassiers L: Locus of control and metabolic control. *Diabete Metab* 21:180–187, 1995
19. Shlenk EA, Hart LK: Relationship between health locus of control, health value, and social support and compliance of persons with diabetes mellitus. *Diabetes Care* 7:566–574, 1984
20. Bennett PH, Burch TA, Miller M: Diabetes mellitus in American (Pima) Indians. *Lancet* ii:125–128, 1971
21. Knowler WC, Bennett PH, Hamman RF, Miller M: Diabetes incidence and prevalence in Pima Indians: a 19-fold greater incidence than in Rochester, Minnesota. *Am J Epidemiol* 108:497–505, 1978
22. World Health Organization: *WHO Expert Committee on Diabetes Mellitus. Second Report*. Geneva, World Health Org., 1980 (Tech. Rep. Ser., No. 646)
23. Nowicki S, Strickland B: Locus of control. In *The Mind Test*. Aero R, Weiner E, Eds. New York, William Morrow, 1981, p. 20–23
24. Kriska AM, Knowler WC, Laporte RE, Drash AL, Wing RR, Blair SN, Bennett PH, Kuller LH: Development of a questionnaire to examine relationship of physical activity and diabetes in Pima Indians. *Diabetes Care* 13:401–411, 1990
25. Kriska AM, Bennett PH: An epidemiological perspective of the relationship between physical activity and NIDDM: from activity assessment to intervention. *Diabetes Metab Rev* 8:355–372, 1992
26. Katz RC, Simkin LR, Beauchamp KL, Matheson DW: Specific and nonspecific effects of EMG biofeedback. *Biofeedback Self Regul* 12:241–253, 1987
27. Folkins CH, Sime WE: Physical fitness training and mental health. *American Psychologist* 36:373–389, 1981
28. Roviaro S, Holmes DS, Holmsten RD: Influence of a cardiac rehabilitation program on the cardiovascular, psychological, and social functioning of cardiac patients. *J Beh Med* 7:61–81, 1984
29. Lau RR, Ware JF: Refinements in the measurement of health-specific locus-of-control beliefs. *Med Care* XIX:1147–1157, 1981
30. Bandura A: Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev* 84:191–215, 1977
31. Godin G: Theories of reasoned action and planned behavior: usefulness for exercise promotion. *Med Sci Sports Exerc* 26:1391–1394, 1994
32. Phares EJ: *Locus of Control in Personality*. Morristown, NJ, General Learning Press, 1976
33. Nowicki S, Duke MP: The Nowicki-Strickland life-span locus of control scales: construct validation. In *Research With Locus of Control Construct*. Lefcourt HM, Ed. New York, Academic Press, 1983, p. 13–43