Association of Diabetes and Prediabetes Risk Perception with Leisure-time Physical Activity and Weight Loss

By: Rosendo Murillo, Bozena J. Katic, Tailisha Gonzalez, Elizabeth Vasquez, and Sandra Echeverria

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Abstract:

Purpose: To examine the association of perceived risk of prediabetes and diabetes with leisure-time physical activity (LTPA) and weight loss, and determine whether the association of risk perception with LTPA and weight loss varies by race/ethnicity. Design: Cross-sectional. Setting: National Health and Nutrition Examination Survey (NHANES) 2011-2014. Subjects: Non-Latino white, non-Latino black, and Latino nondiabetic and nonprediabetic NHANES participants ≥18 years of age who were not underweight (n = 9550). Measures: Demographic characteristics, LTPA, attempted weight loss, and perceived risk of prediabetes or diabetes. Analysis: Log-binomial regression models were fit to assess the association of perceived risk with meeting LTPA recommendations and having attempted to lose weight, overall and by race/ethnicity. Results: Individuals reporting that they perceived they could be at risk for diabetes/prediabetes were less likely to meet LTPA recommendations (adjusted prevalence ratio [aPR]: 0.87; 95% confidence interval [CI]: 0.79-0.95), but significantly more likely to report attempting weight loss in the past year (aPR: 1.14; 95%CI: 1.04-1.25), compared with those reporting no risk perception. Latino and non-Latino blacks who perceived they could be at risk for diabetes/prediabetes were 25% and 35% more likely to report trying to lose weight in the past year (aPR: 1.25; 95% CI: 1.08-1.44 and aPR: 1.35; 95% CI: 1.19-1.54, respectively), compared with Latino and non-Latino blacks that did not perceive being at risk. In contrast, non-Latino whites who perceived they were at risk were 20% less likely to report meeting LTPA recommendations (aPR: 0.80; 95% CI: 0.72-0.89), compared with non-Latino whites reporting no risk perception. Conclusion: Findings highlight the role of perceived risk for prediabetes and diabetes in LTPA and weight loss, with findings varying by race/ethnicity. Awareness of prediabetes and diabetes risk could contribute to efforts aimed at improving LTPA and weight loss.

Keywords: diabetes | prediabetes | risk perception | physical activity | weight loss | adults

Article:

Purpose

Diabetes is associated with a decrease in life expectancy as well as increased lifetime health expenditures.[1] Among US individuals 18 years of age and older in 2015, 30.2 million had diabetes, of which 1.7 million were new cases.[2] Additionally, prediabetes, which is associated with a high risk of diabetes due to elevated fasting plasma glucose and hemoglobin A1C levels, is also on the rise.[3,4] In 2015, an estimated 84.1 million US adults had prediabetes.[2] Given the increasing prevalence of prediabetes and diabetes among US adults and the complications associated with diabetes (eg, heart disease, kidney failure, and lower-limb amputation), it is critical to continue to obtain further insight into factors that can help forestall the development of diabetes.

Lifestyle modifications, such as weight loss and physical activity, have been shown to reduce the risk of diabetes.[5,6] For example, based on findings from one study, for every kilogram of weight lost, there was a 16% reduction in diabetes risk.[7] Further, weight loss attempts have been shown to vary by race/ethnicity, with non-Latino blacks and Latinos often being less likely to report attempting weight loss.[8-10] There is also significant evidence that physical activity aids in the prevention of type 2 diabetes via improved blood glucose control and insulin sensitivity.[11,12] Specifically, leisure-time physical activity (LTPA) or voluntary activity is often targeted in diabetes prevention efforts since it is a modifiable risk factor of type 2 diabetes.[13] There is variation in LTPA by race/ethnicity, with non-Latino whites performing higher levels of LTPA and being more likely to meet the current physical activity recommendations, compared with non-Latino blacks and Latinos.[14] Despite the benefits of lifestyle modification, many individuals at risk for diabetes do not engage in positive behavioral changes.[15]

Factors such as perceived risk of disease, knowledge of being at risk for the disease, and family history of disease have been suggested as key factors impacting lifestyle modification among vulnerable populations.[16-20] Specifically, risk perception, or the individual perception of risk for a particular disease, may contribute to disease prevention through lifestyle modification, and has been shown to vary by race/ethnicity.[21] While research has examined perceived risk of diabetes in relation to lifestyle behaviors, this has been limited to small samples or adolescent populations.[18,22] To our knowledge, studies have not examined the associations between perceived risk of prediabetes or diabetes and behaviors related to diabetes risk prevention, such as the performance of physical activity and engaging in weight loss, in a diverse nationally representative adult sample. Further, whether these relationships vary by race/ethnicity remains unknown.

Using data from the 2011-2014 Nutrition and Health Examination Survey (NHANES), the aims of our study were to (1) examine the association of perceived risk of prediabetes and diabetes with LTPA and attempted weight loss and (2) determine whether the association of risk perception with LTPA and attempted weight loss varies by race/ethnicity. We hypothesized that individuals who perceived they could be at risk for prediabetes and diabetes were more likely to engage in LTPA and to make attempts to lose weight, compared with those who did not perceive they could be at risk for prediabetes or diabetes. We further hypothesized that the association of perceived risk with LTPA and weight loss would vary by race/ethnicity.

Methods

Design

The study population included NHANES respondents from the 2011-12 and 2013-14 waves of data collection. The Nutrition and Health Examination Survey is a cross-sectional survey of adults and children in the United States designed to assess the health and nutritional status of the US population. The study obtains a nationally representative sample of the noninstitutionalized US civilians employing a complex, multistage stratified probability cluster sample design.[23]

Sample

Approximately 19150 participants were selected from NHANES over the 4-year period. This sample was further limited to adults 18 years of age or older (n = 11539) who did not report being diagnosed with prediabetes (n = 11044) or diabetes (n = 9655). After excluding those individuals who could not be categorized on the primary exposure variable (n = 105), the analytic sample consisted of 9550 (nondiabetic) adults.

Measures

Leisure-time physical activity. Moderate-to-vigorous LTPA was based on a combination of variables that assessed the frequency and duration of vigorous or moderate recreational activity. Weekly LTPA minutes were calculated by multiplying the number of days per week and minutes per day engaged in physical activity. Those reporting vigorous LTPA had their minutes multiplied by 2, as vigorous physical activity is given twice the credit as moderate activity as per the *2008 Physical Activity Guidelines for Americans*.[24] Those reporting their total LTPA as >3360 minutes per week (28 hours vigorous or 56 hours per moderate LTPA weekly) were removed from the sample frame based on what might be considered excessive, per NHANES interviewer question prompts (n = 27). Leisure-time physical activity was categorized into a dichotomous variable in accordance with the *2008 Physical Activity Guidelines for Americans*[24] as follows: (1) met recommendation (≥150 minutes/week); and (2) did not meet recommendation (<150 minutes/week).

Weight loss attempt. Weight loss attempt was measured by a single question on whether the respondent had tried to lose weight in the past year. The response options were “yes” or “no” and the resulting variable was dichotomous.

Perceived risk of prediabetes or diabetes. Risk perception was measured by a single question in NHANES: “Do you feel you could be at risk for diabetes or prediabetes?” Individuals responding “yes” or “no” were selected and the resulting variable was dichotomous. Due to survey skip patterns, those who previously reported that a doctor told them they had diabetes when asked the question, “Other than during pregnancy, have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?” did not answer this perceived risk question and were thus not part of the sample. Additionally, those who reported a doctor told them they had high blood sugar or prediabetes based on the question “Have you ever been told

by a doctor or other health professional that you have any of the following: prediabetes, impaired fasting glucose, impaired glucose tolerance, borderline diabetes, or that your blood sugar is higher than normal but not high enough to be called diabetes or sugar diabetes?" were already removed from the sample, to ensure that we were estimating behavior change for those who perceived they were at risk but not yet diagnosed.

Covariates. Participants self-reported race/ethnicity and were categorized as non-Latino white, non-Latino black, and Latino (including Mexican-American or other Hispanic origin) groups. Age was measured continuously and educational attainment level was dichotomized as "less than a high school degree" versus "high school degree (or equivalent) or more". Body mass index (BMI) category was also included in covariate models. Body mass index was categorized as obese (BMI ≥30 kg/m^2), overweight (BMI 25-<30 kg/m^2), or of normal weight (BMI 18.5-<25 kg/m^2). Underweight participants (BMI < 18.5 kg/m^2) were removed from the sample.

Analysis

Weighted percentages and standard errors (SE) were used to describe categorical variables, while the mean and SE, and median and interquartile range were used to describe the distribution of continuous variables. Log-binomial regression models were fit to estimate prevalence ratios and to assess the association between perceived risk of diabetes and the LTPA and weight loss outcomes. Unadjusted and adjusted multivariable models were run, where the adjusted model included age, sex, education, race, and BMI. For all models, sampling probability weights were applied to account for the complex sampling design of NHANES. Models were also tested for statistical interaction between race/ethnicity and diabetes risk perception for each outcome. A race × perceived risk interaction term was added to fully adjusted models and the association between perceived risk of diabetes at each race/ethnicity level (Latino, non-Latino black, non-Latino white) on LTPA or weight loss was reported. *P* values of <.05 were considered statistically significant and all tests were 2-tailed. Analyses were conducted with SAS Version 9.4 (Cary, NC) and SAS-callable SUDAAN Version 11.0.1.

Results

Table 1 displays participant characteristics, including weekly LTPA, attempted weight loss in the past year, BMI, and demographics by perceived risk of diabetes. The sample population was 49% male and approximately 44 years old. More than half (60%) did not meet the LTPA recommendation. Average LTPA was 239 min/week and was lower among those who perceived they could be at risk (203.6 min/week). About one-third (36.4%) of our sample population and nearly one-third (32.3%) of those with perceived diabetes risk reported trying to lose weight over the past year. Similarly, 38.6% of those with perceived risk identified as obese (BMI ≥ 30 kg/m^2).

Table 2 shows the unadjusted and adjusted prevalence ratios (aPR) for the association between perceived diabetes risk and each of the outcomes. Upon adjustment for age, sex, education, race/ethnicity, and BMI, those who reported feeling they could be at risk for diabetes/prediabetes were 13% less likely to meet weekly recommendations for LTPA (aPR: 0.87; 95% CI: 0.79-0.95), compared with those reporting not perceiving themselves at risk for diabetes/prediabetes.

After adjusting for the same covariates, those with perceived risk were 14% more likely to have attempted to lose weight over the past year (aPR: 1.14; 95% CI: 1.04-1.25).

Table 1. Participant Characteristics Overall and by Perceived Risk of Diabetes or Prediabetes Among Adults: NHANES 2011-2014.

	Total[a] (N = 9550)	Perceived Risk of Diabetes or Prediabetes (n = 2519)
Characteristic	**Mean (SE)[b] or % (SE)**	**Mean (SE)[b] or % (SE)**
Demographic characteristics		
Age, years (mean)	44.6 (0.48)	43.3 (0.60)
Male, %	48.6 (0.51)	23.1 (0.80)
Race/ethnicity, %		
Latino	15.9 (1.79)	29.9 (1.69)
Non-Latino white	72.1 (2.57)	24.4 (1.04)
Non-Latino black	12.0 (1.51)	29.2 (1.29)
Less than high school, %	15.9 (1.20)	24.0 (1.39)
LTPA		
Moderate-vigorous LTPA[b],		
Weekly activity (minutes/week); median (IQR)[c]	239 (11.31); 58.4 (311.4)	203.6 (14.27); 27.8 (236.2)
Did not meet recommendation[c], %	60.0 (1.30)	28.6 (0.99)
Met recommendation[d], %	40.0 (1.30)	22.2 (0.93)
Tried to lose weight (in past year)	36.4 (0.81)	32.3 (1.54)
Body mass index		
Obese ≥30 kg/m^2, %	33.0 (0.83)	38.6 (1.26)
Overweight, 25-<30 kg/m^2, %	34.4 (0.88)	23.3 (1.07)
Normal weight, 18.5-<25 kg/m^2, %	32.5 (1.02)	16.7 (0.88)

Abbreviations: IQR, interquartile range; LTPA, leisure-time physical activity

[a] Total is analyzable population of adults 18 years of age or older, without diabetes or prediabetes with available primary exposure data.

[b] Standard error.

[c] Not meeting recommendation: 0 to 149 minutes of leisure time physical activity per week.

[d] Meeting recommendation is defined as reporting a combination of vigorous- and moderate-intensity activity totaling to 150 minutes per week (but not exceeding 3360 minutes per week).

We also tested whether this association differed by race/ethnicity with a cross product race × perceived risk interaction term (*P* for interaction: *P* = <.0001, *P* = 0.0384 for LTPA and weight loss, respectively). In Table 3, adjusting for age, sex, education, and BMI, individuals who were non-Latino white who felt they could be at risk were 20% less likely to meet the LTPA recommendation (aPR: 0.80; 95% CI: 0.72-0.89; *P* = .0001), compared with non-Latino white individuals who reported not feeling at risk. The effect estimates for Latinos and non-Latino blacks were 1.04, but confidence intervals overlapped with 1.00 in both cases (95% CI: 0.88-1.24 and 0.90-1.20, respectively).

Table 2. Association of Perceived Risk of Diabetes or Prediabetes with Leisure-Time Physical Activity and Weight Loss Among Adults: NHANES 2011-2014.

	Lesiure-Time Physical Activity (Met Recommendations vs Did Not Meet Recommendation)[a]		Weight Loss (Tried to Lose Weight vs Did Not Try to Lose Weight)	
	Unadjusted	Model 1[b]	Unadjusted	Model 1[b]
	PR (95% CI)	aPR (95% CI)	PR (95% CI)	aPR (95% CI)
Perceived risk				
Yes	0.81 (0.75-0.88)	0.87 (0.79-0.95)	1.42 (1.31-1.54)	1.14 (1.04-1.25)
No	1.00	1.00	1.00	1.00
Sex				
Male		1.21 (1.11-1.31)		0.59 (0.55-0.64)
Female		1.00		1.00
Age category				
18-39		2.26 (1.73-2.94)		2.81 (2.10-3.76)
40-59		1.71 (1.31-2.22)		2.51 (1.88-3.35)
60-79		1.58 (1.20-2.07)		2.16 (1.64-2.86)
80+		1.00		1.00
Education				
Less than high school		0.56 (0.49-0.63)		0.67 (0.58-0.77)
More than high school degree		1.00		1.00
Race/ethnicity				
Latino		0.92 (0.85-1.00)		1.00 (0.91-1.10)
Non-Latino black		0.96 (0.87-1.05)		0.83 (0.74-0.92)
Non-Latino white		1.00		1.00
Body mass index[c]				
Obesity		0.64 (0.58-0.72)		2.59 (2.27-2.95)
Overweight		0.88 (0.82-0.94)		1.95 (1.73-2.21)
Normal weight		1.00		1.00

Abbreviations: aPR, adjusted prevalence ratio; PR, prevalence ratio; CI, confidence interval.

[a] Meeting recommendation is defined as reporting a combination of moderate- and vigorous-intensity activity totaling to ≥150 minutes per week (but not exceeding 3360 minutes per week). Did not meet LTPA recommendations: 0 to 149 minutes of leisure time physical activity per week.

[b] Adjusted for age, sex, education, race/ethnicity, and body mass index category.

[c] Obese: BMI 30 ≥ kg/m^2 , overweight: BMI 25-<30 kg/m^2, BMI – 18.5-<25 kg/m^2

Table 3. Association of Perceived Risk of Diabetes or Prediabetes with Meeting Leisure-Time Physical Activity Recommendation[a]Among Adults by Race/Ethnicity: NHANES 2011-2014.[b]

	Latino	Non-Latino Black	Non-Latino White
	aPR (95% CI)	aPR (95% CI)	aPR (95% CI)
Perceived risk[c]			
Yes	1.04 (0.844-1.24)	1.04 (0.94-1.20)	0.80 (0.72-0.89)
No	1.00	1.00	1.00

Abbreviations: aPR, adjusted prevalence ratio; CI, confidence interval.

[a] Meeting recommendation is defined as reporting a combination of moderate- and vigorous-intensity activity totaling to 150 minutes per week (but not exceeding 3360 minutes per week). Did not meet LTPA recommendations: 0 to 149 minutes of leisure time physical activity per week.

[b] Adjusted for age, sex, education, and body mass index category

[c] Race × perceived risk: $P = .0001$.

The association between perceived diabetes/prediabetes risk and past-year weight loss by race/ethnicity is presented in Table 4. Adjusting for the same covariates, those who identified as non-Latino black who felt they could be at risk were 35% more likely to have attempted weight

loss over the past year (aPR: 1.35; 95% CI: 1.19-1.54), compared with non-Latino black individuals who reported not feeling at risk. Similarly, Latinos were 25% more likely to have attempted weight loss (aPR: 1.25; 95% CI: 1.08-1.44), compared with Latino individuals who reported not feeling at risk. Perceived risk of diabetes/prediabetes was not significantly associated with weight loss attempt among non-Latino whites.

Table 4. Association of Perceived Risk of Diabetes or Prediabetes with Trying to Lose Weight Among Adults by Race/Ethnicity: NHANES 2011-2014[a].

	Latino	Non-Latino Black	Non-Latino White
	aPR (95% CI)[b]	aPR (95% CI)	aPR (95% CI)
Perceived risk[c]			
Yes	1.25 (1.08-1.44)	1.35 (1.19-1.54)	1.09 (0.97-1.22)
No	1.00	1.00	1.00

Abbreviations: aPR, adjusted prevalence ratio; CI, confidence interval.
[a] Adjusted for age, sex, education, and body mass index category
[b] Race × perceived risk: $P = .0384$.

Discussion

Our study examined the associations of perceived risk of diabetes/prediabetes with LTPA and weight loss and whether these associations varied by race/ethnicity. Individuals who reported that they felt they could be at risk were significantly less likely to meet the recommendations for LTPA, but significantly more likely to have attempted to lose weight in the past year. When we examined this association by race/ethnicity, results indicated variation in the association of perceived diabetes risk with LTPA by race/ethnicity. Specifically, results showed a significant lower probability of meeting the LTPA recommendation for those with perceived risk compared to no perceived risk among non-Latino whites only. In contrast, for Latinos and non-Latino blacks, those who perceived they could be at risk for diabetes/prediabetes were significantly more likely to have attempted to lose weight in the past year.

Our study findings also indicate that individuals who perceive that they could be at risk for diabetes or prediabetes are less likely to engage in recommended amounts of physical activity, although results are statistically significant for non-Latino whites only. Our findings differ from related research that has indicated that those at risk for diabetes are more likely to engage in physical activity.[15,19,25] One potential explanation for our findings is that respondents may perceive they are at risk for diabetes/prediabetes because they do not engage in much LTPA. Hence, given that our study was a cross-sectional study design, this may explain why perceived risk for diabetes and LTPA were inversely related. Future research should consider longitudinally examining the changes that may occur over the course of a specific time frame to better capture the relationship between diabetes risk perception and physical activity.

Another plausible explanation is that LTPA was dichotomized on the recommended threshold of 150 minutes or more per week of physical activity. Individuals doing any less were considered not as physically active and were grouped with those doing no LTPA at all. However, we conducted sensitivity analysis by constructing a 3 level category measure of LTPA and found that effect estimates associated with some LTPA and no LTPA were similar given diabetes risk perception. There may also be other factors not measured in our study that may play a role in the performance of physical activity, such as community factors (eg, neighborhood safety) and the

built environment (eg, availability of walking paths). Future studies should consider examining how environmental factors may contribute to physical activity outcomes among those who perceive themselves at risk for diabetes. Lastly, when we examined the association of diabetes risk perception with LTPA by racial/ethnic groups, we found that the overall association remained only significant in non-Latino whites. Since non-Latino whites comprised the largest racial/ethnic category, the sheer number of their representation in the sample may be driving the significant association between perceived risk and meeting LTPA recommendations. Studies with larger numbers of racially/ethnically diverse groups are needed to confirm our observed patterns.

Consistent with our hypothesis, our findings also suggested that those who perceive they could be at risk for prediabetes or diabetes are significantly more likely to have attempted to lose weight in the last year. These results are consistent with related research that shows that individuals at risk for diabetes are more likely to engage in weight loss and weight management appropriate for their BMI.[15,19,25] Also, this association was present among most racial/ethnic groups even when adjusting for covariates, such as BMI. Based on these findings, the role of perceived risk should be considered in the development and promotion of lifestyle interventions, specifically those focused on reducing BMI, which have been shown to be effective in lowering diabetes incidence rates.[26]

Our study results also indicated that perceived diabetes/prediabetes risk and weight loss association differs among racial/ethnic groups. Specifically, our findings showed that Latinos and non-Latino blacks who perceived being at risk for diabetes/prediabetes were more likely to have attempted weight loss in the past year. However, our findings showed that this association was strongest among non-Latino blacks. A possible explanation for this finding is that non-Latino black adults have a high prevalence of being overweight/obese[27] and the second highest prevalence of diabetes in the U.S.[28] As a result, this population group may be more likely to have family members with a history of diabetes compared with other racial/ethnic groups, which may play a role in their risk reduction behaviors. For example, previous research showed that adults with a family history of diabetes were more likely to engage in risk reduction behaviors such as weight control, increased physical activity, and reducing fat and calories in their diet.[29-31] Furthermore, previous research has also indicated that among African Americans, those with a family history of diabetes are more likely to be aware of diabetes risk factors such as physical inactivity, being overweight, and consumption of energy dense foods, and were more likely to report consuming 5 or more servings of vegetables and fruits per day.[30] Lastly, as racially/ethnically diverse groups are disproportionately affected by diabetes, they may report higher rates of behavioral modification attempts. However, we are not aware of studies showing increased misreporting of behavioral modification attempts among these groups relative to non-Latino whites.

The strengths of our study should be considered in light of the limitations. Given the cross-sectional nature of NHANES, we were not able to examine changes that may occur in risk perception, LTPA, and weight loss attempts over time, nor could we assess directionality or causality, as evidenced by prevalence ratios for LTPA as a result of risk perception. Moreover, physical activity was self-reported rather than objectively measured. Previous research has indicated that compared with objectively measured activity, self-reported activity may result in

the overestimation of the amount of physical activity performed due to reporting bias.[32] However, objective methods do not provide information on domain-specific activity, which was important in our study, given our focus on LTPA. Weight loss attempt in the past year was also self-reported, which, as suggested may have resulted in differential misclassification due to recall bias.

Our study adds to current knowledge on how perceived risk of prediabetes or diabetes relates to lifestyle behaviors, specifically LTPA and weight loss, and whether these relationships differ by race/ethnicity. The findings from our study highlight the role of perceived risk in behaviors related to diabetes prevention, bringing to light a potential area to target in health promotion efforts focused on diabetes prevention. Specifically, it may be worthwhile taking into consideration perceived risk of prediabetes or diabetes among individuals at risk for diabetes to obtain further insight into how perceived risk, in addition to other individual factors, may contribute to the performance and maintenance of diabetes prevention behaviors. Thus, when developing health interventions aimed at increasing physical activity and weight loss, it will be important to consider the potential role of perceived risk of diabetes in lifestyle modification. Given the burden of diabetes and the related adverse health outcomes, it will be critical to continue to obtain a better understanding of the factors that contribute to diabetes prevention to improve behavioral modification efforts.

So What? Implications for Health Promotion Practitioners and Researchers

What is already known on this topic?
The prevalence of prediabetes and diabetes among US adults is on the rise. Perceived risk of prediabetes and diabetes may contribute to lifestyle modification, and provide further insight into forestalling the development of diabetes. Research on the associations of perceived risk of prediabetes or diabetes with performance of LTPA and weight loss, and whether these relationships vary by race/ethnicity, remains limited.

What this Study Adds?
Compared with individuals reporting no risk perception, those reporting feeling at risk of diabetes/prediabetes were less likely to meet the LTPA recommendation, but significantly more likely to report attempting weight loss in the past year. Among only non-Latino whites (ie, not Latinos or non-Latino blacks), perceived risk for diabetes/prediabetes was significantly associated with meeting the LTPA recommendation. In contrast, Latinos and non-Latino blacks, but not non-Latino whites, reporting feeling at risk of diabetes/prediabetes were significantly more likely to have attempted weight loss.

What are the Implications for Health Promotion Practice or Research?
Understanding the role of perceived risk of prediabetes and diabetes in physical activity and weight loss outcomes will be important for intervention development and health promotion efforts aimed at preventing diabetes.

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