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Risk perception and self-management in urban, diverse adults with type 2 diabetes: the improving diabetes outcomes study

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Abstract

Purpose—The relationship between risk perceptions and diabetes self-care remains ambiguous. This study aimed to assess baseline, one-year follow-up and change score relationships among perceived risk, diabetes self-care and glycemic control for adult individuals participating in a behavioral intervention that improved glycemic control relative to the active control.

Methods—One-year randomized trial compared a behavioral telephonic intervention with a print only intervention. Participants ($N = 526$): members of a union/employer sponsored health benefit plan, $HbA_{1c} \geq 7.5\%$, prescribed at least one oral diabetes medication. Participants rated perceived risk of diabetes and its complications and diabetes self-care at baseline and one year. Data were collected in a large urban area in the United States.

Results—There were no relationships between risk perceptions and glycemic control during the study. Baseline perceived risk predicted follow-up self-care. Additionally, participants assigned to the intervention group showed significant changes in dietary and exercise adherence at high levels of risk knowledge and low levels of optimistic bias.

Conclusions—Perceived risk relates to dietary, exercise and medication adherence in diabetes. The perceived risk construct might foster a more coherent conceptualization of the relationship between one's diabetes, possible complications, and diabetes self-care behaviors.

Keywords

Risk perception; Diabetes; Self-care; Glycemic control

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Conflict of Interest Statement

The authors have no conflicts of interest to disclose.

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Introduction

Risk perception plays a role in many theories of health behavior, including the Health Belief Model, Protection Motivation Theory and the Subjective Expected Utility theory [1–3]. It is often defined as perceived probability, likelihood or susceptibility to harm. The construct has been explored in relation to behavior, such that risk perceptions can affect one's engagement in protective or harmful behaviors, just as protective and harmful behaviors can reciprocally influence one's risk perception [4]. Some studies in the area of chronic illness have shown positive relationships between perceived risk and adherence to protective health behaviors [5], while other studies report negative or no associations between the two [6–9]. Consequently, inconsistent results support defining the nature of the relationship between risk perceptions of chronic disease and health behaviors more clearly, especially in the complex area of diabetes self- management.

Diabetes is a chronic disease that is characterized either by an absolute insulin deficiency (type 1 diabetes) or by insulin resistance/abnormal secretion (type 2 diabetes) [10]. The WHO (2011) estimates that 346 million people worldwide have diabetes and more than 80% of diabetes-related deaths occur in low- and middle-income countries. The diabetes epidemic relates particularly to type 2 diabetes, which comprises about 90% of people with diabetes worldwide [10]. Diabetes necessitates a self-management regimen which includes administering insulin injections and/or taking oral medication, monitoring blood glucose levels and following nutrition and exercise recommendations [11,12]. Careful adherence to these recommendations is necessary to avoid short and long-term complications, yet challenges to medication adherence and self-management are often manifested in poor glycemic control. More specifically, in the United States, 43% of people with known type 2 diabetes have glycosylated hemoglobin (HbA_{1c}) above the target level of <7.0% [13].

Moreover, studies indicate the increasing prevalence of type 2 diabetes in Canadian, Native American, Pacific Island, Indian and Australian aboriginal communities, with the greatest potential for increases in Asia [14–17]. In addition, the prevalence of type 2 diabetes and its related complications is disproportionately high among minorities in the United States [18–21]. According to the 2011 National Diabetes Fact Sheet, the prevalence rate of diabetes in general is 7.1% among non- Hispanic whites compared to 11.8% among Hispanics and 12.6% of non-Hispanic blacks African Americans [22]. Regional data also indicate that diabetes is more common among Native Americans, Asian Americans/Pacific Islanders and other racial/ethnic groups [23]. Furthermore, the literature indicates that ethnic minority individuals are less likely to own diabetes treatment equipment, less likely to engage in treatment recommendations than Caucasians, and that cultural and health belief differences across diverse groups play a role in how people understand their illness and engage in self-management [24–26]. An exploration of risk perception and self-care behaviors is important in minority groups to understand and promote effective self-management, as the literature indicates that misconceptions and inconsistent beliefs regarding diabetes risks and treatment, as well as perceived treatment barriers, are especially common among minority populations [27,28]. Given the increased prevalence of type 2 diabetes and related complications in minority populations, there has been growing interest in understanding how patients' beliefs

about their disease, such as risk perception, affect self-care, in an effort to target areas to enhance self-management [27].

Perception of risk may play a role in whether an individual will engage in self-management behaviors, in that recognition of a significant health risk or one's perceived vulnerability to the threat of complications, may motivate one to adopt preventive health behaviors [29,30]. Additionally, the aforementioned models of health behaviors [1–3] posit that risk perception is multi-dimensional, consisting of anticipation of a negative health outcome, the likelihood that it will occur, the desire to avoid or reduce the consequences of the outcome and the perceived efficacy in carrying out the health behaviors to reduce the initial risk. Taken together, the risk perception construct sets the stage for one to engage in self-protection, through the expectation that action can reduce the likelihood of harm and that one is capable of carrying out the action [1–3,7]. Moreover, strategies for understanding and measuring perceptions of risk are needed to effectively inform risk communication so that health care providers can relay critical information to motivate successful self-management of diabetes [30]. Assessing perceived risk may help explain how individuals with diabetes integrate ideas of the disease and its treatment and how this understanding affects their self-management. This understanding can provide a framework for the individual to improve self-care behaviors and glycemic control.

One model of risk perception and health behavior that is particularly applicable for examining the relationship in diabetes is Brewer et al.'s model [4]. While different theoretical frameworks use components of risk perception (i.e. perceived behavioral control, probability of a threatening event) when explaining the relationship to health behavior, Brewer et al. [4] discuss the relationship between perceived risk and protective health behaviors more directly. The framework describes overall perceived risk through the accuracy, behavior motivation and risk reappraisal hypotheses [4]. These hypotheses have been evaluated in meta-analyses in the area of risk for HIV and protective sexual behavior and risk perception and precautionary behaviors, such as mammograms, vaccinations and home radon screenings, but have not been examined in risk for diabetes-related complications and self-care behaviors [6,31]. The direct examination of risk perception, the model's ability to evaluate the relationship longitudinally and the dearth of research evaluating these longitudinal hypotheses in diabetes supports testing the model's applicability for the current report.

The aforementioned model serves as a heuristic for the current study. The accuracy hypothesis states that people who engage in risky behaviors have higher actual risk and therefore should have higher perceived risk. Moreover, perceived risk acts as an accurate indicator of one's risk factors and behaviors. This hypothesis is typically tested cross-sectionally, as a correlation between risk perceptions and risk behaviors [4]. For example, one who takes his diabetes medication as prescribed may perceive him- or herself to be at lower risk for developing complications, such that the perception of risk reflects one's behaviors. The behavior motivation hypothesis extends the temporal component of the accuracy hypothesis, evaluating the effects of perceived risk on changes in behavior. Consequently, this hypothesis must be tested with a longitudinal design, such that risk perception at time 1 is hypothesized to have positive effects on behavior at time 2. In this

case, one who perceives himself at high risk for diabetes-related complications may decide to take his medication more regularly. Lastly, the risk reappraisal hypothesis, which is also measured longitudinally, describes the effects of changes in behavior on changes in perceived risk, such that increasing protective behaviors, or the anticipation of engaging in the health behavior decreases perceived risk [4]. According to this hypothesis, a person who starts to take his medication on a regular basis will reassess and now perceive less risk of diabetes-related complications.

Brewer's conceptualization of the relationship between risk perception and protective health behaviors provides a framework for understanding disease conceptualizations and addressing issues of treatment adherence and self-care behaviors in people with diabetes. Due to the complexity inherent in the risk perception construct and diabetes self-care behaviors and the scarcity of research evaluating this relationship over time, the purpose of the current study was to assess the relationships between risk perceptions and various aspects of diabetes self-management, longitudinally, and in change-based analyses. It is a sub-study of the larger Improving Diabetes Outcomes with Medication, Diet and Exercise (IDO) study, which was designed as a longitudinal, randomized controlled trial to test a behavioral intervention among adults with type 2 diabetes. The primary hypothesis of the study was supported and previously reported results indicate that a culturally-adapted telephonic, self-management support intervention, significantly improved glycemic control relative to an active control of mailed self-management materials [32,33].

Research questions and aims

Current objectives include evaluating: 1) relationships between baseline risk perception components and one-year follow-up scores on self-care behaviors and glycemic control and 2) relationships between changes from baseline to one-year follow-up in risk perception components and changes in self-care.

Corresponding hypotheses include:

1. Baseline risk perception subscales will significantly predict one-year follow up scores on self-care behaviors and glycemic control, after controlling for any intervention effects. More specifically, higher levels of risk knowledge, perceived personal control, worry, comparative disease risk, environmental risk and composite risk were expected to predict increases in self-care behaviors and decreases in glycemic control. Higher levels of optimistic bias were expected to predict decreases in self-care behaviors and increases in glycemic control.
2. Changes from baseline to one-year follow up on risk perception subscales will significantly predict changes from baseline to one-year follow up on self-care behaviors and glycemic control, after controlling for any intervention effects in the same directions as hypothesized above.

Methods

Participants, setting & recruitment

As previously described [32,33], potential participants were urban, diverse adults (≥ 30 years old) with type 2 diabetes. Potential participants were members of the 1199SEIU Benefit and Pension Funds, which provide health benefits for members and their spouse. The sample consisted of lower-income, mostly minority individuals who were current or recent health workers or their spouses (primarily home health attendants and nursing home and hospital workers) [30]. All participants had been prescribed one or more oral glucose-lowering agents (OGLA) in the year prior to enrollment and had a baseline HbA1c ≥ 7.5%. Oral informed consent and Health Insurance Portability and Accountability Act authorization were obtained by telephone with approval of the Institutional Review Board of the Albert Einstein College of Medicine and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. For complete review of participants, see [32,33].

Additionally, as previously described [33], the participant recruitment pool started with 8,083 adults with diabetes taking an oral glucose-lowering agent. Individuals (n = 4,558) individuals were assessed for eligibility and 4,021 individuals were excluded (55% did not meet eligibility criteria and 45% refused). 526 individuals were randomized. Response rates for outcome variables are reported in the results section.

Interventions

Participants were randomly assigned to either a telephonic intervention group or an active control group. Participants in the telephonic group received up to 10 calls over 4 to 6 week intervals throughout the one-year intervention. The intervention was delivered by health educators who were trained and supervised by a nurse certified diabetes educator. The calls, based on a standard, but tailored protocol, focused on diabetes medication adherence, healthy eating and exercise behaviors. Furthermore, the protocol focused on improving self-efficacy through developing problem-solving, goal setting and communication skills. All participants received diabetes self-management materials via mail, but only intervention group members were encouraged by the health educators via phone to actively use the materials [33]. The intervention did not specifically target perceived risk. Risk perception measures were included for planned secondary analyses.

Measures

HbA1c—HbA1c mail-in kits were obtained from a vendor [Home Healthcare Laboratory of America (HHLA), Franklin, TN, USA] whose process had been approved by the National Glycohemoglobin Standardization Program and used as previously described [32–34].

Diabetes Self-Care—Diabetes self-care behaviors were assessed with The Summary of Diabetes Care Activities (SDSCA) [35]. The SDSCA is a brief self-report questionnaire of diabetes self-management. The following aspects of the diabetes regimen were used in analyses: two items on the general diet subscale ($\alpha = .78$ for this sample): calculated by adding days in the past week following a healthful eating plan and average days per week

following a healthful eating plan over the past month, two specific diet questions: days in the past week eating five or more serving of fruits and vegetables and days in the past week eating high-fat foods and two exercise questions: days participating in a specific exercise session outside of doing things around the house or at work in the past week and days participating in at least 30 minutes total of physical activity in the past week. A one-item medication adherence question was used, evaluating how many days in the past week (7 days) one has taken diabetes pills as prescribed [35].

Risk perceptions—Risk perception related to diabetes and its complications was measured with the validated Risk Perception Survey-Diabetes Mellitus (RPS-DM) [36]. The RPS-DM measures comparative perceptions of risk for diabetes and its complications: 1) Risk Knowledge subscale ($\alpha = .72$) measures risk knowledge of diabetes-related complications, 2) Personal Control subscale ($\alpha = .51$) assesses perceived control over developing diabetes complications, 3) Optimistic Bias subscale ($\alpha = .80$) examines the belief that one is less likely to develop complications compared to people of similar demographic characteristics and 4) Worry subscale (worry, $\alpha = .57$) evaluates concerns over developing diabetes-related complications. Additionally, 5) Comparative Disease Risk subscale ($\alpha = .88$) evaluates perceived risk for other diseases and conditions, such heart attack, cancer, stroke or foot amputation, and allows the individual to specify whether or not they or a family member have had the condition, and 6) Environmental Risk subscale ($\alpha = .88$) compares the perceived risk of potential hazards in the environment, such as risk from violent crime, extreme weather, illegal drugs and air pollution, which may contribute to overall perceived risk. Lastly, a Composite Risk score ($\alpha = .88$) is calculated from all of the subscales except for Risk Knowledge and it provides a measure of overall perceived risk for diabetes and its complications [36]. All reported α values are for this sample.

Self-reported demographics included age, sex, race/ethnicity, income and education, as well as other disease-related characteristics, including years with diabetes, number and type of diabetes medications and insulin use in the past year. Risk perception and self-care measures were completed at baseline and 12 months [32].

Statistical analyses

The behavior motivation hypothesis as described by Brewer et al. was tested and served as a framework for analysis, given its ability to test relationships longitudinally and that the relationship between risk perceptions and health behaviors has been characterized as a process that unfolds over time [4]. Moreover, this focused analysis was chosen as a way to expand the current literature, as much of the extant data is cross-sectional. Changes in risk perception, self-care activities, medication adherence and glycemic control were calculated as follow-up values minus baseline values. Change scores were normally distributed, while follow-up outcome variables were not normally distributed. Transformations did not bring normality back to acceptable levels for follow-up variables. To be consistent with previous treatment of the data [33], follow up variables were dichotomized as optimal adherence (7 days) and less than optimal adherence (< 7 days) for dietary, exercise and medication adherence (to diabetes pills) variables. For the model with OGLA medication adherence, we ran the analysis with the addition of the risk perception component and insulin use as an

interaction term. Additionally, HbA_{1c} was dichotomized as less than 9% and greater than or equal to 9% for HbA_{1c} (considered poor control) in accordance with previous literature to discriminate between those with good and poor glycemic control [37, 38]. The median follow-up HbA_{1c} value was near 9.0%, providing further justification for the dichotomy. Dichotomized follow-up variables were used in logistic regression analyses. SDSCA single or scale items were used where appropriate, as indicated by author recommendations to use single item questions where subscale item consistencies were low [35]. The item, days eating high-fat foods, was reverse coded, so that higher scores indicate fewer days eating high-fat foods.

Logistic regression models evaluated the predictive nature of baseline risk perception subscales on follow-up measures of glycemic control and self-care adherence. Linear regression models evaluated baseline to follow-up changes on risk perception subscales predicting baseline to follow-up changes on glycemic control and self-care activities. Multiple regression models controlled for intervention group and baseline glycemic control and baseline self-care behaviors. Regression models were entered stepwise, with intervention in the first step and baseline risk perception components and self-care behaviors in the second step. First, risk perception components were evaluated in the models separately. Then, the analyses were run again, with all of the risk perception components that were associated with the outcome variables in the initial step, to determine the unique variance of each risk perception predictor. The investigators believed each of the risk perception subscales might help explain results, but there was no specific *a priori* hypothesis regarding specific subscales as distinct from others. Additionally, models evaluated for moderation effects between intervention group and risk perception subscales. Post-hoc probing of significant moderation results was completed using Aiken & West's guidelines [39]. Statistical analyses were performed using PASW Statistics, release version 18.0.0 (SPSS, Inc., Chicago) and a two-tailed α of 0.05 denoted statistical significance.

Results

Approximately 77% of those recruited (406 participants) provided data for follow-up HbA_{1c} and the SDSCA variables and were included in the current analyses. Table 1 summarizes the sample characteristics. Participants ($n = 526$) had a mean $\pm$ SD age of 56 ± 7.3 years, were primarily female (67%), Black (62%), married (61%) and full-time employees (74%). Additionally, participants had a mean $\pm$ SD diabetes duration of 9.2 ± 6.6 years, baseline HbA_{1c} levels of median (interquartile range, 25–75th percentiles) of 8.6 (8.0–10.0%), were predominantly taking at least 2 diabetes pill classes (68.4%), and 24% of participants were taking insulin. Over 30% of participants had a high school or high school equivalent degree, 28.1% earned between \$20,000–\$29,000 a year, about 15% classified Spanish as their preferred language, and about 80% were born outside of the United States.

Hypothesis 1

The logistic regression models revealed significant associations of risk perception components and general dietary adherence, number of days eating high-fat foods, days participating in specific exercise, and medication adherence, after controlling for

intervention assignment and baseline self-care activities. When risk perception components were added into the regression models together, results remained similar, except that the relationship between optimistic bias and general dietary adherence became non-significant. Additionally, the association between optimistic bias and medication adherence remained significant as an independent predictor, but was not significant in the overall model. Those relationships that were significant in the regression models are summarized in Tables 2–5; these should be viewed as exploratory and not confirmatory. Furthermore, the model in Table 5, with regard to optimistic bias and medication adherence, did not show a significant interaction term between optimistic bias and insulin use. No other significant relationships were found between risk perception components and self-care behaviors or glycemic control.

Hypothesis 2

Those relationships that were significant in the regression model between risk perception sub-scale components and self-care behaviors are summarized in Tables 6, namely relationships between optimistic bias and exercise adherence and risk knowledge and dietary adherence. No other significant relationships were found between risk perception components and self-care behaviors or glycemic control. Changes in the baseline to follow-up scores on optimistic bias significantly predicted changes in baseline to follow up scores on days participating in at least 30 minutes of physical activity ($\beta = 0.61$, $SE = 0.28$, $t(268) = 2.21$, $p = .03$). However, this main effect was qualified by a significant interaction between changes in optimistic bias and intervention assignment ($\beta = -0.87$, $SE = 0.42$, $t(268) = -2.09$, $p = .04$). Post-hoc analyses indicate a moderating effect of intervention assignment at low levels of changes in optimistic bias, $t(269) = 2.21$, $p = .03$, as illustrated in Fig 1. When optimistic bias decreased, assignment to the telephone intervention predicted significant increases in days participating in 30 minutes of exercise. This intervention effect was not significant when optimistic bias increased over time.

Additionally, there was a significant interaction between changes in risk knowledge and intervention group in predicting changes in days eating high-fat foods ($\beta = -0.32$, $SE = 0.15$, $t(282) = 2.13$, $p = .03$). Post-hoc analyses indicate a moderating effect of intervention assignment at increases in risk knowledge, $t(282) = 2.11$, $p = .04$, as illustrated in Fig 2. When patients reported increased risk knowledge over time, assignment to the telephonic intervention predicted significant decreases in days eating high fat foods, relative to the active control condition.

Discussion

Analyses of baseline and follow-up data from the I DO study add to the knowledge base for understanding the relationship between risk perception and diabetes self-management behaviors over time. Moreover, our longitudinal analyses may be an important contribution to the diabetes self-care literature that has relied to a large extent on cross-sectional evaluations. Our findings, showing that baseline risk perception components predict self-management behaviors evaluated approximately 12 months later, suggest that risk perceptions may have enduring relationships with diabetes self-care over time. Results

indicate that baseline perceived personal control predicted follow up general dietary adherence and days eating high-fat foods; baseline optimistic bias predicted follow up general dietary adherence and days of medication adherence. Additionally, baseline comparative disease risk predicted follow up days participating in specific exercise, providing further evidence that perceived risk plays a role in impacting diabetes self-care. Furthermore, when the risk perception components were added into the model together, results remained similar, except the relationship between optimistic bias and general dietary adherence became non-significant. This result may suggest that optimistic bias plays less of a role once the other risk perception components are accounted for. Additionally, it is possible that this attenuated relationship may still exist in a larger sample of participants.

Overall, results partially support Brewer's behavior motivation hypothesis [4] in that certain components of baseline risk perception, such as perceived personal control, were related to follow-up days eating high fat foods in the hypothesized direction, while baseline optimistic bias, comparative disease risk and composite risk were related to follow-up dietary, exercise and medication adherence, but not in the hypothesized direction. In terms of optimistic bias, these counterintuitive findings may possibly be explained such that if one views oneself as less likely to develop diabetes-related complications, he may be more apt to want to maintain that condition by continuing to engage in the protective health behaviors. With greater comparative disease risk and composite risk predicting less exercise adherence, it is possible that recognition of one's risk for other diseases and complications related to diabetes and an overall measure of perceived risk may have exceeded a threshold for positive action through exercise. Instead of engendering motivation, the awareness of increased risk may have led to feelings of being overwhelmed, in turn deterring action. Additionally, in the context of our results, it is possible that despite perceived risk, there were not sufficient opportunities for implementing the exercise behaviors. Previous research indicates that people in urban environments report environmental barriers, such as crime and weather, and that perceived neighborhood safety is positively associated with physical activity [40,41]. Perceived barriers may deter exercise behavior despite having risk knowledge about the consequences of physical inactivity. Lastly, risk perception components were not related to follow-up glycemic control. Self-care behaviors are often viewed as important predictors of glycemic control [42,43] and given the inconsistencies between risk perception and self-care behavior, it is probable that the pathway from risk perception to glycemic control involves other factors. Additionally, the ethnic and socio-economic diversity of the current sample may have played a role in the modest findings, as the previous literature demonstrating relationships between risk perceptions and health behaviors have been conducted in more suburban areas with well-educated participants [4,31]. The partial support for the hypothesis highlights the complexity inherent in understanding the relationship between risk perception and diabetes self-care behaviors. Furthermore, it suggests taking a step back to explore what risk for diabetes-related complications means to individuals and how it is perceived, to more coherently understand the elusive construct.

Research in the area of other chronic illnesses corroborates the complexity and ambiguity in the relationship between risk perception and protective health behaviors. For example, studies investigating the relationships between perceived risk for breast cancer and decision-

making for undergoing a mammogram or prophylactic surgery have yielded mixed results. Some studies showed that greater perceived risk was associated with greater intention, as well as action in undergoing a prophylactic mastectomy, while other studies showed that increased levels of cancer-related distress or worry were associated with decreased levels of screening compliance [44–48]. Contradictory results have also been found in the area of hypertension, such that one study showed that both above and below average perceived risk for a stroke were associated with decreased self-monitoring of blood pressure [49]. Research in the area of HIV treatment adherence indicates that people who perceived greater vulnerability to complications if not adherent to their medication, were more likely to be adherent, supporting a positive relationship between perceived risk and self-care behaviors [50,51]. Moreover, the evidence for contradictory relationships between perceived risk and protective health behaviors in diabetes and other chronic illnesses suggests continued examination of the risk perception for a more coherent understanding of the construct and ways to impact its components. Due to the ethnic diversity and lower socioeconomic status of the sample, further research should explore similarities and differences in how risk is perceived and experienced across socio-demographic variables.

The strongest evidence from our study to suggest the utility of interventions that aim to modify risk perceptions as a means to improving diabetes self-management and control come from moderation analyses demonstrating that the effect of the I DO intervention on important self-care behaviors depended on changes in certain risk perceptions. These interaction effects illustrate that when risk knowledge increased and optimistic bias decreased (i.e., supporting greater perceived risk) over the course of the intervention period, the telephone group scored significantly higher on decreases in consumption of high-fat food and significantly higher on increases in days participating in 30 minutes of exercise respectively, when compared to the active control group.

Although the intervention was not designed to directly impact risk perceptions and discussions of risk were not an explicit component of the intervention content, it is possible that counseling about ways to improve diabetes self-management and enhancing one's self-efficacy, may have highlighted behaviors that people were or were not doing. This may have indirectly influenced conceptualizations of risk regarding diabetes-related complications. These results continue to support the efficacy of the intervention on improving self-care behaviors and suggest the possibility of future interventions targeting risk perceptions. A more nuanced understanding of the pathway of influence in the relationship between perceived risk and diabetes self-care behaviors holds promise for positively supporting clinicians' ability to discuss patients' risk for diabetes-related complications and overall treatment management in order to motivate behavior change.

Our results should be considered within the context of our study design [32,33]. One limitation is in the use of the SDSCA, as the low inter-item reliability and use of single questions may have precluded finding significant results, such that associations and relationships trending toward significance may indeed have reached the significance threshold. Additionally, different measures of adherence appear to have differential validity in diabetes treatment adherence research [32, 52]. Nevertheless, single-item measures of self-reported medication adherence do have strong evidence for validity, both in the

literature on HIV/AIDS medication adherence and in adults with type 2 diabetes [53, 54]. It was not feasible to measure adherence to insulin accurately through pharmacy refill data, and thus adherence to an OGLA (an eligibility criterion) was emphasized in this study. It may be a limitation of our study design that we did not also measure insulin adherence in the 24% who were taking insulin as well as an OGLA. Furthermore, results indicate that the interaction term between optimistic bias and insulin adherence in predicting medication adherence was not significant. Results should be interpreted with caution as no adjustments were made for multiple statistical tests and thus there is an increase in the likelihood of Type 1 error; additionally, p values for the logistic and linear regression models were close to the threshold of significance. We chose not to correct for family-wise error given the lack of prior data in this area and because risk perceptions and diabetes self-management are each inherently multidimensional constructs. However, given the number of tests performed, further replication of our findings is needed. Additionally, the lack of consistency in the findings and partial support for Brewer's model are significant limitations in this current report; thus, future research is required to more coherently understand the inconsistencies and work to develop an inclusive theoretical framework for risk perceptions and self-care behaviors in diabetes.

Nevertheless, strengths of the study are in the size and diversity of the sample and its efficacy in reaching low-income minority groups who are at high risk for developing complications from type 2 diabetes [14]. The use of a comprehensive measure of risk perception that used subscale and total scores as predictors was also helpful, given that the risk perception construct remains ambiguous and appears to be the product of multiple interacting factors. Furthermore, the inclusion of non-traditional aspects of risk perception, such as environmental risk, provides a more holistic view of the construct. Environmental risk may be important, in terms of competition for, or in addition to, an individual's attention to perceived risk of diabetes, especially in disadvantaged, urban areas. Additionally, Brewer's model allowed for a longitudinal evaluation of a comprehensive set of self-care behaviors and risk perceptions.

In summary, this was an examination of perceived risk, self-care behaviors and glycemic control in a diverse sample of people with type 2 diabetes. Components of risk perceptions predicting self-care behaviors support a model that perceived risk is related to and may influence health behaviors. Moreover, the study suggests that risk perception is a worthwhile construct to explore in understanding how one thinks about diabetes and possible complications and how these conceptualizations are related to self-care behaviors. This conceptualization may be important in working to effectively address the critical issue of improving glycemic control. Additionally, future interventions aimed at manipulating risk perceptions and further exploration of the components of the concept across socio-demographic variables may continue to explicate the relationship between risk perception and self-care behaviors in type 2 diabetes.

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Fig 1.

Relationship between intervention group and changes in number of days doing 30 minutes of exercise (ND30E) moderated by changes optimistic bias. (see page 32 as per request for separate pages)

Blue line represents high changes in optimistic bias and pink line represents low changes in optimistic bias. Print and intervention group are labeled on the x-axis. Changes in number of days doing 30 minutes of exercise is labeled on the y-axis.

Fig 2.

Relationship between intervention group and changes in number of days eating high fat foods (DEF) moderated by changes in risk knowledge (see page 33 as per request for separate pages)

Blue line represents high changes in risk knowledge and pink line represents low changes in risk knowledge. Print and intervention group are labeled on the x-axis. Changes in number of days eating high fat foods is labeled on the y-axis.

Table 1

Baseline Descriptive Statistics for total sample (Cohen et al., 2010; Walker et al., 2011)

Characteristic	Telephone n = 262	Print n = 264	Total N = 526
Female (%)	68.3	65.9	67.1
Race/Eth (%)			
Non- Hispanic Black	61.8	61.0	61.4
Hispanic	24.8	20.5	22.6
Non-Hispanic White	6.1	6.8	6.5
Other	8.0	11.7	9.9
Age (yr, mean±sd)	55.7±7.4	55.4±7.2	55.5±7.3
Spanish preferred (%)	18.7	12.9	15.8
Diabetes duration (yr, mean±sd)	8.8±6.8	9.5±6.4	9.2±6.6
Work full time (%)	73.3	74.6	74.0
Household income (%)			
<\$20,000	17.2	14.4	15.8
\$20–29,000	26.7	26.5	26.6
\$30–39,000	29.0	29.2	29.1
\$40–49,000	10.7	9.1	9.9
\$50,000+	16.4	20.8	18.6
Education (%)			
<8 th grade	16.4	16.7	16.5
9–11 th grade	11.8	10.2	11.0
H.S. or GED	36.3	28.8	32.5
Some college	22.1	26.1	24.1
> College grad	13.4	18.2	15.8
2 diabetes pill classes (%)	68.7	68.2	68.4
Prescribed insulin (%)	24.3	24.6	24.0
HbA _{1c} (median, IQR)	8.6 (8.0–9.6)	8.7 (8.0–10.2)	8.6 (8.0–10.0)

Table 2
Logistic regression analyses predicting follow-up general dietary adherence (GDA)

	Personal control		Optimistic bias		All components	
	B(SE)	OR (95% CI)	B(SE)	OR (95% CI)	B(SE)	OR (95% CI)
Intervention	-.54(.30)	.58 (.33, 1.04)	-.66(.30)*	.52 (.29, .93)	.56 (.30)	1.75 (.97, 3.15)
GDA	.19(.06)**	1.21 (1.08,1.36)	.18(.06)**	1.19 (1.06,1.34)	.18 (.06)	1.20 (1.07, 1.35)
<i>d</i> PPC	-.71(.31)* <i>a</i>	.49 (.27, .90)			-.64 (.32)* <i>c</i>	.53 (.29, .98)
<i>e</i> OB			.39(.19)* <i>b</i>	1.48 (1.01,2.16)	.31(.21)	1.36 (.92,2.04)

a $R^2 = .06$ (Cox & Snell), .09 (Nagelkerke). Model $\chi^2(3) = 19.79, p < .001$

b $R^2 = .06$ (Cox & Snell), .09 (Nagelkerke). Model $\chi^2(3) = 18.50, p < .001$

c $R^2 = .07$ (Cox & Snell), .11 (Nagelkerke). Model $\chi^2(5) = 24.09, p < .001$

d PPC= baseline perceived personal control

e OB= baseline optimistic bias

* $p < .05$.

** $p < .01$.

Table 3

Logistic regression analyses predicting follow-up days eating high-fat foods (DEF)

	Personal control		All components	
	B(SE)	OR (95% CI)	B(SE)	OR (95% CI)
Intervention	-.01(.23)	.99 (.63, 1.56)	.01 (.23)	1.01 (.64, 1.60)
Baseline DEF	.32(.07)***	1.38 (1.20, 1.58)	.32 (.07)***	1.37 (1.19, 1.58)
^c PPC	.56(.24)* ^a	.57 (.36, .91)	.60 (.25)* ^b	.55 (.33, .90)

^a $R^2 = .08$ (Cox & Snell), .11 (Nagelkerke). Model $\chi^2(3) = 16.42, p = .001$

^b $R^2 = .08$ (Cox & Snell), .11 (Nagelkerke). Model $\chi^2(5) = 30.00, p < .0001$

^c = Baseline perceived personal control

*
p < .05.

**
p < .01.

p < .001

Table 4

Logistic regression analyses predicting follow-up number of days in a specific exercise session (NDSE)

	Comparative risk		All components	
	B(SE)	OR (95% CI)	B(SE)	OR (95% CI)
Intervention	-.29(.32)	.75 (.40, 1.39)	.31(.32)	1.37 (.73, 2.58)
Baseline NDSE	.09(.06)	1.09 (.97, 1.22)	.08(.06)	1.09 (.97, 1.22)
^c CDR	-.57(.21)** ^a	.56 (.37, .85)	-.54(.21) * ^b	.59 (.39, .89)

^a $R^2 = .03$ (Cox & Snell), .05 (Nagelkerke). Model $\chi^2(3) = 10.41$ $p=.02$

^b $R^2 = .03$ (Cox & Snell), .06 (Nagelkerke). Model $\chi^2(5) = 11.28$ $p=.04$

^c CDR= Baseline comparative disease risk

* $p<.05$.

** $p<.01$

Table 5

Logistic regression analyses predicting follow-up days of medication adherence (DMA)

	Optimistic bias		All components	
	B(SE)	OR (95% CI)	B(SE)	OR (95% CI)
Intervention	.10(.31)	.91 (.49, 1.67)	.07(.32)	1.07 (.58, 1.99)
Baseline DMA	.16(.07)*	1.17 (1.03, 1.33)	.14(.07)*	1.15 (.97, 1.22)
^c OB	.47(.22)* ^a	1.60 (1.04, 2.45)	-.54(.21)* ^b	1.15 (1.01, 1.31)

^a $R^2 = .03$ (Cox & Snell), .06 (Nagelkerke). Model $\chi^2(3) = 11.45$ $p=.01$

^b $R^2 = .03$ (Cox & Snell), .06 (Nagelkerke). Model $\chi^2(3) = 10.59$ $p=.06$

^cOB= Baseline optimistic bias

* $p<.05$

Table 6

Linear regression analysis predicting changes in days doing 30 min of exercise (Model 1) and changes in days eating high-fat foods (Model 2)

Variable	Model 1		Model 2	
	B	SE	B	SE
Intervention group	0.75*	0.44	0.40	0.28
Changes in optimistic bias	0.61*	0.28		
Optimistic bias*intervention group	-0.87*	0.42		
Changes in risk knowledge			-0.19	0.10
Risk knowledge*intervention group			-0.32*	0.15

*
p<.05*