I, Brandon J. Smith, hereby submit this original work as part of the requirements for the degree of Master of Science in Genetic Counseling.

It is entitled:
Risk and Control of Type II Diabetes: Perceptions of Unaffected Relatives

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This work and its defense approved by:

Committee chair: Melanie Myers, PhD

Committee member: Ge Zhang, PhD
Risk and Control of Type II Diabetes: Perceptions of Unaffected Relatives

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Master of Science

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Of the College of Medicine
By
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Abstract

Introduction: Type II diabetes is the most common form of diabetes and is increasing in incidence across the world and especially in the United States, despite known behaviors that can reduce risk. Identifying perceptions within families regarding personal risk and control may lead to the development of effective family based interventions to reduce the incidence of type II diabetes. Methods: Phone interviews of a quantitative survey were conducted and participant responses were recorded in the online tool, CIKNOW. The variables described were perceived personal and comparative risk of developing type II diabetes and heart disease; perceived control over preventing type II diabetes and heart disease; and the risk reducing behaviors of exercise and fruit and vegetable consumption. Additionally, following data transformation, Pearson’s Correlation statistics were used to identify significant associations between the collected variables. Results: A total of 13 first degree relatives of individuals with type II diabetes completed the phone interview. More participants perceived a higher comparative risk than personal lifetime risk of type II diabetes; whereas the opposite was true for heart disease. Additionally, more respondents reported a higher perceived personal risk of heart disease than type II diabetes. The majority of respondents perceived a sense of control over both type II diabetes and heart disease. Significant correlations at the .05 level included a negative correlation between exercise and perceived risk (r = -0.618, p = 0.024), and a positive correlation between perceived risk and perceived control (r = 0.637, p = 0.019). Discussion: The results indicate that participants may underestimate their personal risk of developing type II diabetes, but most agreed the diseases were controllable suggesting they understand the influence of personal behaviors on risk. The associations found in this study will require further investigation through studies with greater statistical power and larger sample sizes.

Key words: Family history, first degree relatives, type 2 diabetes, heart disease, perceptions, risk, control
Acknowledgements

I would like to thank my research advisory committee members, Melanie Myers, PhD, Laura Koehly, PhD and Ge Zhang, PhD for their help and support in the completion of this project. I would also like to thank Jennifer Hopper, MS and Sara Fernandes, BS who served as members of the research team and assisted in the data collection for the study.
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Introduction

Type II diabetes (T2D) is the most common form of diabetes affecting approximately 16 million people in the United States [1]. The incidence of T2D is increasing across the world and especially in the United States, despite known behaviors that can reduce risk [2]. Family health history is an important risk factor that is often ignored or misunderstood by relatives of individuals with T2D [3, 4]. As of 2007, 5.7 million people in the United States had undiagnosed diabetes, and another 57 million were considered to have pre-diabetes. Based on current trends, the Centers for Disease Control and Prevention (CDC), estimates that by 2050 the occurrence of diabetes could be as high as 1 in every 3 adults in the United States [5]. The rising prevalence is an indication of the need for new and effective methods to reduce the public health burden of T2D [6].

Overview of Type II Diabetes (T2D)

Complications of T2D are well described [1], including an increased risk of heart disease, hypertension, blindness, kidney disease, nervous system disease, amputations, dental disease and complications in pregnancy. Heart disease death rates among adults with diabetes are 2-4 times higher than adults without T2D. Additionally, the risk of stroke is 2-4 times higher in adults with T2D [1]. The National Diabetes Education Program states that with diabetes being the seventh leading cause of death in the United States, approximately 68% of diabetes related deaths are due to heart disease or stroke [7].

Risk Factors Associated with T2D
According to the American Diabetes Association (ADA) there are several factors that contribute to an increased risk of T2D, some of which can be controlled and others which cannot [8]. Controllable factors that increase risk for T2D include being overweight, not exercising regularly, having low HDL cholesterol or high triglycerides, high blood pressure and people who have impaired glucose tolerance and/or impaired fasting glucose. Factors which increase risk that a person cannot control include age (risk increases at 45 years); and certain racial and ethnic groups (Non-Hispanic Blacks, Hispanic/Latino Americans, Asian Americans and Pacific Islanders, and American Indians and Alaska Natives have shown to have a higher risk). Lastly, a family history of diabetes is a common risk factor, and often not completely understood within families [3]. As described by Valdez et al [9], individuals categorized as having a moderate or high familial risk of T2D were 2.3 and 5.5 times more likely to develop T2D compared to those considered to have an average risk. Understanding how relatives of T2D patients view their risk of developing diabetes as well as heart disease based on family health history (FHH) may help in developing interventions focused on reducing such risks.

**Perceptions of Risk and Control**

Theories of health behavior suggest that increased perceptions of risk, as well as perceptions of worry and control are motivators for preventive behaviors [10-12]. Acheson et al suggested that interpretation of family history risk of disease may influence an individual’s perceived susceptibility to the disease as well as actions taken to prevent it [13]. In a study by Pierce et al, 105 offspring of T2D patients were surveyed about personal risk of diabetes, worry of developing diabetes, prevention of diabetes and knowledge of
risk factors for diabetes, among other things. Findings suggested that the unaffected offspring, who had a median age of 38 years, underestimated their personal risk of T2D, had a poor sense of the seriousness of T2D and knew little about how to reduce their risk [14]. Results showed that 66% of participants felt that their risk of developing diabetes was “not very likely” or “not likely at all”. Approximately half (54%) thought it possible to prevent diabetes through risk reducing behaviors, all others indicated it was not possible (11%) or that they did not know if it were possible to reduce their risk (34%).

A study described by Walker et al using the Risk Perception Survey for Developing Diabetes (RPS-DD) evaluated the risk perceptions of 535 physicians unaffected by T2D. Participants were grouped into lower risk and higher risk categories based on self-reported risk factors and were asked to complete a survey measuring perceived risk and control. The results indicated that the physicians in the low risk group actually had a greater sense of perceived control than those in the high risk group. Even though participants demonstrated an accurate assessment of personal risk, 50% of high risk physicians reported feeling they were less likely to develop diabetes than people of the same age, sex and race (comparative risk). Walker’s findings suggested that the reason for decreased perceived comparative risk may be a result of optimistic bias [15]. Optimistic bias is the unrealistic perceived low assessment of risk status by individuals who actually have high-risk characteristics [16].

As mentioned earlier, family health history is a known risk factor for T2D that can help identify undiagnosed diabetes in the U.S. population [17]. Additionally, FHH can be used to identify individuals at an increased risk who can adopt risk-reducing health
behaviors to prevent or delay their onset of diabetes. Based on FHH, approximately 30% of
the US population has a moderate or high T2D risk which is associated with an odds ratio
of 2.3-5.5 for developing diabetes [9]. The functionality of FHH as a tool to help identify
those at increased risk of T2D and its associated complications is limited by the fact that
patients must have an accurate knowledge of their FHH. Recruiting individuals to a study
based on their family history of T2D will help to assess knowledge of FHH and T2D risk
among a higher risk population. Assessing perceptions of risk and control in at-risk
individuals may lead to the development of interventions based on risk and control among
those who could benefit most from risk-reducing strategies.

Although a family history of T2D is associated with an increased perceived risk, at-
risk individual’s perceptions of these risks tend to be underestimated [3, 13, 14, 18, 19].
While it appears that an increased perceived risk is likely to lead to some preventive
behaviors such as increased exercise, weight loss and healthy dieting [3, 18], the
effectiveness of FHH as a screening and prevention tool for T2D is in need of additional
research [3, 20-22]. It is estimated that among T2D patients, 30-69% [14, 20, 21, 23, 24]
have had discussions with unaffected family members about the increased risk of diabetes
within the family. Those individuals who were notified by their doctor of an increased
familial risk of T2D typically had a higher perceived risk and were more likely to discuss
that risk with their family members than those who had not been informed by their doctor
of a higher familial risk [20].

The perceptions of control among those unaffected by T2D, yet still at an increased
risk due to FHH, have not been well reported in the literature. However, the influence of
higher perceived control over illness has been associated with better psychological and physiological outcomes in those affected by T2D [25]. Macrodimitris et al found that T2D patients who reported high perceived control showed better psychological adjustment to the diagnosis of a chronic disease and better blood glucose control through measurements of HbA1c levels. It is possible that higher perceived control among those at risk of T2D may be associated with risk-reduction behaviors such as diet and exercise.

The perceptions of risk and control are areas of health management that can be utilized as tools to develop interventions that may help reduce the incidence of T2D in today’s society [26]. To successfully reduce the incidence of T2D at a societal level, a logical approach is to take advantage of family structures and communication patterns to begin developing and implementing precautionary interventions such as education and counseling on T2D risks at a familial level. If such interventions result in increased communication between patients and their family members about T2D risks and preventive behaviors, then at-risk families may adopt healthier lifestyles which could in turn, reduce the incidence of T2D among those at increased risk based on FHH.

**Purpose**

The purpose of this study was to assess the perceptions that unaffected family members of diabetic patients had regarding their personal risk of developing T2D. Additionally, we assessed these same family members’ perceived control over developing T2D. Since heart disease is the most common cause of T2D-related deaths [1, 7], we also assessed perceived risk and control of heart disease among our unaffected participants.
Lastly, we wanted to describe any associations between perceptions of risk or control and the self-reported protective behaviors adopted by the unaffected relatives.

**Methods**

Quantitative data on perceived risk, control, and lifestyle behaviors such as diet and physical activity were collected by means of a telephone survey. This study was approved by the Institutional Review Board (IRB) of the University of Cincinnati.

**Study Subjects**

The target population included unaffected adults at an increased risk for developing T2D due to a family health history of the condition. The sample population was obtained from an ongoing pharmacogenomics (PGx) study which aimed to examine the effect of common genetic variants in the PPARG gene on patients’ responses to thiazolidinediones. Eligible participants for this study were unaffected first degree relatives of a participant in the PGx study. Members of the PGx cohort were 18+ years of age, fluent in English and had a diagnosis of T2D. Those unable to provide informed consent were excluded from participation.

**Data Collection**

The aims to measure perceived risk and perceived control were a part of a larger study collecting qualitative and quantitative data, including social interaction data, titled *Social influence of family networks on T2D risk perceptions and health behavior*. The larger study applied social network analysis methods to examine how family network systems impact the communication of risk information and the adoption of risk-reducing behaviors.
in families at risk of T2D. A total of three telephone surveys were administered to each participant – an eligibility survey, a qualitative interview and a quantitative interview.

Four randomly selected groups of 30 PGx study participants were mailed an invitation letter, an insert asking potential participants to check whether or not they were willing to participate, and a return envelope for the insert. The groups were proportionally oversampled for ethnicity/race with each group containing 10 Caucasian, 10 African American and 10 Appalachian individuals. Each invited individual who agreed to participate was asked to provide available times during which they would like to be contacted. Two weeks following the initial mailing all individuals who did not reply to the initial mailing letter were sent a second mailed invitation. Those who did not respond to the second mailing were then contacted by phone. Up to two attempts were made to contact each non-respondent by phone.

Eligibility to participate was confirmed among all who agreed to participate. Demographic information as well as names and contact information of unaffected adult family members who could be considered as future study participants were collected as part of the eligibility phone call. These unaffected family members became the sample described in this study. Two additional phone questionnaires (one qualitative and one quantitative) were then conducted, each at a time that was convenient for the participant. The qualitative interview asked questions about diabetes risk communication within the family. Information on T2D and heart disease diagnosis, perceived risk, perceived control, and lifestyle behaviors was collected as part of the quantitative phone call and is reported here. Also at the time of the quantitative phone call, a three generation family history was
collected for each participant. All participants received a $25 gift card for completion of each of the qualitative and quantitative surveys ($50 in total) in appreciation of their participation.

All questions within the survey were pooled from a survey used in a prior study by Walker et al [15] as well as a previous study examining communication patterns in families affected by Lynch Syndrome [27]. The questionnaires were completed by phone and answers were entered into an online survey tool, Cyber-infrastructure for Inquiring Knowledge Networks On the Web (CIKNOW) [28]. The survey questions were built into the CIKNOW tool and pretested on colleagues who were not familiar with the details of this project but had experience in social network analysis, survey design, and T2D research. The phone interviews were conducted by one of three researchers, Brandon Smith, Jennifer Hopper or Sara Fernandes, all three of which were genetic counseling students.

**Measures**

Perceived risk is the subjective evaluation that an individual can make to determine their likelihood of developing T2D or heart disease. Perceived control can be defined as the belief that one has the ability to make a difference in the course or the consequences of some event or experience; often helpful in dealing with stressors [29]. Each was evaluated by a series of questions asking the participants to compare their risk of T2D and heart disease to others of the same sex, age and race as well as to identify their perceived personal risk and feelings of control related to T2D and heart disease.

*Perceived Risk.* Perceived personal risk of T2D/Heart Disease was measured on a five-point scale in which the participants indicated their likelihood (not likely =1,
somewhat likely =2, likely =3, very likely =4 or definitely =5) of developing T2D or heart disease. Perceived comparative risk was measured on a five-point scale for T2D and heart disease in which participants indicated how likely they were to get T2D (much less likely =1, less likely=2, about the same=3, more likely=4 or much more likely=5) compared to other people of the same age, sex and race. These measures were adapted from a study that used the same questions, but with different scales [30]. A composite risk score was calculated for both T2D and heart disease by averaging the standardized scores for each item following transformation, a method used in previous research [31].

**Perceived Control.** Perceived control was measured by four questions on a four-point scale for each T2D and heart disease which asked participants their level of agreement (strongly disagree, disagree, agree or strongly agree) with statements of control over their personal risk of developing T2D or heart disease. The four questions were “People who make a good effort to control the risks of getting T2D/heart disease are much less likely to get T2D/heart disease”, “If I am going to get T2D/heart disease, there is not much I can do about it”, “I think my personal efforts will help control my risks of getting T2D/heart disease”, and “People who make a good effort to control the symptoms of T2D/heart disease are much less likely to get complications from T2D/heart disease.” These measures were taken from a previous study [15] which had evaluated the survey for validity and reliability among a panel of experts and through the use of a pilot study. The measure was designed and validated for T2D, but we also used it to measure perceptions for heart disease. In the study by Walker, control responses were also measured by four questions on the same four-point scale listed above and values were averaged together in scoring; the same approach was used in this study. There was one question of perceived
control that required reverse score transformation, as it was asked in the negative. The control scale score was constructed by averaging each participant’s responses to the four control questions.

*Lifestyle Behaviors.* Physical activity and fruit and vegetable consumption were taken from the Family Healthware[32] and asked as categorical variables. These measures were designed to provide tailored disease prevention messages based on family history and lifestyle behaviors such as exercise and diet. The Family Healthware tool has been used widely in family history research studies and has been evaluated for its clinical utility [33]. Participants indicated the number of times they exercised each week (<1, 1-2, 3-4, 5+, never) and the length of time in minutes spent on each activity (<10, 10-19, 20-29, 30-39, 40+). An estimate of weekly exercise time was computed by multiplying the number of times exercised each week (median value) with the length of time each participant reported exercising on average each time (median value). For example, if a participant reported exercising 3-4 times a week for 30-39 minutes each time, their weekly average would be 3.5 times per week multiplied by 35 minutes, totaling 122.5 minutes of exercise per week. Categories of 5+ times per week and 40+ minutes were scored as 6 times and 50 minutes, respectively. Similarly, respondents indicated the amount of fruits and vegetables consumed on a daily basis (1-2, 3-4, 5-6, 7-8, 9-10, 10+, none). The mid-points for these response options were reported as continuous variables (e.g. 3-4 = 3.5).

*Demographic characteristics.* Demographic variables included age (a continuous variable), gender, race/ethnicity (Caucasian, African American, Indian, Asian, Pacific Islander, other, Hispanic and Appalachian), household income (<$25k, $25,001-$50k,
Data were exported from the online collection tool, CIKNOW, formatted into Excel spreadsheets and imported into SPSS (version 21) for analysis. The sample was described in terms of demographic characteristics. Summary descriptive statistics were computed on the key measures: perceived risk (personal and comparative), perceived control and individual risk-reducing behaviors (exercise and fruit/vegetable consumption). Chi-squared analyses were conducted to identify the associations between race, gender, income or education and perceptions of risk/control. Correlational analyses were conducted to examine associations between perceived risk, perceived control, and risk-reducing behaviors.

Results

Of the initial 120 PGx participants who were invited into the study, 32 agreed to participate, 21 declined to participate, 13 invitations were returned to sender and 54 did not respond to the mailed invitation and were unreachable by phone. A total of 21 of the 32 who agreed to participate completed the survey. From the 21 completed interviews, 39 first degree relatives were enumerated. Nineteen of those 39 agreed to participate, the remaining 20 either declined or were unreachable and a total of 13 first degree relatives unaffected by T2D completed all interviews. Approximately 77% of the respondents were
female, 23% male, the average age of the sample was 51 years and average BMI was 28.75. The self-identified race of participants from the current study was divided between Caucasian (61.5%) and African American (38.5%), 0% of respondents reported being Appalachian and the average household income, a categorical variable was between $50,001 and $75,000. Additionally, 77% of participants had at least some level of college education while the remaining 23% reported no schooling beyond high school. Results of chi-squared analyses did not show any significant associations between race, gender, income or education and perceived risk or control (data not shown).

Perceived Risk

More participants perceived a higher comparative risk than personal lifetime risk of T2D (Table 1) and the difference in means was shown to have a medium effect size ($r = 0.53$). The opposite was true for heart disease, as more participants indicated higher perceived personal risk than comparative risk, which had a larger effect size ($r = 0.698$). Additionally, more respondents reported a higher perceived personal risk of heart disease than T2D with 15% feeling that it was very likely for them to develop heart disease, and none feeling it very likely that they would develop T2D.
Table 1

<table>
<thead>
<tr>
<th>Lifetime T2D Risk Perception</th>
<th>Mean Response Value</th>
<th>Standard Deviation</th>
<th>Lifetime HDz Risk Perception</th>
<th>Mean Response Value</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Likely</td>
<td>38.5%</td>
<td>1.92</td>
<td>Not Likely</td>
<td>30.8%</td>
<td>2.17</td>
</tr>
<tr>
<td>Somewhat Likely</td>
<td>30.8%</td>
<td></td>
<td>Somewhat Likely</td>
<td>30.8%</td>
<td></td>
</tr>
<tr>
<td>Likely</td>
<td>30.8%</td>
<td></td>
<td>Likely</td>
<td>15.4%</td>
<td></td>
</tr>
<tr>
<td>Very Likely</td>
<td>0%</td>
<td></td>
<td>Very Likely</td>
<td>15.4%</td>
<td></td>
</tr>
<tr>
<td>Definitely</td>
<td>0%</td>
<td></td>
<td>Definitely</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Compared T2D Risk Perception</th>
<th>Mean Response Value</th>
<th>Standard Deviation</th>
<th>Compared HDz Risk Perception</th>
<th>Mean Response Value</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much less likely</td>
<td>15.4%</td>
<td>2.77</td>
<td>Much less likely</td>
<td>23.1%</td>
<td>2.50</td>
</tr>
<tr>
<td>Less likely</td>
<td>30.8%</td>
<td>3.08</td>
<td>Less likely</td>
<td>23.1%</td>
<td></td>
</tr>
<tr>
<td>About the same</td>
<td>23.1%</td>
<td>3.08</td>
<td>About the same</td>
<td>23.1%</td>
<td></td>
</tr>
<tr>
<td>More likely</td>
<td>23.1%</td>
<td>3.08</td>
<td>More likely</td>
<td>23.1%</td>
<td></td>
</tr>
<tr>
<td>Much more likely</td>
<td>7.7%</td>
<td>3.08</td>
<td>Much more likely</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

Transformed Values: 1 = not likely/much less likely, 2 = somewhat likely/less likely, 3 = likely/about the same, 4 = very likely/more likely, 5 = definitely/much more likely

**Perceived Control**

Categorical responses to perceived control questions are represented in Table 2a with mean transformed values and standard deviations. In general, most responses indicated that participants felt they had some level of control over the risks of developing T2D and heart disease. There was not one single participant consistently indicating a
feeling of no control, but rather a few participants exhibiting feelings of lower control across different questions. Effect size calculations showed a medium effect ($r = 0.546$) when comparing mean responses between diseases.

Table 2

<table>
<thead>
<tr>
<th>Perceived Control T2D</th>
<th>Perceived Control Heart Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Control T2D</strong></td>
<td><strong>Mean Response Value</strong></td>
</tr>
<tr>
<td><strong>Risks</strong></td>
<td><strong>n = 13</strong></td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>0%</td>
</tr>
<tr>
<td>Disagree</td>
<td>15.4%</td>
</tr>
<tr>
<td>Agree</td>
<td>46.2%</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>38.5%</td>
</tr>
<tr>
<td><strong>No Control T2D</strong></td>
<td><strong>Mean Response Value</strong></td>
</tr>
<tr>
<td><strong>Risks</strong></td>
<td><strong>n = 13</strong></td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>23.1%</td>
</tr>
<tr>
<td>Disagree</td>
<td>69.2%</td>
</tr>
<tr>
<td>Agree</td>
<td>7.7%</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Personal Control T2D</strong></td>
<td><strong>Mean Response Value</strong></td>
</tr>
<tr>
<td><strong>Risks</strong></td>
<td><strong>n = 13</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td><strong>Strongly Disagree</strong></td>
<td>0%</td>
</tr>
<tr>
<td><strong>Disagree</strong></td>
<td>0%</td>
</tr>
<tr>
<td><strong>Agree</strong></td>
<td>76.9%</td>
</tr>
<tr>
<td><strong>Strongly Agree</strong></td>
<td>23.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>General Control T2D Complications</th>
<th>n = 12</th>
<th>Mean Response Value</th>
<th>Standard Deviation</th>
<th>General Control HDz Complications</th>
<th>n = 13</th>
<th>Mean Response Value</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strongly Disagree</strong></td>
<td>0%</td>
<td>3.42</td>
<td>0.669</td>
<td><strong>Strongly Disagree</strong></td>
<td>0%</td>
<td>3.23</td>
<td>0.599</td>
</tr>
<tr>
<td><strong>Disagree</strong></td>
<td>7.7%</td>
<td></td>
<td></td>
<td><strong>Disagree</strong></td>
<td>7.7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Agree</strong></td>
<td>38.5%</td>
<td></td>
<td></td>
<td><strong>Agree</strong></td>
<td>61.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Strongly Agree</strong></td>
<td>46.2%</td>
<td></td>
<td></td>
<td><strong>Strongly Agree</strong></td>
<td>30.8%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Transformed Values: 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree.

**Response options were scored inversely, values: 1 = strongly agree, 2 = agree, 3 = disagree, 4 = strongly disagree.**

**Lifestyle Behaviors**

The frequencies of physical activity and fruit and vegetable consumption are reported in Tables 3 and 4, respectively, in addition to the mean values and standard deviations for the continuous variable transformations. Minutes of self-reported exercise per week ranged from 75 to 300, and self-reported servings of fruits and vegetables per day ranged from 1.5 to 5.5.
Table 3

<table>
<thead>
<tr>
<th>Physical Activity 1</th>
<th>Physical Activity 2</th>
<th>Mean Minutes/Week</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities per week</td>
<td>Minutes per activity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than once</td>
<td>Less than 10 minutes</td>
<td>189.42</td>
<td>76.93</td>
</tr>
<tr>
<td>1-2</td>
<td>10-19 minutes</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>3-4</td>
<td>20-29 minutes</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>5 or more</td>
<td>30-39 minutes</td>
<td>38.5%</td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>40+ minutes</td>
<td>53.8%</td>
<td></td>
</tr>
</tbody>
</table>

Table 4

<table>
<thead>
<tr>
<th>Fruits and Vegetable Consumption</th>
<th>Mean Servings/Day</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servings per day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2 daily</td>
<td>38.5%</td>
<td>3.04</td>
</tr>
<tr>
<td>3-4 daily</td>
<td>46.2%</td>
<td></td>
</tr>
<tr>
<td>5-6 daily</td>
<td>15.4%</td>
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<tr>
<td>7-8 daily</td>
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<tr>
<td>9-10 daily</td>
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<tr>
<td>10+ daily</td>
<td>0%</td>
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<tr>
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**Perception/Behavior Correlations**

Perceived risk of T2D was positively correlated with perceived control of T2D ($r = 0.646, p = 0.017$), and showed a medium effect size ($r = 0.492$) with perceived risk of heart
disease. There was no significant association between perceived risk of T2D and perceived control of heart disease ($r = -0.202$).

A negative correlation between mean perceived risk for T2D and weekly exercise was significant at the .05 level ($r = -0.597$, $p = 0.031$); and no significant association between perceived risk of heart disease and weekly exercise ($r = -0.311$, $p = 0.326$). No significant correlations were discovered between perceived risk of T2D and fruit/vegetable consumption ($r = 0.380$, $p = 0.201$), or perceived risk of heart disease and fruit/vegetable consumption ($r = 0.376$, $p = 0.229$).

Associations between perceived control and behaviors were not significant, however there was a medium effect size between perceived control of heart disease and fruit/vegetable consumption ($r = -0.514$, $p = 0.072$). Small effect sizes existed between perceived control of T2D and exercise ($r = -0.280$), perceived control of heart disease and exercise ($r = 0.129$) and perceived control of T2D and fruit/vegetable consumption ($r = 0.078$).

The results indicate that higher perceived risk is associated with less exercise, and higher amounts of exercise are associated with lower perceived risk. These significant correlations are also indicative of a medium to strong effect size. The other notable effect size exists between perceived risk of T2D and perceived risk of heart disease ($r = 0.492$).

**Discussion**

The purpose of this study was to assess the perceptions that unaffected family members of diabetic patients had regarding their personal risk of developing T2D.
Additionally, we assessed these same family members’ perceived control over developing T2D. Since heart disease is the most common cause of T2D-related deaths [1, 7], we also assessed perceived risk and control of heart disease among our unaffected participants. Lastly, we described associations between perceptions of risk or control and the self-reported protective behaviors. Our findings suggest that unaffected relatives of individuals with T2D tend to underestimate their personal and comparative risks of developing T2D, which is consistent with previous literature [3, 13, 14]. Based on family history alone, we know that our participants fall into an increased risk category associated with an odds ratio for developing T2D of 2.3-5.5 when compared to individuals at average risk or having no family history of T2D [9]. Since participants were recruited based on family history, in general we would expect to see higher perceived personal and comparative risks than what has been reported. Also taking into account the average age of our participants, 51, and the average BMI, 28.75, we would expect risk to increase with those variables as well since age and weight are known risk factors for T2D[8].

Mean perceived risk scores for T2D were lower than heart disease, and mean perceived control scores were higher for T2D than heart disease. The discrepancy could be due to a belief that T2D is more controllable than heart disease which would also explain the feelings of higher perceived personal risk of heart disease as compared to T2D. The distribution of categorical responses for risk perceptions also showed that more participants tended to have a higher perceived comparative risk for T2D than perceived personal risk. This difference may exist because of the participants feeling that their exercise is reducing their risk of T2D, but that it is still increased over the general population based on family history. This inference suggests that participants may be
considering environmental and behavioral risk factors in addition to family history when evaluating their personal risk for T2D and that there is a balance of risk factors and protective behaviors. Interventions being developed could be targeted not only to address family history and the risks associated, but also the influence of environmental risk factors including age, obesity, lack of exercise and unhealthy dieting in the development of T2D.

In responding to questions of perceived control, it is interesting that most agreed that risks and complications were controllable for both T2D and heart disease, although the mean scores of the individual control variables were slightly higher for T2D than heart disease. This is an encouraging finding and it may be that at-risk individuals are well educated about the controllability of these diseases. This finding improves upon those of an earlier study that indicated only about half (54%) of at risk participants felt their risk of T2D was controllable[14]. However, as mentioned above, it appears that accurate perceptions of risk may be the biggest hurdle in battling T2D as a common chronic disease, seeing that 0% of respondents felt it very likely that they would develop T2D during their lifetime, and this finding remains consistent with previous studies [3, 13, 14]. This finding could be explained by an adjusted risk perception based on lifestyle factors such as increased exercise; however this explanation would not take into consideration additional risk factors. Based on other factors such as age and BMI in addition to family history, the individuals in this sample would be expected to have an increased risk of developing T2D.

While the measurements of risk perceptions in this study resemble those of previous reports, the negative correlation between perceived risk and exercise paired with the positive correlation between perceived risk and control of T2D warrants further
discussion. The negative correlation between exercise and perceived risk may explain why perceived personal risk is lower than what we would expect to find. This finding supports the idea that participants may be attempting to control their risk through exercise, and thus perceive their risk to be lower. However, our results also show that increased perceived control is associated with increased perceived risk. This finding may mean that participants understand their personal risk to be controllable; however they do not perceive themselves to be at lower risk. Examining participants’ reasoning for these feelings could be the focus of future research studies to really determine why these associations are being seen and gain insight into motivating behavioral change.

Limitations to this study include the small sample size. While some findings were statistically significant, with only 13 participants, the power of our results is minimal; this was countered through the reporting of effect sizes which provide insight into associations even with small samples. The initial recruitment strategy of the study yielded a low response rate, in spite of multiple mailings and follow-up phone calls. Additionally, there may be the limitation of selection bias in our sample, given the large rate of non-responses. This presents the possibility that our respondents are individuals who are more interested in T2D research, or may have based their participation on monetary incentives offered from the study. If a selection bias exists, our sample data may not be representative of the population. The associations found in this study need confirmation with larger numbers. Another limitation is that we did not ask any questions about risk or control over stroke. As we know, heart disease and stroke account for 68% of diabetes related deaths\[7\], but stroke was not included in our questionnaire. In an effort to add power to our results,
recruitment for this study continues, and qualitative data from the overall project may be able to contribute to the discussion of the correlations found in this study.

On the most basic level, the relevance of these findings is that many relatives of individuals with T2D do not perceive an increased lifetime risk of developing T2D due to family history. This finding continues to suggest an opportunity for family history to be used as a clinical tool to educate unaffected individuals about their risk for developing diabetes [3]. However, it is encouraging that participants are demonstrating a high level of perceived control over the risks of developing T2D and heart disease, because it suggests they understand their personal behaviors influence risk. The correlations between perceptions and behaviors require further examination, with greater statistical power, but if they hold true it would be important to ascertain the reasons for these trends and what could be done to motivate individuals towards healthier lifestyles to reduce T2D and heart disease risks.

Previous research has shown that those who have been notified of their increased risk of T2D, tend to have a higher perceived risk and also tend to have more discussions about familial risk [20]. A key role of genetic counseling is the recording and evaluation of family histories in a clinical setting. Interventions to reduce the incidence of T2D could begin with genetic counselors in a clinical setting to draw attention to familial risk of common diseases such as T2D. Additionally, the role of genetic counselors could be expanded to the area public health research focusing on the use of family history to create tailored interventions for common chronic diseases. The findings of this study help us to further understand that perceived risk of T2D may still be underestimated, but also that
individuals understand risk to be controllable. Successful education and counseling of at risk individuals may be achieved by addressing the seriousness of familial risk along with the benefits of healthy lifestyle.

Future studies on the perceptions of risk and control as it relates to T2D in at risk populations should examine reasons for participants’ feelings of perceived risk and control. For example, questions to be asked could include: “I feel I am at low/average/high risk of developing T2D because...” with response categories including options mentioning diet, exercise and family history. Additionally, it may be important to examine the motivation or lack thereof in at risk individuals. As seen in previous studies[15], the phenomenon of optimistic bias may be influencing the results found in studies of perceived risk and control. Initially, this topic may benefit from qualitative research to better describe the subjective attitudes, beliefs and opinions about risk and control of T2D in a sample of individuals at increased risk for the disease. As the rate of T2D diagnoses continues to rise, it will be important to understand perceived risk and control of those at increased risk for developing the disease based on family history and develop effective interventions aimed at correcting misperceptions and educating about risks of family history.
References


