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Health beliefs among individuals at increased familial risk for type 2 diabetes: Implications for prevention☆,☆☆

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Abstract

Aim—To evaluate perceived risk, control, worry, and severity about diabetes, coronary heart disease (CHD) and stroke among individuals at increased familial risk of diabetes.

Methods—Data analyses were based on the Family Healthware™ Impact Trial. Baseline health beliefs were compared across three groups: (1) no family history of diabetes, CHD or stroke (*n* =

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836), (2) family history of diabetes alone (n = 267), and (3) family history of diabetes and CHD and/or stroke (n = 978).

Results—After adjusting for age, gender, race, education and BMI, scores for perceived risk for diabetes ($p < 0.0001$), CHD ($p < 0.0001$) and stroke ($p < 0.0001$) were lowest in Group 1 and highest in Group 3. Similar results were observed about worry for diabetes ($p < 0.0001$), CHD ($p < 0.0001$) and stroke ($p < 0.0001$). Perceptions of control or severity for diabetes, CHD or stroke did not vary across the three groups.

Conclusions—Among individuals at increased familial risk for diabetes, having family members affected with CHD and/or stroke significantly influenced perceived risk and worry. Tailored lifestyle interventions for this group that assess health beliefs and emphasize approaches for preventing diabetes, as well as its vascular complications, may be an effective strategy for reducing the global burden of these serious but related chronic disorders.

Keywords

Family history; Health beliefs; Diabetes; Coronary heart disease; Stroke

1. Introduction

During the first decade of the 21st century, the increase in the global burden of diabetes exceeded prior predictions [1]. This was primarily the result of a rise in obesity, and a concomitant increase in the incidence of type 2 diabetes. The most recent estimates indicate that there are now 285 million individuals in the world with diabetes [2]. This number is expected to climb to 439 million adults diagnosed with diabetes by 2030. In North America alone, it is anticipated that the prevalence of diabetes will be 12%, representing a 42% increase from the current rate.

More than three-quarter of individuals with diabetes will die from vascular complications [3]. Myocardial infarction, stroke and peripheral artery disease are common causes of death. In a meta-analysis of individual records from 102 prospective studies, the hazard ratios, after adjusting for age and sex, were 2.06 (95% CI: 1.82–2.34) for coronary heart disease (CHD) and 2.56 (95% CI: 2.15–3.05) for stroke for diabetic compared to non-diabetic individuals [4]. As the global burden of diabetes increases, one can predict that there will be a corresponding rise in the prevalence of CHD and stroke among affected individuals.

Based on evidence from the Diabetes Prevention Program (DPP) in the US [5] and the Diabetes Prevention Study (DPS) in Finland [6] that diabetes and its vascular complications can be prevented through lifestyle modifications [3,7–9], the identification of persons at increased risk, and targeting these individuals for interventions is paramount to reducing the global burden of these diseases. High risk individuals include those with impaired fasting glucose or impaired glucose tolerance, as well as persons with a family history of the disease. Family history of diabetes, which reflects the effect of shared genes and environmental risk factors, has been consistently shown to be a significant independent risk factor for developing the disease [10–15]. Compared to individuals with a negative family history, those with affected relatives have a two-to six-fold increased risk of developing diabetes. In the adult US population, approximately 30% of non-Hispanic whites have a moderate-to-high familial diabetes risk [10]. These proportions are higher for non-Hispanic blacks (37%) and Mexican Americans (36%).

In addition to its effect on diabetes risk, having a family history of diabetes independently increases one's likelihood of developing its vascular complications, particularly CHD and stroke. Scheuner et al. showed that a family history of diabetes was significantly associated

with a positive score for coronary artery calcification [16], which is highly predictive of major cardiovascular events. Similar findings were reported from a study of healthy young Caucasian adults [17], as well as an investigation based on a Mexican American cohort [18]. Although the relationship between family history and stroke is less clear, a recent Korean study reported that a positive family history of diabetes doubled the risk of stroke among diabetic adults [19].

Given that obesity, a high-fat diet and physical inactivity increase risk of developing diabetes [5,6], CHD [3,7] and stroke [8,9], interventions that emphasize the importance of these three modifiable risk factors for preventing diabetes and its vascular complications may be more effective long-term than those that focus on diabetes alone. However, it is unclear whether healthy individuals with a family history of diabetes are aware that they at increased risk of developing these co-morbid conditions, or attempt lifestyle modifications to prevent their development. The few studies that have addressed these issues reported that among individuals at increased familial diabetes risk, only about half worried [20– 24] or perceived that they were at increased risk for developing diabetes [22–28]. A similar proportion thought that diabetes could be prevented [21,25,26] or attempted to make lifestyle changes to reduce their risk [26,29]. Thus, individuals at increased familial risk for diabetes appear to have misconceptions regarding their degree of susceptibility and the risk factors that contribute to the development of diabetes.

Health beliefs, attitudes and knowledge are major constructs of health behavior theories. In particular, perceptions of disease risk, control, and severity are included in social cognitive models such as the Health Belief Model [30] and the Theory of Planned Behavior [31] because they underlie health behaviors, mediate the effects of other risk factors, are amenable to change, and are targets for disease interventions [32]. Therefore, the development of successful interventions for individuals at increased familial risk for diabetes is contingent upon understanding their health beliefs regarding diabetes, CHD and stroke. Moreover, it is important to determine whether these beliefs are influenced by the presence of family members who are also affected CHD and/or stroke. Evidence supporting this premise would further justify the need for multiple risk factor interventions that focus on diabetes, as well as its vascular complications, as an approach for reducing the global burden of these related disorders.

To our knowledge, no study has examined health beliefs regarding these three conditions among individuals stratified by their familial risk for diabetes. We have a unique opportunity to address this issue using data collected for the Family Healthware™ Impact Trial (FHITr), which is the focus of this report.

2. Materials and methods

2.1. Study design

The FHITr was designed to determine whether providing tailored prevention messages, based primarily on an individual's family health history for six chronic diseases (CHD, stroke, diabetes, and breast, colon and ovarian cancer) influenced health behaviors and communication about disease risk. Details regarding the study have been previously published [33–37]. To summarize, 41 primary care practices associated with three academic centers (NorthShore University HealthSystem in Chicago, the University of Michigan and Case Western Reserve University in Ohio) were randomized to an intervention (23 practices; $n = 2650$) or control arm (18 practices; $n = 1598$). All participants recruited from these practices were age 35–65 years and had no personal history of CHD, stroke, diabetes, breast, colon or ovarian cancer. Protocols were approved by institutional review boards at CDC and all three academic centers.

Individuals first completed a baseline questionnaire online; these data are the focus of this report. Included was an assessment of demographics, self-reported health status, height and weight (for BMI calculations) and health behaviors (e.g., smoking, physical activity, fruit and vegetable intake, alcohol use, aspirin use, and screening tests) and communications with family members or health providers about prevention approaches for the six conditions under study. Individuals in the intervention arm then used the interactive web-based Family Healthware™ tool to provide information about their family health history, including first- and second-degree relatives. This was followed by a message that included a personalized risk assessment and recommendations for screening and lifestyle changes based on their current health behaviors and family history. For example, individuals in the intervention group who were moderate or high familial risk for diabetes, CHD and/or stroke, and had not had their blood sugar tested in the past two years, received the following personalized prevention message: "You may benefit from blood sugar testing because of your family history. Talk to your healthcare professional about your blood sugar and how it affects your risk of diabetes, CHD and/or stroke" [37]. This was followed by a paragraph explaining the role of elevated blood sugar in terms of risk for diabetes, CHD and stroke.

Participants in the control arm received standard prevention messages about screening and lifestyle recommendations for each of the six conditions, such as: "Talk to your health professional about blood sugar testing [37], as well as information regarding the potential impact of elevated blood glucose". Controls did not utilize Family Healthware™ or receive personalized risk assessments until follow-up, which enabled risk stratification. A total of 3344 individuals completed the entire protocol (n = 2105 intervention arm; n = 1239 control arm). Retention rates were 79.4% and 77.5%, respectively, for the two arms.

2.2. Health beliefs

Health beliefs were based on the following single item measures using five-point Likert scales: perceived risk: "Compared to most people your age and sex, what would you say your chances are for developing ____ (disease)?" (1 = much lower than average to 5 = much higher than average); perceived control: "There's a lot I can do to prevent _____ (disease)." (1 = strongly disagree to 5 = strongly agree); worry: "During the past four weeks, how often have you thought about your chances of getting ____ (disease)?" (1 = not at all to 5 = almost all the time); perceived severity: "Getting/having ____ (disease) would be a very serious problem." (1 = strongly disagree to 5 = strongly agree).

2.3. Familial risk assessments

The Family Healthware™ risk algorithms considered the number of affected family members for diabetes, CHD and stroke, their degree of relatedness to the proband, lineage, gender and age at diagnosis. Participants were classified as being either at strong, moderate or weak familial risk for each condition based on well-established methods [38,39]. Because individuals with either a moderate or strong familial risk of developing diabetes, CHD or stroke are significantly more likely to develop these disorders than those with a weak familial risk, we combined the moderate and strong risk categories and defined this new group as being at 'increased familial risk' for the disease.

2.4. Statistical analysis

We focused on the baseline health belief data obtained from individuals in both the intervention and control arms. Familial risk distributions were compared between study arms and were not significantly different for diabetes, CHD or stroke. Therefore, baseline survey and family history data for the intervention and control arms were combined for the analysis presented.

Health beliefs regarding diabetes, CHD and stroke were compared across the three familial risk groups, defined for the current report, based on the algorithms employed for the Family Healthware™ tool. Group 1, which served as a control, consisted of 836 individuals who were not at increased familial risk for either diabetes, CHD or stroke. Individuals at increased familial risk for diabetes were divided into two subgroups: those with a family history of diabetes alone ($n = 267$), which represents Group 2; and those with a family history of diabetes and CHD ($n = 137$), diabetes and stroke ($n = 52$), and diabetes, CHD and stroke ($n = 789$), which together comprise Group 3. Individuals with a family history of CHD and/or stroke, but not diabetes were excluded from the analyses ($n = 1263$) since our focus was on those at increased familial risk for diabetes.

Associations between familial risk groups and categorical baseline demographic factors were examined using the Chi-square test. For the analysis of health beliefs, the baseline scores of perceived risk, perceived control, worry and perceived severity were treated as continuous variables. Analysis of variance (ANOVA) was performed to test the differences in continuous variables (i.e., health belief scores and age) across familial risk groups. General linear models (GLM) procedure in SAS was used to account for unbalanced design of the data with ANOVA approach. Multiple linear regression models were constructed for the adjusted estimates. Least square means were estimated with standard errors.

Data management and statistical analyses were conducted using SAS software (version 9.2, SAS Institute Inc, Cary, NC). Due to the exploratory nature of the current study, the significance level (type 1 error of 0.05) was not adjusted for multiple testing.

3. Results

The demographic characteristics for the three familial risk groups are illustrated in Table 1. Individuals at increased familial risk for diabetes, CHD and/or stroke (Group 3) were significantly older ($p < 0.001$), more likely to be female ($p = 0.006$) and have less education ($p = 0.007$) than those who were at increased familial risk for diabetes alone (Group 2) or those who were not at increased familial risk for any of the metabolic disorders (Group 1). Individuals in Group 1 were significantly more likely to be white ($p < 0.001$) and have a healthy BMI ($p < 0.0001$) compared to those in Group 2 or Group 3. There were no differences in smoking status across the three familial risk groups.

Baseline health beliefs are presented in Table 2. In terms of perceived risk for diabetes ($p < 0.0001$), CHD ($p < 0.0001$) and stroke ($p < 0.0001$), scores became significantly higher, after adjusting for demographic differences between groups, as the number of conditions in their family history increased. In contrast, there were no significant differences in scores for perceived control for diabetes ($p = 0.21$), CHD ($p = 0.63$) or stroke ($p = 0.051$). However, scores for worry about diabetes ($p < 0.0001$), CHD ($p < 0.001$) and stroke ($p < 0.0001$) were also significantly higher among individuals with the strongest familial risk. Perceived severity scores for diabetes ($p = 0.08$), CHD ($p = 0.72$) and stroke ($p_t = 0.82$) did not vary significantly across familial risk groups.

4. Discussion

Although several studies have examined health beliefs among individuals at increased familial risk for diabetes [20–29], little is known about how such perceptions vary when the family history also consists of individuals with additional metabolic disorders. To our knowledge, these analyses represent the first evaluation of health beliefs regarding diabetes, CHD and stroke among individuals with different familial risk profiles for diabetes.

Having family members affected with CHD and/or stroke, as well as diabetes, had a significant impact on perceived risk of all three disorders, after adjusting for demographic differences across familial risk groups. This may be due to the fact that having personal experience with a chronic disease (i.e., a relative or close friend affected with diabetes, CHD or stroke) can strengthen health beliefs [40]. It should be noted, however, that most of the actual scores were less than 3 on a 5-point Likert scale. Thus, despite significant differences in perceived risk across familial risk groups, most individuals with a family history of these disorders consider themselves to be at 'average' risk.

Previous reports have shown that the majority of individuals with a family history of diabetes are unaware of their increased risk of developing the disease [22–28]. This may be due, in part, to optimistic bias regarding future risk, which has been shown to be related to perceived risk, worry and seriousness for multiple conditions [41]. These findings also stress the importance of risk communications by clinicians about diabetes, CHD and stroke so that risk perceptions can become more congruent with actual disease risk.

No differences were observed for perceived control for diabetes, CHD or stroke across familial risk groups. It has been suggested that knowledge about the health experiences of other family members will result in a more fatalistic attitude about health [42]. Harwell et al. [25] reported that individuals with a family history of diabetes were less likely to believe that the disease could be prevented. In addition, a study from the Netherlands found that among individuals at increased familial risk for diabetes, those who attributed this to genetics believed that, at best, they may be able to postpone, but not prevent, its development [21]. Thus, developing effective prevention approaches for individuals at increased diabetes familial risk will likely require improving their knowledge about the modifiable and non-modifiable risk factors for diabetes, CHD and stroke.

It has previously been reported that perceived risk scores were strongly correlated with those for worry in the FHITr [35]. Thus, it's not surprising that for the subgroup included in this report, scores for worry increased with increasing familial risk. However, most worry scores were less than 2 on a 5-point Likert scale. This is consistent with the result of studies from Oregon [20], the Netherlands [21], Korea [22], England [23] and Ireland [24], where the vast majority of individuals with a family history of diabetes did not worry about developing the disease. It has been suggested that some individuals may not be concerned because they see their affected family members coping with diabetes and following their treatment regimen [21]. However, two of these studies reported that those who did perceive themselves to be at increased diabetes risk worried more about developing the disease [23,24]. Effective interventions for individuals with a family history must assess health beliefs.

There is a paucity of research regarding lifestyle interventions among individuals at increased familial risk of diabetes; most studies have focused on those with pre-diabetes. A Swedish study randomized individuals with a family history of diabetes to one of three groups: diet alone, diet and exercise and a control group [43]. The diet and exercise interventions were intensive; there were telephone conversations with participants every 10 days, on average, during the first four months. Those in the intervention groups had significant improvements in diet, physical activity and metabolic risk factors after 16 weeks, which were sustained for approximately one year [44]. However, both intervention groups were comprised of subjects who were related to one another, which may have confounded the results.

Recently, the results of a larger randomized trial by Pijl et al. illustrated that among individuals with a family history of diabetes, those who received diabetes information based

on familial and general risk factors perceived greater control over preventing diabetes (p = 0.03) and reported eating a more healthy diet after three months (p = 0.01) compared to subjects who received information based on general risk factors alone [45]. There were no changes in perceived susceptibility, worry or psychological well being in either group at follow-up. The authors speculated that familial risk information did not result in fatalism, but may have been more personally relevant and, therefore, has greater potential to lead to positive lifestyle modifications.

These findings were similar to the most recent report from the FHITr [37]. Those in the intervention group, who were not at goal at baseline for lifestyle factors, were more likely to increase their fruit and vegetable intake (OR = 1.29, 95% CI: 1.05–1.58) and their level of physical activity (OR = 1.47, 95% CI: 1.08–1.98) six months after the intervention compared to controls. It is not yet known whether this was potentially due to, or mediated by, changes in health beliefs that may have occurred because of the personalized messages that included information about actions that could be taken to reduce their familial risk if it was moderate or strong.

Fear appeal campaigns can be particularly effective if they induce higher levels of perceived susceptibility or severity, but also include recommendations regarding ways of diminishing an alleged threat [46]. Simply informing individuals of their increased familial risk for diabetes is unlikely to be effective in changing health beliefs or behaviors, and may induce denial or a defensive response. People also need to know about what they can do lower their risk, and believe they are capable of making the recommendation lifestyle modifications. This was the approach employed by the DPP [5] and the Finnish DPS [6]. Participants in the intervention group had case managers who helped them understand their likelihood of progressing to diabetes and how this could be prevented, as well as address any challenges that developed as they adopted the intensive intervention. Developing similar methods for individuals at increased familial risk are likely to be equally effective.

These analyses have several limitations. We restricted our focus to those who were and were not at increased familial risk for diabetes and its vascular complications. Thus, the findings cannot be generalized to individuals at increased familial risk for other disorders, such as cancer. In addition, each health belief for each disease was assessed using a single-item measure to minimize participate burden. Therefore, a more thorough examination of health beliefs is warranted. Minorities were under-represented in this study and the sample consisted of relatively well-educated and healthy individuals. Future studies should target underserved groups to better understand their health beliefs about diabetes and its complications. Finally, other risk factors, such as smoking, physical activity and BMI, were not incorporated into the risk algorithms.

We sought to examine health beliefs associated with diabetes, CHD and stroke among individuals at increased familial risk for diabetes, which represented approximately 40% of the FHITr participants. The presence of family members affected with CHD and/or stroke significantly increased scores for perceived risk and worry about diabetes, CHD and stroke. However, the data suggest that they did not fully appreciate the extent to which they are susceptible. A lack of understanding of the inter-relationships of perceived risk among these conditions has been reported by both qualitative [47] and quantitative evaluations' of persons with diagnosed diabetes [48]. It has been suggested that underestimation of their increased risk for CHD and stroke may be due, in part, to the emphasis on glycemic control rather than hypertension and dyslipidemia in patient management.

This stresses the need for the development of tailored interventions that address risk factors and health beliefs for diabetes, CHD, as well as stroke among individuals at increased

familial risk for diabetes, particularly since vascular disturbances often precede the diagnosis of diabetes by as much as a decade [49]. This could be accomplished by applying the approach recently proposed by the International Diabetes Federation [3], which emphasizes the assessment of family health histories for both diabetes and cardiovascular disease using tools such as Family Healthware™. If health beliefs were also examined, then personalized health messages could be based on familial risk, as in the FHITr, but also targeted to address perceptions of risk, control, worry and severity, and emphasizing the benefits of lifestyle modifications for the prevention of diabetes, as well as its cardiovascular complications.

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References

1. Amos AF, McCarty DJ, Zimmet P. The rising global burden of diabetes and its complications: estimates and projections to the year 2010. Diabet Med. 1997; 14(Suppl 5):S7–85.
2. Shaw JE, Sicree RA, Zimmet P. Global estimates of the prevalence of diabetes for 2010 and 2030. Diabetes Res Clin Pract. 2010; 87:4–14. [PubMed: 19896746]
3. Alberti KGMM, Zimmet P, Shaw J. International Diabetes Federation: a consensus on type 2 diabetes prevention. Diabet Med. 2007; 24:451–63. [PubMed: 17470191]
4. The Emerging Risk Factors Collaboration. Diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease: a collaborative meta-analysis of 102 prospective studies. Lancet. 2010; 375:2215–22. [PubMed: 20609967]
5. Tuomilehto J, Lindström J, Eriksson JG, Valle TT, Hämäläinen H, Ilanne-Parikka P, et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. N Engl J Med. 2001; 344:1343–50. [PubMed: 11333990]
6. Knowler WC, Barrett-Conner E, Fowler SE, Hamman RF, Lachine JM, Walker EA, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med. 2002; 346:393–403. [PubMed: 11832527]
7. Maruthur NM, Wang NY, Appel LJ. Lifestyle interventions reduce coronary heart disease risk: results from the PREMIER Trial. Circulation. 2009; 119:2026–31. [PubMed: 19349322]
8. Galimanis A, Mono ML, Arnold M, Nedeltchev K, Mattle HP. Lifestyle and stroke risk: a review. Curr Opin Neurol. 2009; 22:60–8. [PubMed: 19155763]

9. Zhang Y, Tuomilehto J, Jousilahti P, Wang Y, Antikainen R, Hu G. Lifestyle factors on the risks of ischemic and hemorrhagic stroke. Arch Intern Med. 2011; 171:1811–8. [PubMed: 21911621]
10. Valdez R, Liu T, Yoon P, Khoury MJ. Family history and prevalence of diabetes in the US population: the 6-year results from the National Health and Nutrition Examination Survey (1999–2004). Diabetes Care. 2007; 30:2517–22. [PubMed: 17634276]
11. Hariri S, Yoon PW, Qureshi N, Valdez R, Scheuner MT, Khoury MJ. Family history of type 2 diabetes: a population-based screening tool for prevention? Genet Med. 2006; 8:102–8. [PubMed: 16481893]
12. Hariri S, Yoon PW, Moonesinghe R, Valdez R, Khoury MJ. Evaluation of family history as a risk factor and screening tool for detecting undiagnosed diabetes in a nationally representative survey population. Genet Med. 2006; 8:752–9. [PubMed: 17172938]
13. Harrison TA, Hindorff LA, Kim H, Wines RCM, Bowen DJ, McGrath BB, et al. Family history of diabetes as a potential public health tool. Am J Prev Med. 2003; 24:152–9. [PubMed: 12568821]
14. Valdez R. Detecting undiagnosed type 2 diabetes: family history as a risk factor and screening tool. J Diabetes Sci Technol. 2009; 3:722–6. [PubMed: 20144319]
15. Annis AM, Caulder MS, Cook ML, Duquette D. Family history, diabetes, and other demographic and risk factors among participants of the National Health and Nutrition Examination Survey 1999-2002. Prev Chronic Dis. 2005; 2:1–12.
16. Scheuner MT, Setodji CM, Pankow JS, Blumenthal RS, Keeler E. Relation of familial patterns of coronary heart disease, stroke, and diabetes to subclinical atherosclerosis; the multi-ethnic study of atherosclerosis. Genet Med. 2008; 10:879–87. [PubMed: 19092440]
17. Pannacciulli N, Rizzon P, DePergola G, Giorgino F, Ciccone M, Giorgino R. Effect of family history of type 2 diabetes on intima-media thickness of the common carotid artery in normal-weight, overweight and obese glucose-tolerant young adults. Diabetes Care. 2003; 26:1230–4. [PubMed: 12663602]
18. Kao WHL, Imumorin IG, Hsueh WC, Stern MP, Rainwater DL, Mitchell BD, et al. Family history of type 2 diabetes is associated with increased carotid artery intimal-media thickness in Mexican Americans. Diabetes Care. 2005; 28:1882–9. [PubMed: 16043727]
19. Park JW, Yun JE, Park T, Cho E, Jee SH, Jang Y, et al. Family history of diabetes and atherosclerotic cardiovascular disease in Korean men and women. Atherosclerosis. 2008; 197:224–31. [PubMed: 17493625]
20. Kemple AM, Zlot AI, Leman RF. Perceived likelihood of developing diabetes among high-risk Oregonians. Prev Chronic Dis. 2005; 2:1–17.
21. Pijl M, Henneman L, Claassen L, Detmar SB, Nipels G, Timmermans DRM. Family history of diabetes: exploring perceptions of people in the Netherlands. Prev Chronic Dis. 2009; 6:A54. [PubMed: 19288997]
22. Kim J, Choi S, Kim CJ, Oh Y, Shinn SH. Perception of risk of developing diabetes in offspring of type 2 diabetic patients. Korean J Intern Med. 2002; 17:14–8. [PubMed: 12014207]
23. Pierce M, Harding D, Ridout D, Keen H, Bradley C. Risk and prevention of type 2 diabetes: offspring's view. Br J Gen Pract. 2001; 51:194–9. [PubMed: 11255900]
24. Whitford DL, McGee H, O'Sullivan B. Reducing health risk in family members of patients with type 2 diabetes: views of first degree relatives. BMC Public Health. 2009; 9:244. [PubMed: 19607719]
25. Harwell TS, Dettori N, Flook BN, Priest L, Williamson DF, Helgerson SD, et al. Preventing type 2 diabetes: perceptions about risk and prevention in a population-based sample of adults ≥45 years of age. Diabetes Care. 2001; 24:2007–8. [PubMed: 11679480]
26. Qureshi N, Kai J. Informing patients of familial diabetes mellitus risk: how do they respond? A cross-sectional survey. BMC Health Serv Res. 2008; 8:37. [PubMed: 18257922]
27. Farmer AJ, Levy JC, Turner RC. Knowledge of risk of developing diabetes mellitus among siblings of type 2 diabetic patients. Diabet Med. 1999; 14:233–7. [PubMed: 10227569]
28. Nishigaki M, Yokoyama M, Kobayashi K, Seki N, Hitomi T, Kazuma K, et al. Perception of offspring risk of type 2 diabetes among patients with type 2 diabetes and their adult offspring. Diabetes Care. 2007; 30:3033–4. [PubMed: 17804684]

29. Nishigaki M, Kobayashi K, Abe Y, Seki N, Yokomura T, Yokoyama M, et al. Preventive behavior in adult offspring of type 2 diabetic patients and its relationship to parental advice. Diabet Med. 2008; 25:1343–8. [PubMed: 19046226]
30. Janz NH, Becker MH. The Health Belief Model: a decade later. Health Educ Q. 1984; 11:1–47. [PubMed: 6392204]
31. Ajzen I. Theory of planned behavior. Organ Behav Hum Decis Process. 1991; 50:171–211.
32. Conner, M.; Norman, P. Predicting health behavior: a social cognition approach. In: Conner, M.; Norman, P., editors. Predicting health behavior: research and practice with social cognition models. Berkshire, England: Open University Press; 2005. Chapter 1
33. Wang C, O'Neill SM, Rothrock N, Gramling R, Sen A, Acheson LS, et al. Comparison of risk perceptions and beliefs across common chronic disorders. Prev Med. 2009; 48:197–202. [PubMed: 19073208]
34. O'Neill SM, Rubinstein WS, Wang C, Yoon PW, Acheson LS, Rothrock N, et al. Familial risk for common diseases in primary care: the Family Healthware™ Impact Trial. Am J Prev Med. 2009; 236:506–14. [PubMed: 19460658]
35. Acheson LS, Wang C, Zyzanski SJ, Lynn A, Ruffin MT, Gramling R, et al. Family history and perceptions about risk and prevention for chronic diseases in primary care: a report from the Family Healthware™ Impact Trial. Genet Med. 2010; 12:212–8. [PubMed: 20216073]
36. Rubinstein WS, O'Neill SM, Rothrock N, Starzyk EJ, Beaumont JL, Acheson LS, et al. Components of family history associated with women's disease perceptions for cancer: a report from the Family Healthware™ Impact Trial. Genet Med. 2011; 13:52. [PubMed: 21150785]
37. Ruffin MT, Nease DE, Sen A, Pace WD, Wang C, Acheson LS, et al. Effect of preventive messages tailored to family history on health behaviors: the Family Healthware™ Impact Trial. Ann Fam Med. 2011; 9:3–11. [PubMed: 21242555]
38. Scheuner MT, Wang SJ, Raffel LJ, Larabell SK, Rotter JI. Family history: a comprehensive genetic risk assessment method for the chronic conditions of adulthood. Am J Med Genet. 1997; 71:315–24. [PubMed: 9268102]
39. Yoon PW, Scheuner MT, Jorgensen C, Khoury MJ. Developing family healthware: a family history screening tool to prevent common chronic diseases. Prev Chronic Dis. 2009; 6:1–11.
40. Montgomery GH, Erblich J, DiLorenzo T, Bovbjerg D. Family and friends with disease: their impact on perceived risk. Prev Med. 2003; 37:242–9. [PubMed: 12914830]
41. Weinstein ND. Unrealistic optimism about susceptibility to health problems. J Behav Med. 1982; 5:441–60. [PubMed: 7154065]
42. Condit CM, Gronnvoll M, Landau J, Shen L, Wright L, Harris TM. Believing in both genetic determinism and behavioral action: a materialist framework and implications. Public Understand Sci. 2009; 18:730–46.
43. Brekke HK, Jansson PA, Månsson JE, Lenner RA. Lifestyle changes can be achieved through counseling and follow-up in first-degree relatives of patients with type 2 diabetes. J Am Diet Assoc. 2003; 103:835–43. [PubMed: 12830021]
44. Brekke HK, Jansson PA, Lenner RA. Long-term (1- and 2-year) effects of lifestyle intervention in type 2 diabetes relatives. Diabetes Res Clin Pract. 2005; 70:225–34. [PubMed: 15885845]
45. Pijl M, Nijpels G, Timmermans DRM, Dekker JM, Claassen L, Marteau TM, et al. Impact of communicating familial risk of diabetes on illness perceptions and self-reported behavioral outcomes. Diabetes Care. 2009; 32:597–9. [PubMed: 19131458]
46. Witte K, Allen M. A meta-analysis of fear appeals: implications for effective public health campaigns. Health Educ Behav. 2000; 27:591–615. [PubMed: 11009129]
47. Carroll C, Naylor E, Marsden P, Dornan T. How do people with type 2 diabetes perceive and respond to cardiovascular risk? Diabet Med. 2003; 20:355–60. [PubMed: 12752483]
48. Bairey-Merz CN, Buse JB, Tuncer D, Twillman GW. Physician attitudes and practices and patient awareness of the cardiovascular complications of diabetes. J Am Coll Cardiol. 2002; 40:1877–81. [PubMed: 12446074]
49. Haffner S. Diabetes and the metabolic syndrome—when is it best to intervene to prevent? Atherosclerosis. 2006; (Suppl 7):3–10. [PubMed: 16504598]

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Table 1

Baseline demographic characteristics of participants across familial risk groups.[a]

Variables	Overall (*n* = 2081)	Group 1 None (*n* = 836)	Group 2 Diabetes alone (*n* = 267)	Group 3 Diabetes and CHD or stroke (*n* = 978)	*p*-Value[b]
Age (years)					
Mean (SE)	50.82 (0.14)	47.93 (0.28)	48.10 (0.50)	51.86 (0.25)	<0.0001
Gender (%)					
Male	644 (30.9)	289 (34.6)	85 (31.8)	270 (27.6)	
Female	1437 (69.1)	547 (65.4)	182 (68.2)	708 (72.4)	0.006
Race (%)					
White	1843 (88.6)	761 (91.0)	224 (83.9)	858 (87.7)	
Black	76 (3.7)	17 (2.0)	21 (7.9)	38 (3.9)	
Hispanic	49 (2.4)	9 (1.1)	10 (3.7)	30 (3.1)	
Other	113 (5.4)	49 (5.9)	12 (4.5)	52 (5.3)	<0.001
Education (%)					
<12 years	173 (8.3)	55 (6.6)	17 (6.4)	101 (10.3)	
>12 years	1908 (91.7)	781 (93.4)	250 (93.6)	877 (89.7)	0.007
BMI					
<25	834 (40.1)	384 (45.9)	104 (39.0)	346 (35.4)	
25 to <30	678 (32.6)	275 (32.9)	79 (29.6)	324 (33.1)	
>30	569 (27.3)	177 (21.2)	84 (31.5)	308 (31.5)	<0.0001
Smoking					
Current	159 (7.6)	72 (8.6)	20 (7.5)	67 (6.9)	
Former	573 (27.5)	214 (25.6)	65 (24.3)	294 (30.1)	
Never	1349 (64.8)	550 (65.8)	182 (68.2)	617 (63.1)	0.122

[a] Group 1: not at increased familial risk for diabetes, CHD or stroke; Group 2: increased familial risk for diabetes alone; Group 3: increased familial risk for diabetes and CHD, diabetes and stroke, and diabetes, CHD and stroke.

[b] Based on chi-square tests except for age, which was based on ANOVA for unbalanced design data.

Table 2

Baseline health beliefs of participants across familial risk groups.[a]

Variables (mean (SE))	Group 1 None (n = 836)	Group 2 Diabetes alone (n = 267)	Group 3 DM and CHD, or stroke (n = 978)	p-Value[b]
Diabetes				
Perceived risk	2.58 (0.07)	3.22 (0.08)	3.26 (0.06)	<0.0001
Perceived control	4.02 (0.06)	4.09 (0.07)	4.09 (0.05)	0.21
Worry	1.53 (0.06)	1.91 (0.07)	1.94 (0.06)	<0.0001
Perceived severity	4.55 (0.05)	4.44 (0.06)	4.53 (0.02)	0.08
CHD				
Perceived risk	2.61 (0.06)	2.71 (0.08)	3.13 (0.06)	<0.0001
Perceived control	4.33 (0.05)	4.37 (0.06)	4.35 (0.05)	0.63
Worry	1.86 (0.07)	1.93 (0.08)	2.10 (0.06)	<0.0001
Perceived severity	4.76 (0.05)	4.80 (0.06)	4.78 (0.05)	0.72
Stroke				
Perceived risk	2.68 (0.06)	2.79 (0.07)	2.99 (0.06)	<0.0001
Perceived control	4.09 (0.06)	4.23 (0.07)	4.14 (0.03)	0.051
Worry	1.63 (0.06)	1.74 (0.07)	1.80 (0.05)	<0.0001
Perceived severity	4.74 (0.04)	4.75 (0.05)	4.76 (0.04)	0.82

[a] Group 1: not at increased familial risk for diabetes, CHD or stroke; Group 2: increased familial risk for diabetes alone; Group 3: increased familial risk for diabetes and CHD, diabetes and stroke, and diabetes, CHD and stroke.

[b] Based on ANOVA for unbalanced design data and adjusted for age, gender, race, education, and BMI.