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Research Article

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Knowledge, attitude, and practices towards diabetes mellitus among non-diabetes community members of Riyadh, Kingdom of Saudi Arabia

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ABSTRACT

Background: *The Kingdom of Saudi Arabia is in the midst of a diabetes mellitus (DM) epidemic whose origins can be traced to (a) the widespread adoption of the Western diet that is high in sugar, (b) an increase in sedentary activity, and (c) ignorance of the importance of DM. The purpose of this cross-sectional study was to quantify various aspects of (a) knowledge, (b) attitudes, and (c) practice relating to DM.* ***Methods:*** *The three research questions addressed in this study were: (1) Is there any significant relationship between attitudes to DM and practices related to DM? (2) Is there any significant relationship between knowledge of DM and practices related to DM? (3) Is there any significant relationship between knowledge of DM and attitudes to DM? Separate surveys for each question collected data from a representative sample of 1,067 adult both male and female Saudis from Riyadh who have not been diagnosed with DM.* ***Results:*** *Data analysis of the data from the study indicated that for each of the three research questions, the null hypothesis could not be rejected, indicating that none of the relationships were statistically significant.* ***Conclusion:*** *The absence of significance for each of the findings has important implications, including (a) the possibility that many Saudis incorrectly believe themselves to be unsusceptible to DM and (b) the high prevalence of DM-causing behaviors in the Saudi population. These two implications should be of particular concern to public health authorities and health educators in Saudi Arabia, who may need to work more diligently to educate non-DM-diagnosed Saudis on their vulnerability to DM.*

Key words: *Diabetes Knowledge, Prevention, Community awareness.*

INTRODUCTION

Diabetes mellitus (DM) is one of the most pressing public health problems in the world [1-9]. It is estimated to have over 20 million diabetic cases which are estimated to increase to 57 million by 2025 [10]. According to the recent research [5, 11, 12], the Kingdom of Saudi Arabia is in the midst of a DM epidemic whose origins can be traced to (a) the widespread adoption of a Western diet that is high in sugar, (b) an increase in sedentary activity, and (c) ignorance of the importance of DM. The objective of this study was to quantify various aspects of (a) practice, (b) knowledge, and (c) attitudes relating to DM among a representative sample of Saudis. This objective was attained by administering questionnaires to 1,067 adult Saudis, none of whom have been diagnosed with DM, from Riyadh. Specifically, the study examined whether (a) attitudes to DM predict practices related to DM, (b) knowledge of DM predicts practices related to DM, and (c) knowledge of DM predicts attitudes to DM. Examining the relationships through regression models might allow public health specialists, physicians, and other stakeholders in Saudi Arabia to improve the DM-related outcomes of the Saudi population, thus addressing what has been described as one of the leading public health crises in the country [5, 11].

THEORETICAL FOUNDATION

The theoretical foundation of this study was the Health Belief Model (HBM), which was described by Hayden in the following manner: "according to the Health Belief Model, modifying variables, cues to action, and self-efficacy affect our perception of susceptibility, seriousness, benefits, barriers and, therefore, our behavior" [13, 14]. Below is a definition of these constructs as they appear in the HBM:

Table 1: The elements of the HBM

HBM Component	Definition
Perceived susceptibility	An individual's assessment of his or her chances of getting the disease.
Perceived benefits	An individual's conclusion as to whether the new behavior is better than what he or she is already doing.
Perceived barriers	An individual's opinion as to what will stop him or her from adopting the new behavior.
Perceived seriousness	An individual's judgment as to the severity of the disease.
Modifying variables	An individual's personal factors that affect whether the new behavior is adopted.
Cues to action	Those factors that will start a person on the way to changing behavior.
Self-efficacy	Personal belief in one's own ability to do something.

The HBM thus predicts that, for a given disease state such as DM, (a) more concerned attitudes will predict better health practices, (b) more knowledge will predict better health practices, and (c) more knowledge will predict better attitudes. Several empirical studies [15-19] have tested some combination of these specific predictions made by the HBL in the context of various disease states. The three research questions of this study also follow from the HBM as it might apply to the disease state of DM in the context of Saudi Arabia.

Research Questions

The research questions of the study were as follows:
RQ1: Is there a statistically significant relationship between attitudes to DM and practices related to DM?
RQ2: Is there a statistically significant relationship between knowledge of DM and practices related to DM?
RQ3: Is there a statistically significant relationship between knowledge of DM and attitudes to DM?

Materials & Methods

Data for the study were collected by means of three scales. These scales were designed to measure the DM-related (a) practices, (b) knowledge, and (c) attitudes of Saudis. Details on each of these scales is provided below. Afterwards, the research questions and analytical procedures of the study have been specified.

Knowledge: Data Collection

Participants were asked 31 questions related to their knowledge of DM. These questions were subdivided into the knowledge domains of (a) the medical nature of DM (5 questions); (b) the risk factors of DM (6 questions); (c) the signs and symptoms of DM (8 questions); (d) appropriate care and management of DM (7 questions); and (e) complications of DM (5 questions). Each question in the knowledge of DM scale could be answered as Yes, No, or Do Not Know. The scale was scored by awarding 1 point for every correct answer and 0 points for either an incorrect answer or a failure to answer the question. Therefore, knowledge of DM was measured on a continuous scale with a possible range of 0-31, with 0 representing the lowest possible extent of DM knowledge and 31 representing the higher possible extent of DM knowledge.

Attitude

The attitude of the respondents towards diabetes was measured by 11 questions that asked participants about DM management and prevention behaviors, perceived efficacy of such behaviors, and assessments of the impact of DM on various aspects of life. The questions in the attitude scale were answered by Likert-style scoring in which 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly agree. Of the 11 questions in the attitude to DM scale, three questions ('I don't mind if others know that I have DM,' 'DM does not seriously affect the marital relationship', and 'DM doesn't seriously affect daily activities') were reverse-coded. Therefore, attitudes to DM were measured on a continuous scale with a possible range of 11 to 55, with lower scores representing passive attitudes to DM and higher scores representing higher levels of concern with respect to DM.

Practice

DM-related practices of participants were measured through five questions ('Do you consume fatty foods?', 'Do you get 30-60 minutes of daily physical activity?', 'Do you maintain a healthy weight?', 'Do you drink alcohol and smoke regularly?', and 'Do you check your blood sugar regularly?') that were answered through a 5-point scale in which 1 = Not at all, 2 = Infrequently, 3 = Not sure, 4 = Frequently, and 5 = Very frequently. Because the scales of DM knowledge and attitude were coded so that, respectively, (a) higher knowledge scores represented higher knowledge of DM and (b) higher attitude scores represented more concerned attitudes related to DM, the scoring system for the practice scale was reverse-coded after data collection so that 1 = Very frequently, 2 = Frequently , 3 = Not sure, 4 = Infrequently, and 5 = Not at all. After this reverse coding, practices related to DM were measured on a continuous scale with a possible range of 5 to 25, with lower scores representing less healthy practices and higher scores representing more healthy practices.

Research Questions (RQ) and Hypotheses (H)

The research questions and hypotheses of the study were as follows:

RQ1: Is there a significant relationship between attitudes to DM and practices related to DM?

H10: There is no significant relationship between attitudes to DM and practices related to DM.

H1A: There is a significant relationship between attitudes to DM and practices related to DM.

RQ2: Is there a significant relationship between knowledge of DM and practices related to DM?

H20: There is no significant relationship between knowledge of DM and practices related to DM.

H2A: There is a significant relationship between knowledge of DM and practices related to DM.

RQ3: Is there a significant relationship between knowledge of DM and attitudes to DM?

H30: There is no significant relationship between knowledge of DM and attitudes to DM.

H3A: There is a significant relationship between knowledge of DM and attitudes to DM.

Data Analysis

In order to answer RQ1, the dependent variable of practices related to DM was regressed on the independent variable of attitudes related to DM. The expectation for RQ1 was that there would be a statistically significant and positive relationship between practices related to DM and attitudes related to DM. In order to answer RQ2, the dependent variable of practices related to DM was regressed on the independent variable of knowledge of DM. The expectation for RQ2 was that there would be a statistically significant and positive relationship between practices related to DM and knowledge of DM. In order to answer RQ3, the dependent variable of attitudes related to DM was regressed on the independent variable of knowledge of DM. The expectation for RQ3 was that there would be a statistically significant and positive relationship between attitudes related to DM and knowledge of DM.

For all RQs, an ordinary least squares (OLS) model was fit, followed by a Breusch-Pagan / Cook-Weisberg [20, 21] test of heteroscedasticity. In case of heteroscedasticity, a robust standard errors regression model would be fit instead. For all RQs, the normality of the distribution of the outcome and predictor variables was also assessed by means of the Shapiro-Wilk [22] test of normality. In addition, after the bivariate regression models, the possible effects of the covariates of (a) exposure to health education about DM and (b) family history of DM were also tested. These covariates were defined as dummy variables. For health education about DM, Yes was coded as 1, and No was coded as 0. For family history of DM, Yes was coded as 1, and No was coded as 0. The level of statistical significance for all research questions was .05. All data analyses and graphs were created in Stata / SE 15.2 statistical software.

RESULTS

The results of the study have been presented separately for each of the research questions. Each research question is accompanied by a hypothesis test and appropriate visualizations. In addition, each research question is accompanied by the appropriate diagnostics for the underlying regression models. Before presenting the answers to the research questions, demographic statistics related to the sample have been presented.

Characteristics of the Sample: Table 2 below contains the selected descriptive statistics for the sample.

Table 2: The Selected Characteristics of the Sample

Variable	Descriptive Statistics
Gender	Female *n* = 433 (40.59%) Male *n* = 634 (59.42%)
Age	18-25 *n* = 229 (21.46%) 26-35 *n* = 225 (21.09%) 36-45 *n* = 201 (18.84%) 46-60 *n* = 208 (19.49%) > 60 *n* = 204 (19.12%)
Marital Status	Divorced / widowed *n* = 205 (19.21% Married *n* = 425 (39.83%) Single *n* = 437 (40.96%)
Education	College and above *n* = 263 (24.65%) High school *n* = 547 (51.27%) Some secondary school *n* = 197 (18.46%) No school *n* = 60 (5.62%)
Occupation	Freelancer *n* = 287 (26.90%) Government or private sector employee *n* = 357 (33.46%) Retired *n* = 111 (10.40%) Student *n* = 98 (9.18%) Unemployed / housewife *n* = 214 (20.06%)

RQ1 Results:

RQ1 was as follows: Is there a statistically significant relationship between attitudes to DM and practices related to DM? Figure 1 below contains the scatter plot for the variables in RQ1, with the OLS line of best fit as well as the 95% CI of the line of best fit superimposed. It appears that there is no obvious trend, either positive or negative, in the slope for the regression model of RQ1. It therefore appeared as if there no statistically significant relationship between attitudes to DM and practices related to DM.

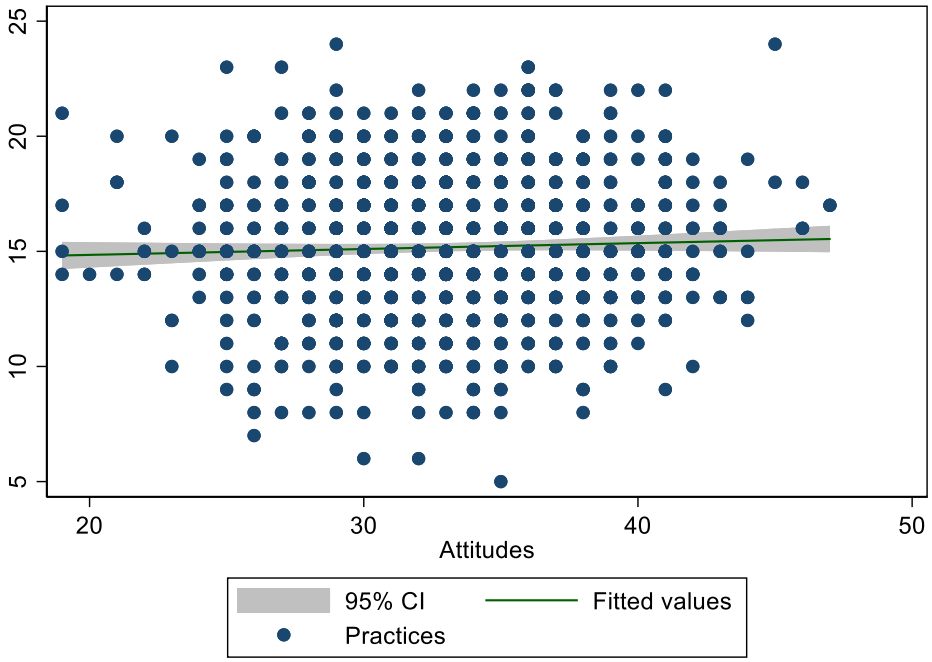

Figure 1. Scatter plot, RQ1. *Note*: OLS line of best fit and 95% *CI* superimposed.

The regression in RQ1 failed to achieve statistical significance, F(1, 1,065) = 1.610, p = .205. The beta coefficient for attitude, b = 0.025, included 0 in its 95% CI (-0.140, 0.650). Therefore, the null hypothesis for RQ1 could not be rejected. There was no evidence, at an Alpha of .05, of a statistically significant relationship between attitudes to DM and practices related to DM in the sample.

The Breusch-Pagan / Cook-Weisberg test indicated the absence of heteroskedasticity in the residuals for the OLS regression carried out for RQ1, $\chi 2(1) = 1.840$, $p = .175$. Therefore, an RSE regression was not run on RQ1. However, some normality diagnostics related to both the independent and dependent variables in RQ1 were calculated. As is clear from Figure 2, the histograms for both DM-related practices and attitudes appeared Gaussian.

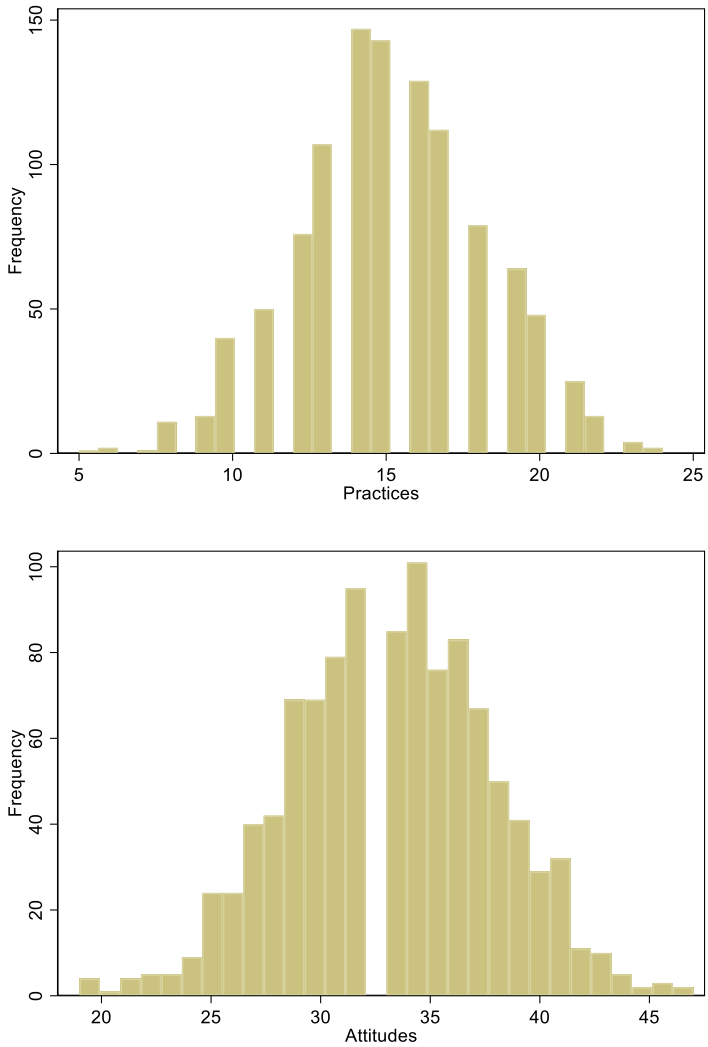

Figure 2. Histograms of practices (top) and attitudes (bottom) related to DM

A Shapiro-Wilk test of normality was applied to the distributions of both attitudes and practices related to DM. Practices related to DM were normally distributed, $W = 0.999$, $p = .912$. In addition, attitudes to DM were normally distributed, $W = 0.999$, $p = .994$. Therefore, no transformations were applied to these variables. The normality of the distribution in both practices and attitudes related to DM, as well as the absence of heteroscedasticity in the OLS regression for RQ1, suggested that the absence of statistical significance in this model is likely to be an attribute of the data, not a reflection of weaknesses in the underlying statistical model.

RQ2 Results

RQ2 was as follows: Is there a statistically significant relationship between knowledge of DM and practices related to DM? Figure 3 below contains the scatter plot for the variables in RQ2, with the OLS line of best fit as well as the 95% CI of the line of best fit superimposed. It appear that there is no obvious trend, either positive or negative, in the slope for the regression model of RQ2. It therefore appeared as if there no statistically significant relationship between knowledge of DM and practices related to DM.

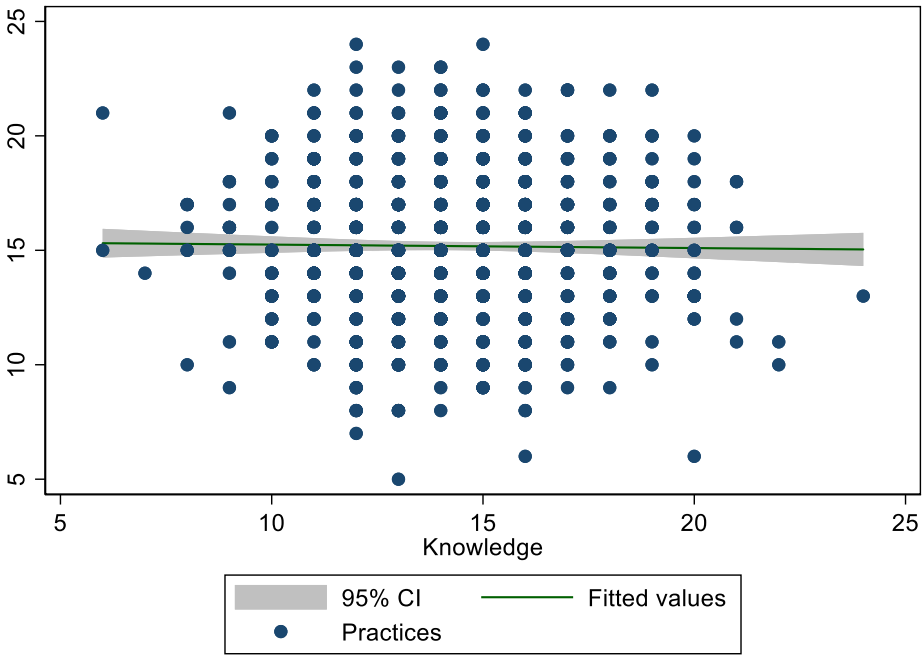

Figure 3. Scatter plot, RQ2. *Note*: OLS line of best fit and 95% *CI* superimposed.

The regression in RQ2 failed to achieve statistical significance, F(1, 1,065) = 1.610, p = .170. The beta coefficient for knowledge, b = -0.015, included 0 in its 95% CI (-0.087, 0.057). Therefore, the null hypothesis for RQ2 could not be rejected. There was no evidence, at an Alpha of .05, of a statistically significant relationship between knowledge of DM and practices related to DM in the sample.

The Breusch-Pagan / Cook-Weisberg test indicated the absence of heteroskedasticity in the residuals for the OLS regression carried out for RQ2, $\chi 2(1) = 0.170$, p = .682. Therefore, an RSE regression was not run on RQ2. However, some normality diagnostics related to both the independent and dependent variables in RQ2 were calculated. The analysis for RQ1 already indicated a Gaussian distribution and normality for the variable of practices related to DM, W = 0.999, p = .912. Figure 4 below is the histogram for knowledge.

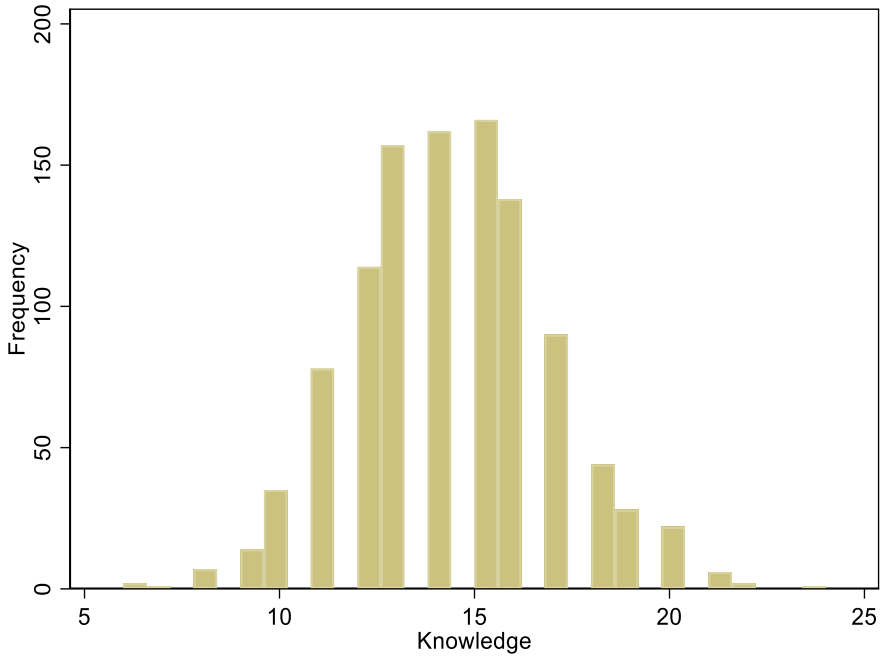

Figure 4. Histograms of knowledge of DM.

A Shapiro-Wilk test of normality was applied to the distribution of knowledge of DM. Knowledge of DM was found to be normally distributed, W = 0.998, p = .338. Therefore, no transformations were applied to the variables in RQ2. The normality of the distribution in both practices and knowledge related to DM, as well as the absence of heteroscedasticity in the OLS regression for RQ2, suggested that the absence of statistical significance in this model is likely to be an attribute of the data, not a reflection of weaknesses in the underlying statistical model.

RQ3 Results

RQ3 was as follows: Is there a statistically significant relationship between knowledge of DM and attitudes to DM? Figure 5 below contains the scatter plot for the variables in RQ3, with the OLS line of best fit as well as the 95% CI of the line of best fit superimposed. It appear that there is no obvious trend, either positive or negative, in the slope for the regression model of RQ3. It therefore appeared as if there no statistically significant relationship between knowledge of DM and attitudes related to DM.

The regression in RQ3 failed to achieve statistical significance, F(1, 1,065) = 0.380, p = .1536. The beta coefficient for knowledge, b = -0.035, included 0 in its 95% CI (-0.145, 0.075). Therefore, the null hypothesis for RQ3 could not be rejected. There was no evidence, at an Alpha of .05, of a statistically significant relationship between knowledge of DM and attitudes related to DM in the sample.

The Breusch-Pagan / Cook-Weisberg test indicated the absence of heteroskedasticity in the residuals for the OLS regression carried out for RQ3, $\chi 2(1) = 0.600$, p = .437. Therefore, an RSE regression was not run on RQ3. However, some normality diagnostics related to both the independent and dependent variables in RQ3 were calculated. The analyses for RQ1 and RQ2 already demonstrated a Gaussian distribution and normality for (a) attitudes related to DM, W = 0.999, p = .912; and (b) knowledge of DM, W = 0.998, p = .338. Therefore, no transformations were applied to the variables in RQ3. The normality of the distribution in both attitudes and knowledge related to DM, as well as the absence of heteroscedasticity in the OLS regression for RQ3, suggested that the absence of statistical significance in this model is likely to be an attribute of the data, not a reflection of weaknesses in the underlying statistical model.

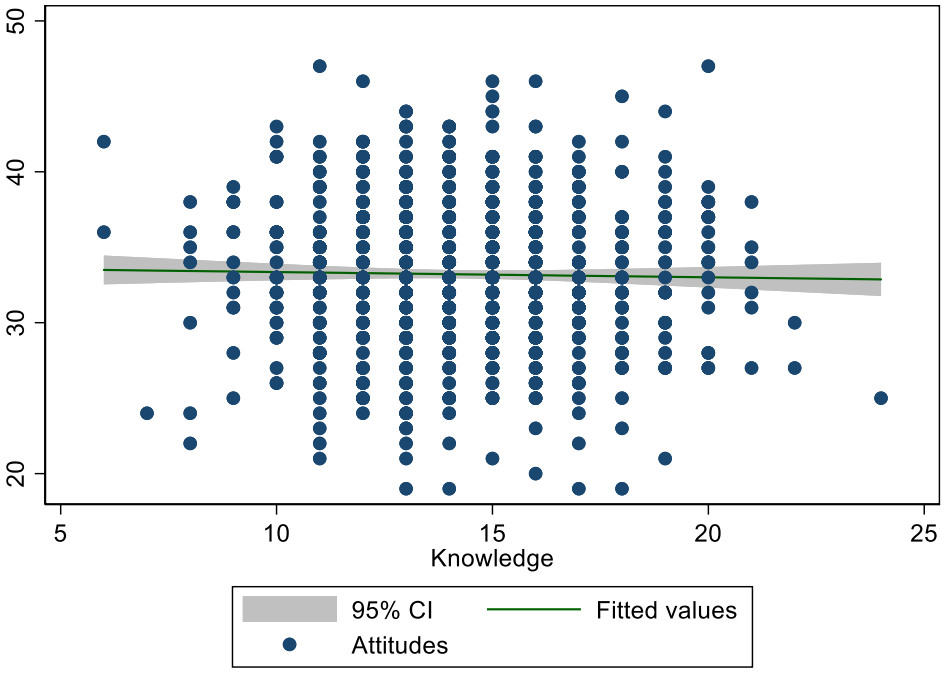

Figure 5. Scatter plot, RQ3. *Note*: OLS line of best fit and 95% *CI* superimposed.

Possible Effects of Health Education and Family History

In order to test for the possible effects of health education and family history, the regressions in RQs 1-3 were re-run with the inclusion of these covariates. There were two points of interest in these new regression models. The first point of interest was whether health education related to DM or family history of DM would independently predict practices or attitudes related to DM. The second point of interest was whether the inclusion of these

covariates would alter the statistical significance of the original predictors in the regressions of RQ1-3. Table 3 below constitutes a summary of the new regression models.

Table 3: Regression Models with Inclusion of Health Education and Family History Predictors

Research Question	DV	Original IV	Expanded IVs
RQ1: Is there a statistically significant relationship between attitudes to DM and practices related to DM?	DM practices	DM attitudes, *b* = 0.026, *SE* = 0.020 , *p* = .205, 95% *CI*(*b*) = -0.140, 0.065	(1) DM attitudes, *b* = 0.026, *SE* = 0.020 , *p* = .191, 95% *CI*(*b*) = -0.132, 0.066 (2) Health education, *b* = 0.134, *SE* = 0.190 , *p* = .480, 95% *CI*(*b*) = -0.239, 0.507 (3) Family history, *b* = -0.098, *SE* = 0.191 , *p* = .606, 95% *CI*(*b*) = -0.472, 0.276
RQ2: Is there a statistically significant relationship between knowledge of DM and practices related to DM?	DM practices	DM knowledge, *b* = -0.015 , *SE* = 0.037, *p* = .682, 95% *CI*(*b*) = 0.087,0.057	(1) DM knowledge, *b* = -0.016 , *SE* = 0.037, *p* = .669, 95% *CI*(*b*) = -0.088,0.057 (2) Health education, *b* = 0.123, *SE* = 0.190, *p* = .518, 95% *CI*(*b*) = -0.250, 0.495 (3) Family history, *b* = -0.097, *SE* = 0.191 , *p* = .611, 95% *CI*(*b*) = -0.471, 0.277
RQ3: Is there a statistically significant relationship between knowledge of DM and attitudes to DM?	DM attitudes	DM knowledge, *b* = -0.035 , *SE* = 0.056, *p* = .535, 95% *CI*(*b*) = -0.145,0.075	(1) DM knowledge, *b* = -0.031 , *SE* = 0.056, *p* = .576, 95% *CI*(*b*) = -0.141,0.079 (2) Health education, *b* = -0.526, *SE* = 0.289, *p* = .069, 95% *CI*(*b*) = -1.093, 0.040 (3) Family history, *b* = 0.036, *SE* = 0.290 , *p* = .902, 95% *CI*(*b*) = -0.533, 0.604
The unstandardized beta (B). The standard error (SE). The probability value (P). Confidence interval (CI)			

For RQ1, the addition of health education and family history as independent variables alongside the independent variable of attitudes did not alter the non-significance of attitudes as a predictor of DM-related practices. In RQ1, the predictor of attitudes was non-significant when it was the sole independent variable in the OLS regression, and it remained non-significant when family history of DM and health education about DM were added as covariates. In addition, it would found that neither family history of DM nor health education about DM were significant predictors of practices related to DM when included alongside the predictor of DM attitudes.

For RQ2, the addition of health education and family history as independent variables alongside the independent variable of knowledge did not alter the non-significance of knowledge as a predictor of DM-related practices. In RQ2, the predictor of knowledge was non-significant when it was the sole independent variable in the OLS regression, and it remained non-significant when family history of DM and health education about DM were added as covariates. In addition, it would found that neither family history of DM nor health education about DM were significant predictors of practices related to DM when included alongside the predictor of DM knowledge.

For RQ3, the addition of health education and family history as independent variables alongside the independent variable of knowledge did not alter the non-significance of knowledge as a predictor of DM-related attitudes. In RQ3, the predictor of knowledge was non-significant when it was the sole independent variable in the OLS regression, and it remained non-significant when family history of DM and health education about DM were added as covariates. In addition, it would found that neither family history of DM nor health education about DM were significant predictors of attitudes related to DM when included alongside the predictor of DM knowledge.

DISCUSSION

The findings of the study have been summarized in Table 4 below.

Table 4: Hypothesis Testing Results

Research Question	Null Hypothesis	Results
RQ1: Is there a statistically significant relationship between attitudes to DM and practices related to DM?	H1_0: There is not a statistically significant relationship between attitudes to DM and practices related to DM.	The null hypothesis could not be rejected, $F(1, 1{,}065) = 1.610$, $p = .205$, as the beta coefficient for attitude, $b = 0.025$, included 0 in its 95% *CI* (-0.140, 0.650).
RQ2: Is there a statistically significant relationship between knowledge of DM and practices related to DM?	H2_0: There is not a statistically significant relationship between knowledge of DM and practices related to DM.	The null hypothesis could not be rejected, $F(1, 1{,}065) = 1.610$, $p = .170$, as the beta coefficient for knowledge, $b = -0.015$, included 0 in its 95% *CI* (-0.087, 0.057).
RQ3: Is there a statistically significant relationship between knowledge of DM and attitudes to DM?	H3_0: There is not a statistically significant relationship between knowledge of DM and attitudes to DM.	The null hypothesis could not be rejected, $F(1, 1{,}065) = 0.380$, $p = .1536$, as th beta coefficient for knowledge, $b = -0.035$, included 0 in its 95% *CI* (-0.145, 0.075).
F-Test (F). The unstandardized beta (B).The probability value (p). Confidence interval (CI).		

The findings were unexpected insofar as, on the basis of the HBM, it was hypothesized that attitudes to DM would predict practices related to DM, knowledge of DM would predict practices related to DM, and knowledge of DM would predict attitudes to DM. None of these predictions were validated in the empirical analyses carried out in the study. It is possible that the failure to reject each of the null hypotheses could reflect the DM status of the sample itself. As the sample consisted solely of individuals who had not themselves been diagnosed with DM, it could be the case that the HBM was not applicable to this population. In terms of RQ1, individuals without DM might have formed DM-related practices independently of both their attitudes (RQ1) and their knowledge (RQ2) of DM because they do not believe that DM will be applicable to them. For this reason, future researchers should include individuals who have been diagnosed with DM as well as non-DM individuals in empirical studies. The HBM might be more applicable to people who either know themselves to have DM or believe in their susceptibility to DM.

Similarly, the lack of a significant link between knowledge of DM and attitudes to DM can be explained by the DM status of the sample. As none of the members of the sample had been diagnosed with DM, both their knowledge of, and attitudes towards, DM might not be conditioned by personal considerations or fears related to actually having DM or believing themselves susceptible to DM. In light of the non-significance of the regressions for RQ1 and RQ2, the non-significance of the RQ3 findings was a major limitation of the current study and suggests that, in future studies, individuals without DM should also be sampled.

The findings of the study are still of interest in two contexts. First, the failure of both attitudes and knowledge to inform DM-related practices suggests that many Saudis might have come to form the incorrect conclusion that they are not susceptible to DM. The absence of significant correlations in RQs 1 and 2 can be interpreted in light of Saudis' own beliefs that, because they are not susceptible to DM, their DM-related practices need not be guided by either attitudes or knowledge related to DM. If so, then the findings from RQs 1 and 2 should be of particular concern to public health authorities and health educators in Saudi Arabia. Saudis should be more assiduously encouraged to understand their vulnerability to DM; such a public health or health education campaign could result in a positive correlation between (a) knowledge of DM and DM-related practices and (b) attitudes to DM and DM-related practices. In addition, the findings of the study are particularly concerning in terms of revealing a Gaussian distribution of DM-related practices in Saudi Arabia, which in itself indicates that many Saudis who do not have DM are nonetheless engaging in practices that can increase the likelihood of their acquiring DM in the future.

CONCLUSION

The purpose of this cross-sectional study was to quantify various aspects of (a) Knowledge, (b) Attitude, and (c) Practice relating to DM among a representative sample of 1067 adult Saudi from Riyadh. Specifically, on the basis of conceptual relationships supported by the HBM, the study assessed whether (a) attitudes to DM predict practices related to DM, (b) knowledge of DM predicts practices related to DM, and (c) knowledge of DM predicts attitudes to DM. None of these relationships was found to be statistically significant. The non-significance of the

findings was unexpected given the widely corroborated predictions made by the HBM. In light of the evidence in favor of the HBM, the non-significance of the findings of the current study can possibly be explained by the absence of DM-diagnosed individuals in the sample. However, the absence of significance for each of the findings has important implications, including (a) the possibility that many Saudi people incorrectly believe themselves to be unsusceptible to DM and (b) the high prevalence of DM-causing behaviors in the Saudi population. These two implications should be particular concern to public health authorities and health educators in Saudi Arabia, who might have to work more diligently to educate non-DM-diagnosed Saudi people on the increased likelihood of their acquiring DM in light of particular practices. Given the epidemic proportions of DM both globally and in the country of Saudi Arabia, public authorities and health educators are required to continue their efforts to educate the public as means of re-engineering attitudes, knowledge, and behaviors.

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