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Association between Type 2 diabetes mellitus and health literacy, behavioral and environmental risk factors in Lebanon: A case-control study

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Abstract

Introduction: The prevalence of type 2 diabetes mellitus (T2DM) in Lebanon is ranked twelfth in the MENA region. However, few studies have been conducted to determine its risk factors. These could include socio-demographic factors, environmental factors, behavioral factors, and health literacy. The objective of this study is to determine the different risk factors for T2DM and to study the association between health literacy and T2DM in Lebanon.

Methods: A case-control study was conducted in Lebanon. Subjects were contacted by phone on randomly selected numbers. The cases and the controls were reached by the same method due to COVID-19. ARA-BRISK, BRIEF, Lebanese Mediterranean Diet Scale, WHOQOL-BREF and the BDS22 were included in the questionnaire.

Results: 232 individuals were included in the analysis. Women versus men (adjusted OR = 0.31; 95% CI 0.127 to 0.763), age (adjusted OR = 1.06; 95% CI 1.03 to 1.10), BMI (adjusted OR = 1.16; 95% CI 1.045 to 1.291), individuals with a family history of T2DM versus individuals with no history of T2DM (adjusted OR = 2.40; 95% CI 1.051 to 5.495), and people with limited health literacy versus people with adequate health literacy (adjusted OR = 3.24; 95% CI 1.225-8.584) were associated with T2DM. Quality of life, psychological distress, and education were not significantly associated with T2DM.

Discussion or Conclusion: These results introduced a new factor that could play an important role in the development of T2DM, which is the health literacy. Therefore, it is necessary to pay particular attention to this factor and to conduct additional studies concerning its association with T2DM. The association between quality of life and T2DM and psychological distress and T2DM should also be studied.

KEY WORDS: Diabetes Mellitus, Type 2; health literacy; Lebanon; population at risk; environmental impact.

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) accounts for 90-95% of all diabetes cases in the world. Worldwide, the number of people living with T2DM quadrupled between 1980 and 2014 [1]. And between 2010 and 2030, the number of adults with T2DM is expected to increase by 20% in developed countries and by 69% in developing countries. Today in Lebanon, 15% of the population is affected by this disease with a rank of 12 among countries of the Middle East and North Africa (MENA) region. Even more worrisome, Lebanon ranks sixth in the MENA region in terms of years of life lived with disabilities. With a high level of morbidity and complications associated with T2DM, Lebanon has a high level of risk factors for T2DM [2].

Since changes in the gene pool cannot explain the fast increase in prevalence of T2DM in recent decades, environmental changes are critical to understanding the epidemic [3]. The reasons for the escalation of the T2DM epidemic are multiple, including an aging population, poor dietary habits [4], obesity [5], smoking [6], physical inactivity [7], and other potential reasons such as education level [8], quality of life [9], psychological distress [10], and health literacy [11], that have recently received more attention worldwide.

Health literacy is the ability to perform basic tasks necessary to function in the health care setting [12]. It can be divided into three stages: The limited stage is when the person is unable to read most health materials and prescription labels; the marginal stage is the stage when the patient may need help; the adequate stage is when the person is able to read and understand most patient education materials [13, 14].

Despite facing many public health challenges and having some of the highest levels of illiteracy, the Arab world has produced very little research on health literacy. In Lebanon, 10% of the population has a limited level of health literacy [15]. However, Lebanon, where low health literacy is common among patients with chronic diseases including T2DM, has produced little research on this topic [11, 16, 17]. Furthermore, few research on T2DM and on its associated risk factors has been produced, even though an increase in T2DM

TAKE-HOME MESSAGE

Type 2 Diabetes Mellitus (T2DM) has increased very rapidly over the past few decades. Genetic and environmental factors are responsible for this increase. Health literacy could play an important role in the development of T2DM.

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is expected worldwide, particularly in developing countries like Lebanon [18]. Prevention of the disease must, therefore, be considered a high priority, hence the need to conduct a study in Lebanon on the various risk factors for T2DM, including health literacy [7]. With this consideration in mind, the main objective of this study was to identify individuals at high risk of T2DM in Lebanon and to determine whether health literacy is associated with T2DM.

METHODS

Study design and procedure

A case-control study was conducted using a stratified sample of Lebanese regions between April and May 2020. Subjects were contacted by phone on randomly selected numbers as a method of selection. 40% were contacted in Beirut, 30% in the Mount Lebanon region, 25% in the North, 10% in the Bekaa, and 15% in the South. A sample of at least 213 individuals, 71 diabetics and 142 non-diabetics, was targeted to allow adequate power (80%) and 95% confidence interval for bivariate and multivariate analysis with an OR of 3 and a case/control ratio of 2 for practical reasons.

Study participants and sampling

In Lebanon, the list of phone numbers of people living in a specific area does not exist. Therefore, another method was needed to be able to make random phone calls. A list of 6-digit numbers, ranging from six zeros to six nines, was therefore written in Excel and using the RAND function, a list of random phone numbers was created. Phone calls were then made based on this list. Each time the numbers on this list (valid or not) were all called, a new list was created. On average, a questionnaire was completed in 30 minutes. At the end of the process, the completed questionnaires were sent for data entry. Out of 700 valid phone calls 234 persons (33.4%) accepted and completed the questionnaire orally, 138 (19.7%) refused to answer the questionnaire and 328 (46.9%) did not pick up the phone. The most common reasons for

non-response were lack of free time and lack of interest in participating. The criteria for inclusion of cases were: both sexes, over 18 years of age, and having reported that the T2D has been confirmed by a health professional. The main criteria for inclusion in the control group were the absence of T2D and age over 18 years.

Ethical aspects

An ethical approval was obtained from the ethical committee in Beirut. The objectives of the study were explained to the participants and after obtaining their oral consent, the questionnaire was administered by telephone interviews. During the data collection process, the anonymity of the participants was guaranteed, emphasizing on their right to withdraw participation at any time. The consent explained the aim of the study along with clarification about voluntary participation with making sure that confidentiality is highly implemented. For this study, the criteria of Helsinki have been followed.

Study instruments and measures

The questionnaire was administered in Arabic; it was composed of five parts, derived and translated from several internationally validated questionnaires. Data entry was carried out by the investigator. Diabetes status, which is the judgment criterion, was verified if participants reported that their T2DM was confirmed by a health professional.

Socio-demographic characteristics

The socio-demographic variables reflect the characteristics of the sample. They were taken from the ARABRISK questionnaire [19], a questionnaire that identifies individuals at high risk of developing T2DM. The socio-demographic variables were: gender, age, and level of education. In addition to these variables, other variables were also included, such as BMI (calculated for each participant based on weight and height), the presence of concomitant chronic diseases, HbA1C, fasting blood glucose, medications, and the presence of T2DM complications.

Health literacy

Health literacy was measured using the BRIEF Health literacy instrument. This instrument included the following questions: "How often do you have someone help you read hospital materials?"; "How confident are you filling out medical forms by yourself?"; "How often do you have problems learning about your medical condition because of difficulty understanding written information?"; "How often do you have a problem understanding what is told to you about your medical condition?".

For the second question, the following five-point Likert scale were proposed as follows: 1 = not at all, 2 = a little bit, 3 = somewhat, 4 = quite a bit and 5 = extremely. For the first, third and fourth questions, the possible answers were administered in the form of the following five-point Likert scale: 1 = always, 2 = often, 3 = sometimes, 4 = occasionally and 5 = never. Thus, values of 1, 2, 3, 4 and 5 were assigned to the five possible responses for each of the four questions. The first three questions were assessed as in previous studies [13, 20]. The fourth question, evaluated by Haun et al. (2009), assessed difficulties with hearing health information and thus increased the validity of the tool. By summing the values of the four responses, the BRIEF score ranged from a minimum of 4 to a maximum of 20 [14]. Scores from 4 to 12 represented a limited level of health literacy, scores from 13 to 16 represented a marginal level of health literacy, and scores from 17 to 20 represented an adequate level of health literacy [14].

Behavioral factors

The Lebanese Mediterranean Diet Score (LMDS), a questionnaire assessing dietary intake based on food consumption frequencies, was administered. Greater adherence to this diet was associated with a lower risk of T2DM in adults [4].

The frequency of consumption of each food or drink was represented by five possible responses: Never, 2 times or less per week, 3 to 6 times per week, at least once a day and at all meals. A partial score of 0 to 4 was assigned to each component [21]. Foods presumed to be beneficial received a high score when consumed frequently. However, foods presumed to be harmful received high scores when consumed less frequently [22]. The components presumed to be beneficial were raw vegetables, cooked vegetables, fruits, olive oil, cereals, beans, fish, rice and pasta, brown bread and white bread. Presumed harmful components were meat, potatoes or French fries, sweets and fast food. LMDS score ranged from a minimum of 0 (minimum adherence to the traditional Lebanese Mediterranean diet) to a maximum of 52 (maximum adherence) [21].

Four other variables were also obtained: smoking, alcohol, daily physical activity and sleep satisfaction.

The genetic factor

The variable 'presence of family history for diabetes' represents the familiarity or genetic factor and was taken from the ARABRISK questionnaire [19].

Environmental factors

Gestational diabetes' history was one of the environmental variables collected, followed by WHOQOL-BREF, the quality of life score and the psychological distress score BDS22.

The WHOQOL-BREF allowed a detailed assessment of each facet of the individual's quality of life. Quality of life was defined as people's perception of their position in life, in the context of culture and value systems in which they live and in relation to their goals and expectations [9].

The WHOQOL-BREF examined the profile of quality of life in four different domains: physical health, psychology, social relationships and environment. Scores for the domains were scaled in a positive direction (higher scores indicated a better quality of life). The mean score of the items in each domain was used to calculate the domain score. When more than 20% of the data were missing from an item, the item was removed. When more than two items were missing from a domain,

the domain score was not calculated [23]. The BDS22, a short measure of mental distress validated for use in the Lebanese population [24], assessed psychological distress and perception of psychological health in the general population. The instrument was divided into six components, depression, de-motivation, pychosomatization, mood deterioration, intellectual inhibition and anxiety, and each one of them was calculated alone.

Data analysis

The statistical analyses were performed using SPSS version 25. The maximum percentage of missing data tolerated for each variable was 15%. The significance level was set at 0.05 for both bivariate and multivariate analyses. First, a description of the variables was made, mean ± standard deviation for quantitative variables and number and percentage for qualitative variables, as well as Chronbach's alpha for each score reflecting internal consistency. Then, bivariate analyses, the chi-2 test, the Fisher test and the T-test, were used. Finally, a logistic regression was performed with the enter method to define the model that explains T2DM. The T2DM was the judgment criterion, the risk factor variables were the independent variables. At least seven independent variables could be included in the model, since there were at least 71 people with diabetes (10% of the 71).

RESULTS

Characteristics of the sample

The final sample consisted of 232 participants, including 72 diabetics and 160 non-diabetics. Women outnumbered men. The percentage of men was higher in the diabetic group than in the non-diabetic group ($P = 0.006$). The mean age of the participants was 55.4 ± 16.4 years. The mean age of diabetics was higher than the mean age of non-diabetics ($P < 0.001$). Similarly, the mean BMI of diabetics was higher than the one of non-diabetics ($P < 0.001$). The percentage of diabetics with a bachelor's degree or more was lower than that of non-diabetics ($P = 0.049$). In ad-

dition, older people (63.3 ± 14.6 years) had a lower level of education than younger people (49.5 ± 15.1 years) ($P < 0.001$). Table 1 provides an overview of the characteristics of the sample.

In addition, 12.9% of diabetics had high blood pressure, compared to 5.7% of non-diabetics ($P = 0.06$). HbA1C, fasting blood glucose and medications had more than 20% of missing data, so they were removed from the analysis.

Health literacy

Chronbach's alpha for the Brief Health Literacy questionnaire was equal to 0.81. The percentage of people with limited health literacy was significantly higher among diabetics than among non-diabetics. However, for the adequate level of health literacy, the percentage of diabetics was significantly lower than non-diabetics ($P < 0.001$). Table 1 and Figure 1 show the different levels of health literacy for the diabetics and non-diabetics.

People with limited health literacy (26.7%) were less engaged in a minimum of 30 minutes of daily physical activity than those with adequate health literacy (49.6%) ($P = 0.001$). Among diabetics, 12.9% had complications due to their disease including 13% who had adequate health literacy and 23.1% who had limited health literacy ($P = 0.06$).

Behavioral factors

The percentage of current smokers among non-diabetics was higher than among diabetics with a non-significant p value. Diabetics did less daily physical activity than non-diabetics ($P = 0.028$). The average LMDS score among diabetics was almost identical to that of non-diabetics with a non-significant p value. Table 1 provides an overview of the behavioral characteristics of the sample.

Genetic factor

The percentage of people with diabetes with at least one diabetic parent was higher than the percentage of people without diabetes ($P = 0.021$).

Table 1. Bivariate analyses between T2D and the different factors.

Variables	Diabetes (N (%) or mean ± SD)		P-value
	No	Yes	
Age(years)	50,9 ± 16.6	65.5 ± 10.5	<0.001
Sex			
Male	52 (32.5%)	37 (51.4%)	0.006
Female	108 (67.5%)	35 (48.6%)	
BMI	25.8 ± 4.0	28.7 ± 4.2	<0.001
Brief health literacy test			
Limited level	20 (12.9%)	26 (37.1%)	
Marginal level	31 (20.0%)	21 (30.0%)	<0.001
Adequate level	104 (67.1%)	23 (32.9%)	
Education			
Less than a high school diploma	61 (38.1%)	39 (54.2%)	0.049
High school diploma and more	99 (61.9%)	33 (45.8%)	
Smoking			
Non-smoker	87 (54.4%)	47 (65.3%)	
Ex-smoker	13 (8.1%)	6 (8.3%)	0.241
Current smoker	60 (37.5%)	19 (26.4%)	
Daily physical activity			
No	89 (55.6%)	51 (71.8%)	0.028
Yes	71 (44.4%)	20 (28.2%)	
Alcohol			
No	105 (65.6%)	45 (62.5%)	0.658
Yes	55 (34.4%)	27 (37.5%)	
LMDS	34.2 ± 4.09	34.0 ± 4.4	0.738
Sleeping			
Dissatisfied	32 (20.5%)	10 (13.9%)	
Neither satisfied nor dissatisfied	27 (17.3%)	16 (22.2%)	0.401
Satisfied	97 (62.2%)	46 (63.9%)	
Family history of T2DM			
No	106 (66.3%)	36 (50.0%)	0.021
Yes	54 (33.8%)	36 (50.0%)	
Physical Health (WHOQOL-BREF)	15.7 ± 2.6	15.2 ± 2.9	0.162
Psychological health (WHOQOL-BREF)	15.8 ± 2.5	15.6 ± 2.1	0.734
Social relations (WHOQOL-BREF)	15.1 ± 3.0	14.46 ± 3.4	0.152
Environment (WHOQOL-BREF)	14.9 ± 2.5	14.8 ± 2.4	0.929
Depression (BDS22)	1.6 ± 2.7	1.4 ± 2.5	0.507
Psychosomatisation (BDS22)	1.1 ± 2.0	0.9 ± 2.0	0.468
Demotivation(BDS22)	1.5 ± 2.3	1.3 ± 2.0	0.515
Mood Deterioration (BDS22)	2.1 ± 2.3	1.8 ± 2.0	0.296
Intellectual Inhibition (BDS22)	1.3 ± 1.6	1.2 ± 1.3	0.835
Anxiety (BDS22)	0.6 ± 1.3	0.5 ± 1.1	0.481

Table 2. Adjusted odds ratios (OR) of the variables in the logistic regression.

Correlates of TD2M	P-value	Adjusted OR	95% IC for adjusted OR	
			Lower limit	Upper limit
Health literacy				
Adequate Health Literacy	-	-	-	-
Marginal Health Literacy	0.103	2.772	0.814	9.433
Limited Health Literacy	0.018	3.243	1.225	8.584
Family History of T2DM				
No	-	-	-	-
Yes	0.038	2.403	1.051	5.495
Age	<0.001	1.068	1.032	1.106
Sex				
Male	-	-	-	-
Female	0.011	0.311	0.127	0.763
BMI	0.006	1.161	1.045	1.291
Daily physical activity				
No	-	-	-	-
Yes	0.143	0.537	0.233	1.235
Education				
Less than a high school diploma	-	-	-	-
High school diploma and more	0.928	1.045	0.401	2.723

Environmental factors

No cases among non-diabetic women were found to have gestational diabetes during pregnancy, compared with a 20% of cases among women affected by T2DM. In this study, the WHOQOL-BREF quality of life instrument showed a Cronbach's alpha of 0.84. Physical health, psychological health, social and the environment did not differ significantly between diabetics and non-diabetics. The psychological distress instrument BDS22 obtained a Cronbach's alpha of 0.91. Depression, psychosomatization, motivation, mood deterioration, intellectual inhibition and anxiety did not differ significantly between diabetics and non-diabetics. Table 1 presents the environmental characteristics of the sample.

Multivariate analysis

Health literacy, BMI, family history, gender, age, education and lack of physical activity were associated with TD2M. They were therefore included in the logistic regression.

Table 2 provides an overview of the multivariate analysis.

Individuals with limited health literacy were 3.2 times more likely to have T2D than those with adequate health literacy. Other factors were also associated with T2DM. Having at least one close relative with diabetes increased the risk of T2DM by approximatively 2.4 times. Getting one year older increased the risk of T2DM by about 6%. Being female reduced the risk of T2DM by about 69%. An increase of one unit of BMI increased the risk of T2DM by about 16%. Daily physical activity and education were not associated with T2DM.

DISCUSSION

To date, many characteristics concerning the etiology of T2DM remain unknown. Various factors can contribute to this disease. Our study sheds light on the role of a neglected risk factor, the level of health literacy, which can be decisive in the occurrence of T2DM in the Lebanese population. In our research, factors like gender, age, BMI, family history

of T2DM, and limited health literacy were associated with T2DM. On the contrary, lack of physical activity, and education were not found to be associated with it. Our study was conducted during the COVID-19 pandemic, when the entire population was in forced lockdown, therefore, the majority of respondents who were interviewed by telephone, were women.

Gender was associated with TD2M, namely males were more likely to be affected by this disease. This finding was in agreement with findings by Costanian et al. [8], and Sattar [25] about the association between gender and T2DM. This association could be explained by the fact that men are more resistant to insulin than women and by the lower subcutaneous storage capacity in men [25]. However, Asiimwe et al. (2020) found that women were more at risk than men because in the country where the study was conducted, women were socially less active [26].

BMI was also associated with T2DM, therefore, an increase in this factor could increase the risk of T2DM as well. In our sample, the mean BMI exceeded the upper limit of the normal BMI category (18.5; 24.9) in both diabetics (28.7 ± 4.2) and non-diabetics (25.8 ± 4.0), being all the participants overweight. This, however, reflects the high number of overweight adults in Lebanon [5, 27]. The majority of diabetics did not have a bachelor degree. This is consistent with the findings by Bener et al. (2005) who found that low education was strongly associated with T2DM [28]. However, in this study, when adjusting for other factors like age, education was no longer associated with T2DM. This could be due to the fact that diabetics in this study were older than non-diabetics, and could be the reason why older people had lower level of education than younger people. In our study, participants with diabetes had a much lower level of health literacy than those without diabetes, as in the study by O'Meara et al. [29]. This confirms the role played by lack of knowledge on how to prevent diabetes in individuals with limited health literacy. As a consequence, 23.1% of diabetics with limited

health literacy had complications due to their disease compared with 13.0% of diabetics with adequate health literacy. This could suggest that people with low health literacy have less resources to control their diabetes compared to people with adequate health literacy. These findings are consistent with those found by Schillinger et al. (2002), showing that diabetic patients with limited health literacy were more likely to have poor glycemic control and to report complications, compared to diabetic patients with adequate health literacy [30]. Also, individuals in our sample with limited health literacy were less physically active than those with adequate health literacy. In addition, diabetics were significantly less physically active than non-diabetics. However, when adjusting for other factors, lack of physical activity was no longer associated with T2DM. This result is not in agreement with the study by Costanian et al., which showed an association between poor physical activity and T2DM [8]. It could be explained by the high number of diabetics with limited health literacy, suggesting that these individuals were not aware of the benefits of physical activity. Thus, when adjusting for health literacy, lack of physical activity was no longer associated with T2DM. In addition, the majority of the sample did not engage in daily physical activity and this result was also found in other studies [31], indicating a high lack of physical activity among the Lebanese.

Diet was almost similar for non-diabetics and diabetics. People with diabetes might, after becoming aware of their disease, change their diet to a healthier diet, lower in fat and sugar. The majority of diabetics and non-diabetics was found not to drink alcohol. This is likely to be due to religious reasons. Quality of life and psychological distress were not associated with T2DM. These results, however, are not consistent with the findings found by previous research [9, 10].

Lebanon is going through a disastrous economic and political crisis. As a result, the quality of life of the entire population tends to decrease and the psychological distress of the entire population tends to increase [32, 33]. This could

explain why the different domains of quality of life and psychological distress did not differ significantly between diabetics and non-diabetics and were not associated with T2DM.

This study is subject to some limitations. The first is that the small sample size did not allow for a more in-depth analysis of subgroups. In addition, cases and controls differed on several variables and were not matched. This could lead to residual confounding bias. A multivariate analysis was therefore conducted to control this bias. Moreover, as explained earlier, the presence of measurement bias in the domains of quality of life and psychological distress could be due to the COVID-19 related crisis, economic and political, that Lebanon is going through. The results concerning psychological distress and quality of life could lead to a non-differential classification bias and thus to an underestimation of ORs for diabetics. There is also an information bias that can be due to the misunderstanding caused by conducting interviews via telephone. This study was also subject to selection bias. Subjects were contacted by telephone. Several people (19.7%) refused to participate and several people did not have access to the telephone and, therefore, were not included in the study. In addition, males were less represented in this sample than females. These limitations would result in selection bias, making the sample not representative of the overall population. Therefore, our results should not be generalized to the entire population.

CONCLUSION

In this research, individuals at high risk for developing T2DM were men, the elderly, people with a high BMI, people with at least one parent with T2DM, and people with limited health literacy. We highlighted the importance of health literacy in the Lebanon population and the need for additional studies to better confirm its association with T2DM. There is also a need for intervention to promote weight reduction and physical activity, as overweight and physical inactivity are very common among Lebanese adults and increase the risk of T2DM. It is, however, necessary to conduct further research to investigate the role of environmental factors and explore their true relationship with T2DM in Lebanon.

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