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Most Common Symptoms of Prediabetic and Insulin Resistance in Adults in Saudi Arabia

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Most Common Symptoms of Prediabetic and Insulin Resistance in Adults in Saudi Arabia

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Abstract

Background: The prediabetic stage exhibits common symptoms; hence, the risk of developing diabetes can be reduced by identifying these symptoms in the most affected population. This study aimed to examine the prevalence of the main symptoms of insulin resistance in healthy adults aged 18 years and above.

Methods: A cross-sectional study was conducted on 1,514 Saudi adults using an online questionnaire collected from 13th November 2020 to 23rd March 2021. Data on personal, lifestyle, and common symptoms were gathered, and the main symptoms were presented as frequencies with percentages. Association with insulin resistance was evaluated using the Chi-square test and other variables by logistic regression models.

Results: The four most commonly presented symptoms at a frequency of 23% were tiredness after eating, tiredness all day, frequent urination, and thirst even after drinking. When gender and income levels were considered together with insulin resistance levels in the logistic models, only thirst remained a substantial symptom.

Conclusions: In the prediabetic stage, tiredness, urinating more than usual, excessive eating, and thirst were the common symptoms. Implementing public health campaigns and drawing attention to these symptoms for healthcare providers would improve the diagnosis and treatment of diabetes.

Keywords: frequent urination, income levels, insulin resistance, prediabetes symptoms, Saudi Arabia

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is caused by impaired glucose metabolism associated with insulin resistance (IR) and occurs in 18.7% of the Saudi population aged 20–80 years. A recent review indicated diabetes to be the 7th cause of mortality.[1] It is also associated with heart disease, cancer, chronic kidney disease, and high blood pressure.[2]

Symptoms associated with IR could develop due to the toxicity of the accumulated glucose and lipids. Peterson and Shulman explored the alterations in metabolic pathways and showed that obesity leads to insulin receptor defect in adipocytes, which was previously found in human and animal studies.[3] In turn, this phenomenon causes low lipid metabolism and increased glucose synthesis because of glycerol boosting the IR symptoms. Although the symptoms are more linked to diabetes or prediabetes than to IR itself, IR shares the same symptoms with T2DM.[4,5] These symptoms are listed as urinating more often than usual, thirst, tiredness, unexplained weight loss, itchiness around the genital area or regular bouts of thrush, cuts or wounds that heal slowly, and blurred vision caused by the drying of eye lenses.[4] IR could occur with no clear symptoms and develop over a long period.[4–7]

According to the Association of Diabetes, many people do not know or seek proper diagnosis and treatment until they have developed explicit diabetes because of the lack of signs and symptoms.[5,8] In addition, approximately 49% of affected individuals lack symptoms and awareness of being ill, and their condition eventually progressed to T2DM.[9] Thus, diabetes is called a new silent disease.[10] The American Diabetes Association recently released guidelines that emphasize regular screening every 3 years for apparently healthy adults aged 35 years and older.[11] In addition, the high risk of IR and prediabetes receives minimal attention from health practitioners.[12]

Some of these symptoms are very common in apparently healthy individuals and should not be alarming. In fact, six out of ten people show no symptoms when diagnosed with T2DM.[13] Most people do not seek help until late because the symptoms often develop gradually and mildly over many years.[4,5,14] These symptoms are listed as urinating more often than usual, particularly at night; thirst; tiredness; unexplained weight loss; itchiness around the genital area or regular bouts of thrush (a yeast infection); cuts or wounds that heal slowly; and blurred vision caused by dried eye lenses.[14]

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To date, no article has been published with regard to the risk levels of IR and symptoms associated with IR in the Makkah region, Saudi Arabia. Only one study was conducted by Al Khaldi *et al*. in a different region of Saudi Arabia.[15] Thus, this study aimed to identify the risk levels of the respondents to connect IR prevalence to the most common symptoms. Characteristic differences were also examined.

METHODS

A cross-sectional study was carried out for 1,514 people using a Google Forms questionnaire (response rate 88%). Data were collected from 13th November 2020 to 23rd March 2021 during the academic year of 2020–2021. The subjects were selected randomly, and the inclusion criteria were the ability to speak Arabic and being Saudi adults. The sample size was sufficient for this analysis. The sociodemographic of the sample was 60.04% (909) females and 39.96% (605) males. Out of all the participants, 2.44% (37) were 18–20 years old, 13.34% (202) were 21–29 years old, and 27.41% (415) were 30–39 years old.

A validated questionnaire containing several parts, including personal information and T2DM symptoms, was sent online. The first page was a consent form for the participants, asking them to agree to participate in the project and stating that all their data would be confidential. The participants have the right to withdraw from completing the questionnaire and participate in the study as they wish. Ethical approval (number HAPO-02-M-11-2020-12-912) was obtained for the project.

On the basis of previous studies, the IR risk score was developed to estimate the number of individuals at risk.[16,17] A simple risk score was developed to screen for IR prevalence and identify prediabetics among individuals in the Makkah region. The IR risk score includes variables that can be measured routinely, objectively, cheaply, quickly, and noninvasively in any primary clinical setting or even by the general public. This approach was based on a cross-sectional study from the Finnish Diabetes Risk Score. In addition, the Leicester Risk Assessment score developed by the Leicester University and University Hospitals of Leicester NHS Trust was scrutinized by the team.[16] Finally, the Lindstrom and Tuomilehto score was also employed to detect IR prevalence using a simple scoring method.[16]

The Lindstrom and Tuomilehto score provided all participants with a score according to their answers to seven questions: age, BMI, waist circumference, used drugs for high blood pressure, have diabetes or not, physically active or not, and daily consumption of vegetables, fruits, or berries.[16]

Two modifications from the Lindstrom and Tuomilehto score were applied to the risk factors included in this study.[16] First, additional questions on dietary risk factors (three questions instead of one (type of snack, eating breakfast or skipping, and number of meals) were included to focus on nutrition because diet has a considerably substantial effect on IR and diabetes development. Thus, the risk factors were increased to nine instead of seven (Table 1). The cut points to identify people at risk were the same as those stated previously by Lindstrom and Tuomilehto.[16] These cut points were also applied to the three dietary questions. The total score of each participant was computed after all the awarded points were summed up.

Second, the total score in the last study started from zero for the participant as a whole point. Meanwhile, the range of scores in the current study was from 6 to 22. The reason is that every individual gets six points for the 1st three risk factors, namely, age, BMI, and waist circumference, regardless of their risk status. The total score was then separated into three score levels, which differed from that in the study of Lindstrom and Tuomilehto, who divided participants into four risk levels.[16]

TABLE 1. Nine risk factors related to IR in the questionnaire

Risk factors	Not having risk	Having risk
Age (years)	≥54 = 2	55 and more = 3
BMI	Normal and less 30 = 1	More than 30 = 3
Waist Circumference	Below 88 for women and 102 for men = 3	Over 88 for women and 102 for men = 4
Have you ever used drugs for high blood pressure? No/Yes	No = 0	Yes = 2
Having a history of diabetes in the family or being told that you have diabetes	No, or do not know = 0	Yes =5
Physical activity	Yes = 0	No = 2
Diet factor 1 (number of meals)	Four and below = 0	More than four meals = 1
Diet factor 2 (dietary pattern)	Healthy pattern = 0	Unhealthy habit and other related = 1
Diet factors 3 (skipping breakfast)	No-Skipping or sometimes = 0	Skipping = 1
Total score	6	22

The first reason was the difference in the score range between the study of Lindstrom and Tuomilehto and the current work.[16] In particular, the total score was 22 in the current study and 20 in the previous study. In the work of Lindstrom and Tuomilehto, the first level included 0–3 points, and the second included 4–8 points for each participant.[16] In the current study, the lowest score was 6 points, and the maximum was 22. Thus, the two lower levels were mostly not comparable (0–8 points). This approach also predicts the risk level to be higher than actual.For each risk level, the same range of points was provided for the third and fourth risk levels to increase their weight. This step was similar to that in the study of Lindstrom and Tuomilehto, who placed more weight on the last fourth level.[16] Therefore, many risk factors were found among the respondents with an increased risk of developing diabetes.

The questionnaire asked about the following symptoms: feeling tired after eating, feeling tired when waking up or when going to sleep without making an effort, feeling thirsty frequently during the day, noticing an increase in the urge to urinate more often during the night than the usual, feeling difficulty in concentrating when resting and in the absence of pressures, feeling hungry frequently even after eating a meal and eating excessively. Each question can be answered by usually, sometimes, or never.

Minitab version 21 was used to analyze statistical data. Frequencies and percentages were applied to describe the sociodemographic and the prevalence of symptoms. A Chi-square test was employed for categorical data with >5% significance to determine significant associations between IR and symptoms. A regression linear model was used to determine the correlations of symptoms. A dummy binary IR variable was set as a group with no IR risk and compared with all the groups with various levels of risk. Associations with gender or income levels were also determined to identify significant variations.

RESULTS

The sociodemographic data and IR levels were presented in a previous work.[17] This study shows that 22.19% of the subjects had the symptoms of tiredness after eating. At almost the same level, the symptoms of being tired all day, urinating more than usual, and feeling thirsty even after drinking accounted for the same percentage in the sample population (22%). The minimum proportions were recorded for having trouble concentrating, being hungry after meals, and eating in excess at 12%, 11.5%, and 9.5%, respectively.

The number of respondents divided according to IR and symptoms is shown in Table 2. All group variations were statistically significant. Approximately 23% of the subjects had the risk of developing IR and the symptoms of tiredness after eating, tiredness when waking up, and increased urge to urinate more often compared with the no IR risk group. Feeling hungry frequently, even after eating a meal and eating excessively, was the least common symptom for the people at risk of developing IR compared with those not at risk. Approximately 45% of the respondents answered that they never had those symptoms.

The linear model for associations was used to determine the independent factors, namely, IR and gender association with symptoms (Table 3). Four symptoms appeared to be common in the subjects with a high risk of IR with a statistically significant association. On the contrary, all symptoms were not correlated significantly with gender. The respondents with a high risk of having IR experienced being tired all day, feeling thirsty, frequently urinating, and eating in excess.

When all the other terms in the model were held as constant, the occurrence of the symptom of feeling tired all day increased by 1.14 times in the subjects with IR. Therefore, the group with IR had a 14% greater risk of being tried all day. The symptom of feeling thirsty showed 19% greater risk of occurrence in people with IR compared with those not at risk. Urinating more than usual was also a common symptom in the group with high IR risk, which had a 16% higher probability of experiencing this symptom compared with those not at risk. Finally, the probability of eating in excess among the participants with a high risk of developing IR was 18% greater than that among those with no risk.

The linear association model was used to determine the independent factors, namely, IR and total income association with symptom occurrence levels (Table 4). The model showed the following five common symptoms with a statistically significant association of less than 5%. Tiredness all day, urination more frequent, and eating excess were only associated with IR risk levels. The respondents with a high IR risk were usually associated with being tired all day, feeling thirsty, urinating more, and eating in excess.

When the other terms in the model were held constant, the occurrence of the symptom of feeling tired all day increased by 1.14 times for people with IR. Therefore, the group with IR had a 14% greater risk of being tried all day. The symptom of feeling thirsty had a 19% greater risk of occurring in people with IR compared with those not at risk. Urination, more than usual, was 16% more common in people with high IR risk than in those with no risk. Finally, the occurrence of the symptom of eating in excess was 18% greater among those with a high risk of developing IR than among those not at risk. Thirst was associated with both dependent variables, IR risk levels and income groups, for those with income more than 1,500–3,500 SR and more than 10,000 at great risks of 20%, 19, and 27%. The highest occurrence (26%) of being

hungry after a meal was recorded for the group with an income of more than 3,500–5,000 SR.

When all variables were placed in the same model (Table 5), only thirst remained a significant symptom associated with a high IR risk and being on the two sides of the income spectrum (i.e., between 1,500 and 3,500 SR and ≥10,000 SR).

TABLE 2. Symptoms' frequencies divided by dummy binary IR levels for all respondents (N = 1,514)

Symptoms of IR	Responses (N)	No risk of IR (N = 245)		have the risk of IR (N = 1,269)		*p*
		N	%	N	%	
Symptom 1: Feeling tired after eating	Never (183)	42	17.14	141	11.11	16.8 (0.0001)
	Sometimes (995)	170	69.39	825	65.01	
	Often (336)	33	13.47	303	23.88	
Symptom 2: Feeling tired when waking up or when going to sleep without doing an effort	Never (283)	65	26.53	218	17.18	13.2 (0.001)
	Sometimes (904)	139	56.73	765	60.28	
	Often (327)	41	16.73	286	22.54	
Symptom 3: Feeling thirsty frequently during the day.	Never (533)	105	42.86	428	33.73	7.8 (0.020)
	Sometimes (692)	96	39.18	596	46.97	
	Often (289)	44	17.96	245	19.31	
symptom 4: Noticing an increase in your urge to urinate more often during the night	Never (623)	127	51.84	496	39.09	18.8 (0.0001)
	Sometimes (568)	87	35.51	481	37.90	
	Often (323)	31	12.65	292	23.01	
*Symptom 6: Feeling hungry frequently, even after eating a meal	Never (685)	127	51.84	558	43.97	6.0 (0.049)
	Sometimes (654)	89	36.33	565	44.52	
	Often (175)	29	11.84	146	11.51	
Symptom 7: Eating excessively	Never (708)	131	53.47	577	45.47	13.3 (0.001)
	Sometimes (662)	105	42.86	557	43.89	
	Often (144)	9	3.67	135	10.64	

*Symptom no. 5: Difficulty concentrating was not statistically significant, so it was removed from the table

TABLE 3. Occurrence of symptoms classified by having IR risk and gender

Variable	Coefficients (SE)	Odds ratio	*p*
Tired after eating			
Having risk	0.015 (0.049)	1.010	0.765
Male	−0.060 (0.037)	1.060	0.127
Tired all day			
Having risk	0.128 (0.055)	**1.140**	0.020
Male	−0.045 (0.041)	**1.050**	0.277
Feel thirsty			
Having risk	0.170 (0.062)	**1.190**	0.007
Male	0.013 (0.047)	**1.010**	0.784
Urination more			
Having risk	0.150 (0.062)	**1.160**	0.014
Male	0.030 (0.046)	**1.030**	0.475
Difficulty concentration			
Having risk	0.114 (0.064)	**1.121**	0.083
Male		**1.036**	0.481
Eat in excess			
Having risk	0.161 (0.066)	**1.180**	0.014
Male	−0.004 (0.049)	**1.000**	0.934
Hungry after meal			
Having risk	0.092 (0.066)	**1.096**	0.165
Male	0.052 (0.050)	**1.053**	0.294

Standard errors are reported in parentheses. The reference group was was no IR risk, and female.

TABLE 4. Symptoms' occurrence divided by having IR risk and income level

Variable	Coefficients (SE)	Odds ratio	*p*
Tired after eating			
Having risk	0.011 (0.049)	**1.011**	0.816
1,500 to 3,500 SR	0.030 (0.048)	**1.030**	0.524
3,500 to 5,000 SR	−0.065 (0.080)	**1.070**	0.421
5,000 to 10,000 SR	0.041 (0.060)	**1.040**	0.495
> 10,000 SR	0.077 (0.056)	**1.080**	0.169
Tired all day			
Having risk	0.130 (0.055)	**1.140**	0.018
1,500 to 3,500 SR	−0.006 (0.053)	**1.010**	0.911
3,500 to 5,000 SR	0.005 (0.090)	**1.010**	0.955
5,000 to 10,000 SR	−0.010 (0.067)	**1.010**	0.883
> 10,000 SR	0.093 (0.063)	**1.097**	0.141
Feel thirsty			
Having risk	0.180 (0.062)	**1.200**	0.004
1,500 to 3,500 SR	−0.170 (0.060)	**1.190**	0.005
3,500 to 5,000 SR	−0.150 (0.100)	**1.162**	0.142
5,000 to 10,000 SR	−0.010 (0.076)	**1.010**	0.886
> 10,000 SR	−0.240 (0.071)	**1.270**	0.001
Feel thirsty			
Having risk	0.143 (0.062)	**1.154**	0.022
1,500 to 3,500 SR	0.047 (0.060)	**1.076**	0.438
3,500 to 5,000 SR	−0.125 (0.102)	**1.133**	0.220
5,000 to 10,000 SR	0.015 (0.076)	**1.015**	0.841
> 10,000 SR	0.068 (0.071)	**1.070**	0.341

TABLE 4. Continue

Variable	Coefficients (SE)	Odds ratio	*p*
Difficulty concentration			
Having risk	0.120 (0.066)	**1.127**	0.065
1,500 to 3,500 SR	−0.060 (0.064)	**1.060**	0.340
3,500 to 5,000 SR	0.030 (0.110)	**1.030**	0.768
5,000 to 10,000 SR	−0.095 (0.081)	**1.099**	0.239
> 10,000 SR	−0.110 (0.750)	**1.116**	0.129
Hungry after meal			
Having risk	0.100 (0.067)	**1.110**	0.119
1,500 to 3,500 SR	−0.060 (0.065)	**1.060**	0.379
3,500 to 5,000 SR	0.230 (0.110)	**1.260**	0.035
5,000 to 10,000 SR	−0.070 (0.082)	**1.072**	0.377
> 10,000 SR	−0.050 (0.076)	**1.050**	0.552

Standard errors are reported in parentheses. The reference group was no IR risk, and income levels below 1,500 SR.

TABLE 5. Occurrence of thirst symptom divided by IR, income, and gender

Variable	Coefficients (SE)	*p*
Constant	2.06 (0.071)	0.000
Binary risk no or yes (having risk)		
No risk [reference]	0.0	*
Having risk	0.183 (0.062)	0.003
Total income levels		
< 1,500 SR [reference]	0.0	*
1,500 to 3,500 SR	−0.181 (0.061)	0.003
3,500 to 5,000 SR	−0.152 (0.102)	0.135
5,000 to 10,000 SR	−0.009 (0.076)	0.903
> 10,000 SR	−0.249 (0.072)	0.001
Gender		
Female [reference]	0.0	*
Male	0.050 (0.480)	0.321

DISCUSSION

Our previous research showed that the factors associated with a high risk of IR are males, high income, and low education.[17] In the current study, the symptoms were studied in combination with the participants' two characteristics, namely, gender and income association with the symptoms for IR.

The most prevalent symptoms in individuals with IR in the Makkah region of Saudi Arabia were feeling tired after eating, tired all day, frequently urinating, and feeling thirsty even after drinking (23%) compared with those in the no-risk group. According to the logistic model for the seven symptoms and gender with binary IR levels of risk, only the respondents with a high risk of IR were associated with being tired all day, feeling thirsty, urinating more, and eating in excess. No significant correlation with gender was observed.

With regard to the risk level of these symptoms, thirst showed a 19% greater risk of occurring in people with IR compared with those not at risk, followed by eating in excess at 18% and urinating more than usual at 16%. Finally, being tired all day had a 14% greater risk of occurring in people with IR compared with those not at risk. The minimum portions were recorded for difficulty of concentration, hunger after meals, and eating in excess at 12%, 11.5%, and 9.5%, respectively. These results were in agreement with Kumar *et al*., who studied diabetes' most common symptoms and found that frequent urination was the most common symptom (94.6%), followed by increased thirst (86.6%).[18]

All these symptoms lead to being lethargic and losing the energy to be active because the cells are deprived of the energy fuel from glucose, specifically the muscles, liver, and adipose tissues.[3,4,19,20] Fatigue is prominent at this stage and increases as the disease progresses to the full diabetic stage.[20–22]

Akhilesh *et al*. found that being tired with no energy (fatigue) was common in 68% of patients with diabetes.[23] This symptom intensifies when the person has a long disease duration, unregulated glucose level, and obesity. Romadlon *et al*. added to these findings by indicating that half of the respondents with T2DM have suffered from fatigue, which is associated with low physical activity and depression.[22]

Engin *et al*. in Turkey found a different distribution of symptoms' prevalence in the prediabetic stage, where the most common symptom was fatigue, occurring in 88% of the respondents.[5] For the symptom of feeling tired when waking in the morning, only 68% agreed that fatigue increased during the day by 65%. The Turkish study disagreed with our finding regarding excess thirst, as only 45% of their respondents suffered from this symptom. Meanwhile, it agreed with our results that few subjects suffered from difficulty concentrating and excess eating. This phenomenon might be due to the different weather conditions, with Saudi Arabia having a hotter environment than Turkey. In addition, a low proportion of their respondents experienced frequent urination (58%), which is different from our findings.

According to the logistic model for IR, all symptoms, and income levels, only thirst was associated significantly with IR and income levels. The highest relative risk of developing this symptom was high at 27% for the high-income category (more than 10,000) and 19% for those with income in the range of 1,500–3,500 SR. Clark *et al*. also found that the most common symptom of diabetes and prediabetes in the high IR risk group was frequent urination (27%), followed by fatigue (26%). Meanwhile, excessive thirst was at a low level of prevalence (23%), followed by extreme hunger (11%).[24]

A study on newly diagnosed patients with type 1 and 2 diabetes found that 100% of them urinate more than usual, and approximately 80% suffer from thirst.[21] This

finding was explained by the accumulation of glucose in the circulation and the high insulin levels, prompting the kidneys to eliminate the extra glucose and increasing urination more than usual.[4] Furthermore, the occurrence of early-stage bacterial infection in prediabetic individuals would be increased. With the progression of the disease, other symptoms such as polyuria, hematuria, and pain and inflammation of the urinary tract will occur and might increase the urge for frequent urination, especially at night. This phenomenon is due to the rise of osmotic diuresis enhanced by the high, uncontrolled level of blood glucose.[4] Furthermore, the feeling of thirst increases in magnitude with emotional distress and depression.[5]

This study has several limitations. First, the online nature of the questionnaire might cause a bias on data with no control on whom to answer the survey. However, as an early-stage study, this circumstance was not the main concern of the study group. In a future work, other sample collection criteria will be applied. Second, the symptoms were obtained through observation and self-evaluation, and no laboratory tests to confirm IR have been conducted. Finally, the generalization of the results might be limited to only one region of Saudi because most of the respondents live in the same region. Even though the responses rate was good and individuals from all regions contributed to this study, the focus was the Makkah region because of the ease in contacting respondents in this area.

CONCLUSIONS

This study demonstrated the prevalence of some symptoms of prediabetic and IR stages in the Makkah region. Tiredness, greater need to urinate than usual, excessive eating, and thirst are the most common symptoms in the study sample. Understanding these symptoms can help in developing public health campaigns that educate and increase awareness to avoid progression to diabetes.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

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