CODEN [USA]: IAJPBB **ISSN: 2349-7750**

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

http://doi.org/10.5281/zenodo.2537639

Available online at: http://www.iajps.com ***Research Article***

PREVALENCE OF PREDIABETES CONDITION AMONG STUDENTS AND STAFF IN TAIBAH UNIVERSITY IN MADINAH

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Abstract:

Background: *Prediabetes is a common health problem around the world, and its prevalence in several developing countries has sharply increased In the past decades. So, this study aimed to determine the prevalence rate of prediabetes among students and staff (both gender) in Taibah University in Madinah and to identify the risk of sociodemographic, lifestyle and medical factors on the prevalence of prediabetes.*

Methods: *Methods: This study is an observational descriptive study, survey was conducted using a structured questionnaire on students and staff (both gender) who attend to Taibah University in Madina, Saudi Arabia in May 2018. The questionnaire designed to obtain information to determine prevalence of prediabetes and to identify the risk of sociodemographic, lifestyle and medical factors on the prevalence of prediabetes. The questionnaire consisted of three parts, the first part was about demographic data, while the second was about lifestyle and medical factors, and the third was special of female about past history of gestational diabetes or baby weight more than 4 kg and PCOS.*

Results: *The study included 834 participants 11.9% of the participants had data of pre-diabetes, 47.5% of participants with pre-diabetes were female, while 52.5% were male. Only 21.2% of participants with pre-diabetes were nonsmokers, 13.1% had hypertension, 85.9% had family history of DM, about 67.7% didn't practice physical activity, about 83% didn't eat fruit daily, and about 65% didn't eat vegetables daily. The mean of waist circumference of participants with pre-diabetes was 101.8 and the mean of BMI was 33%. Only 23.4% of females with pre-diabetes had past history of gestational diabetes or baby weight more than 4 kg, while 4.3% of females had PCOS.*

Conclusion: *The study showed that in general there was a low prevalence of prediabetes among students and staff (both gender) in Taibah University in Madinah. There was a relationship between prediabetes and family history of type 2 diabetes. But, there was no relationship between prediabetes and smoking, hypertension, BMI, or past history of gestational diabetes or baby weight more than 4 kg.*

Keywords: *Prediabetes prevalence, Risk factors, Taibah University.*

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Please cite this article in press Faisal Fahad Almohammadi et al., ***Prevalence of Prediabetes Condition Among Students And Staff In Taibah University In Madinah.,*** *Indo Am. J. P. Sci, 2019; 06(01).*

INTRODUCTION:

Prediabetes is defined as blood glucose concentrations higher than normal, but below diabetes thresholds, It's a grey area between normal blood sugar and diabetic levels. (1) According to the American Diabetes Association (ADA), prediabetes means impaired fasting plasma glucose (IFG), or impaired glucose tolerance (IGT), or high glycated haemoglobin (HbA1c) levels, between 100 and 125 mg/dL for impaired fasting plasma glucose (IFG), or between 140 and 199 mg/dL for impaired glucose tolerance (IGT), or between 5.7% and 6.4% for HbA1c (2).

the prevalence of pre-diabetes is much more than the prevalence of diabetes ,around 5–15% of individuals with pre-diabetes become type-2 diabetes mellitus more than individuals with normal blood glucose levels. (3)

Usually there are no obvious symptoms for prediabetes and the only reliable method of diagnosis is by blood testing. (4) previous study mentioned that many risk factors such as increased age, overweight or obesity, hypertension, and dyslipidemia have relation with prediabetes. (5) as the Prediabetes may developed to diabetes individuals with pre-diabetes are at high risk of cardiovascular disease and premature mortality. (2)

The worldwide prevalence of (IGT) in 2010 was estimated to be 343 million (7.8%), the prevalence of prediabetes is increasing worldwide according to International Diabetes Federation projects an increase in prevalence to 471 million globally by 2035. (6)

According to the National Survey for Health Information [2013], in the Kingdom of Saudi Arabia, the prevalence of pre-diabetes was 17% among males and 15.5% among females. The total prevalence of diabetes was 14.8 %among males and 11.7% among females (7)

Prediabetes is the tip of the iceberg, Screening for early diagnosis and intervention for the prediabetes and its risk factors could decrease the risk for development diabetes and its complications such as cardiovascular disease, diabetic retinopathy, neuropathy, and nephropathy. (8)

Lifestyle modification is effective in preventing or delaying the progression to diabetes, for preventing or delaying prediabetes developing to type-2 diabetes People can decrease their risk by a healthy diet, losing weight, more physical activity, stop smoking. (9)

Many studies have been conducted around the world about the prevalence of prediabetes and its risk factors, such as; In Makkah, a study was applied on 225 subjects depending only on HbA1c showed that the prevalence of prediabetes was 17.3% in adult population and showed a higher prevalence of pre-diabetes was in adults with physical inactivity (23.3%), obesity (high body mass index) (28.1%) and central obesity (high waist circumference) (29.4%) [2016]. (3)

Another study done in England showed the prevalence rate of prediabetes increased from 11.6% to 35.3% from 2003 to 2011 and by 2011, 50.6% of the population who had BMI >25 and ≥40 years of age had prediabetes, individuals with less socioeconomic were more likely to have prediabetes in 2003. (10)

In Mexico, a study was done on 288 young adults subjects using impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) the prevalence of prediabetes was 14.6% and showed a relation between prediabetes and old age, high BMI and waist circumference, history of diabetes, hypertension, smoking and alcohol, and no significant difference between gender [2014].(11)

In Cameron, a Population-based cross-sectional studies published between January 1, 2000 and April 30, 2017 including healthy adults residing in Cameroon, using fasting plasma glucose or 2-hour plasma glucose. The prevalence of prediabetes was 7.1% in a sample of 5,872 people and showed increase prevalence with age, hypertension, overweight and obesity and no difference between sex and settings (rural versus urban). (12)

Also, in Jeddah, a study was done on 1420 subjects depending on HbA1c and Fasting plasma glucose showed that the prevalence of prediabetes was 9.0%; 9.4% in men and 8.6% in women, the prevalence of prediabetes increased with age prediabetes was significantly associated with general obesity in women, and with central obesity in both sexes [2016]. (13)

MATERIALS AND METHODS:

Study design and participants

This study is an observational descriptive study, survey was conducted using a structured questionnaire on students and staff (both gender) who attend to Taibah University in Madina, Saudi Arabia in May 2018. Sample size was determined using the

sample size software online (14) for prevalence studies of population (0 for unknown population), assuming prevalence of prediabetes among students and staffs in Taibah university is 17.3% (3), at a 95% confidence interval and margin error 5%, these inputs yielded a sample of at least 220 participants.
After providing informed consent for each one of the participant and explaining the objectives of the study, we started with interviewing each volunteer by a structured questionnaire which is directed by us then start measuring the Height, weight, hip and waist circumference and for glycated hemoglobin (HbA1c) via finger prick for the participants whom had two or more risk factors of the following BMI more than 29, positive family history, hypertension and past history of gestational diabetes.

The study tool:
Information was collected using a questionnaire, to determine the prevalence rate of prediabetes and to identify the risk of sociodemographic, lifestyle and medical factors on the prevalence of prediabetes. The questionnaire consisted of three parts, the first part was about demographic data such as (gender, age ، Nationality, marital status, income, and educational level), while the second part was about lifestyle and medical factors such as (smoking, hypertension, past history of gestational diabetes, polycystic ovary syndrome, physical activity, fruits and vegetables intake, and family history of diabetes.), and the third part was special of female about past history of gestational diabetes or baby weight more than 4 kg and PCOS to determine prediabetes condition (prediabetes 5.7- 6.4%).
Confidentiality and privacy was maintained by data coding to eliminate identifying data with personal information.

Inclusion criteria: Male or female (students and staff) who attend to Taibah University.

Exclusion criteria: Known case of diabetes, pregnant female, known case of anemia, liver disease and CRF

- The participants were reassured that their participation in the study is voluntary. and the discovered prediabetes cases or who has a risk factors, were referred to the nearest primary health care unit to start the management and following up.
- glycated hemoglobin (HbA1c) was measured for the participants whom had two or more risk factors of the following BMI more than 29, positive family history, hypertension and Past history of gestational diabetes to determine prediabetes condition (prediabetes 5.7- 6.4%).

Statistical methods:
The statistical analysis program (SPSS v.22) was been used in the study in data entry and analysis, with the use of necessary statistical methods to achieve the objectives of the study. The following statistical methods were used: Frequencies, Percentages, Graphs, and Chi-square test.

RESULTS:

Table 1 shows the participant's distribution according to demographic data, where we notes that 65% of them were female, while 34.3% of them were male, and their distribution according to nationality, 95.8% of them were Saudi, while 4.2% of them were non-Saudi.

Their distribution according to age, 86.6% of them were between 18-29 years, 12.1% of them were between 30-49 years, and 1.3% of them were between 50-70 years.

Their distribution according to marital status, 84.1% of them were single, 14% of them were married, and 1.9% of them were divorced or widowed.

Their distribution according to educational level, 84.8% of them were ≤ High school graduate, 12.4% of them were basic university degree, and 2.9% of them were post graduate degree.

Finally; their distribution according to income, 71.9% of them were below average (< 5000 SR/month), 14% of them were average (5000-10000 SR/month), and 14% of them were above average (> 10000 SR/month).

		Freq. (N= 834)	Per. 100%	P-value
Gender	Male	286	34.3	.000
	Female	548	65.7	
Nationality	Saudi	799	95.8	.000
	Non-Saudi	35	4.2	
Age	18-29 years	722	86.6	.000
	30-49 years	101	12.1	
	50-70 years	11	1.3	
Marital status	Single	701	84.1	.000
	Married	117	14.0	
	Divorced or widowed	16	1.9	
Education level	≤ High school graduate	707	84.8	.000
	Basic university degree	103	12.4	
	Post graduate degree	24	2.9	
Income	Below average (< 5000 SR/month)	600	71.9	.000
	Average (5000-10000 SR/month)	117	14.0	
	Above average (> 10000 SR/month)	117	14.0	

Table 2 shows the participants' distribution according to smoking, hypertension, family history of DM, physical activity, and eating vegetables and fruits.

Where we note that 86.8% of participants are not smokers, while 13.2% are smokers. 97% of them don't have hypertension, while 3% have hypertension, 60.3% have a family history of DM, while 39.7% don't have a family history of DM.

51.1% of participants don't exercise, 22.3% exercise less than 60 minutes per week, 11.9% exercise 50-150 minutes per week, 14.7% exercise more than 150 minutes per week.

38.8% of the participants didn't eat fruit, 49.5% ate fruit every other day, and 16.7% ate fruit every daily.

24% of the participants didn't eat vegetables, 38.8% of them eat vegetables every other day, and 37.2% of them eat vegetables daily.

		Freq. (N= 834)	Per. 100%	P-value
Smoking	Smoker	110	13.2	.000
	Non-smoker	724	86.8	
Hypertension	Yes/ on treatment	25	3.0	.000
	No	809	97.0	
Family history of DM	Yes	503	60.3	.000
	No	331	39.7	
Physical activity/week	No	426	51.1	.000
	< 60 mins/week	186	22.3	
	60-150 mins/week	99	11.9	
	≥150 mins/week	123	14.7	
Fruits intake/day	Non	282	33.8	.000
	Every other day	413	49.5	
	Daily	139	16.7	
Vegetables intake/day:	Non	200	24.0	.000
	Every other day	324	38.8	
	Daily	310	37.2	

The total number of participants in this study was 834. Only 99 people had data on pre-diabetes.

Table 3 shows the participants with pre-diabetes distribution according to demographic data. About 47.5% of them were female, while 52.5% of them were male, and their distribution according to nationality, 94.9% of them were Saudi, while 5.1% of them were non-Saudi.

Their distribution according to age, 67.7% of them were between 18-29 years, 25.3% of them were between 30-49 years, and 7.1% of them were between 50-70 years.

Their distribution according to marital status, 68.7% of them were single, 24.4% of them were married, and 7.1% of them were divorced or widowed.

Their distribution according to educational level, 75.8% of them were ≤ High school graduate, 21.2% of them were basic university degree, and 3% of them were post graduate degree.

Finally; their distribution according to income, 79.8% of them were below average (< 5000 SR/month), 12.1% of them were average (5000-10000 SR/month), and 8.1 of them were above average (> 10000 SR/month).

		Freq. (N= 99)	Per. 100%	P-value
Gender	Male	52	52.5	.615
	Female	47	47.5	
Nationality	Saudi	94	94.9	.000
	Non-Saudi	5	5.1	
Age	18-29 years	67	67.7	.000
	30-49 years	25	25.3	
	50-70 years	7	7.1	
Marital status	Single	68	68.7	.000
	Married	24	24.2	
	Divorced or widowed	7	7.1	
Education level	≤ High school graduate	75	75.8	.000
	Basic university degree	21	21.2	
	Post graduate degree	3	3.0	
Income	Below average (< 5000 SR/month)	79	79.8	.000
	Average (5000-10000 SR/month)	12	12.1	
	Above average (> 10000 SR/month)	8	8.1	

Table 4 shows the participants with pre-diabetes distribution according to smoking, hypertension, family history of DM, physical activity, and eating vegetables and fruits.

Where we note that 78.8% of participants are not smokers, while 21.2% are smokers. 86.9% of them don't have hypertension, while 13.1% have hypertension, 85.9% have a family history of DM, while 14.1% don't have a family history of DM.

67.7% of them don't exercise, 13.1% exercise less than 60 minutes per week, 10.1% exercise 50-150 minutes per week, 9.1% exercise more than 150 minutes per week.

43.4% of them didn't eat fruit, 39.4% ate fruit every other day, and 17.2% ate fruit every daily.

32.3% of them didn't eat vegetables, 32.3% of them eat vegetables every other day, and 35.4% of them eat vegetables daily.

		Freq. (N= 99)	Per. 100%	P-value
Smoking	Smoker	21	21.2	.000
	Non-smoker	78	78.8	
Hypertension	Yes/ on treatment	13	13.1	.000
	No	86	86.9	
Family history of DM	Yes	85	85.9	.000
	No	14	14.1	
Physical activity/week	No	67	67.7	.000
	< 60 mins/week	13	13.1	
	60-150 mins/week	10	10.1	
	≥150 mins/week	9	9.1	
Fruits intake/day	Non	43	43.4	.003
	Every other day	39	39.4	
	Daily	17	17.2	
Vegetables intake/day:	Non	32	32.3	.913
	Every other day	32	32.3	
	Daily	35	35.4	

Table 5 shows the distribution of participants with prediabetes by height, weight, BMI, waist circumference, Hip circumference, and Waist-to-hip ratio.

The mean height of participants with prediabetes is 164.29 with a standard deviation 9.326, while the mean weights of participants with prediabetes is 89.71 with a standard deviation 17.504, and the mean of BMI is 33.1% with a standard deviation 5.1%.

The mean of waist circumference of participants with prediabetes is 101.76 with a standard deviation 16.652, while the mean of Hip circumference of participants with prediabetes is 116.62 with a standard deviation 14.509, and the mean of Waist-to-hip ratio is 88% with a standard deviation 12.4%.

The mean of HbA1C is 6.21 with a standard deviation 0.751

76.6% of the participants with prediabetes don't have past history of gestational prediabetes OR baby weight more than 4 kg, while 23.4% have past history of gestational prediabetes OR baby weight more than 4 kg, 95.7% don't have PCOS, while 4.3% have PCOS.

Height	Mean ± Std. Deviation	164.29	9.326	
Weight		89.71	17.504	
BMI		33.1	5.1	
Waist circumference		101.76	16.652	
Hip circumference		116.62	14.509	
Waist-to-hip ratio		88	12.4	
HbA1C		6.21	0.751	
		Freq. (N= 47)	**Per. 100%**	**P-value**
Past history of gestational diabetes OR baby weight more than 4 kg	Yes	11	23.4	.000
	No	36	76.6	
PCOS	Yes	2	4.3	.000
	No	45	95.7	

DISCUSSION:

In the past decades, prediabetes prevalence in several developing countries has sharply increased (5). The observed evidence showed association between pre-diabetes and diabetes complications including; early retinopathy, small fiber neuropathy, early nephropathy and risk of macrovascular disease (7). As well as, if prediabetes untreated, 37% of the prediabetic may have diabetes in 4 years (15). But, intervention in the patient's lifestyle may reduce the risk of prediabetes progression to diabetes for as long as 10 year (15).

Hence, this study aimed to determine the prevalence rate of prediabetes among students and staff (both

gender) in Taibah University in Madinah and to identify the risk of sociodemographic, lifestyle and medical factors on the prevalence of prediabetes. In this study when the group of high-risk subjects undergo confirmation test, we expect to find undiagnosed diabetes. So, it is expected that there will be many cases for early treatment. It is also possible to intervene in lifestyle modifications for patients, thus preventing the development of the disease with type 2 diabetes.

In our study we studied several risk factors such as smoking, hypertension, family history of DM, physical activity, diet, weight, and medical history. These factors could contribute with the prevalence of prediabetes. The results showed that some of these risk factors high prevalence while others were low prevalence, so we can say that in general there was a moderate prevalence of prediabetes risk factors among the participants.

Regarding the smoking, there was a low prevalence of smoking among participants with prediabetes in this study, this may be because most of the participants are female, and smoking among females is known to be low in Saudi Arabia due to religious and social constraints. Tobacco smoke and its products like; cigars, smokeless tobacco and pipes, includes several harmful and potentially harmful constituents (HPHC), Which affect various organ systems and physiological processes in a tissue-specific manner (16). Actually, current smokers have been reported to have an increased risk of type 2 diabetes by 30-40% compared to nonsmokers (16). As well as tobacco exposure is directly lead to insulin resistance, therefore, it is considered one of the main causes of prediabetes (16). But, in our study there was no relationship between prediabetes and smoking. while, Aeschbacher et al. found that smoking is strongly associated with prediabetes and accumulating as few as 5–10 pack-years of smoking hold a nearly 2-fold increased odds of having prediabetes (17). The difference in the results between our study and the Aeschbacher et al. study could be due to the fact that our study included a small number of smokers compared to Aeschbacher et al. study, which may affect the results of our study.
Hypertension is one of the most important risk factors for prediabetes. In our study there was low prevalence of hypertension among our participants with prediabetes only 13%. A mechanism has been suggested that angiotensin II activity increases in the circulatory system of hypertension patients. Angiotensin II activates renin-angiotensin-aldosterone system (RAAS) and influence in the function of the pancreatic islets, leading to islet fibrosis and decreasing synthesis of insulin, and lastly leading to insulin resistance (18). Insulin resistance can also aggravate the hypertension situation (18). Insulin resistance is known to lead to prediabetes, because it leads to increased concentration of glucose in the blood. Many studies performed in several ethnic groups showed a close association between hypertension and diabetes mellitus. Nearly one-third of the hypertension patients develop diabetes later (19). But, in our study there was no relationship between prediabetes and hypertension, this may be due to low prevalence of hypertension among our participants with prediabetes, which may affect the outcome of statistical analysis

The risk of diabetes is almost doubled in people with a positive family history of type 2 diabetes (FHD). Since FHD is associated with all the characteristics of diabetes pathophysiology, individuals with FHD may be at increased risk of prediabetes (20). In the present study the majority of participants with prediabetes had a family history of diabetes mellitus, and we found a relationship between prediabetes and FHD. This is consistent with what Wagner et al. found that FHD is an important risk factor for prediabetes (20).
The waist circumference and the Body Mass Index (BMI) are among the most used parameter to assess obesity (21). According to our results, the mean of BMI among our participants with prediabetes was 33.1, a BMI of 33.1 is obese. The mean of waist circumference of our participants with prediabetes were 101.8, waist circumference of 101.76 is Above the normal range. And there was no relationship between the prediabetes and BMI. As well as, the participants showed low physical activity and they did not follow a healthy diet. There is an inverse relationship between the glycosylated hemoglobin (A1C) and intense physical activity (PA) this is compatible with the literature that suggests that physical activity has physiological benefits, one of these physiological benefits is the control of blood glucose for the prevention of diabetes stands out (21).
Insulin resistance increases during pregnancy, and when associated with impaired beta cell function, the risk of gestational diabetes mellitus (GDM) increases. After the pregnancy glucose tolerance normalizes (22), but several previous studies showed that affected women have at least a seven-fold risk of developing type 2 diabetes in life later (23-26). Also, Shen et al. found that women with prior GDM had significantly increased risks for postpartum prediabetes and diabetes, with the highest risk at the first 3-4 years after delivery, compared with those without GDM. Therefore, GDM is considered as one of the most important factors of prediabetes (27). In our study only 23.4% of the participants had Past

history of gestational diabetes OR baby weight more than 4 kg, this result may be because the study included both genders, and most of the participants in this study are single. But, our study showed that there was no relationship between prediabetes and the Past history of gestational diabetes OR baby weight more than 4 kg. The difference in results between our study and the Shen et al. study could be due to the difference in the characteristics of the target group in both studies.

CONCLUSION:

This study was performed to determine the prevalence rate of prediabetes among students and staff (both gender) in Taibah University in Madinah and to identify the risk of sociodemographic, lifestyle and medical factors on the prevalence of prediabetes. The study showed that in general there was a moderate prevalence of prediabetes risk factors the among students and staff in Taibah University. Which means that there is a possibility of the existence of many cases of prediabetes, which need to make changes in their lifestyle to prevent the development of their cases to diabetes. With regard to the prevalence of risk factors among prediabetes patients in this study, the study showed a high prevalence of some of these factors such as family history of DM, Obesity, Low physical activity and prevalence of unhealthy food habits. The study showed a relationship only between prediabetes and family history of type 2 diabetes

Recommendation

- ✓ Conduct more studies on the same subject to include wider areas and more community groups.
- ✓ Conduct awareness campaigns in different regions to raise awareness about prediabetes
- ✓ People in general, and individuals with a family history of diabetes or any other risk factor in particular, should conduct regular blood glucose tests.
- ✓ Physical activity should be done at an adequate rate.
- ✓ a healthy and diverse diet should be followed.
- ✓ Avoid smoking.
- ✓ Avoid stress as much as possible.

LIMITATIONS:

The study sample is limited to employees and students at the University of Taiba. Therefore, the limited of study place and the Limited of targeted group makes the study unrepresentative for the entire of Medina population.

Declarations:

Ethics approval and consent to participate

The study received ethical approval from the Research ethics committee at the Faculty of Medicine, Taibah University, Saudi Arabia. The study ID is 054 - 1439. Confidentiality and privacy was maintained by data coding to eliminate identifying data with personal information.

Availability of data and material

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Funding

Not applicable. All cost of data collection and analysis were covered by the authors.

Acknowledgement

The authors gratefully acknowledge the help of the following:

- Lamees Lemrabet Mohammed
- Sarah Awadh Alserhani
- Afnan Abdulaziz Hussain
- Rzaan Abdulraheem Almuzaini
- Sufanah Hatem Al-shryofi
- Maram Mohammed Siraj Alabbasi
- Ghadi Khalid Ternati
- Alyaa Mohammed Kheder
- Lena Abdulla Jameel

And we would like to thank everyone who participate in this study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author's contributions

The authors contributed equally to this work

REFERENCES:

1. Diabetes.co.uk. Prediabetes or Borderline Diabetes. https://www.diabetes.co.uk/pre-diabetes.html. Accessed 23 Apr 2018.
2. Vilanova M, Falguera M, Marsal J, Rubinat E, Alcubierre N, Catelblanco E et al. Prevalence, clinical features and risk assessment of pre-diabetes in Spain: the prospective Mollerussa cohort study. BMJ Open. 2017;7(6):e015158.
3. Turki Y, Hegazy A, Abaalkhail B. Prevalence of Pre-Diabetes among Adults Attending Primary Health Care Centers, Makkah City, Saudi Arabia. International Journal of Medical Research Professionals. 2016;2(6).
4. Healthxchange.sg. What is Prediabetes and What to Do When You're Diagnosed? https://www.healthxchange.sg/diabetes/essential-guide-diabetes/what-is-prediabetes-what-do-when-diagnosed. Accessed 23 Apr 2018
5. Zhao M, Lin H, Yuan Y, Wang F, Xi Y, Wen L

et al. Prevalence of Pre-Diabetes and Its Associated Risk Factors in Rural Areas of Ningbo, China. International Journal of Environmental Research and Public Health. 2016;13(8):808.
6. Bansal N. Prediabetes diagnosis and treatment: A review. World Journal of Diabetes. 2015;6(2):296.
7. Health Days 2015 - World Diabetes Day. Moh.gov.sa. https://www.moh.gov.sa/en/healthawareness/healthday/2015/pages/healthday-2015-11-14.aspx. Accessed 23 Apr 2018.
8. Muthunarayanan L, Ramraj B, Russel J. Prevalence of prediabetes and its associated risk factors among rural adults in Tamil Nadu. Archives of Medicine and Health Sciences. 2015;3(2):178.
9. National Institute of Diabetes and Digestive and Kidney Diseases. Insulin Resistance & Prediabetes.https://www.niddk.nih.gov/health-information/diabetes/overview/what-is-diabetes/prediabetes-insulin-resistance. Accessed 23 Apr 2018.
10. Mainous A, Tanner R, Baker R, Zayas C, Harle C. Prevalence of prediabetes in England from 2003 to 2011: population-based, cross-sectional study. BMJ Open. 2014;4(6):e005002-e005002.
11. Urena-Bogarin E, Martinez-Ramirez H, Torres-Sanchez J, Hernandez-Herrera A, Cortes-Sanabria L, Cueto-Manzano A. Prevalence of pre-diabetes in young Mexican adults in primary health care. Family Practice. 2014;32(2):159-164.
12. Bigna J, Nansseu J, Katte J, Noubiap J. Prevalence of prediabetes and diabetes mellitus among adults residing in Cameroon: A systematic review and meta-analysis. Diabetes Research and Clinical Practice. 2018;137:109-118.
13. Bahijri S, Jambi H, Al Raddadi R, Ferns G, Tuomilehto J. The Prevalence of Diabetes and Prediabetes in the Adult Population of Jeddah, Saudi Arabia- A Community-Based Survey. PLOS ONE. 2016;11(4):e0152559.
14. Sampsize. Sampsize.sourceforge.net. http://sampsize.sourceforge.net/iface/. Accessed 28Apr 2018
15. Tuso, Phillip. "Prediabetes and lifestyle modification: time to prevent a preventable disease." *The Permanente Journal* 18.3 (2014): 88.
16. Keith, Rachel J., et al. "Tobacco use, insulin resistance, and risk of type 2 diabetes: results from the multi-ethnic study of atherosclerosis." *PLoS One* 11.6 (2016): e0157592.
17. Aeschbacher, Stefanie, et al. "Association of smoking and nicotine dependence with pre-diabetes in young and healthy adults." *Swiss Med Wkly* 144 (2014): w14019.
18. Pinto, Elisabete. "Blood pressure and ageing." *Postgraduate medical journal* 83.976 (2007): 109-114.
19. Shah, Ahsana, and Mohammad Afzal. "Prevalence of diabetes and hypertension and association with various risk factors among different Muslim populations of Manipur, India." *Journal of Diabetes & Metabolic Disorders* 12.1 (2013): 52.
20. Wagner, Robert, et al. "Family history of diabetes is associated with higher risk for prediabetes: a multicentre analysis from the German Center for Diabetes Research." *Diabetologia* 56.10 (2013): 2176-2180.
21. Compeán-Ortiz, Lidia G., et al. "Obesity, physical activity and prediabetes in adult children of people with diabetes." *Revista latino-americana de enfermagem* 25 (2017).
22. Huopio, Hanna, et al. "Long-term changes in glucose metabolism after gestational diabetes: a double cohort study." *BMC pregnancy and childbirth* 14.1 (2014): 296.
23. Kim, Catherine, Katherine M. Newton, and Robert H. Knopp. "Gestational diabetes and the incidence of type 2 diabetes: a systematic review." *Diabetes care* 25.10 (2002): 1862-1868.
24. Järvelä, Ilkka Y., et al. "Gestational diabetes identifies women at risk for permanent type 1 and type 2 diabetes in fertile age: predictive role of autoantibodies." *Diabetes care* 29.3 (2006): 607-612.
25. American Diabetes Association. "Diagnosis and classification of diabetes mellitus." *Diabetes care* 37.Supplement 1 (2014): S81-S90.
26. Bellamy, Leanne, et al. "Type 2 diabetes mellitus after gestational diabetes: a systematic review and meta-analysis." *The Lancet* 373.9677 (2009): 1773-1779.
27. Shen, Yun, et al. "Gestational diabetes with diabetes and prediabetes risks: a large observational study." *European journal of endocrinology* (2018): EJE-18.