Prediabetes and its Relative Risk Factors in Saudi-adult Men

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Abstract

Background: Type2 diabetes mellitus (T2DM) is a global public health problem. Most diabetic people live in developing countries and Saudi Arabia is not an exception, however; the data is limited. Prediabetes is always a prodromal period to T2DM. **Objectives:** This study was designed to identify the prevalence of prediabetes and its associated risk factors in a group of healthy young men blood donors from the Al-Baha region in Saudi Arabia. **Material and methods:** A total of 165 Saudi-adult men between the ages of 20 and 57 years old participated in the study. A questionnaire was derived and pre-tested, then given to the participants to obtain appropriate data regarding age, nationality, job, living place, G6PD status, history of blood pressure, lifestyle, family history of diabetes, and smoking status. A pre-designed pro forma "Diabetes Risk Test" was used to calculate a risk-factor score of each participant for having T2DM. Blood pressure, weight, and height were measured, and glycated hemoglobin (HbA1c) was used to diagnose prediabetes and diabetes according to the American Diabetes Association (ADA) criteria. **Results:** This study showed a high prevalence of prediabetes (24.24%) and diabetes (3.03%). Factors that were significantly associated with prediabetes and diabetes included: age, BMI, smoking status, subject's physical activity, consumption soft drinks and high fat diets, subject's job, and subject's blood group. **Conclusion and Recommendation:** This study found that prediabetes prevalence is high (24.24%) in Al-Baha-adult men between the age of 20 and 57 years old, which highlights the necessity for providing health education programs for Al-Baha-adult men, so they can amend the risk factors of prediabetes before they end up with full onset diabetes. This study also shows which risk factors are associated with prediabetes and diabetes within this cohort.

Keywords: Prevalence, Prediabetes, Risk factors, BMI, High altitude, Al-Baha, Saudi Arabia

Introduction

Diabetes mellitus is a major non-communicable chronic health problem worldwide especially in developing countries (Danaei et al., 2011; World Health Organization, 2008). Its high-economic costs and burdens put on patients and public health providers leads to pathological complications that increase mortality and morbidity (Zimmet, 2003; Yach et al., 2006). The global prevalence of diabetes mellitus was estimated to be 382 million in 2013, where ~46% of individuals went undiagnosed, and this number is likely to increase to 592 million by the year 2035 (Guariguata et al., 2013).

In Saudi Arabia, there are ~1.7. million diabetic people (Saudi Ministry of Health, 2013). In addition, there are a lot of Saudi people that are undiagnosed, and the prevalence varies by the are in Saudi Arabia, where the higher proportion of diabetics are in Hail and Tabuk, whereas the Qaseem, Makka, Jazan and Najran regions have the lowest proportion (Saudi Ministry of Health, 2013).

Prediabetes, which is also known as non-diabetes hyperglycemia (NDH), impaired glucose regulation (IGR), intermediate hyperglycemia, or high risk for diabetes can be described as abnormal blood glucose levels that exists between normal blood glucose levels and type2 diabetes (Santaguida et al., 2005). Prediabetes risk factors, such as age, sex, diabetes family history, blood pressure, lifestyle status, and Body Mass Index (BMI) are the same as type 2 risk factors, due to the similarity of their metabolic processes and cardiovascular complications (Wilson et al., 2007; American Diabetes Association, 2008; Rathmann et al., 2010).

Prediabetes is always a prodromal period to having type 2 diabetes mellitus, which means prediabetic people often have a chance to develop type 2 diabetes (Buijsse et al., 2011; Nichols et al., 2007; Mason et al., 2007; Garber et al., 2008). A prediabetic person is 5-15 times more likely to have type2 diabetes mellitus compared to a normal person (Diabetes UK: Policy and improvement team, 2009). Between 5%-10 % of prediabetic people have a high risk of developing type 2 diabetes annually while the same proportion has the same chance of converting back to normoglycaemia (Bansal, 2015). The number of prediabetic people worldwide is estimated to be more than 470 million people by 2030 (Tabák et al., 2012).

In Saudi Arabia the prevalence of prediabetes is estimated to be about 2.2 million (Saudi Ministry of Health, 2013). However, there are a lot of Saudi people unaware of their prediabetic state. Abnormal Insulin resistance and/or B-cell dysfunction is the first step of prediabetes before detectable abnormal high blood glucose level (Abdul-Ghani et al., 2006).

Prediabetes hyperglycemia can be diagnosed using three specific tests: Fasting Plasma Glucose (FPG), two hours Oral Glucose Tolerance (OGTT), and Hemoglobin glycosylated test [hemoglobin A1C (HbA1c)] (World Health Organization, 2008; American Diabetes Association, 2014). Prediabetes is an asymptomatic state, but it is a major risk factor for developing type2 diabetes and its complications. It is also associated with elevated risk of developing (Tabák et al., 2012; Tarasova et al., 2014; Papanas & Ziegler, 2012). In addition to that, there are several studies have shown increased risk of some health problems with prediabetes, such as microvascular and macrovascular diseases, diabetic retinopathy, chronic kidney disease and early nephropathy (Tabák et al., 2012; Rydén et al., 2007; Diabetes Prevention Program Research Group, 2007; Plantinga et al., 2010).

The aim of prediabetes treatment is the prevention or delaying of diabetes and the complications associated with both diabetes and prediabetes (Gillies et al., 2007; DeFronzo et al., 2011; Sjöström et al., 2004; Rubino et al., 2004). Although, there are several modalities of prediabetes management include lifestyle intervention, pharmacological interventions, and bariatric surgical interventions (Gillies et al., 2007; DeFronzo et al., 2011; Sjöström et al., 2004; Rubino et al., 2004), lifestyle intervention with dietary habits modifications and increased physical activity is found to be safer, with no serious negative side effects, lower cost and is as effective as or more effective than pharmacological interventions for reducing the potential risk of onset of prediabetes or diabetes and their associated complications (Nathan et al., 2007; Diabetes Prevention Program Research Group, 2002).

Significance of the Study:

In Saudi Arabia, type2 diabetes is starting to reach epidemic proportions (Elhadd et al., 2007). Therefore, Saudi Arabia needs an urgent-preventive campaign to quell the rising proportion of diabetes mellitus and its complications. To achieve this, Saudi Arabia needs to identify prediabetes people early in order to design the appropriate preventative interventions for reducing prediabetes complications, such as diabetes incidence. Therefore, this study was designed to determine the prevalence of pre-diabetes and its relative risk factors in Saudi adult men.

Aim of the Study:

The main aims of this study were

- To Understand the prevalence of prediabetes and its associated risk factors in a sample of apparently healthy adult men blood donors in Saudi Arabia.
- To encourage the development of health education programs everywhere in Saudi Arabia under the supervision of the Saudi Education Ministry and Saudi Ministry of Health for amending the risk factors of prediabetes and to arrest or reverse the conversion of prediabetes (the first step before diabetes) to full onset diabetes.

Materials and Methods

This study was conducted in Al-Baha city, which is a high-altitude city, located 2165 meters above sea level. Al-Baha city is the capital city of the Al-Baha region, located in Southwest Saudi Arabia. The data collection for the study was done between July 2015 - November 2015, from 165 Saudi-adult men, between 20 to 57 years old, who were living in Al-Baha and donated blood at the "Regional Lab and Blood Bank".

Data Collection Tools

A Questionnaire

A questionnaire was devised and pre-tested, then_given to the participants after they answered questions on the Ministry of Health donation forms. Once identified, data regarding age, nationality, job, living place, G6PD status, history of blood pressure, lifestyle, including physical activity habits and dietary habits, family history of diabetes, and smoking status was collected (American Diabetes Association, 2015; National Diabetes Education Program, 2006; American Diabetes Association, 2014).

The following criteria was used for classifying individuals: blood pressure (BP) was measured with a sphygmomanometer, where BP $<$ 120/80 mm Hg, BP = 120-139/80-89 mm Hg, and BP $\geq$140/90 mm Hg for an adult 25 or over was consider normal, prehypertension, and hypertension, respectively, as recognized by the American Heart Association (AHA) (American Heart Association, 2014); playing outdoor games for half an hour at least three times a week was considered good activity (National Diabetes Education Program, 2006; Misra, 2009); consumption of soft drinks and high fat diets, such as fast food at least once a week was considered consumption of unhealthy food; having at least one parent or sibling with diabetes (Diabetes Prevention Program Research Group, 2002; American Diabetes Association, 2015; National Diabetes Education Program , 2006; American Diabetes Association, 2014) was defined as a positive family history of diabetes; subjects who smoked cigarettes or other tobacco products every day for at least 2 years was defined as a smoker. Using this criterion, a pre-designed proforma "Diabetes Risk Test" was used to calculate a risk-factor score of each participate for having type2 diabetes. Having a score of 5 or higher was considered a high-risk factor of having type2 diabetes. A follow-up HbA1c biochemical test as recommended by American Diabetes Association (ADA) was used to confirm or deny having type2 diabetes or prediabetes (American Diabetes Association, 2015; American Diabetes Association, 2014).

Anthropometric Measuring

Anthropometric data was taken by medical graduates under the supervision of the investigator. Height was measured with a Stadiometer and weight was measured using a digital weighing instrument. Body Mass Index (BMI) was calculated using the standard formula (BMI=Mass/ height^2), where M is a subject weight in kilograms divided by a subject height in meters squared. Participants with a BMI 25 kg/m^2 to 29.99 kg/m^2 was considered overweight, and those with a BMI equal or higher than 30 kg/m^2 was defined as obese (World Health Organization, 2015).

The HbA1c Biochemical Test

The HbA1c biochemical test was used for all participants to measure the average blood glucose level in the participants earlier sample from the 2 to 3 months prior, where prediabetes was defined as HbA1c between 5.7% to 6.4%, HbA1c ≥ 6.5% was considered as diabetes, and HbA1c < 5.7 % was considered as normal (American Diabetes Association, 2014). A fresh whole blood sample was drawn in an EDTA-anticoagulant 2ml tube, and HB1C Flex reagent cartridge was used to measure the average blood glucose level by the HB1C method using the Dimension RxL Max clinical chemistry system analyzer, where the calibration and results were reported in % HbA1c.

Ethical and Administrative Considerations

Permission was obtained from the head of the "Regional Lab and Blood Bank" in Al-Baha city to carry out this study at the "Regional Lab and Blood Bank". Before participation, the aims of the study were explained to every participant. They were informed that the information they provided would be kept confidential and used solely for the study's purposes, and that their privacy would be respected during data collection.

Statistical analysis

The collected data was entered into Microsoft Excel (Office 2010) and a Statistical Package for Social Sciences (SPSS, version 16.0) software was used to do the descriptive analysis, which includes calculating frequencies, percentages, crosstabs, averages, standard deviations (SD), and Chi-squared.

Results

A total of 165 Saudi-adult men in the age group of 20-57 years old participated in the study. The "Diabetes Risk Test" for having type2 diabetes was performed, and the risk-factor scores for having type2 diabetes is shown in Table (1), where the minimum score of the diabetes risk test was 1 and the maximum score was 7. The average type2 diabetes risk-factor score for the "Diabetes Risk Test" was 3.76 with a standard deviation (SD±1.44). Among the 165 study subjects who did the "Diabetes Risk Test", 50 men were at high risk for having type2 diabetes with a risk-factor score ≥5 and a prevalence of 30.30%, whereas the other 115 men had normal scores.

Hemoglobin glycosylated (HbA1c) was done to confirm or deny subjects having type2 diabetes or prediabetes after doing the "Diabetes Risk Test". The HbA1c levels in the study are shown in Table (1), where the minimum value of HbA1c was 4.4% and the maximum was 6.7%. The average of HbA1c was 5.4% with a standard deviation (SD ±0.49%). Out of 165 participants, 40 men had prediabetes with HbA1c 5.7%-6.4%, and 5 men had diabetes with HbA1c ≥ 6.5%. The prevalence of prediabetes and diabetes was 24.24% and 3.03% respectively. Out of the 45 men which had prediabetes and diabetes, 25 men only had risk-factor scores ≥5 with a percentage of 15.15%, whereas the other 20 men had risk-factor scores <5 with a percentage of 12.12%. This shows that the HbA1c test was necessary to confirm or deny subjects having type2 diabetes or prediabetes since some scores of the risk-factor for having type 2 diabetes were normal <5, even though they had prediabetes (HbA1c:5.7%-6.4%). On the other hand, there were subjects where their risk-factor for having type2 diabetes was high (≥5), but they had normal (HbA1c < 5.7%). The prevalence of risk-factor scores for having type2 diabetes, and the prevalence of prediabetes and diabetes of HbA1c level were 30.30% and 27.27% respectively. The correlation between risk factor scores and HbA1c was found to be statistically significant (p<0.001) and the result is shown in Table (2).

The correlation of the following variables: subject age, Body Mass Index (BMI), family history of diabetes, smoking status, subject's physical activity, consumption soft drinks and high fat diets, subject's job, subject's blood group, and blood pressure with HbA1c was studied and the results are shown in Table (1). The minimum age was 20 and the maximum was 57, where the average subject age of all the study participants was 35.27 years with standard deviation (SD ±9.47 years). The prevalence of prediabetes in the different age groups is shown in Table (1). Prediabetes prevalence increased with the age of the subjects. Among the 50 men in the age group 20-29 years, 10 men had prediabetes with a prevalence of 6.06%, and out of 40 men in the age group 40-49 years, 20 men had prediabetes with prevalence of 12.12%, while there were 5 men that had diabetes with a prevalence of 3.03%, whereas 10 men out of 15 in the age group ≥50 had prediabetes with a prevalence of 6.06%. The other 60 men of age group 30-39 years had no prediabetes nor diabetes. The relation between age and prediabetes was statistically calculated, and there was a significant association observed (p<0.001) as shown in Table (2).

The Body Mass Index (BMI) of each participant was calculated, and the relation between BMI and HbA1c is shown in Table (1), where the minimum value of BMI was 19.75 kg/ m^2 and the maximum was 44.12 kg/m^2. The average BMI of all the study participants was 29.46 kg/ m^2 with a standard deviation (SD±5.46) and the prevalence of overweight and obesity in this study was 33.3% and 42.42% respectively. The highest prediabetes prevalence was among the obese group (>=30 kg/m2) with a prevalence of 12.12% as shown in Table (1). Out of 165 men who had their BMI calculated, 55 men were overweight with a BMI 25-29.99 kg/m^2, 10 men had prediabetes with a prevalence of 6.06% and 5 men had diabetes with a prevalence of 3.03%, 70 men were obese with a BMI ≥30 kg/m^2, 20 men had prediabetes with a prevalence of 12.12%. None of the obese subjects had diabetes in this study, while the remaining 40 men had a normal BMI, but 10 men of those had prediabetes with a prevalence of 6.06%. The correlation between BMI and prediabetes was statistically significant (p<0.001) and the result is shown in Table (2).

The relationship between family history and prediabetes were done and the results are shown in Table (1). Out of 165 men who had their family history were studied, 50 men had a family history of diabetes, 20 of them had prediabetes with a prevalence of 12.12% and 5 men had diabetes with a prevalence of 3.03%. The remaining 115 men had no family history of diabetes, where 20 of them had prediabetes with a prevalence of 12.12%. There was no correlation between family history and prediabetes found in this study.

Table 1 shows the results of relationship between smoking status and prediabetes in the study group, where out of the 165 men in the study group, 80 men reported as non-smokers and 85 men were smokers. Out of the 80 non-smokers, 20 men had prediabetes with a prevalence of 12.12% and 5 men had diabetes with a prevalence of 3.03%, whereas for 85 smokers, 20 men had prediabetes with a prevalence of 12.12%. Table (2) shows the result of the relationship between smoking and prediabetes was determined to be significant (p<0.001).

Table (1) shows the relationship between activity status of the study group and prediabetes, where the prediabetes prevalence was higher among inactive participants (18.18%) than active subjects (6.06%). Out of 165 men of the study group, 60 men were active and 105 were not active. Of the 60 active men, 10 men had prediabetes with a prevalence of 6.06%, whereas for the 105 inactive men, 30 had prediabetes with a prevalence of 18.18%, while 5 men had diabetes with a prevalence of 3%. The statistical relationship between the subject's physical activity and prediabetes was observed to be significant (p<0.001) as shown in Table (2).

The relationship between the consumption soft drinks and high fat diets of the study group and prediabetes prevalence was shown in Table (1), where the prediabetes prevalence was higher among subjects who consumed soft drinks and high fat diets (15.15%) than subjects who did not consume them (9.09%). Out of 165 men, 85 men consumed soft drinks and high fat diets, while the other 80 men did not consume them. Of the 85 men, who consumed soft drinks and high fat diets, 25 men had prediabetes with a prevalence of 15.15% and 5 men were found to be diabetic with a prevalence of 3.03%. Out of the 80 men, who did not consume soft drinks and high fat diets, 15 men had prediabetes with a prevalence of 9.09%. The relationship between the consumption of soft drinks and high fat diets and prediabetes was statistically significant ($p<0.001$) and the result is shown in Table (2).

Table (1) shows the relationship between subject's job of the study group and prediabetes prevalence, where the highest prevalence was among teachers (12.12%). Out of 165 men, 55 were teachers, 20 were students, 55 were government employees, 25 were military, and 10 worked in health centers. Out of 55 teachers, 20 of them had prediabetes with a prevalence of 12.12%, while 5 had diabetes with a prevalence of 3.03%. 5 students were found to have prediabetes with a prevalence of 3.03%, 10 government employees had prediabetes with a prevalence of 6.06% and 5 military men had prediabetes with a prevalence of 3.03%. There was a statistically significant association observed between job and prediabetes ($p<0.001$) as shown in Table (2).

Table (1) shows the relationship between blood groups of study participants and prediabetes, where the highest prediabetes prevalence was among subjects with blood group O+ with a prevalence of 12.12%. Out of 165 men, 75 men had O+, 45 men had A+ 3.03%, and 5 men with AB+ had prediabetes with a prevalence of 3.03%, but the 5 men with O- were within the normal range of HbA1c (<5.7%). The Statistical association between blood group and prediabetes was found to be significant ($p<0.001$) and the result is shown in Table (2).

Table (1) shows the relationship between blood pressure (BP) of study group and prediabetes, where the minimum value of systolic was 92 mm Hg, the maximum was 140 mm Hg, and the average systolic blood pressure of all the study participants was 121.03 mm Hg with a standard deviation (SD±9.54). The minimum value for diastolic was 60 mm Hg, the maximum was 90 mm Hg, and the average of diastolic blood pressure of all the study participants was 74.97 mm Hg with a standard deviation (SD±8.19). The highest prediabetes prevalence was among subjects with BP <120/80 mm Hg (12.12%). Out of 165 men, 55 men had prehypertension with BP 120-139/80-89 mm Hg, 10 men had prediabetes with a prevalence of 6.06% and 5 men had diabetes with prevalence 3.03%, 10 men had hypertension with BP >=140/90 and all of them had prediabetes with a prevalence of 6.06%. None of hypertension subjects were found to have diabetes in this study. The remaining 100 men had normal BP, although 20 men of them had prediabetes with a prevalence of 12.12%. The correlation between systolic BP and prediabetes showed no statistical significance ($p>0.001$), the correlation between diastolic BP and prediabetes showed no statistical significance ($p>0.001$) and the correlation between blood pressure and prediabetes also showed no statistical significance ($p>0.001$).

Discussion

Diabetes mellitus is one of the most common chronic diseases in Saudi Arabia. Saudi Arabia has a large number of diabetic subjects which is increasing rapidly (Saudi Ministry of Health, 2013). Diabetes develops at a young age in Saudi Arabia, where the prevalence of diabetes is 7.8% for Saudi people between the ages 25-34 years old and this percentage is expected to be 50.4% when they are age 65 years old (Saudi Ministry of Health, 2013). The international diabetes federation (IDF) reported in 2013, that Saudi Arabia is one of the top 10 countries for the prevalence of diabetes for people between the ages of 20 to 79 years old, where the IDF estimated the prevalence would be 24.5% in 2035 (Guariguata et al., 2013). Prediabetes is a higher risk factor of diabetes, and it is always a prodromal period to having type2 diabetes mellitus (Santaguida et al., 2005; Buijsse et al., 2011; Nichols et al., 2007; Mason et al., 2007; Garber et al., 2008). Prediabetes risk factors are the same as type2 diabetes risk factors due to the similarity of their metabolic processes and cardiovascular complications (Wilson et al., 2007; American Diabetes Association, 2008; Rathmann et al., 2010).

This study showed a high prevalence of prediabetes in Al-Baha in apparently healthy adult men (24.24%) and it showed 3.03% as having a prevalence for diabetes in the same study subjects. These findings are similar to a study done in Riyadh, Saudi Arabia by the Family and Community Medicine Department, where their study reported that the prevalence of prediabetes for both male and female as 23.6%, while 3.8% were newly diagnosed diabetics (Ghoraba et al., 2016). It also was observed that increasing age leads to increasing prediabetes. The highest prevalence of prediabetes in this study was 12.12% within the subgroup age of 40-49 years old. In a study done by El-hazmi, et al in 1996 on 1000 male samples from Al-Baha with an age 2-70 years old, they reported a high prevalence for diabetes mellitus increasing with increasing age (El-Hazmi et al., 1996), and this study supports that evidence, where the results of this study showed a significant positive association between age and prediabetes status among the study subjects ($p<0.001$).

In this study, being overweight or obese was observed as a high-risk indicator to prediabetes state. The prediabetes prevalence increased with increasing BMI was also reported in the Al-Shafee et al study in 2011 (Al-Shafaee et al., 2011) and this observation between BMI and prediabetes prevalence was found to be statistically significant in this study ($p<0.001$).

Studies have reported that a family history of diabetes increases the risk of prediabetes and diabetes (Wagner et al., 2013; Valdez et al., 2007). However, the current study showed 12.12% was the prevalence of prediabetes of both groups: who had/had no family history of diabetes, which was similar to a study done on Bahrainis by Al-Mahroos and Mckeigue in 1998 (Al-Mahroos & McKeigue, 1998)**.** This current result might be due to undiagnosed diabetes in parents or due to the younger age of subject parents since marriage happens at very young age in Al-Baha city where the study took place. The results suggested no association between family history of diabetic and prediabetes state ($p>0.001$).

Smoking is a risk factor for prediabetes and diabetes. Studies have suggested that active smoking increased the risk of incidence of type2 diabetes (Willi et al., 2007; Kawakami et al., 1997). For example, it was reported by Kwakami et al that Japanese males who were currently smoking 16-25 cigarettes per day had 3.27 times higher risk to have type2 diabetes than Japanese males who never smoked (Kawakami et al., 1997). However, this study results revealed 12.12% of both smokers and non-smokers to be prediabetic. This may be due to other factors, for example, lifestyle, such as, eating patterns and physical activity levels, or the influence of other possible environmental factors, or genetic factors, or it may be due to a short time of smoking of number of cigarettes per day. In this current study, an association between smoking and prediabetes was observed to be significant ($p<0.001$).

Physical activity may prevent/protect from the incidence of type2 diabetes (Manson et al., 1991; Helmrich et al., 1991). This current study showed 18.18% subjects from the non-active group of individuals had prediabetes, while 3.03% of them had diabetes, whereas 6.06% of the active subjects had prediabetes. This results showed a significant positive association between subject physical activity and prediabetes/diabetes ($p<0.001$).

This study showed 15.15% and 3.03% of consumption soft drinks and high fat diets people had prediabetes and diabetes respectively, in contrast to 9.09% of the low consumption soft drink and high fat diets group. As a result of consuming soft drinks and high fat diets, subjects may become overweight and obese and thus increase their BMI to an abnormal level, which may lead to prediabetes and then diabetes as reported in some studies (Narayan et al., 2007; Odegaard et al., 2009). A positive association was found between the consumption soft drinks and high fat diets, and prediabetes/diabetes prevalence ($p<0.001$).

Job strain plays a role in increasing risk of type2 diabetes as reported by Nyberg et al study (Nyberg et al., 2014) who observed that job strain is a risk factor for incident type2 diabetes in both genders, independent of lifestyle factors (Nyberg et al., 2014). The results of the current study were similar to Nyberg et al's findings (Nyberg et al., 2014). The current study showed the highest prevalence of prediabetes for teachers (12.12%) and it showed 3.03% as the prevalence of diabetes for the same teacher group, whereas the lower prevalence was for students and military (3.03%). Subject's job was significantly associated with prediabetes prevalence ($p<0.001$).

ABO blood group are inherited and associated with gaining type2 diabetes mellitus (Fagherazzi et al., 2015; Meo et al., 2016). In two independent studies done by Fagherazzi et al (Fagherazzi et al., 2015) and Meo et al (Meo et al., 2016), they suggested that people with blood group" B" were at high risk of type2 diabetes, whereas subject with blood group "O" were at low risk of type2 diabetes. The current study did not observe similar findings, since it showed that people with group "O" had the highest prevalence with prediabetes (12.12%), whereas the prevalence of group "B" and group" AB" had the lowest prevalence of prediabetes (3.03%), which might be due to small number subjects in study who had prediabetes. There was a correlation between subject blood group and prediabetes ($p<0.001$).

Hypertension is also a risk factor for diabetes (Vuvor et al., 2011; De Courten et al., 1996). This study showed 12.12% of people with normal blood pressure had prediabetes in contrast to 6.06% of subjects with hypertension and prehypertension. This result may show hypertension or prehypertension by this study subjects may be due to the temporary stress of giving a blood donation for the study (Narayan et al., 2007), since the study subjects were not diagnosed as having hypertension or prehypertension before their donation. Moreover, the blood pressure measured for the study subjects was only performed one time before the donation, so we cannot report if the subjects have hypertension or prehypertension. This study showed a significant relationship between hypertension and prediabetes/diabetes ($p<0.001$). This study can be used for further studies into the associations of prediabetes and diabetes (follow up studies will be done to better understand the effect of risk factors on prediabetes and diabetes).

This present study has certain limitations, such as the need for follow-up studies, such as looking further into the subject's job, subject's blood groups, and determination hypertension using more samples to better understand the relationship between these risk factors and prediabetes or diabetes.

Conclusion

This study is the first published study on the Al-Baha area regarding the prediabetes problem and its relative risk factors. This study shows that around one/fourth of the Saudi-adult men have prediabetes (24.24%). This percentage shows that prediabetes is a serious health problem in Al-Baha adult males. This research also identifies the risk factors linked to prediabetes and diabetes in this group. The Risk factors that were significantly associated with prediabetes and diabetes in this study include: age, BMI, smoking status, subject's physical activity, consumption of soft drinks and high fat diets, subject's job, and subject blood group.

Recommendations

Based on the results of this study, the following recommendations are proposed:

- Implementing health education programs to amend the risk factors attributed to prediabetes, and to arrest or reverse the conversion of prediabetes to onset diabetes.
- Conducting further research involving larger sample sizes.
- Utilizing the HbA1c measurement, since it is convenient for both the researchers and participants, as it does not require fasting or much time.

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Table (1): Association between Risk Factors for Having Type2 Diabetes and Hemoglobin Glycosylated (HbA1c) Levels in Study Group.

Risk Factor	Classification	Hemoglobin Glycosylated (HbA1c)% of Study Subject N (%)			Total
		<5.7%	5.7%-6.4%	>=6.5%	
Diabetes Risk Factor Scores	<5	95 (57.58)	20 (12.12)	0 (0.00)	115 (69.70)
	>=5	25 (15.15)	20 (12.12)	5 (3.03)	50 (30.30)
	Total	120 (72.72)	40 (24.24)	5 (3.03)	165 (100)
Age	20-29	40 (24.24)	10 (6.06)	0 (0.00)	50 (30.30)
	30-39	60 (36.36)	0 (0.00)	0 (0.00)	60 (36.36)
	40-49	15 (9.09)	20 (12.12)	5 (3.03)	40 (24.24)
	>=50	5 (3.03)	10 (6.06)	0 (0.00)	15 (9.09)
	Total	120 (72.72)	40 (24.24)	5 (3.03)	165 (100)
Body Mass Index	<25 kg/m2	30 (18.18)	10 (6.06)	0 (0.00)	40 (24.24)
	25-29.99 kg/m2	40 (24.24)	10 (6.06)	5 (3.03)	55 (33.33)
	>=30 kg/m2	50 (30.30)	20 (12.12)	0 (0.00)	70 (42.42)
	Total	120 (72.72)	40 (24.24)	5 (3.03)	165 (100)
Family History of Diabetes	Yes	25 (15.15)	20 (12.12)	5 (3.03)	50 (30.30)
	No	95 (57.57)	20 (12.12)	0 (0.00)	115 (69.70)
	Total	120 (72.72)	40 (24.24)	5 (3.03)	165 (100)
Smoking Status	Yes	65 (39.39)	20 (12.12)	0 (0.00)	85 (51.52)
	No	55 (33.33)	20 (12.12)	5 (3.03)	80 (48.48)
	Total	120 (72.72)	40 (24.24)	5 (3.03)	165 (100)
Subject Physical Activity	Yes	50 (30.30)	10 (6.06)	0 (0.00)	60 (36.36)
	No	70 (42.42)	30 (18.18)	5 (3.03)	105 (63.64)
	Total	120 (72.72)	40 (24.24)	5 (3.03)	165 (100)
Consumption Soft Drinks and High Fat Diets	Yes	55 (33.33)	25 (15.15)	5 (3.03)	85 (51.52)
	No	65 (39.39)	15 (9.09)	0 (0.00)	80 (48.48)
	Total	120 (72.72)	40 (24.24)	5 (3.03)	165 (100)
Subject Job	Teacher	30 (18.18)	20 (12.12)	5 (3.03)	55 (33.33)
	Student	15 (9.09)	5 (3.03)	0 (0.00)	20 (12.12)
	Employee	45 (27.27)	10 (6.06)	0 (0.00)	55 (33.33)
	Military	20 (12.12)	5 (3.03)	0 (0.00)	25 (15.15)
	Health Center	10 (6.06)	0 (0.00)	0 (0.00)	10 (6.06)
	Total	120 (72.72)	40 (24.24)	5 (3.03)	165 (100)
Subject Blood Group	O+	50 (30.30)	20 (12.12)	5 (3.03)	75 (45.45)
	A+	35 (21.21)	10 (6.06)	0 (0.00)	45 (27.27)
	B+	20 (12.12)	5 (3.03)	0 (0.00)	25 (15.15)
	AB+	10 (6.06)	5 (3.03)	0 (0.00)	15 (9.09)
	O-	5 (3.03)	0 (0.00)	0 (0.00)	5 (3.03)
	Total	120 (72.72)	40 (24.14)	5 (3.03)	165 (100)
Blood Pressure	<120/80 mm Hg	80 (48.48)	20 (12.12)	0 (0.00)	100 (60.61)
	120-139/80-89 mm Hg	40 (24.24)	10 (6.06)	5 (3.03)	55 (33.33)
	>=140/90	0 (0.00)	10 (6.06)	0 (0.00)	10 (6.06)
	Total	120 (72.72)	40 (24.24)	5 (3.03)	165 (100)

Table (2): The Statistically Significant Relation between Risk Factors for Having Type2 Diabetes and Prediabetes in Study Group.

Risk Factor	Statistically Significant Relationship with Prediabetes (p-value)	Risk Factor	Statistically Significant Relationship with Prediabetes (p-value)
Diabetes Risk Factor Scores	<0.001*	**Subject Physical Activity**	<0.001*
Age	<0.001*	**Consumption Soft Drinks and High Fat Diets**	<0.001*
Body Mass Index	<0.001*	**Subject Job**	<0.001*
Smoking Status	<0.001*	**Subject Blood Group**	<0.001*

(*) Statistically Significant at p ≤.0.05

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