Risk Factors Associated with Diabetes Mellitus among Adults in the Hohoe Municipality of Ghana

Abstract
Background: Diabetes Mellitus (DM), one of the Non-Communicable Diseases (NCDs) is a major cause of morbidity and mortality worldwide and is increasingly becoming an important public health concern. This study examined the prevalence, control and risk factors associated with DM2 among adults in the Hohoe Municipality. Method: This was a hospital-based case control study that involved 70 cases and 140 controls. Data was collected using a face-to-face interview with structured questionnaires. Blood pressure, fasting blood glucose and anthropometric indices were measured with appropriate instruments following standard procedures. Differences in means were determined using t-test. Chi-square test and conditional logistic regression model were used to determine association and the strength of the association between independent categorical variables and DM2 respectively. Results: Prevalence of diabetes among controls was 5.7%. Uncontrolled diabetes among cases was 78.6%. Prevalence of hypertension among cases was higher (64.3%) than in controls (60.0%). Adults with overweight and obesity were 13.03 and 12.81 times more likely to develop diabetes (AOR=13.02, p=0.011) and (AOR=12.81, p=0.015) respectively. Civil servants were 0.15 times less likely to have diabetes (AOR=0.15, 0.048). Adults who recently tested their blood glucose, or current/ex-smokers were 12.03 and 12.88 times more likely to develop diabetes (OR=12.03, p<0.001) and (OR=12.88, p=0.037) respectively. Conclusion: One out of 5 diabetics could not control their blood glucose levels. Six out of 10 diabetics had hypertension. About 5.7% of adults’ population with diabetes are not aware. Recent testing of blood sugar, overweight and obesity, smoking and occupation were factors found to be associated with diabetes in the Hohoe Municipality.

Keywords: Type 2 Diabetes Mellitus, Hospital-based, Hypertension, Cases, Controls, Risk Factors, Hohoe, Ghana.

Introduction
Diabetes Mellitus (DM) is a metabolic disease characterized by hyperglycaemia resulting from defects in insulin secretion and action or both. Diabetes a condition that occurs when the body cannot utilize glucose. The levels of glucose in the blood are controlled by a hormone called insulin produced by the pancreas, and insulin helps glucose to enter the cells. The effects of DM include long-term damage, dysfunction and failure of various organs [1]. Diabetes Mellitus occurs either when the pancreas does not produce sufficient insulin (a hormone that regulates blood glucose) (Diabetes Type 1), or when the body cannot effectively use the insulin it produces (Diabetes type 2) [2]. This causes the glucose levels in the blood to rise, leading to symptoms such as frequent urination, lethargy, excessive thirst and hunger [3].

Type 2 Diabetes Mellitus (DM2) is a principal cause of morbidity and mortality and 422 million adults live with diabetes globally [4]. The number of people with diabetes has risen from 108 million in 1980 to 422 million in 2014 [4]. The global prevalence of diabetes among adults over 18 years of age has risen from 4.7% in 1980 to 8.5% in 2014 and is said to be the
major cause of blindness, kidney failure, heart attacks, stroke and lower limb amputation [5]. In 2012 alone, diabetes and high blood glucose globally killed 1.5 and 2.2 million people respectively[6]. In 2014, 8.5% adults aged 18 years and older had diabetes [5]. The International Diabetes Federation (IDF), reported that persons affected by Diabetes worldwide in 2015 were 415 million, of which 14 million were from Sub-Saharan African and 266,200 cases from Ghana [7].

When diabetes is not well managed, complications which threaten health and life may develop. Over time, diabetes can damage the heart, blood vessels, eyes, kidneys and nerves, and increase the risk of heart disease and stroke. Such damages can result in reduced blood flow, which when combined with nerve damage (neuropathy) in the feet, increases the chance of foot ulcers, infection and the eventual need for limb amputation. Diabetic retinopathy is an important cause of blindness and occurs as a result of long-term accumulated damage to the small blood vessels in the retina. Diabetes can increase rates of specific cancers and physical and cognitive disability [6].

There are numerous factors that affect the management of diabetes. Several dietary practices are related to unhealthy body weight and/or DM2 risk. High intake of saturated fatty acids, high total fat intake, sugar-sweetened beverages which contain substantial amounts of free sugars and inadequate consumption of dietary fibre increase the likelihood of being overweight or obese, particularly among children [1].

Studies have shown that Hypertension has a high prevalence in diabetic patients and contributes to the risk of renal disease and heart failure [8-10]. Shanthi and colleagues reported that only 1 in 4 diabetic patients attained optimal DM2 controls[9]. A study by the third National Health and Nutritional Examination Survey (NHANES-III) revealed that 31% of all diabetics and nearly 60 in every 100 of diabetics had HPT [11,12]. Similarly, it was found among Moroccan Sahraoui women that, about 7 in 10 of the diabetics had HPT [13]. In Nigeria, it was found that 75% of adults with diabetes also had HPT [14].

Socio-economic and demographic factors such as age, sex, ethnicity, education level, marital status, employment, retirement status and Health Insurance are said to be associated with DM2. Age has shown to be associated with diabetes [1,9,15,16]. Previous studies have shown that adults who were married or divorced were less likely to developed DM2 [17-19]. Family history has also been found to be associated with diabetes [1].

Lifestyle behaviours play a major role in DM2, and their effects on Diabetes have been given increasing attention in the past decade. Studies have shown that exercise or weight control and adherence to prescribed medication, diet and appointment schedule, improve DM2 in patients with diabetes [10,12,14,20,21].

In 2014, the Ghana Statistical Service (GSS) reported that early childhood nutrition can affect the risk of DM2 later in life and that, factors that appear to increase risk include poor foetal growth, low birth weight and high birth weight. The report also indicated that active smoking increases the risk of DM2, especially among heavy smokers and the risk remains elevated for about 10 years after smoking cessation [22].

The prevention and control of DM2 have not received much attention in many developing countries like Ghana despite the fact that it is one of the most modifiable risk factors for
Metabolic (Endocrine) diseases. Data from the District Health Information Management System 2 (DHIMS 2) (2014) indicates that in the Volta Region, DM2 cases rose from 16,472 in 2013 to 16,549 in 2015. Type 2 diabetes is ranked fourth among the non-communicable diseases in Ghana.

After the establishment of a diabetic clinic at the Hohoe Municipal hospital (HMH) in 2011, DM2 has received attention in the Hohoe Municipality. The Annual Report of the Hohoe Municipal Health Directorate (HMHD) (2015) indicated that DM2 increased from 952 in 2013 to 1,751 in 2015. Diabetes Mellitus accounted for 3.7% and 6.6% in Out Patient Department (OPD) cases of morbidity in 2013 and 2015 respectively [23]. This study determined risk factors associated with DM2 among adults in the Hohoe municipality. It also assessed how DM2 is controlled and the prevalence of HPT among diabetics.

Materials and methods

Study area
Hohoe Municipality is one of the 25 administrative districts/municipalities in the Volta Region of Ghana. The municipality has a total land surface area of 1,172 km square, which is 5.6% of the regional and 0.05% of the National land surface area. It is located at longitude 0 degrees 15 East and 0 degrees 45 East and latitude 6 degrees 45 North and 7 degrees 15 North and lies almost in the heart of the Volta Region. It shares boundary to the East with Togo, forming part of the International borders, on the South East by the Afadzato District and the SouthWest with Kpando Municipal, on the North East with Jasikan District and on the North West with Biakoye District. The capital, Hohoe, is located about 78km away from Ho, the Regional Capital and 220km from Accra, the National Capital of Ghana. According to the 2010 population census, Hohoe had a total population of 167,016, representing 7.9% of the total population of the Volta Region. The major ethnic groups in the municipality are Ewes, Lolobis, Sankrokofis and Likpes. Some economic activities engaged by the people in the municipality include agriculture, petty trading, construction and formal sector.

Study Population
The study population was adults aged 18 years and above residing in the Hohoe municipality.

Exclusion & Inclusion Criteria

Inclusion Criteria for cases
Adults residing in the Hohoe Municipality who were attending the diabetic clinic at the Hohoe Municipal hospital and consented to participate in the study were included.

Inclusion Criteria for controls
Adults residing in the Hohoe Municipality and attending the Hohoe Municipal Hospital with other conditions apart from diabetes who consented to participate in the study were included.

Exclusion Criteria for cases
Adults with diabetes but did not reside within the Hohoe Municipality, pregnant women, seriously ill patients requiring admission and unable to give consent were excluded in the study.

Exclusion Criteria for controls
Adults not having diabetes and outside Hohoe Municipal, pregnant women and seriously ill patients requiring admission for other conditions apart from diabetes and not able to give consent were excluded from the study.

**Study Design**

The was a hospital-based case-control study and involved adults aged 18 years and above attending Hohoe Municipal hospital in January 2017. The cases included respondents who were diabetics and were attending the diabetic clinic at the Hohoe municipal hospital. Two controls were selected from the Out-Patient Department (OPD) to match each case. The controls were patients with similar characteristics such as age and sex and resided within the municipality and had visited the hospital with other conditions apart from Diabetes Mellitus.

**Sample Size Determination**

A sample size of 210 participants (70 cases and 140 controls) was obtained using the sample size formula for unmatched case-control study[24]. Reliability coefficient ($Z_\alpha$) of 1.96 at 95% confidence level, the power of 80% ($Z_\beta = .84$), an expected prevalence of 6%, Odds Ratio (OR) of 4.2 and a ratio of proportionality of 1 case: 2 controls were plugged into the formula.

**Sampling Method**

The cases were selected from the diabetic clinic at Hohoe Municipal Hospital using simple random sampling technique (lottery). However, a convenience sampling technique was employed to select the controls. A one-to-two (1 case: 2 controls) ratio was adopted to select controls with similar characteristics (age ±5 years and sex) in the same hospital who resided within the municipality.

**Data Collection**

Data was collected with reference to WHO STEPWISE approach for non-communicable disease surveillance (Diabetes Mellitus) on risk factors assessment with particular emphasis on steps 3. **STEP 1** was used to capture information associated with nutritional habit, sedentary lifestyle, socio-demographic characteristics and many others with the use of a questionnaire which was administered through a face-to-face interview. **STEP 2** was used to collect information on weight, height, waist to hip ratio, blood pressure level and BMI (This was carried out with the use of tools such as an electronic weighing scale, Stadiometer, Glucometer, tape measure and digital blood pressure monitor) including **STEP 1**. **STEP 3** was used to collect finger-prick blood samples which were used to measure the level of both random and fasting blood glucose using a digital Glucometer (ONE TOUCH Ultra Easy blood glucose monitoring system, LIFESCAN Johnson & Johnson company New Jersey-USA).

**Anthropometric measurements**

Heights of respondents were measured with a Stadiometer (SECA Leicester height measure with a fixed footplate and movable headboard made in the United Kingdom) to the nearest 0.1 centimetres. Weight was measured with digital weighing scale (Bed and Bathroom model BB-3018A manufactured by Conair Company based in the USA) with respondents dressed in...
light clothing to the nearest 0.1 kilogrammes. All anthropometric measurements were taken in triplicates and in accordance with WHO standard anthropometry guidelines.

**Measurement of Blood Pressure**

Blood pressure levels of respondents were measured with the aid of digital blood pressure monitor (Omron M2 Basic manufactured in India by Omron Company). Respondents were made to rest for at least 10 minutes before their blood pressures checked. BP was checked at one-minute intervals for three times of which the average reading was recorded.

**Classification of blood glucose and Blood pressure**

Classifications of blood glucose levels were done using the cut-off standard point of American Diabetes Association.

**Fasting Blood Glucose Levels (FBS):** Diabetes diagnosed at fasting blood glucose of $\geq 126$ mg/dl or FBS > 7.0 mmol/L. Fasting means not having anything to eat or drink (except water) for at least 8 hours before the test.

**Random Blood Glucose levels (RBS):** Diabetes is diagnosed with a blood glucose of $\geq 200$ mg/dl or RBS > 11.0 mmol/L. Random blood sugar test means the test was done at any time of the day when one had eaten.

**Classification of Diabetes**

Diabetes was classified based on recommended cut-offs [5] as follows:

- Normal (FBG < 6.0 mmol/dl)
- Pre-diabetic (FBG = 6.1-6.9 mmol/dl)
- Diabetic (FBG $\geq 7.0$ mmol/dl)

**Classification of hypertension**

Hypertension was classified based on recommended cut-offs [5] as follows:

- Normal (Systolic BP < 120 and Diastolic BP < 80 mmHg)
- Pre-hypertension (Systolic BP = 120-139 and/or Diastolic BP = 80-89 mmHg)
- Hypertension- Stage I hypertension (Systolic BP = 140-159 and/or Diastolic BP = 90-99 mmHg) and Stage II hypertension (Systolic BP > 160 and/or Diastolic BP > 100 mmHg).

**Data Management and Analysis**

Data from the field was checked for completeness and accuracy. Data was entered using EpiData version 3.1 statistical software and was later exported to STATA version 13 for analysis. Data was analysed for frequency distribution, proportion and percentages for qualitative variables. Proportions were reported for the various quantitative variables. Odds Ratio was used to test the strength of the associations between DM2 and some lifestyle risk factors. Chi-square was used to determine the associations between DM2 and demographic characteristics. Pearson’s correlations coefficient was used to determine the relationship between BMI and diabetes. A p-value less than 0.05 was considered statistically significant.

**Ethical Issues**

Before the commencement of the study, approval was sought from the Ethical Review Committee (ERC) MoH /GHS. Permission was sought from the Hohoe Municipal Health Directorate. A written informed consent was obtained from all respondents. In addition, respondents were informed that participation in the study was entirely voluntary and that they
had the right to withdraw from the study if they chose to do so. Controls found to be diabetic or hypertensive were advised to visit the diabetic or hypertension clinic at the Municipal hospital for further investigations, management and counseling.

Results

Background Characteristics of Respondents

Table 1 summarizes the background information of the respondents. Out of a total of 210 respondents, 70 were cases and 140 were controls. Only 27(12.9%) of the respondents were aged less than 40 years with 7(10.0%) as cases and 20(14.3%) as controls. The respondents aged less than 50 years were 40 (19.0%) with 11(15.7%) cases and 29(20.7%) controls. Respondents aged between 50-59 years were 57(27.1%) of which 21(30%) were cases and 36 (25.7%) were controls. Those aged between 60-69 years were 63(30.0%) with 24(34.3%) cases and 39(27.9%) controls. Respondents aged 70 years and above were 50(23.8%) out of which 14(20.0%) were cases and 36(125.7%) were controls. The majority of cases 49(70.0%) and controls 95 (69.9%) were females while 21(30.0%) of cases and 45(32.1%) of controls were males. Only 19(9.1%) respondents were single out of which 8(11.4%) were cases and 11(7.9%) were controls. The majority 117(55.7%) of the respondents were married or cohabiting with 37(52.9%) cases and 80(57.1%) controls. Respondents who were divorced were 28(13.3%) out of which 9(12.9%) were cases and 19(13.6%) were controls. A total of 46(21.9%) respondents were widows out of which 16(22.9%) were cases and 30(21.4%) were controls. The respondents with no formal education were 21(10.0%) of which 5(7.1%) were cases and 16(11.4%) were controls. A total of 18(8.6%) respondents had a primary level of education. However, all of them 18(12.9%) were controls. Most respondents interviewed had basic education up to the Junior High School (JHS) level 106(50.5%) out of which 43(61.4%) were cases and 63(45.0%) were controls. The respondents who had Senior High School (SHS) education were 19(9.0%) with 10(14.3%) as cases and 9(6.4%) as controls. The respondents who had a tertiary level of education were 46(21.9%) of which 12(17.2%) were cases and 34(24.3%) were controls. A total of 39(18.6%) of the respondents were unemployed or had retired out of which 21(30.0%) were cases and 18(12.8%) were controls. The majority 62(29.5%) of the respondents were traders out of which 22(31.4%) were cases and 40(28.6%) were controls. Those who were farmers constituted 39(18.6%) of which 10(14.3%) were cases and 29(20.7%) were controls. Civil servants were 39(18.6) out of which 5(7.1%) were cases and 34(24.3%) were controls. Of the 31(14.8%) Artisans, 12(17.2%) were cases and 19(13.6%) were controls. The majority of the respondents were Christians 197(93.8) with 66(94.3%) cases and 131(93.6%) controls. Muslim respondents were 13(6.2%) out of this, 4(5.7%) were cases and 9(6.4%) were controls.

Table 1. Background characteristics of respondents and associations between background characteristics and Diabetes

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Cases [n=70] n (%)</th>
<th>Controls [n=140] n (%)</th>
<th>Total (%) N=210</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group (in years)</td>
<td></td>
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6
<table>
<thead>
<tr>
<th>Age Group</th>
<th>Reference 1</th>
<th>Reference 2</th>
<th>Reference 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 40</td>
<td>11 (15.7)</td>
<td>29 (20.7)</td>
<td>40 (19.0)</td>
</tr>
<tr>
<td>50 – 59</td>
<td>21 (30.0)</td>
<td>36 (25.7)</td>
<td>57 (27.1)</td>
</tr>
<tr>
<td>60 – 69</td>
<td>24 (34.3)</td>
<td>39 (27.9)</td>
<td>63 (30.0)</td>
</tr>
<tr>
<td>&gt; 70</td>
<td>14 (20.0)</td>
<td>36 (25.7)</td>
<td>50 (23.9)</td>
</tr>
</tbody>
</table>

**Sex**

- Female: 49 (70.0) | 97 (69.3) | 146 (69.5)
- Male: 21 (30.0)  | 43 (30.7) | 64 (30.5)

**Marital status**

- Single: 8 (11.4)  | 11 (7.9)  | 19 (9.1)
- Married / Co-habitation: 37 (52.9) | 80 (57.1) | 117 (55.7)
- Divorced: 9 (12.9) | 19 (13.6) | 28 (13.3)
- Widow/Widower: 16 (22.9) | 30 (21.4) | 46 (21.9)

**Educational Level**

- None: 5 (7.1) | 16 (11.4) | 21 (10.0)
- JHS: 43 (61.4) | 81 (57.9) | 124 (59.1)
- SHS: 10 (14.3) | 9 (6.4)  | 19 (9.0)
- Tertiary: 12 (17.1) | 34 (24.3) | 46 (21.9)

**Occupation**

- Unemployed/Retired: 21 (30.0) | 18 (12.8) | 39 (18.6)
- Trading: 22 (31.4) | 40 (28.6) | 62 (29.5)
- Farming: 10 (14.3) | 29 (20.7) | 39 (18.6)
- Civil servant: 5 (7.1) | 34 (24.3) | 39 (18.6)
- Artisan: 12 (17.2) | 19 (13.6) | 31 (14.8)

**Religion**

- Christianity: 66 (94.3) | 131 (93.6) | 197 (93.8)
- Muslims: 4 (5.7) | 9 (6.4)  | 13 (6.2)

Table 1 summarizes the association between background characteristics and Diabetes. There was no significant association between age and diabetes \( (\chi^2 = 6.59, p=0.159, \alpha=0.05) \). There was also no significant association between marital status, religion and diabetes \( (\chi^2 = 0.10, p=0.753, \alpha=0.05) \) and \( (\chi^2 = 0.04, p=0.840, \alpha=0.05) \) respectively. However, there was a
significant association between educational level attained, occupation and diabetes ($\chi^2 = 16.62, p=0.002, \alpha=0.05$) and ($\chi^2 = 16.34, p=0.003, \alpha=0.05$) respectively.

Figure 1 shows the classification of diabetes among the cases and controls. At the time of the survey, 21.4% of the cases had normal blood glucose levels (controlled diabetes) whilst 78.6% had high blood glucose levels. Among the controls, 5.7% had high FBS (diabetic) and the rest (94.3%) had normal blood glucose levels (non-diabetic).

At the time of the survey, prevalence of HPT among the cases was 64.3% whilst among the controls HPT was 60.0%.

Table 2 shows that there was a significant association between blood glucose testing within the past 12 months and diabetes status ($\chi^2 = 91.88, p<0.001, \alpha=0.05$). There was also a significant association between awareness, family history of DM2 and DM2 status ($\chi^2 = 210.0, p<0.001, \alpha=0.05$) and ($\chi^2 = 13.2, p<0.001, \alpha=0.05$) respectively.

**Association between anthropometric measurements, HPT and diabetes**
There was a significant association between Body Mass Index (BMI) and Diabetes status ($\chi^2 = 8.09$, $p=0.044$, $\alpha=0.05$); however, there was no significant association between Hypertension and Diabetes status ($\chi^2 = 1.36$, $p=0.507$, $\alpha=0.05$) as shown in table 2.

**Association between Lifestyle and Diabetes**

Table 2 shows that there was no association between smoking and diabetes ($\chi^2 = 2.24$, $p=0.326$, $\alpha=0.05$). There was also no association between fruit and salt intake and diabetes ($\chi^2 = 4.11$, $p=0.128$, $\alpha=0.05$) and ($\chi^2 = 1.39$, $p=0.499$, $\alpha=0.05$) respectively. However, there was a significant association between alcohol intake and diabetes ($\chi^2 = 24.55$, $p<0.001$, $\alpha=0.05$). There was also a significant association between vegetables and oils consumption and diabetes ($\chi^2 = 14.47$, $p<0.001$, $\alpha=0.05$) and ($\chi^2 = 13.39$, $p<0.001$, $\alpha=0.05$) respectively. There was also a significant association between vigorous and moderate exercises and diabetes ($\chi^2 = 8.03$, $p=0.005$, $\alpha=0.05$) and ($\chi^2 = 11.23$, $p=0.004$, $\alpha=0.05$) respectively.

**Association between demographic characteristics and the odds of diabetes**

Table 2 shows the results of the adjusted logistic regression. Respondents who were traders and farmers were 0.66 and 0.29 times less likely to have DM2 compared to those who were unemployed; however the difference was not statistically significant [AOR=0.66 (95% CI: 0.11, 3.68); $p=0.632$] and [AOR=0.29 (95% CI: 0.04, 2.12); $p=0.225$] respectively. Respondents who were artisans were 2.74 times more likely to have DM2 as compared to those who were unemployed; however, the difference was not statistically significant [AOR=2.74 (95% CI: 0.26, 29.40); $p=0.0.405$]. Respondents who were civil servants were 0.15 times less likely to have DM2 as compared to those who were unemployed and the difference was statistically significant [AOR=0.15 (95% CI: 0.02, 0.98); $p=0.048$].

**Anthropometric measurements (BMI), Biochemical blood glucose testing, hypertension and odds of DM2**

Respondents who were overweight and obese were 13.03 and 12.81 times more likely to have DM2 as compared to those with normal weight and the difference was statistically significant [AOR=13.03 (95% CI: 1.78, 95.16); $p=0.011$] and [AOR=12.81 (95% CI: 1.65, 99.26); $p=0.015$] respectively. (Table 2).

Respondents who had recent blood glucose test (within the past 12 months) were 12.03 times more likely to have DM2 as compared to those who did not and the difference was statistically significant [AOR=12.03 (95% CI: 3.29, 44.05); $p<0.001$].

Hypertension was not significantly associated with DM2, even though the respondents who were hypertensive were 1.49 times more likely to have DM2 as compared to those with normal blood pressure [AOR=1.49 (95% CI: 0.36, 6.19); $p=0.579$].

**Associations between lifestyles and odds of DM2 (Adjusted)**

Table 2 shows that there was an association between smoking and DM2. Respondents who were current/ex-smokers were 12.88 times more likely to develop DM2 as compared to those who never smoked and the difference was statistically significant [AOR=12.88 (95% CI: 1.16, 142.55); $p=0.037$].

Respondents whose work involved physical activity (such as; lifting, moving heavy items etc. which results in fast breathing and fast heart beat) were 2.21 times more likely to have DM2
as compared to those who did not do any physical activity. However, the difference was not statistically significant [AOR=2.21 (95% CI: 0.51, 9.63); p=0.288].

Respondents who had a family history of DM2 were 1.71 times more likely to have DM2 as compared to those without. The difference was however not, statistically significant [AOR=1.71 (95% CI: 0.48, 6.09); p=0.405].
Table 2. Risk factors associated with diabetes

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Normal [n=147] n (%)</th>
<th>Diabetes [n=63] n (%)</th>
<th>Total [n=210] N(%)</th>
<th>Chi -2 (χ²) (p-value)</th>
<th>COR (95% CI) p-value</th>
<th>AOR(95% CI) p-value</th>
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<tr>
<td>Educational Level</td>
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<tr>
<td>None</td>
<td>17 (11.6)</td>
<td>4 (6.4)</td>
<td>21 (10.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JHS</td>
<td>87 (59.2)</td>
<td>37 (58.7)</td>
<td>124 (59.1)</td>
<td>1.67 (0.41, 6.87)</td>
<td>0.474</td>
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<tr>
<td>SHS</td>
<td>9 (6.1)</td>
<td>10 (15.9)</td>
<td>19 (9.0)</td>
<td>6.17 (0.104)</td>
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<td></td>
</tr>
<tr>
<td>Tertiary</td>
<td>34 (23.1)</td>
<td>12 (19.0)</td>
<td>46 (21.9)</td>
<td>1.51 (0.31, 7.11)</td>
<td>0.077</td>
<td>5.00 (0.83, 29.59)</td>
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<td>Occupation</td>
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<tr>
<td>Unemployed</td>
<td>24 (16.3)</td>
<td>16 (25.4)</td>
<td>40 (19.1)</td>
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<td>Trading</td>
<td>44 (29.9)</td>
<td>18 (28.6)</td>
<td>62 (29.5)</td>
<td>0.75 (0.28, 1.97)</td>
<td>0.557</td>
<td>0.65 (0.11, 3.68)</td>
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<td>Farming</td>
<td>29 (19.7)</td>
<td>10 (15.9)</td>
<td>39 (18.6)</td>
<td>8.04 (0.090)</td>
<td>0.071</td>
<td>0.29 (0.04, 2.12)</td>
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<td>Civil servant</td>
<td>32 (21.8)</td>
<td>6 (9.5)</td>
<td>38 (18.1)</td>
<td>0.17 (0.05, 0.65)</td>
<td>0.010</td>
<td>0.14 (0.02, 0.98)</td>
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<tr>
<td>Artisan</td>
<td>18 (12.2)</td>
<td>13 (20.6)</td>
<td>31 (14.8)</td>
<td>0.89 (0.29, 2.75)</td>
<td>0.849</td>
<td>2.74 (0.25, 29.4)</td>
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<td>Marital status</td>
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<tr>
<td></td>
<td>No</td>
<td>Yes</td>
<td>Recent blood sugar test (within the past 12 months)</td>
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<tr>
<td>Single</td>
<td>11 (7.5)</td>
<td>8 (12.7)</td>
<td>19 (9.1)</td>
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<tr>
<td>Married/Cohabitation</td>
<td>83 (56.5)</td>
<td>34 (54.0)</td>
<td>117 (55.7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Divorced</td>
<td>21 (14.3)</td>
<td>7 (11.1)</td>
<td>28 (13.3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Widow/Widower</td>
<td>32 (21.7)</td>
<td>14 (22.2)</td>
<td>46 (21.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recent blood sugar test (within the past 12 month)</td>
<td></td>
<td></td>
<td>11.78 (4.61, 30.08) &lt;0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>Normal weight</td>
<td>65 (44.2)</td>
<td>13 (20.6)</td>
<td>78 (37.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight</td>
<td>37 (25.2)</td>
<td>29 (46.0)</td>
<td>66 (31.4)</td>
<td>12.8 (0.002)</td>
<td>5.29 (2.12, 13.17) &lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>45 (60.6)</td>
<td>21 (33.3)</td>
<td>66 (31.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>60 (40.8)</td>
<td>21 (33.3)</td>
<td>81 (38.6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertensive</td>
<td>87 (59.2)</td>
<td>42 (66.7)</td>
<td>129 (61.4)</td>
<td>1.04 (0.307)</td>
<td>1.55 (0.78, 3.09) 0.210</td>
<td></td>
</tr>
<tr>
<td>Smoking Status</td>
<td>Never Smoke</td>
<td>139 (94.6)</td>
<td>54 (85.7)</td>
<td>193 (91.9)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The table above shows the distribution of various demographic and health-related characteristics in a sample. For instance, the table indicates the number of individuals within each category, along with the proportion (in parentheses). Statistical significance is indicated for some comparisons, with p-values and confidence intervals provided.
<table>
<thead>
<tr>
<th>Current/Ex-Smoker</th>
<th>8 (5.4)</th>
<th>9 (12.3)</th>
<th>17 (8.1)</th>
<th>4.64 (0.031)</th>
<th>3.38 (0.87, 12.21)</th>
<th>0.079</th>
<th>28.16 (1.59, 497.7)</th>
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<tbody>
<tr>
<td>Alcoholic Status</td>
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<td></td>
<td></td>
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<tr>
<td>Never consumed Alcohol</td>
<td>68 (46.3)</td>
<td>32 (50.8)</td>
<td>100 (47.6)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current/ex-consumers</td>
<td>79 (53.7)</td>
<td>31 (49.2)</td>
<td>110 (210)</td>
<td>0.36 (0.546)</td>
<td>0.81 (0.435, 1.5)</td>
<td>0.523</td>
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<tr>
<td>Oils Usage</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Don’t use oil</td>
<td>3 (2.0)</td>
<td>2 (3.2)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Vegetable oil</td>
<td>55 (37.4)</td>
<td>33 (52.4)</td>
<td>4.64 (0.098)</td>
<td>4.64 (0.098)</td>
<td>0.50 (0.04, 6.28)</td>
<td>0.596</td>
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<tr>
<td>Palm oil</td>
<td>89 (60.5)</td>
<td>28 (44.4)</td>
<td>0.24 (0.02, 3.12)</td>
<td>0.24 (0.02, 3.12)</td>
<td>0.279</td>
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<tr>
<td>Salts Intake</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Low</td>
<td>50 (34.0)</td>
<td>18 (28.6)</td>
<td>68 (32.4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>73 (49.7)</td>
<td>35 (55.6)</td>
<td>108 (51.4)</td>
<td></td>
<td></td>
<td></td>
<td>1.26 (0.61, 2.59)</td>
</tr>
<tr>
<td>High</td>
<td>24 (16.3)</td>
<td>10 (15.9)</td>
<td>34 (16.2)</td>
<td>0.71 (0.702)</td>
<td>1.09 (0.45, 2.92)</td>
<td>0.865</td>
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</tr>
<tr>
<td>Work involving Physical Activity</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>No</td>
<td>99 (67.4)</td>
<td>34 (54.0)</td>
<td>133 (63.3)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Yes</td>
<td>48 (32.6)</td>
<td>29 (46.0)</td>
<td>77 (36.7)</td>
<td>3.39 (0.065)</td>
<td>2.05 (1.05, 3.97)</td>
<td>0.034</td>
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<tr>
<td>Family History of DM2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>92 (62.6)</td>
<td>23 (36.5)</td>
<td>115 (54.8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>55 (37.4)</td>
<td>40 (63.5)</td>
<td>95 (45.2)</td>
<td>12.10 (0.001)</td>
<td>3.57 (1.71, 7.46)</td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>
Discussion

This study investigated the risk factors associated with type 2 Diabetes Mellitus (DM2) among adults in the Hohoe Municipality. The study involved 70 cases and 140 controls. Risk factors identified to be significantly associated with DM were increasing age, marital status, blood glucose testing within 12 months, smoking and family history of DM2.

This study revealed that increasing age was associated with developing DM2. Adults aged 40-49 years and 60-69 years were 12.83 and 8.48 times more likely to develop DM2 (p=0.031) and (p=0.053) respectively. The findings are in agreement with what was reported in Kumasi, Ghana [25]. They found that adults aged 40-60 were 13.4 times more likely to develop DM2 in Ghana. It was also found at Korle-bu teaching hospital that older age group between 41 and 60 were 3.99 times more likely to become diabetic as compared to the younger age ones[26]. Similarly, another study in North India reported that adults aged 45-69 were 4.7 times more likely to develop DM2 [27]. A study in Iran also found that among diabetics, older age group of 50-59 and 60 years and above were 4.59 and 7.78 times more likely to have DM2 respectively [28].

The current study found that marital status, especially those who were married/co-habiting and divorced were 0.20 (80%) and 0.14 (86%) times less likely to have DM2. This is in disagreement with what was reported among Iranian urban population that marital status was not significantly related to DM2 [28]. On the contrary, several studies have found marital status to be associated with DM2. In North India, respondents who were separated/divorced/widowed were 3.3 times more likely to develop DM2 (p=0.03) [27]. These separated/divorced/widowed were 1.29, 1.70 and 1.15 times more likely to develop DM2 respectively among Chinese, Malaysians and Indians [29].

The current study found the family history of DM2 to be associated with DM2. Those with a family history of DM2 were 2.35 times more likely to develop DM2. Similarly, in Kumasi Ghana, it was revealed that individuals with family history of DM2 were 3.97 times more likely to develop DM2 [25].

The current study found smoking to be associated with DM2. It was found that Current/Ex-Smokers were 9.78 times more likely to develop DM2 (OR=9.78, p=0.006). This is in agreement with findings reported in Western Australia [21], which also found that current smokers were 2.66 times more likely to develop diabetes as compared to those who never smoked. A study in Japan revealed that Ex and current smokers among Japanese adults were 1.16 and 1.34 times more likely to develop DM2 [25]. In Korea individuals who smoked 20 cigarettes or more per day were 1.55 times more likely to develop DM2 than those who never smoked [31].

This current study revealed that the prevalence of hypertension among cases was 64.3%. This implies that 6.4 out of every 10 diabetics had HPT. This is in agreement with what was found by Rgubi in Morocco who found that 7 in every 10 diabetics had HPT. A study in Nigeria also found that 75% of diabetics had HPT [14]. The NHANESS also reported that 60% of diabetics had HPT.

The current study showed that, only 15(21.4%) (1 in 5) of individuals among cases had normal blood glucose, that is, had their blood glucose level under control whilst 78.6% still
had high blood glucose levels. This is in agreement with what was found by Shanthi where only 1 in 4 attained optimal DM2 controls among diabetic patients [9].

Limitations of the study
Limitation of this study included the case-control design, which recalls bias because some of the respondents found it difficult to recall some information since they were sick. This study was a hospital-based type and results may not reflect what happens in the general population.

Conclusion
This study has shown that diabetes control among the cases was very poor. Uncontrolled DM2 was 55(78.6%) in the Hohoe Municipality. Only 1 out of 5 diabetics were able to control their blood glucose level. About 8(5.7%) of adults were walking about with diabetes and were not aware. Increasing age, marital status, smoking and family history of DM2 were factors found in this study to be associated with DM2.

Recommendations
Further studies are required to identify reasons for the poor DM control.

List of abbreviations

Availability of data and material
Available upon request

References


26. Akotey EAA. Barriers to Glycaemic Control Among Diabetes Patients At The Korle-Bu Teaching Hospital 2012.


