Original Research Article

Type 2 Diabetes Risk Assessment among Healthy Non- Diabetic in Sudan using Findrisc tool

Abstract

Introduction: Diabetes is increasingly recognized as a serious, worldwide public health concern. Assessment of the risk for developing type 2 diabetes can be done by risk questionnaire which offers an accurate, low cost, educational and time-efficient method for this purpose. By early identifying those at risk to develop diabetes and if confirmed to be at pre-diabetes stage adequate care provided for them through lifestyle interventions or even hypoglycemic medications if necessary, thus delaying or preventing their progression to diabetic status. **Objectives:** The study aims at assessing the risk of developing type 2 diabetes mellitus (T2DM) among healthy non-diabetic Sudanese in Khartoum city. **Materials and Methods:** The study was community-based study divided into two phases, during the period from November 2016 to March 2017 for 122 Non-diabetic Sudanese adults visiting the garden yard, the data were collected by three tools: Finish diabetes risk score (FINDRISC), Knowledge assessment tool and anthropometric measurements. **Results:** 122 participated in the study, the mean age of the participants was 31.55 ± 10.122, the mean BMI was 25.718 ± 5.813, and the mean of waist circumstances 90.2 ± 16.63. The estimated risk of developing T2DM in 10 years of the study for the participants according to FINDRISC, only 3.3% has high risk.

The risk factors for the participants in the study for developing DM type 2 were 66.4% has positive family history, 44.3% were overweight or obese, has 41.8% limited physical activity and 27.9% has central obesity. The pattern of vegetables and fruits daily intake according to FINDRISC only 36.1% from participants. Significant positive correlation (r= 0.395, p=0.000) High risk score of FINDRISC is >14, Estimated age: Y=24.1+ (0.9x15) = 37.9≈38years. Significant positive correlation (r= 0.6, p=0.000) High risk score of FINDRISC is > 14, Estimated BMI: Y= 19.24+ (0.8x15) = 31 Kg/ m^2.

Conclusion: The knowledge about diabetes risk factors, classical symptoms, and common complications was not satisfactory. None of the "at high" risk had their risk further investigated. While 25% adapted health their lifestyle.

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1. Introduction:

1.1 Background: Diabetes is increasingly recognized as a serious, worldwide public health concern. The number of people living with diabetes is growing rapidly; this rapid growth is driven by population growth, aging, urbanization, and high prevalence of obesity and physical inactivity [(1)]. In 2010 it was estimated that 285 million people are living with diabetes [(2)], the number increased to 366 million in 2011 [(3)], then escalated to 415 million in 2015 [(4)].

Low-and middle-income countries have the highest proportion of people with diabetes [(3)]. Furthermore, the international diabetes federation (IDF) estimates that by 2040 there will be 642 million people living with diabetes worldwide [(4)]. In Sudan, there were 3 million cases of diabetes in 2014 [(5)]. Although those numbers

sound alarming but noteworthy those are only estimates and projections with the real numbers remaining unrevealed, certainly will be way more than those estimated. One of the most worrying characteristics of this rapid growth is that T2 DM is becoming more prevalent among children, adolescents, and young adults [6]; indeed Osman H A et al reported that prevalence of T2DM is now increasing among Sudanese children and adolescents [7]. This may be due to the increasing prevalence of obesity, sedentary lifestyle, and physical inactivity [8].

A primary concern about T2DM is that it remains clinical unapparent for a long time, at the early stage it's not severe enough for patients to notice the classical symptoms of diabetes [9]. The onset of T2DM may occur as early as 9-12 years before its clinical diagnosis [10]. Globally, 45.8% or 174.8 million people are estimated to be living with undiagnosed T2DM; about 83.8% of them live in low and middle-income countries [11]. Nevertheless even those undiagnosed people are placed at increased risk of developing diabetes complications. At the time of diagnosis, complications are established in 20- 30% of the patients [12].

As early introduced diabetes remains undiagnosed for a long time; there's an intermediated stage between normoglycemia and diabetes which is pre-diabetes those with impaired glucose tolerance and impaired fasting glucose have an abnormal blood glucose levels but not up to diagnostic criteria yet they are at increased risk of diabetes [13]. Approximately 5-10% of pre-diabetics per year will progress to diabetes [14].

T2DM is not an inevitable disease; results from worldwide randomized controlled trials support the fact that T2DM can be delayed or even prevented in high-risk subjects [15-16]. Lifestyle interventions targeting weight loss and increasing physical activity and improving diet has produced a 30-60% reduction in the risk of developing T2DM [17].

Pharmacotherapy has been also used; metformin, acarbose and troglitazone with 31, 36, and 56% risk reduction respectively [18].

To prevent or delay the incidence of T2DM, therefore, delaying the incidence of complications and co-morbidities thus alleviating the burden of diabetes on both the healthcare system and the patients and their families those at high risk to develop T2DM needs to be identified. With limited resource low and middle-income countries need a simple cost-effective means of identifying those at high risk, risk scores fulfill the need for such a means [19]. Once identified further tests can be done to confirm or rule out the risk. Various risk scores are available, however in this study, the Finnish diabetes risk score has been used as it received the IDF Recommendation as a simple, fast, non-invasive, inexpensive, and reliable tool to identify individuals at high risk for T2DM [19], and it is validated in many countries with good performance [20].

Diabetes care represents a real challenge in Sudan for both the healthcare system and patients. The direct and indirect medical cost of diabetes is high, the chronic complication is very common, basic knowledge about diabetes is missing, attending private clinics and having a high income doesn’t affect diabetes control and the situation is furthermore complicated by the absence of the concept of chronic disease as an asymptomatic condition [21-23]. According to the annual health report issued by the ministry of health for 2015, among the ten leading diseases

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treated as out-patients diabetes was the fifth, and form the ten leading causes of hospital admissions it was the seventh [24].

Assessment of the risk for developing type 2 diabetes can be done by risk questionnaire which offers an accurate, low cost, educational and time-efficient method for this purpose. This was concluded by Rowan P.C. and his colleagues after performing risk assessment followed by point of care glycosylated hemoglobin (HbA1C) test which showed a positive correlation with the risk score as the risk increased the HbA1C value also increased [25].

Identification of individuals at high risk for developing diabetes has been a major concern worldwide; the number of cross-sectional studies has been conducted in different settings and across different countries utilizing different risk assessment tools. In Community-based settings, a study conducted in Libya by Abduelkarem A.R. et al [26], the second study in Nigeria by Alebiosu C.O. et al [27], and the third one in Saudi Arabia by Alzohairy M. & Hassan M. [28], all of these studies used the FINDRISC as a tool for risk assessment. The percent of individuals at high risk were [49/400(12.3%)], [2,956/58,567(5.05%)] and [197/2007(9.8%)] respectively.

Likewise, two studies have been conducted in India using the Indian diabetes risk score, first, one by Subramani R. et al [29] in the rural area of Sripuram, the second one by Anjana P. et al [30] in the urban slum of Hubli, those at found at high risk were [60/500(12.1%)] and [90/200(45%)] respectively. There is a significant difference in the percent of individuals at high risk in rural areas compared to those in urban areas which is not surprising since urbanization leads to adopting a more westernized lifestyle, therefore, increasing the risk of developing T2DM. However, the difference in sample size should be taken into account.

Furthermore, in rural West Virginia, a study has been conducted by Misra R. et al [31-33] using the center of disease control and prevention pre-diabetes scoring test, [332/532(61.8%)] were found at high risk. Looking at the number of those at high risk in a rural area in the westernized developed country finding and comparing it to that found in a rural area in developing country -[60/500(12.1%)] - there's an obvious contradiction. The sample size is approximately similar, this goes in concordance with the fact that westernization increases the risk of T2DM.

Moreover study by Naranjo A. A. et al [33] in Pinar Del Ríocity, in Cuba individuals attending primary care centers had their risk of developing diabetes assessed using the FINDRISK. [65/620(10.5%)] were found to be at a very high risk to develop T2DM. with obesity being the most common risk factor. Meanwhile, in the rural area of Puducherry, India, an opportunistic screening has been performed by Venugopal V et al [34].

Eighty-one out of 400 (21%) subject had abnormal random blood glucose levels, only 41 of them undergo confirmatory tests from which 5 (11.4%) had impaired blood sugar and 18 (40%) were newly diagnosed to have diabetes with an overall prevalence of 4.5% of undiagnosed cases of diabetes, those findings provide evidence for the feasibility of opportunistic screening.

Given all that has been mentioned so far, one may suppose that regardless of the setting, or the tool used there is no population is free from the risk of diabetes. To best of our knowledge is this first study to assess the risk of developing diabetes in the Sudanese population.

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1.2.Justification:

The vast majority of diabetics were diagnosed either accidentally during health examination or period of ill or after suffering from one diabetes complication. Diabetes Risk scores offer an easy, inexpensive, and non-invasive way of identifying individuals at high risk for developing diabetes. By early identifying those at risk to develop diabetes and if confirmed to be at pre-diabetes stage adequate care provided for them through lifestyle interventions or even hypoglycemic medications if necessary, thus delaying or preventing their progression to diabetic status, therefore reducing the incidence of diabetic complication thus improving the quality of life for individuals and reducing the health care system expenditure on diabetes and spending those savings on other health issues in the country of already scares resources.

1.3. Objectives:

This study aims at assessing the risk of developing type 2 diabetes mellitus (T2DM) among healthy non-diabetic Sudanese in Khartoum city, from November 2016 to February 2017.

Specific objectives:

To determine the percentage of individuals at high risk of T2DM using the Finnish diabetes risk score.

1. To determine the frequencies of the most common risk factors predisposing individuals to develop T2DM.
2. To assess the high-risk group knowledge about causes, symptoms, complications, and modifiable risk factors of T2DM.
3. To assess the effect of perceived risk on those at high-risk behavior to seek further medical care and intention to adopt a healthy lifestyle.

2. Materials and Methods:

The study was a community-based study divided into two phases:

Phase one: a cross-sectional observational study, where all participants had their risk of developing diabetes assessed and provided with verbal counseling.

Phase two: educational interventional for those found at high / very high risk, their diabetes knowledge was assessed, then they were provided with verbal education by feedback method with emphasis on the importance of early testing for diabetes and contact information obtained, average interview time was 15-25 minutes. They were contacted after two weeks to check whether they went to investigate their risk status by doctor or not.

The study conducted during the period from November 2016 to March 2017 for 122 Non-diabetic Sudanese adults visiting public gathering places mainly the Green yard Khartoum city, Sudan selected by convenient sampling technique. It has been selected as the place for data collection as it represents a major destination for entertainment for families and individuals with an average number of visitors approximately 10-15 thousand at weekends from all age groups and diverse areas of Khartoum city.

The data were collected by three tools:

Finish diabetes risk score (FINDRISC):

Risk score form is a one-page questionnaire containing eight questions, with categorized answers, about age, body mass index (BMI, waist circumference,

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physical activity, daily consumption of fruits, berries or vegetables, history of antihypertensive drug treatment, history of high blood glucose, and family history of diabetes(appendix 1). The form was translated to the Arabic language and the layout has been adjusted.

Knowledge assessment tool:

Structured questionnaire to assess the high/ very high-risk group perceptions regarding diabetes causes, signs and symptoms, risk factors, complications of diabetes, early screening attitude toward risk status also demographic information obtained as well as contact information.

Anthropometric measurements

Including body weight, height, waist circumference and Body Mass Index (BMI).

Ethical consideration:

Ethical approval was obtained from the faculty of pharmacy, national university. Participation was completely voluntary and verbal consent was obtained from all participants after providing a full explanation of the objectives of this study and insurance of information confidentiality.

SPSS version 21 was used for data entry and analysis. The variables (age, weight, BMI and WC) were expressed as mean± standard deviation. The frequencies of risk factors were expressed as number (%). The statistical association between nominal variables was estimated using the chi-square test. Linear regression was employed to estimate the correlation between age, BMI and risk score.

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3.Results:

Demographics and anthropometric data of the study participants:

122 participated in the study, 61.5% from the male while 38.5% were female, 86.6% aged below 45 years, 9.8% from them aged between 45- 54 years old while 4.1% aged between 55- 64 years old. The mean age of the participants was 31.55 ± 10. the mean BMI was 25.718 ± 5.813 and the mean of waist circumstances 90.2 ± 16.63 as stated in table 1.

Table 1: Characteristics of study participants

Study variable	Total (n=122)	Males(n=75)	Females(n=47)
Age	31.55 ± 10.122	32.95±10.865	29.3±8.436
BMI	25.718 ± 5.813	25.647±5.944	25.831±5.66
Waist circumstances	90.2 ± 16.63	91.94±16.379	87.415±16.823

All (mean ± standard deviation) Age in years, BMI in kg/m^2, Waist circumference in centimeters

Estimated risk of developing T2 DM in ten years:

The estimated risk of developing T2DM in 10 years of the study for the participants according to FINDRISC, only 3.3% has high risk, 19.9% moderately elevated risk, 34.9% slightly elevated risk and 41.9% has a low risk for developing DM type 2 in the next 10 years as shown in figure 1.

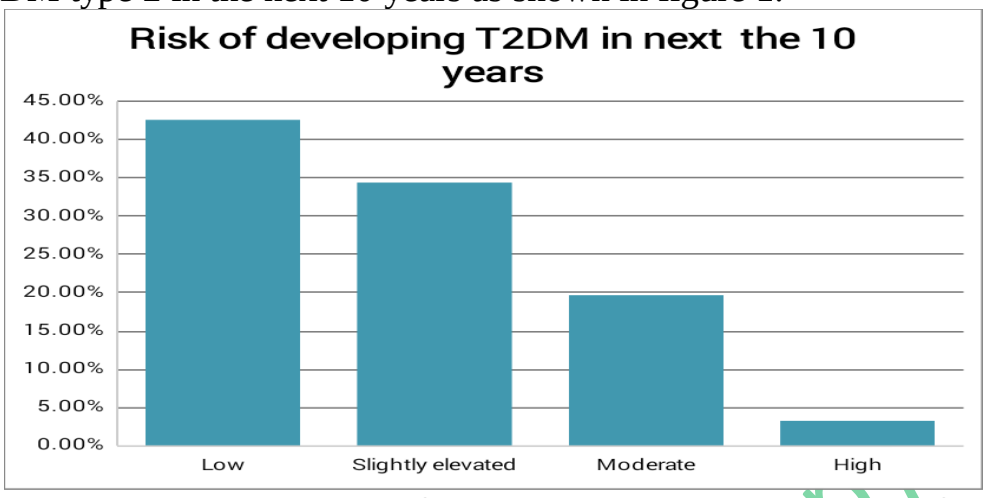
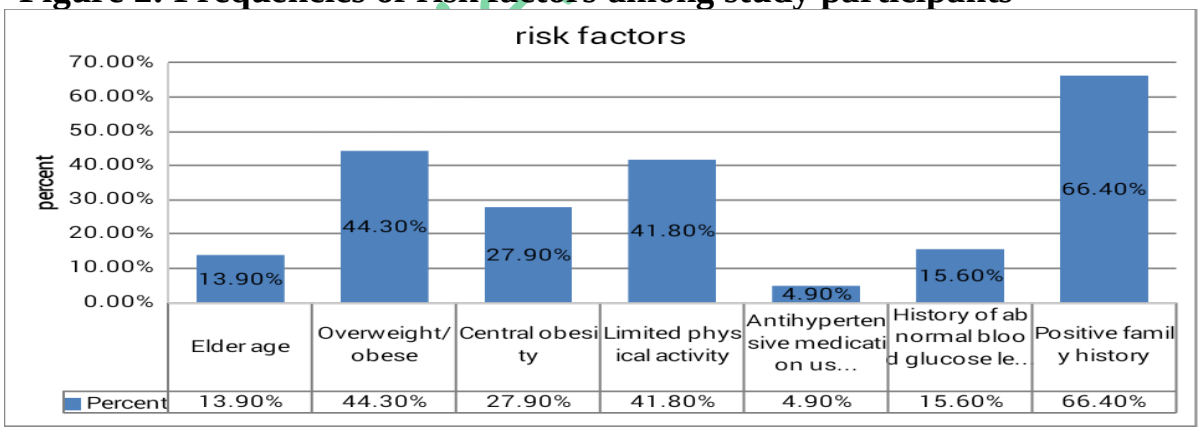


Figure 1: Estimated risk of developing T2DM in 10 years of the study participants according to FINDRISC

The risk factors for the participants in the study for developing DM type 2:

66.4% have a positive family history, 44.3% were overweight or obese, have 41.8% limited physical activity and 27.9% have central obesity as shown in figure 2.

Figure 2: Frequencies of risk factors among study participants



The pattern of vegetables and fruits intake according to FINDRISC: only 36.1% from participant's daily take vegetables and fruits while 63.9% didn't take it daily as shown in figure 3.

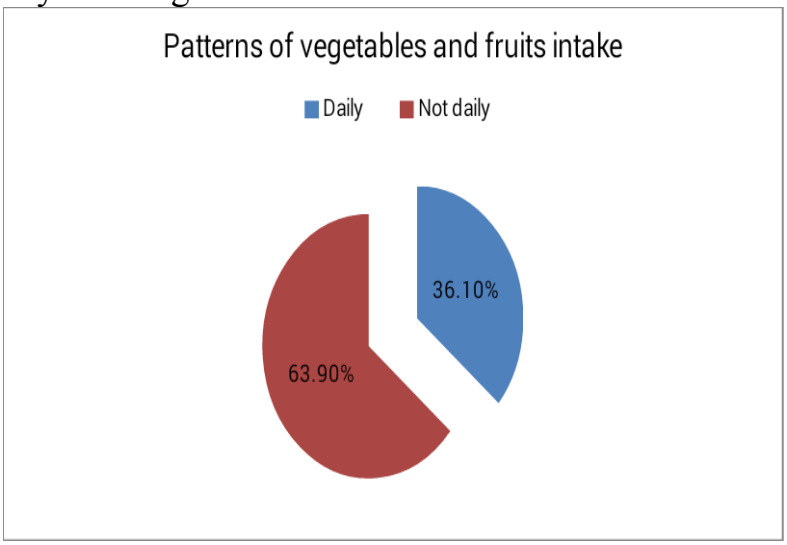


Figure 3: Patterns of vegetables and fruits intake among study participants

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Estimation of the age at which participants are at high risk according to FINDRISC: Significant positive correlation (r= 0.395, p=0.000) High risk score of FINDRISC is >14, Estimated age: Y=24.1+ (0.9x15) = 37.9≈38 years shown in figure 4.

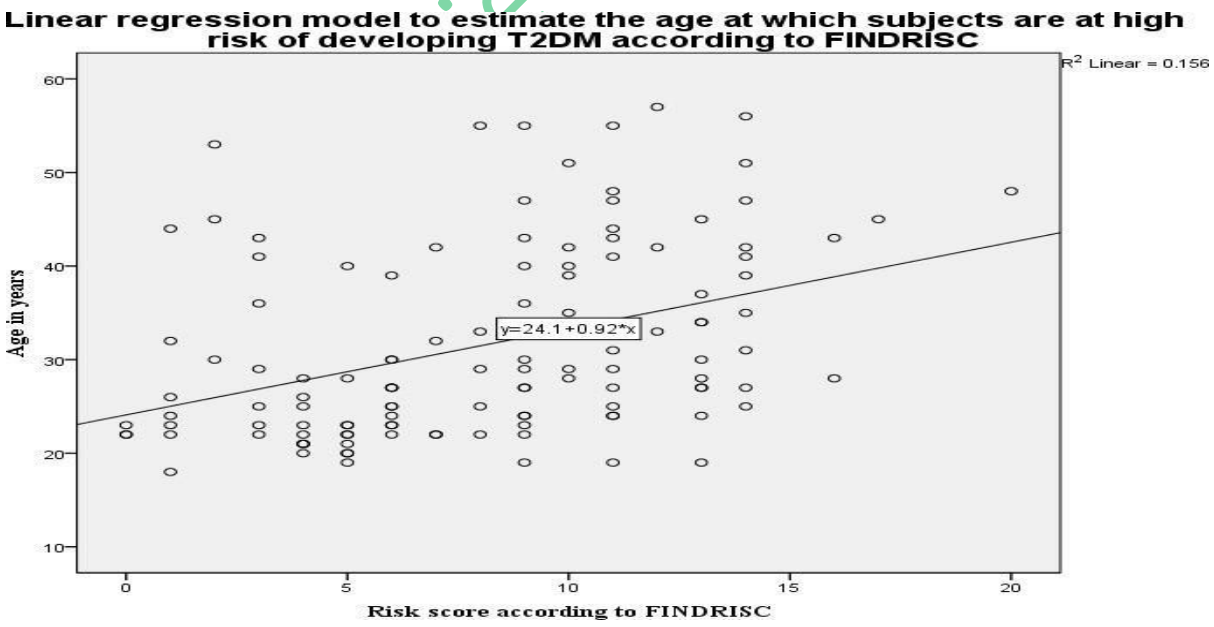

Figure 4: Linear regression model to estimate age at which participants are at high risk according to FINDRISK

Estimation of body mass index at which participants are at high risk:

Significant positive correlation (r= 0.6, p=0.000) High risk score of FINDRISC is > 14, Estimated BMI: Y= 19.24+ (0.8x15) = 31 Kg/ m^2 as shown in figure 5.

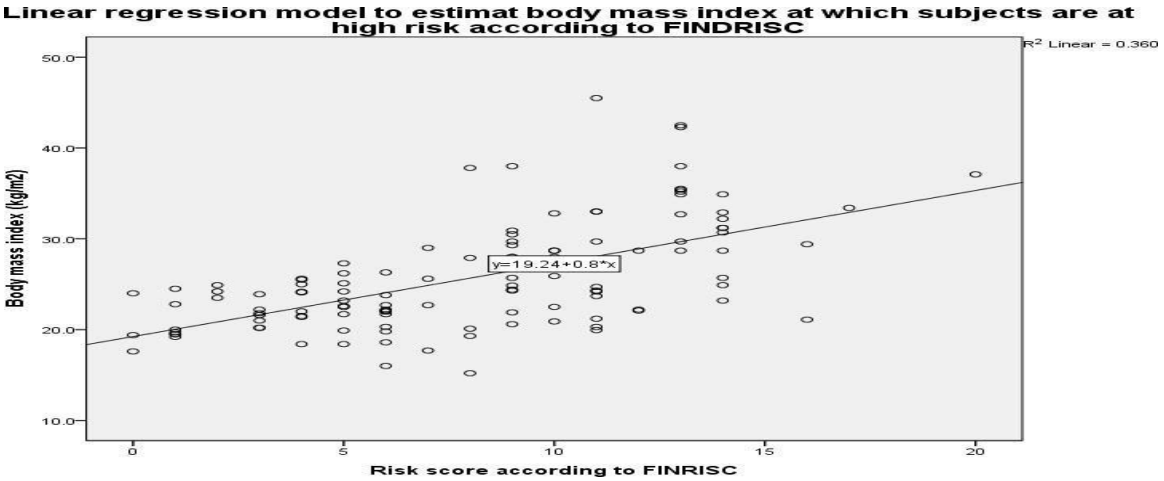

Figure 5: Linear regression model to estimate of body mass index at which participants are at high risk

4.Discussion:

Characteristics of study participants:

Participants were predominantly aged less than 45 years this may be due to several reasons: firstly, the main data collection place the green yard it was presumed that it has a diverse age distribution however most of those encountered aged from 20-35 years. Secondly, the majority of elder people did not show any interest in knowing their risk of developing diabetes, a behavior that is explained by fear of being cursed if they asked about the disease. Males constituted a large portion of the study sample. Females were less likely to participate and showed conservative behavior toward revealing their age and weight.

Risk estimation and its association with risk of developing DM type 2:

Individuals found at high risk of developing DM type 2 constituted only a small portion (3.3%) of the small sample size. Similarly, Alebiosu C.O. et al [27], Alzohairy M. & Hassan M. [28] Subramani R. et al [29] and Abduelkarem A. R. et al [26] reported a 5.05 %, 9.8 %, 12.1 % and 12.3% individual at high risk respectively. In contrast to studies of Anjana P. et al [30] and Misra R. et al [31] whereas 45% and 61.8% were at high risk respectively. Although different risk score is used in these studies yet the Components are approximately similar being at high risk means the individuals had high score regarding age, body mass index, waist circumference, and other risk factors. Worth noting, the sample size is small so this may not be representative of actual percent of individuals at high risk in the Sudanese population.

Moderately risk was detected in 19.7%similar to Abduelkarem A. R. et al 20% [26], and 77% were at low/ slightly elevated risk similar proportion to findings of Alzohairy M. & Hassan M. 70.6%[28]. The majority of participants were aged less than forty-five years old therefore they had less age-associated risk. Additionally, the majority of them had neither family history nor the personal history of abnormal blood glucose level, two components that are given a high score in FINDRISC (5pointsforeach).

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Risk factors will be discussed in order of most common to less common. First among them is the family history of diabetes wither its type1 or 2. Positive family history is significantly associated with a risk score, reported by 66.4% of the study participants and 4/ 4 of those found at high risk reported positive family history. Similar findings reported by Misra R. et al [31] 65% had a family history of diabetes. Type 2 DM is well known to be associated with genetic predisposition; however, genetics of T2DM is not fully understood. Individuals with a positive family history wither it's a second-degree relative or the first-degree relative are most likely to be carrying the genes responsible for the onset of T2 DM, therefore, they are placed at high risk for development of T2 DM.

About 44.3% had BMI ≥ 25kg/ m^2 (24.6% were overweight and 19.7% were obese) contradictory to the study by Alzohairy M. & Hassan M. in Saudi Arabia where 96.5% reported to have BMI ≥25kg/ m^2 [28]. Although the sample size is not comparable as early mentioned even though we compare in terms of a portion of the sample. The socio-economic difference between the two countries and the higher income of the individuals contributed to their ability to purchase fast foods and lead a sedentary lifestyle which plays a major role in increasing the weight. There was a significant association between BMI and risk score (p=0.000). Obesity is not only associated with T2 DM but also with other cardiovascular diseases.

Limited physical activity (< 30 minutes of exercise) was reported by 41.8% of participants. Again Abduelkarem A. R. et al reported that 57.3% of their participants had limited physical activity [26]. According to FINDRISC, the physical activity is measure in terms of performing 30 minutes of exercise at work or during leisure time, it would have been more appropriate to specify the type of exercise such as brisk walking, the intensity of exercise being aerobic or anaerobic. During filling the score the participants are questioned about their occupation which may have a direct effect on the level of activity, those leading an office-based work may be considered as inactive unless they started doing exercise. While others occupying jobs that require long-distance walking, satires claiming or considerable physical effort are considered physically active.

Central obesity defined as waist circumference >102 cm in males and > 88cm in females; detected in 27.9% of the study participants, abdominal or central obesity is closely linked with insulin resistance and glucose intolerance all of which increase the risk of developing T2 DM. A significant association with risk score was found (p=0.000).

History of abnormal blood glucose level was reported by 15.6%, during a health examination or illness or gestational diabetes in females it was significantly associated with the risk score (p=0.000), may suggest that individuals have glucose intolerance which is well known to be associated with a high risk of developing T2 DM.

A total of 13.9% aged ≥ 45years, the process of aging results in a declining metabolic capacity of body and ability to secret or utilize the insulin to regulate blood sugar. Increasing age not only increases the risk of developing T2DM but also other cardiovascular diseases. An only minority reported Antihypertensive medication use 4.9%, this since the majority of participant was aged less than 45 years, the incidence of hypertension increases after the age of 40. The link between

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T2DM and cardiovascular diseases is very well established, hypertension may be the most common cardiovascular disease is known to coexist with diabetes.
Another component of FINDRISC is the pattern of vegetables and fruit intake. Irregular daily consumption was reported by the majority of the participants, Similar to study by Naranjo A. A. et al [33]. Vegetables and fruits thought to play a protective role against damage by oxidative stress and may contain phytochemicals that affect regulating normal blood glucose levels. Berries, miracle fruit and many other fruits are extracted and formulated in the form of supplements and commercially marketed for blood sugar regulation.

Risk results and association with risk of developing type 2 DM score within each gender:

There was no significant difference between males and females regarding risk score (p=0.076); in the small sample size females constituted only a small portion statistical difference requires a large sample size. Male's risk results are associated with their BMI, WC (p=0.000 for both), history abnormal blood glucose level (p=0.005) and physical activity (p=0.004).while age and family history didn't show any association (p= 0.157 and 0.196 respectively). Female's risk of developing T2 DM was associated with their BMI and WC (p=0.00 for both), similar to findings reported by Alebiosu C. O. et al [26] and Misra R. et al [31]. Physical activity and age also showed an association with risk (p=0.000 and 0.018 respectively). There was no significant difference in physical activity between males and females (p= 0.534). However, the risk within each gender was associated with physical activity (p=0.004 for males and 0.000 for females).

Estimation of age and BMI at which individuals are at high according to **FINSRISC:**

According to the Finnish diabetes risk score, the age starting to be scored as increasing risk is > 45years, it is developed in the European country in a different population than the study population this may influence the age cut-point at which individual starts to exhibit an increased predisposition to develop T2DM. In the study population, we estimated the age at which individuals' are at high risk by the linear regression model to 40 years. The relatively small sample size and the younger age encountered may have affected the accuracy of the estimated age. Additionally, we estimated the body mass index at which individuals are at high risk to be 31kg /m^2. It could have been more appropriate to adapt Sudanese specific risk scores as population characteristics are different from one country to another and risk factors may also differ, unfortunately, such score doesn't exist.

Knowledge of high-risk group about T 2 DM:

Family history and unhealthy diet were the most acknowledged risk factors of T2 DM. Obesity, physical inactivity and hypertension were moderately known. In contrast knowledge about aging as a risk factor for T2DM was found poor. Regarding classical symptoms polyuria was the most acknowledged symptoms of diabetes, polydipsia and polyphagia were moderately known. Concerning common complications, nephropathy was well known; retinopathy and neuropathy were moderately known. The level of knowledge was associated with educational level and receiving previous education about diabetes. The most striking thing is that

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one of the individuals had completely missing knowledge regarding all items assessed.

Impact of perceived risk on high-risk individuals behaviors:

None of the "at high" risk performed a further test to investigate their risk; reasons to justify this is the lack of time; underestimating the urgency for doing the tests. Although the majority showed the intention to adopt a healthy lifestyle yet only one did so, lifestyle change adapted was increasing the level of physical activity, consuming less fatty meals and soft drinks. This may give a slight indication that the perception of risk can positively affect an individual's behavior toward reducing their risk of developing T2 DM, however, is this only a single result and cannot be generalized.

Study limitations:

1. The small sample size that hindered the results incomparable with previous studies, resulted from two factors: the first is time and resources constraint.
2. The validity of Finnish diabetes risk score among Sudanese is not tested thus it may over or underestimate the actual risk status.

4. Conclusion & Recommendations

4.1. Conclusion

- Out of the 122 individuals had their risk assessed, 3.3% were found at high risk, 19.7% were at Moderate and 77% were at low/ slightly elevated risk.
- The most common risk factors encountered were positive family history of diabetes 66.4%, overweight/ obese status 44.3%, limited physical activity 41.8% and central obesity 27.9%.
- The knowledge about diabetes risk factors, classical symptoms and common complication was not satisfactory.
- None of the "at high" risk had their risk further investigated. While 25% adapted health their lifestyle.

4.2. Recommendations

- Large scale studies to test the validity of FINDRISC in the Sudanese population should be conducted.
- Development of the Sudanese population-specific risk score that takes into count the local risk factors is war anted.
- Diabetes awareness programs should be commenced to raise awareness about the seriousness of T2 DM and most important of all is the preventability of T2 DM.

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