ORIGINAL ARTICLE

Prevalence of Prediabetes and Associated Factors among University Students and Staff in Mogadishu, Somalia

Mohamed Mustaf Ahmed[1*], Najib Isse Dirie[2], Omar Abdullahi Abdi[1], Bashiru Garba[3], Hodo Aideed Asowe[4], Jamal Hassan Mohamoud[3], Fartun Abdullahi Hassan Orey[5], Jihaan Hassan[1], Fartun Yasin Mohamed[6], Samira Abdullahi Mohamoud[6], Olalekan John Okesanya[7], Zeinab Omar Mohamed[1], Ifrah Ali[1] and Mulki Mukhtar Hassan[1]

[1]*Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia*
[2]*Department of Urology, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia*
[3]*Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia*
[4]*Department of Nursing and Midwifery, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia*
[5]*Department of Pediatrics and Child Health, Dr. Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia*
[6]*Department of Microbiology and Medical Laboratory Sciences, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia*
[7]*Department of Public Health and Maritime Transport, University of Thessaly, Volos, Greece*

Abstract

Background: Prediabetes is a significant risk factor for the development of type 2 diabetes and its associated complications. Within Africa, the prevalence of prediabetes is approximately 7.8%, with a projected escalation of 8.0% by 2045.

Objective: This study aimed to determine the prevalence of prediabetes and its associated factors among staff and students in Mogadishu, Somalia.

Methods: A cross-sectional study was conducted on World Diabetes Day November 14, 2023, at SIMAD University. Convenience sampling was used to include participants aged 17 years or above. Blood glucose levels were measured using a portable glucose meter (CareSens N, South Korea), and participants were classified as having normal glucose levels or prediabetes, based on fasting or post-meal status. Data analysis was performed using R software with descriptive statistics, linear regression, and chi-square tests.

Results: Among 217 participants (mean age 20.95 ± 5.68 years), the prevalence of prediabetes in the population was 15.2% (95% CI: 10.84%-20.84%). Staff members had a significantly higher prevalence of prediabetes (45.45%) than students (13.59%) (95% CI: 8.3%-18.8%) (p=0.004). Fasting participants had a higher prevalence of prediabetes (39.39%) than did post-meal participants (4.64%) (p<0.001). In multivariable analysis, only staff (Adjusted Beta=25.92, 95% CI: 7.39-44.45, p=0.006) and post-meal status (Adjusted Beta=7.52, 95% CI: 2.91-12.13, p<0.001) remained significant.

Conclusion: The prevalence of prediabetes was 15.2%, with staff and fasting participants showing a higher prevalence. Age was positively associated with glucose levels. These findings highlight the need for targeted prevention efforts in university settings to mitigate the progression of prediabetes to overt diabetes and its associated complications.

Keywords: *Prediabetes, prevalence, associated factors, university students, staff, Somalia.*

INTRODUCTION

Diabetes mellitus poses a considerable challenge to global public health, marked by elevated levels of blood glucose that have the potential to result in serious ramifications, including cardiovascular disorders, kidney malfunction, vision loss, and limb amputation, as the condition progresses [1], [2]. In 2021, approximately 529 million individuals worldwide were reported to be affected by diabetes, exhibiting a global age-standardized prevalence of 6.1%. Forecasts suggest a potential escalation of this figure to approximately 1.31 billion by 2050 [3]. The prevalence of diabetes in Africa is rapidly increasing, with approximately 24 million individuals between the ages of 20-79 in the region in 2021, signifying a regional prevalence of 4.5% [4]. Sub-Saharan Africa is currently witnessing a notable surge in both the frequency and extent of diabetes, as forecasted figures suggest that a potential escalation in the diabetic population of the region is expected to increase from 19.4 million in 2019 to 47.1 million by 2045 [5]. The projected increase in this burden is expected to reach 55 million adults by 2045, representing a substantial growth of 129%, the most significant increase in any region [4].

In Somalia, where healthcare infrastructure is already strained due to years of conflict and instability, the increasing burden of diabetes and its complications poses a significant challenge to the country's health system [6]. The prevalence of diabetes in Somalia is estimated to be 5.0% among adults aged 20-79 years, which is expected to increase owing to limited healthcare resources and a lack of widespread awareness and screening programs. Prediabetes, also known as impaired fasting glucose

Corresponding author: Mohamed Mustaf Ahmed, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia, Email: momustafahmed@outlook.com
Received: May 27, 2024; Revised: August 07, 2024; Accepted: August 18, 2024
DOI: https://doi.org/10.37184/lnjpc.2707-3521.7.14

(IFG) level, is a notable risk factor for the development of type 2 diabetes mellitus. This condition is distinguished by elevated blood glucose levels that exceed the normal range but fall below the diagnostic criteria for diabetes [7]. The American Diabetes Association (ADA) regards individuals whose fasting blood glucose levels range from 100 mg/dL (5.6 mmol/L) to less than 126 mg/dL (7.0 mmol/L) as presenting with an IFG [8]. On the contrary, the World Health Organization (WHO) establishes a slightly higher range, extending from 110 mg/dL (6.1 mmol/L) to 126 mg/dL (7.0 mmol/L) [9]. People with prediabetes were found to have a 6-fold higher risk of developing diabetes than those with normoglycemia [10].

Globally, the prevalence of prediabetes is currently estimated to be 7.3%, affecting approximately 373.9 million individuals aged 20-79 years in 2021. It is expected to decrease to 5.8%, affecting approximately 298 million people within the next two decades [11]. In Africa, the prevalence of prediabetes was estimated to be 7.8% (40.9 million people aged 20-79 years) in 2021 and is predicted to increase to 8.0% (84.7 million) by 2045 [12]. However, its prevalence varies widely between and within African countries, ranging from 2.0% to 12% across studies and diagnostic criteria [7, 13]. In East Africa, the estimated prevalence of prediabetes is 12.58% [12].

The pathophysiology of prediabetes involves insulin resistance and beta-cell dysfunction. Insulin resistance occurs when cells in muscles, fat, and the liver respond poorly to insulin and cannot use glucose from the bloodstream for energy. To compensate, the pancreas produces more insulin. Over time, if beta cells cannot keep up with the increased demand for insulin, glucose levels rise, leading to prediabetes and eventually type 2 diabetes [14]. Modifiable risk factors such as obesity, physical inactivity, and poor diet contribute significantly to this process [15]. Most individuals who develop type 2 Diabetes Mellitus (T2DM) experience a transitional phase known as 'prediabetes,' which presents a critical window for early identification and intervention to prevent progression to T2DM [16]. The chance of developing T2DM can be reduced by embracing a healthy lifestyle, which involves maintaining a well-balanced diet, engaging in consistent physical activity, and effectively managing obesity [17, 18].

Given the high risk of progression from prediabetes to overt diabetes and its complications, there is an urgent need to improve the early detection and management of prediabetes. Intervention strategies have documented a reduction in the onset of diabetes among prediabetic individuals, mainly by introducing lifestyle interventions, such as dietary adjustments, enhanced physical activity, and behavioral changes [17-19]. These strategies have demonstrated efficacy in decreasing the prevalence of type 2 diabetes by modulating multiple metabolic factors, including waist circumference, plasma glucose concentration, and body fat composition. However, such interventions are underutilized in low-resource settings such as Somalia. Various risk factors have been linked to prediabetes in African populations, such as age, family history of diabetes, general obesity, hypertension, low educational attainment, unemployment, and urban residence [20, 21]. No prior study has specifically investigated prediabetes in Somalia. Previous studies have focused solely on diabetes. These limitations highlight the need for more targeted studies to better understand the burden of prediabetes and its risk factors.

Academic environments, such as universities, present a distinctive opportunity to investigate the trends in prediabetes and the factors linked to it in the young adult population [22]. University students and staff represent a diverse population with varying socioeconomic backgrounds, lifestyle habits, and health profiles [23]. Previous studies have explored the prevalence and risk factors for prediabetes among university staff and students. For example, a study conducted in Nigeria found a prediabetes prevalence of 22.3% among administrative staff at a tertiary health center, with significant associations with obesity and physical inactivity [24]. Similarly, the prevalence of prediabetes in students in Mangalore was 16.3%, highlighting the impact of sedentary lifestyles and poor dietary habits [25]. These findings underscore the importance of addressing prediabetes in young adult populations in an academic setting. This study aimed to determine the prevalence of prediabetes and its associated factors among SIMAD University staff and students in Mogadishu, Somalia. Specifically, it addresses the gap in localized data on prediabetes prevalence in academic settings in Somalia and identifies key demographic and lifestyle factors that contribute to impaired glucose metabolism in this population. The results have significant implications for public health. By identifying high-risk groups and modifiable risk factors, these findings can guide the development of targeted interventions aimed at preventing the progression from prediabetes to diabetes. Implementing lifestyle intervention programs in university settings could significantly reduce the long-term burden of diabetes in Somalia. Moreover, the results of this study will guide the creation of focused preventive measures, including lifestyle interventions and awareness initiatives aimed at mitigating the impact of prediabetes and its transition to type 2 diabetes within academic environments.

METHODOLOGY

This cross-sectional study was conducted on World Diabetes Day, November 14, 2023, at SIMAD University, Mogadishu, Somalia. The target population consisted of students and staff members at SIMAD University who had attended the screening event. Convenience sampling was employed, and all individuals aged 17 years or older who consented to participate were included. Individuals who were already diagnosed with diabetes and those who did not provide informed consent were excluded from the study.

Cochran's formula was used to determine the sample size needed to estimate the prevalence of prediabetes. The calculation for the required sample size (n) was conducted in the following manner:

$$n = \frac{z^2 * p * (1 - p)}{e^2}$$

Where:

- n is the sample size
- z is the z-score (1.96 for 95% confidence level)
- p is the estimated proportion of the population, which is 12.58% or 0.1258
- e is the margin of error, which was set at 5% (0.05)

The proportion estimate (p) was derived from a systematic review and meta-analysis carried out by Asmelash *et al.* (2023). They reported a prediabetes rate of 12.58% (0.1258) among the adult East African population [12]. To accommodate a possible nonresponse rate of 10%, the sample size was modified to 190. To enhance the probability of acquiring an adequately powered sample for analysis, 217 individuals were screened.

Ethical clearance was obtained from the Institutional Review Board (IRB) of SIMAD University, Mogadishu, Somalia, based on the approval letter dated November 10, 2023 (Reference number: 2023/SU-IRB/FMHS/P008). In line with this approval, all participants in the study provided written informed consent after being properly informed about the study's objectives, their right to confidentiality, and their ability to withdraw consent at any time without facing any consequences.

Data were collected using paper forms that captured information on age, sex, role (student or staff), meal status (postmeal or fasting), and glucose levels. Data were entered into an Excel spreadsheet. Blood glucose levels were assessed using a portable glucose meter (CareSens N, South Korea) in accordance with established standard operating protocols. The staff were employees of SIMAD University, including administrative and academic personnel, while students were enrolled in any academic program at SIMAD University. Fasting was defined as participants who had not consumed any food or beverages, except water, for at least 8 hours before the blood glucose test, whereas post-meal was defined as participants who had consumed a meal within the past 2 hours before the blood glucose test. Individuals were categorized based on their glucose levels as either within the normal range (<100 mg/dL fasting and <140 mg/dL post-meal) or indicative of prediabetes (100-125 mg/dL fasting, 140-199 mg/dL post-meal). Participants indicated whether they had fasted for at least 8 hours or had consumed a meal within the past 2 hours. Anthropometric measurements, such as height and weight, were not performed in this study.

Data was analyzed using R software (version 4.4.0). Descriptive statistics were used to summarize the participant characteristics. Continuous variables are represented as mean ± standard deviation (SD), while categorical variables are expressed as frequencies and percentages. The prevalence of prediabetes was calculated as the proportion of participants with prediabetes among the total number of screened participants. Visualizations such as scatter plots, density plots, and box plots were used to examine the relationships between variables and compare the distribution of glucose levels between the groups. Linear regression analysis and chi-square (χ^2) tests were conducted to examine different relationships. The chi-square test was used to determine the connection between categorical variables such as sex, role, and meal status with glycemic status. The effect sizes for significant associations were calculated using Cramer's V test. To identify the factors associated with glucose levels, we performed both univariate and multivariable linear regression analyses. Initially, univariate linear regression analyses were conducted for each independent variable (age, sex, role, and meal status) to compute univariate beta coefficients. Subsequently, significant variables from the univariate analyses were included in a multivariable linear regression model to obtain adjusted beta coefficients. Statistical analysis was performed to determine a significance level of p-value<0.05. Assumptions for parametric and regression analyses, including normality, homoscedasticity, and multicollinearity, were assessed and met before conducting the analyses. Pilot testing of instruments and protocols was not conducted before the main study.

Quality control protocols were implemented on the study day. This means that specific procedures and checks were performed to ensure the accuracy and consistency of the blood glucose measurements. The glucometer was calibrated according to the manufacturer's instructions, ensuring that the readings were accurate. There were no missing data in the data set. Although some outliers were present, these were retained in the analysis due to their significant findings and the nature of the data. Potential sources of bias include selection bias due to convenience sampling and measurement bias. To minimize these biases, standardized protocols were followed for all measurements and data collection was conducted by trained personnel. Additionally, the use of a portable glucose meter with regular calibration ensured the accuracy of biochemical measurements.

RESULTS

Sociodemographic Characteristics

A total of 217 individuals participated in this study with a mean age of 20.95 ± 5.68 years (range: 17-55 years) participated in this study. The majority of participants were aged 17-25 years, 201 (92.6%), followed by those

Table 1: Sociodemographic characteristics.

Variable	Frequency	Percentage
Age (years)		
17-25	201	92.6
26-40	10	4.6
>40	6	2.8
Age (years)	mean ± SD: 20.95 ± 5.68	
Sex		
Male	137	63.1
Female	80	36.9
Role		
Student	206	95
Staff	11	5
Meal Status		
Post-meal	151	69.6
Fasting	66	30.4
Glucose Level (mg/dL)	mean ± SD: 105.4 ± 16.56	

Table 2: Prevalence of prediabetes.

Glycemic Status	Frequency (%)	95% Confidence Interval
Normal	184 (84.8)	79.1-89.15
Prediabetes	33 (15.2)	10.84-20.84

Table 3: Comparison of glycemic status by age group, sex, role, and meal status.

Variable	Glycemic Status		χ²	P Value
	Prediabetes n(%)	Normal n(%)		
Age (Years)				
17-25	28 (13.93)	173 (86.07)	3.93	0.140
26-33	2 (25)	6 (75)		
> 33	3 (37.5)	5 (62.5)		
Sex				
Male	20 (14.6)	117 (85.4)	0.11	0.744
Female	13 (16.25)	67 (83.75)		
Role				
Student	28 (13.59)	178 (86.41)	8.22	0.004*
Staff	5 (45.45)	6 (54.55)		
Meal Status				
Fasting	26 (39.39)	40 (60.61)	43.03	<0.001*
Post-meal	7 (4.64)	144 (95.36)		

aged 26-40 years, 10 (4.6%), and those over 40 years, 6 (2.8%). The study included 137 males (63.1%) and 80 females (36.9%). Most participants were students, 206 (95%), with a smaller proportion being staff members, 11 (5%). Most participants had consumed a meal within 2 hours before screening (post-meal status), 151 (69.6%), and 66 participants (30.4%) were fasting. The mean glucose level was 105.4 ± 16.56 mg/dL (95% CI: 102.89-107.91) (**Table 1**).

Prevalence of Prediabetes

The prevalence of prediabetes among the study participants was 15.2% (95% CI: 10.84-20.84). The remaining 84.8% (95% CI: 79.1-89.15) had normal glucose levels (**Table 2**).

Comparison of Glycemic Status by Various Factors

The chi-square test revealed a significant difference in glycemic status between roles (student *vs.* staff) and

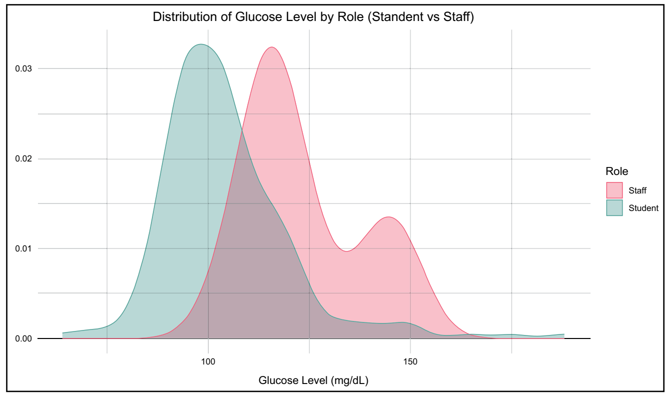

Fig. (1): Distribution of glucose level by role (student *vs.* staff).

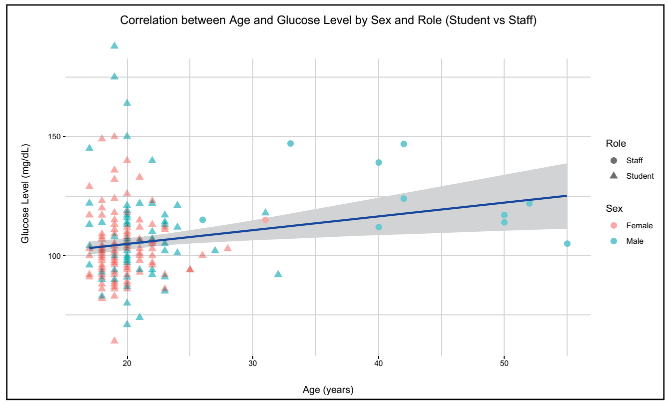

Fig. (2): Correlation between age and glucose level by sex and role (student *vs.* staff).

glycemic status ($\chi^2 = 8.22$, $p = 0.004$, Cramer's V = 0.27). The prevalence of prediabetes was higher among the staff (45.45%; 95% CI: 34.2-56.7%) than among the students (13.59%; 95% CI: 8.3-18.8%) (**Table 3**). The distribution of glucose levels by role is visualized in Fig. **(1)**, showing a broader distribution for staff members than for students, indicating higher glucose levels among the staff. The student distribution had a peak centered around a glucose level of approximately 90-95 mg/dL, whereas the staff distribution peaked occurring around 110-120 mg/dL, suggesting a more dispersed range of glucose levels among the staff. Meal status was also significantly correlated with glycemic status (p<0.001). Participants in the fasting state had a higher prevalence of prediabetes (39.39%) than those in the postmeal state (4.64%) (**Table 3**). No significant relations were found between age (p = 0.140), sex (p = 0.744), and glycemic status (**Table 3**). The correlation between age and glucose levels according to sex and role is shown in Fig. **(2)**.

Univariate and Multivariable Linear Regression Analysis

The univariate linear regression analysis indicated significant associations between glucose levels and age (Beta=0.58, 95% CI: 0.19-0.97, p = 0.003), sex (male) (Beta=6.84, 95% CI: 2.3-11.37, p = 0.003), role (staff) (Beta=18.93, 95% CI: 9.08-28.78, p <0.001), and meal status (post-meal) (Beta=7.73, 95% CI: 2.99-

Table 4: Univariate and multivariate linear regression analysis.

Variable	Beta (95% CI)	p-value	Adjusted Beta (95% CI)	p-value
Age (in years)	0.58 (0.19-0.97)	0.003*	-0.41 (-1.15-0.32)	0.270
Sex (Male)	6.84 (2.3-11.37)	0.003*	4.46 (-0.2-9.13)	0.060
Role (Staff)	18.93 (9.08-28.78)	<0.001*	25.92 (7.39-44.45)	0.006*
Meal Status (Post-meal)	7.73 (2.99-12.47	<0.001*	7.52 (2.91-12.13)	<0.001*

CI = Confidence Interval, *Significance at p<0.05

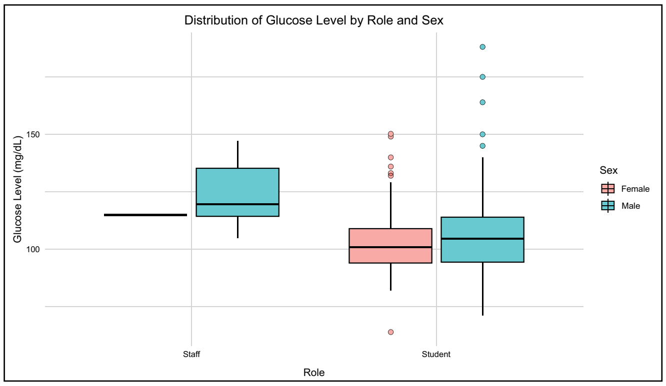

Fig. (3): Distribution of glucose levels by role (staff *vs.* student) and sex (female *vs.* male).

12.47, p <0.001) (**Table 4**). In contrast, the multivariable linear regression analysis revealed that only role (staff) (Adjusted Beta=25.92, 95% CI: 7.39-44.45, p=0.006) and meal status (post-meal) (Adjusted Beta=7.52, 95% CI: 2.91-12.13, p<0.001) maintained significant associations with glucose levels. Age (Adjusted Beta=-0.41, 95% CI: -1.15-0.32, p = 0.270) and sex (male) (Adjusted Beta=4.46, 95% CI: -0.2-9.13, p = 0.060) were not statistically significant in this analysis (**Table 4**).

The scatter plot (**Fig. 2**) revealed an upward trend, confirming the positive correlation between age and glucose levels across the entire age range. Males generally have higher glucose levels than females at any given age. Staff members tend to have higher glucose levels than students, particularly at older ages. However, some students showed higher glucose levels than staff. The box plot (**Fig. 3**) showing the distribution of glucose levels by role (staff *vs.* student) and sex (female vs. male) revealed several key patterns. The median glucose level for male staff members (green) was higher than that for both male and female students. The range of glucose levels was wider for students than for staff, with some outliers present in both male (green) and female (red) students. Additionally, male staff members generally showed higher glucose levels than both male and female students, while the glucose levels of male students showed more variability compared to female students.

DISCUSSION

The prevalence of prediabetes was 15.2% (95% CI: 10.84-20.84), which was higher than the estimated 12.58% prevalence in the adult population of East Africa [12]. However, this finding aligns with the wide prevalence of prediabetes reported across African countries, ranging from 2.0% to 43.2% [7, 13]. A study conducted in Ethiopia reported a total estimated prediabetes prevalence of 20.3% within the study population, which is higher than that reported in our study [26]. This discrepancy could be attributed to the different settings and specific population groups studied, as our research focused on students and staff, who might have different lifestyle factors affecting their glucose levels. The findings of this study also align with global trends, where approximately 7.3% of the adult population is affected by prediabetes. In Africa, the prevalence of prediabetes is estimated to be 7.8% in 2021 and is projected to increase to 8.0% by 2045 [27]. A key finding of this study was the significantly higher prevalence of prediabetes among the staff (45.45%; 95% CI: 34.2-56.7%) than among the students (13.59%; 95% CI: 8.3-18.8%). This observation is consistent with previous research showing higher rates of prediabetes among university staff than among students. For example, a study in Nigeria found a prediabetes prevalence of 22.3% among administrative staff at a tertiary health center [24], whereas in Saudi Arabia, nearly 40% of faculty members and administrative staff at King Faisal University were at high risk of prediabetes [28]. The higher prevalence among staff may be attributed to age-related factors and lifestyle differences between the two groups.

The high prevalence of prediabetes among staff may be attributed to several mechanisms and pathways. One potential mechanism is the increased stress levels experienced by university staff compared with students. Chronic stress elevates cortisol levels, which can lead to insulin resistance and higher blood glucose levels [29]. Additionally, staff members may have more sedentary lifestyles due to the nature of their work, contributing to impaired glucose metabolism [30]. Another pathway to consider is the effect of sleep patterns on glucose metabolism. Staff members might experience irregular or insufficient sleep due to work-related stress and responsibilities, which have been linked to disruptions in insulin sensitivity [31]. Furthermore, the role of meal timing and composition should not be overlooked. Irregular meal patterns and higher consumption of high-glycemic-index foods among staff members could contribute to postprandial glucose spikes, thereby increasing the risk of prediabetes [32]. Understanding these mechanisms is crucial for developing targeted interventions aimed at modifying risk factors to prevent the progression of prediabetes to type 2 diabetes. These factors create an environment conducive to the development of insulin resistance and impaired glucose tolerance. This suggests the need for targeted interventions to prevent diabetes progression. Early detection and lifestyle modifications can significantly reduce the risk of developing type 2 diabetes and its associated complications [33].

In the univariate analysis, age was positively associated with glucose levels, which is consistent with the well-established relationship between aging and impaired glucose metabolism. For each one-year increase in age, the glucose level increased by 0.58 mg/dL. Several studies have reported similar findings, where older individuals tend to have higher glucose levels and an increased risk of prediabetes and type 2 diabetes [20, 34]. This highlights the importance of targeting older age groups for prediabetes screening and prevention. However, after adjusting for sex, role, and meal status in the multivariable model, age was no longer a significant predictor of glucose level. This finding suggests that the association between age and glucose levels may be confounded by other factors in this population. Multivariate analysis revealed that staff roles and post-meal status were significantly associated with higher glucose levels. The higher glucose levels among staff compared to students may be attributed to differences in lifestyle factors such as physical activity levels, dietary habits, and stress levels. Staff members may have a more sedentary work environment and greater job-related stress, which could contribute to impaired glucose metabolism. The finding that post-meal status was associated with higher glucose levels than fasting is consistent with the expected physiological response to food intake. After a meal, blood glucose levels typically rise as the body absorbs and metabolizes the ingested carbohydrates. This highlights the importance of considering meal status when interpreting glucose measurements and determining prediabetes status.

While males generally had higher glucose levels than females in our study, the literature presents mixed findings on sex differences in prediabetes prevalence. A study conducted among university students in Nigeria found that males had a higher prevalence of prediabetes than females [24], which aligns with the findings of the current study. Similarly, a study in the United States found that the adjusted prevalence of prediabetes was higher in male adolescents and young adults than that in females [35]. In contrast, other studies indicate that females in college settings show a higher prevalence of prediabetes than males [36, 37]. These discrepancies highlight the complex interplay of factors influencing prediabetes risk and the need for further research to explain sex-related differences. Unexpectedly, there was no significant association between sex and glycemic status ($p=0.744$). This finding suggests that other factors such as role and meal status may have a stronger influence on glucose levels in this population. The lack of significance for age ($p=0.140$) also indicated that age may not be a critical factor in glycemic status, as previously thought within this cohort. These non-significant results highlight the complexity of the factors influencing glucose levels and suggest areas for further research.

While this study provides valuable insights into the prevalence of prediabetes and its associated factors in an academic setting, several limitations should be noted. The study did not collect data on potentially important confounding variables, such as BMI, family history of diabetes, dietary habits, physical activity levels, and socioeconomic status, which may have limited our ability to fully characterize prediabetes risk factors. Additionally, the use of convenience sampling may introduce selection bias, and reliance on self-reported data for meal status may be subject to recall bias. Despite this limitation, our findings make an important contribution to the limited literature on prediabetes in Somalia and highlight the need for targeted preventive efforts in academic settings. Interventions that promote healthy lifestyles, including balanced diets, regular physical activity, and weight management, should be developed and evaluated to mitigate the progression from prediabetes to overt diabetes and its associated complications. Universities provide a unique opportunity to reach young adults and influence their health behaviors, potentially reducing the long-term burden of diabetes in the population. While the findings provide valuable insights into the prevalence of prediabetes among university staff and students in Somalia, they may not be generalizable to other populations. Future research should include diverse populations to validate these findings and enhance their applicability. The results of this study should be disseminated through academic publications, conferences, and public health campaigns. Collaboration with local health authorities and institutions can help to translate these findings into effective interventions and policies to combat prediabetes. The Social Ecological Model can help contextualize the findings by considering the interplay of individual, interpersonal, organizational, community, and policy factors that influence health behaviors [38]. This model underscores the importance of multilevel interventions to address complex determinants of prediabetes.

CONCLUSION

This study investigated the prevalence of prediabetes and its associated factors among students and staff at SIMAD University in Mogadishu, Somalia. The overall prevalence of prediabetes was 15.2%, which was significantly higher among staff members (45.45%) than among students (13.59%). While age showed a positive association with glucose levels in univariate analysis, it was not significant in multivariate analysis, indicating the influence of other confounding factors. Multivariate analysis revealed that the role (staff) and meal status (post-meal) were significantly associated with higher glucose levels. These findings suggest that targeted prevention efforts in university settings should focus on staff members at a higher risk of prediabetes. Interventions aimed at promoting healthy lifestyles, such as maintaining balanced diets, engaging in regular physical activity, and effectively managing weight, should be created and assessed to reduce the transition from prediabetes to diagnosed diabetes and its related complications. Universities provide a unique opportunity to implement preventive strategies and influence health behaviors among young adults and staff, potentially reducing the long-term burden of diabetes. The high prevalence of prediabetes among staff highlights a critical public health issue that warrants immediate attention. Implementing routine screening and early intervention programs in university settings could significantly reduce the incidence of type 2 diabetes and its associated complications. Addressing this issue through targeted public health strategies can help mitigate the long-term burden of diabetes on the healthcare system.

Despite the valuable insights provided by this study, future research should focus on longitudinal studies to establish causal relationships between lifestyle factors and the progression of prediabetes. Additionally, investigating the effectiveness of specific interventions, such as stress management programs, dietary modifications, and physical activity initiatives, in reducing the prediabetes prevalence would be valuable. Studies that include more diverse samples across different regions and demographics can help generalize the findings and develop universally applicable prevention strategies. Based on these findings, several recommendations for practice and policy changes are outlined. Universities should implement regular health screening and wellness programs focused on identifying and managing prediabetes. Policies that promote healthier lifestyles, including access to nutritious food options and opportunities for physical activity, should be established in academic institutions. Collaboration between public health authorities and educational institutions is crucial for developing comprehensive prevention and intervention strategies that can be scaled up and adapted to other settings.

ETHICS APPROVAL

Ethical clearance was obtained from the Institutional Review Board (IRB) of SIMAD University, Mogadishu, Somalia, based on the approval letter dated November 10, 2023 (reference number: 2023/SU-IRB/FMHS/P008). All procedures performed in studies involving human participants were following the ethical standards of the institutional and/ or national research committee and the Helsinki Declaration.

CONSENT FOR PUBLICATION

All participants in the study provided written informed consent after being properly informed about the study's objectives, their right to confidentiality, and their ability to withdraw consent at any time without facing any consequences.

AVAILABILITY OF DATA

The data supporting the findings of this study are available from DOI the corresponding author upon reasonable request.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS

Declared none.

AUTHORS' CONTRIBUTION

MMA and NID conceptualized the research idea. BG, HAA, FAHO, and JH collaborated in developing the study design. OAA, FYM, and SAM were responsible for material preparation, data collection, and analysis. JHM analyzed and interpreted the data. OJO wrote the manuscript's initial draft. All authors contributed to the writing, reviewing, and editing of subsequent versions of the manuscript.

REFERENCES

1. Gopalan C, Kirk E. Diabetes mellitus. In: Biology of cardiovascular and metabolic diseases. USA: Academic Press 2022; pp. 223-43. DOI: https://doi.org/10.1016/b978-0-12-823421-1.00015-9
2. Chowdhury TA, Shaho S, Moolla A. Complications of diabetes: progress, but significant challenges ahead. Ann Transl Med 2014; 2(12): 120. DOI: https://doi.org/10.3978/j.issn.2305-5839.2014.08.12
3. Ong KL, Stafford LK, McLaughlin SA, Boyko EJ, Vollset SE, Smith AE, *et al.* Global, regional, and national burden of diabetes from 1990 to 2021, with projections of prevalence to 2050: a systematic analysis for the Global Burden of Disease Study 2021. Lancet 2023; 402(10397): 203-34. DOI: https://doi.org/10.1016/s0140-6736(23)01301-6
4. IDF Diabetes Atlas. Diabetes in Africa - 2021 [Internet]. 2021; Available from: https://diabetesatlas.org/idfawp/resource-files/2022/01/IDF-Atlas-Factsheet-2021_AFR.pdf
5. Bascaran C, Zondervan M, Walker C, Astbury NJ, Foster A. Diabetic retinopathy in Africa. Eye 2022; 36(S1):1-3. DOI: https://doi.org/10.1038/s41433-022-01999-3
6. Salad AM, Duale HA, Sheikh IM, Hassan GD, Farah AA, Gele A. Prevalence of diabetes foot ulcers and associated factors among adult diabetic patients in three referral hospitals in Mogadishu, Somalia. Front Public Health 2023; 11: 1-7. DOI: https://doi.org/10.3389/fpubh.2023.1195483
7. Teshome AA, Baih SZ, Wolie AK, Mengstie MA, Muche ZT, Amare SN, *et al.* Magnitude of impaired fasting glucose and undiagnosed diabetic mellitus and associated risk factors among adults living in Woreta town, northwest Ethiopia: a community-based cross-sectional study, 2021. BMC Endocrine Disorders 2022 Oct 5; 22: 243. DOI: https://doi.org/10.1186/s12902-022-01156-7
8. Dall TM, Narayan KMV, Gillespie KB, Gallo PD, Blanchard TD, Solcan M, *et al.* Detecting type 2 diabetes and prediabetes among asymptomatic adults in the United States: modeling American Diabetes Association versus US Preventive Services Task Force diabetes screening guidelines. Population Health Metrics 2014; 12(1). DOI: https://doi.org/10.1186/1478-7954-12-12
9. Pant V, Pradhan S, Gautam K. Clinical laboratorial perspective on screening of prediabetes and need for standardization of post prandial blood glucose testing in Nepal. Journal of Diabetes and Endocrine Association of Nepal 2021; 5(2):33-6. DOI: https://doi.org/10.3126/jdean.v5i2.35776
10. Bashir MA, Yahaya AI, Muhammad M, Yusuf AH, Mukhtar IG. Prediabetes burden in Nigeria: A systematic review and meta-analysis. Front Public Health 2021 23; 9. DOI: https://doi.org/10.3389/fpubh.2021.762429

11. Rooney MR, Fang M, Ogurtsova K, Ozkan B, Echouffo-Tcheugui JB, Boyko EJ, *et al.* Global prevalence of prediabetes. Diabetes Care 2023; 46(7): 1388-94.
DOI: https://doi.org/10.2337/dc22-2376

12. Asmelash D, Bambo GM, Sahile S, Asmelash Y. Prevalence and associated factors of prediabetes in adult East African population: A systematic review and meta-analysis. Heliyon 2023; 9(11): e21286.
DOI: https://doi.org/10.1016/j.heliyon.2023.e21286

13. Bahendeka S, Wesonga R, Mutungi G, Muwonge J, Neema S, Guwatudde D. Prevalence and correlates of diabetes mellitus in Uganda: A population-based national survey. Trop Med Int Health 2016; 21(3): 405-16.
DOI: https://doi.org/10.1111/tmi.12663

14. Brannick B, Dagogo-Jack S. Prediabetes and cardiovascular disease. Endocrinol Metab Clin North Am 2018; 47(1):33-50.
DOI: https://doi.org/10.1016/j.ecl.2017.10.001

15. Díaz-Redondo A, Giráldez-García C, Carrillo L, Serrano R, García-Soidán FJ, Artola S, *et al.* Modifiable risk factors associated with prediabetes in men and women: a cross-sectional analysis of the cohort study in primary health care on the evolution of patients with prediabetes (PREDAPS-Study). BMC Fam Pract 2015; 16: 5.
DOI: https://doi.org/10.1186/s12875-014-0216-3

16. Stefan N. Phenotypes of prediabetes: pathogenesis and consequences for prediction and prevention of type 2 diabetes and cardiovascular diseases. Diabetes Mellit 2020; 22(6): 577-81.
DOI: https://doi.org/10.14341/dm10376

17. Ningsih OS, Pandin MGR, Efendy F. The implementation and outcome of diabetes prevention program lifestyle intervention in high risk or prediabetes: A review of the literature. medRxiv 2023; 10.12.23296982.
DOI: https://doi.org/10.1101/2023.10.12.23296982

18. Walker KZ, O'Dea K. Preventing Diabetes with Diet and Exercise. In: Nutritional and Therapeutic Interventions for Diabetes and Metabolic Syndrome. Bagchi D, Sreejayan N, Eds. USA: Academic Press 2012; pp. 125-34.
DOI: https://doi.org/10.1016/b978-0-12-385083-6.00010-3

19. Walker KZ, O'Dea K, Gomez M, Girgis S, Colagiuri R. Diet and exercise in the prevention of diabetes. J Hum Nutr Diet 2010; 23(4): 344-52.
DOI: https://doi.org/10.1111/j.1365-277x.2010.01061.x

20. Anjana RM, Pradeepa R, Deepa M, Datta M, Sudha V, Unnikrishnan R, *et al.* Prevalence of diabetes and prediabetes (impaired fasting glucose and/or impaired glucose tolerance) in urban and rural India: Phase I results of the Indian Council of Medical Research-INdia DIABetes (ICMR-INDIAB) study. Diabetologia 2011; 54(12): 3022-7.
DOI: https://doi.org/10.1007/s00125-011-2291-5

21. Greiner GG, Emmert-Fees KMF, Becker J, Rathmann W, Thorand B, Peters A, *et al.* Toward targeted prevention: Risk factors for prediabetes defined by impaired fasting glucose, impaired glucose tolerance and increased HbA1c in the population-based KORA study from Germany. Acta Diabetol 2020; 57(12): 1481-91.
DOI: https://doi.org/10.1007/s00592-020-01573-x

22. Banh HL, Chow S, Li S, Letassy N, Cox C, Cave A. Pharmacy students screening for pre-diabetes/diabetes with a validated questionnaire in community pharmacies during their experiential rotation in Alberta, Canada. SAGE Open Medicine 2015; 3: 205031211558504.
DOI: https://doi.org/10.1177/2050312115585040

23. Kabir N, Aujara IA, Ibrahim S. Prevalence of prediabetes and its associated risk factors among staff and students of Federal University Dutse. 2020; Available from: https://www.researchgate.net/publication/344873832.

24. Martins SO, Folasire OF, Irabor AE. Prevalence and predictors of prediabetes among administrative staff of a tertiary health centre, southwestern Nigeria. Ann Ib Postgrad Med 2017; 15(2): 114-23.
DOI: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5846173/

25. Chowdhury A, Das KS. Prevalence and risk factor of prediabetes: A cross-sectional study among young medical students in Mangalore. Natl J Physiol Pharm Pharmacol 2019; 9(5): 405-10.
DOI: https://doi.org/10.5455/njppp.2019.9.0206110032019

26. Vinodhini R, Kebede L, Teka G, Asana B, Abel T. Prevalence of prediabetes and its risk factors among the employees of Ambo University, Oromia Region, Ethiopia. Res Mol Med 2017; 5(3): 11-20.
DOI: https://doi.org/10.29252/rmm.5.3.11

27. Hostalek U. Global epidemiology of prediabetes - present and future perspectives. Clin Diabetes Endocrinol 2019; 5: 5.
DOI: https://doi.org/10.1186/s40842-019-0080-0

28. Shuwaysh AIA, Fabella EL, Hassan MA, Hassan YTA, Hassan AA, Majed HA, *et al.* Association between risk for prediabetes and Type 2 diabetes mellitus prevention among faculty members and administrative staff of a Saudi university. Cureus 2023; 15(7): e41926.
DOI: https://doi.org/10.7759/cureus.41926

29. Yan YX, Xiao HB, Wang SS, Zhao J, He Y, Wang W, *et al.* Investigation of the relationship between chronic stress and insulin resistance in a Chinese population. J Epidemiol 2016; 26(7): 355-60.
DOI: https://doi.org/10.2188/jea.je20150183

30. Colomer FA, Cugat MÀC, Bort-Roig J, Chirveches-Pérez E, Zaldúa YC, Martín-Cantera C, *et al.* Differences in free-living patterns of sedentary behaviour between office employees with diabetes and office employees without diabetes: A principal component analysis for clinical practice. Int J Environ Res Public Health 2022; 19(19): 12245.
DOI: https://doi.org/10.3390/ijerph191912245

31. Rao MN, Neylan TC, Grunfeld C, Mulligan K, Schambelan M, Schwarz JM. Subchronic sleep restriction causes Tissue-Specific insulin resistance. J Clin Endocrinol Metab 2015; 100(4): 1664-71.
DOI: https://doi.org/10.1210/jc.2014-3911

32. Sun L, Goh HJ, Govindharajulu P, Leow MKS, Henry CJ. Postprandial glucose, insulin and incretin responses differ by test meal macronutrient ingestion sequence (PATTERN study). Clin Nutr 2020; 39(3): 950-7.
DOI: https://doi.org/10.1016/j.clnu.2019.04.001

33. Uusitupa M, Khan TA, Viguiliouk E, Kahleova H, Rivellese AA, Hermansen K, *et al.* Prevention of type 2 diabetes by lifestyle changes: A systematic review and meta-analysis. Nutrients 2019; 11(11): 2611.
DOI: https://doi.org/10.3390/nu11112611

34. Noordam R, Gunn DA, Tomlin CC, Maier AB, Mooijaart SP, Slagboom PE, *et al.* High serum glucose levels are associated with a higher perceived age. AGE 2011; 35(1): 189-95.
DOI: https://doi.org/10.1007/s11357-011-9339-9

35. Andes LJ, Cheng YJ, Rolka DB, Gregg EW, Imperatore G. Prevalence of prediabetes among adolescents and young adults in the United States, 2005-2016. JAMA Pediatr 2020; 174(2): e194498.
DOI: https://doi.org/10.1001/jamapediatrics.2019.4498

36. Pabalinas LET, Gonzalez J, Luevano J, Rayner J, Valdez A, Ortiz A. Prediabetes and diabetes in college-aged students at a Hispanic-serving institution in south Texas. Med Sci Sports Exerc 2017; 49(5S): 1018.
DOI: https://doi.org/10.1249/01.mss.0000519792.28056.ce

37. Al-Zahrani JM, Aldiab A, Aldossari KK, Al-Ghamdi S, Batais MA, Javad S, *et al.* Prevalence of prediabetes, diabetes and its predictors among females in Alkharj, Saudi Arabia: A cross-sectional study. Ann Glob Health 2019; 85(1): 109.
DOI: https://doi.org/10.5334/aogh.2467

38. Golden SD, McLeroy KR, Green LW, Earp JAL, Lieberman LD. Upending the social ecological model to guide health promotion efforts toward policy and environmental change. Health Educ Behav 2015; 42(1_suppl): 8S-14S.
DOI: https://doi.org/10.1177/1090198115575098