The Journal of Medical Laboratory Science & Technology South Africa. 2022;4(2):92-98
https://doi.org/10.36303/JMLSTSA.2022.4.1.108
Open Access article distributed under the terms of the
Creative Commons License [CC BY-NC-ND 4.0]
http://creativecommons.org/licenses/by-nc-nd/4.0

JMLSTSA
ISSN 2664 2549 EISSN 2708 3063
© 2022 The Author(s)
ORIGINAL RESEARCH

Manifestation of diabetes among different professionals in the Volta Region of Ghana

AT Bawah,[1] S Nanga[2]

[1] *Faculty of Allied Health and Pharmaceutical Sciences, Tamale Technical University, Ghana*
[2] *Department of Basic Sciences, School of Basic and Biomedical Science, University of Health and Allied Sciences, Ghana*

Corresponding author, email: *ahmed024gh@yahoo.com*

Background: Diabetes mellitus (DM) is a public health threat due to its increasing prevalence and the development of long-term complications which affect quality of life. The aetiopathogenesis of the disease involves a variety of genetic, environmental and lifestyle practices. Therefore, the prevalence of the disease may differ in people with different conditions of work and stress-related activities. There is currently limited data on the prevalence of DM among security services and university students in Ghana. It is for this reason that we carried out this population-based investigation to examine the prevalence of the disease in these specific groups of people.

Methods: We measured the weight and height of three categories of participants, namely, the adult population in the general public, security personnel and university students. Then we calculated their body mass indices (BMIs). We also measured their blood pressure and took blood samples for the estimation of fasting blood glucose (FBG) and glycated haemoglobin (HbA1c) levels.

Results: The prevalence of DM among the participants was 6.4%. There was a statistically significant difference ($p < 0.0001$) in the prevalence of DM among the categories with the security personnel recording the highest occurrence (13.7%) followed by the general population (8.4%) and the university students (1.2%).

Conclusion: The prevalence of DM among security personnel in Ho, Volta Region, Ghana, is higher than that of the general population.

Keywords: stress, security, diabetes mellitus, overweight, blood pressure

Introduction

Diabetes mellitus (DM) is a metabolic disorder of several aetiology characterised by chronic hyperglycaemia with disorders of carbohydrate, fat and protein metabolism resulting from a defect in insulin secretion, insulin action or both.[1] DM can be grouped into two broad aetiopathogenic categories, namely, type 1 and type 2. Type 1 diabetes mellitus (T1DM) occurs within all age groups and represents 10% of the diabetic cases, while type 2 diabetes mellitus (T2DM) occurs during later stages of life (> 30 years) and accounts for approximately 90% of all diabetes cases.[2] Globally, 463 million people between the ages of 20 and 79 were estimated to be living with DM in 2019.[3] This represents approximately 9.3% of the adult population and this number is expected to increase to 578 million (10.2%) in 2030 and 700 million (10.9%) in 2045.[3] The International Diabetes Federation (IDF) has estimated that, globally, one in 11 adults (415 million adults) aged 20–79 years had DM in 2015 and projected this figure to rise to 642 million adults by 2040.[4] In sub-Saharan Africa alone, it was estimated that roughly 15.5 million people had DM in 2017 of which 69% was undiagnosed.[5] A vast number of DM research studies conducted among youth aged 10–19 years have established an increased incidence rate of 12.1 per 100 000 youth.[6] T1DM is considered a public health threat because of the increasing number of patients as well as the severity of complications associated with it.[7,8]

DM comes with some related complications which can be grouped together either as microvascular or as macrovascular complications. Microvascular complications include neuropathy, nephropathy and retinopathy whereas macrovascular complications include cardiovascular disease and cerebrovascular disease.[9] The complications associated with DM call for concerted efforts to diagnose it early in order to prevent or delay the appearance of these complications. Many people first get to know of their diabetes status during screening exercises and a few cases of T1DM have been detected during mass screening of participants in some countries.[10] DM may be affected by environmental and lifestyle practices and may manifest differently in different groups of people as a result of differences in exposure to various conditions of work, stress and diet. A recent study in Ho, Ghana, reported a DM prevalence of 6.9%.[11] However, the paucity of information available on prevalence rates of DM in youth as well as security personnel living in the Ho municipality of Ghana, prompted this population-based epidemiological investigation.

Methods

Study site

This study was conducted in Ho, the capital city of the Volta Region of Ghana. The city is largely inhabited by the Ewe ethnic group and is one of the 25 municipalities and districts in the Volta Region. Ho has a population of about 271 881.

Study design

This was a cross-sectional study involving adult members of the general population, students from the tertiary institutions as well as security personnel within the municipality. The participants were randomly selected from the four main communities in the Ho municipality (New Agbetome, Ho main market, Dave and Dome sub-communities).

Sample size

The number of participants for each of the three categories were determined at a confidence level of 95%. It was calculated using the RAOSOFT online sample size calculator (Raosoft, Inc. http://www.raosoft.com) at a 95% confidence level, 5% confidence interval and 50% population proportion. This gave a minimum sample size of 202 participants for each category. A total 834 participants took part in this study with 202 members of the general population, 227 members of the security personnel and 405 students. The sample population was chosen by random selection of houses in the four sub-communities using Excel sample selection software (XLSTA, Addinsoft Inc., USA).

Inclusion and exclusion criteria

The communities are composed of the local inhabitants, security personnel as well as students from tertiary institutions living in hostels. Seemingly healthy people who consented to take part in the study were included, while known diabetics, pregnant women and visibly sick people were excluded from the study.

Measurements

Information on participant characteristics such as age, gender, occupation, educational level, smoking status, alcohol consumption and physical activity were recorded. The participants' height (in centimetres) and weight (in kilograms) were taken with participants wearing light clothing and without shoes and body mass index (BMI) calculated as weight (kg)/height (m^2).

After an overnight fast of 8–14 hours, venous blood (5 ml) was collected from each participant using a sterile syringe and needle, and was put into sterile ethylenediaminetetraacetic acid (EDTA) and fluoride oxalate tubes. The tubes were then centrifuged at 3 000 rpm to obtain plasma used to estimate fasting blood glucose (FBG) using the Selectra Pro S (Vital Scientific B.V. Van Rensselaerwweg 4, NL 6956 AV Spankeren, The Netherlands) automated chemistry analyser, according to manufacturer's instructions. An oral glucose tolerance test (OGTT) was performed in order to diagnose DM using the American Diabetes Association criteria.[12] The blood in the EDTA tubes were used to estimate glycated haemoglobin (HbA1c) levels for all participants using high performance liquid chromatography (Tosoh G7; Tosoh Corporation, Tokyo, Japan), according to the manufacturer's instructions.

Outcome variable

The participants were grouped into underweight (BMI < 18.5), normal weight (BMI = 18.5–24.9 kg/m^2), overweight (BMI = 25–29.9 kg/m^2) and obese (BMI ≥ 30 kg/m^2). Those whose HbA1c levels were < 5.9% were classified as normoglycaemia while those with HbA1c levels of 6.0–6.4% and ≥ 6.5% were diagnosed as prediabetes and diabetes, respectively. Similarly, participants with FBG ≥ 7.0 mmol/L and 2-hour post 75g glucose of ≥ 11.1 mmol/L, were diagnosed as having DM.

Statistical analysis

Descriptive analysis was carried out to summarise and describe the characteristics of the participants in the study. The non-parametric chi-square and Fisher's exact tests were used to establish the relationship between categorical variables. The chi-square test of goodness of fit for equality of proportions was also used to determine whether statistical difference existed between independent sample proportions. The Marascuilo procedure for multiple comparisons was subsequently used as a post-hoc analysis after chi-square test of equality of proportions indicated the existence of significant differences.

Results

A total of 834 participants took part in this study with 426 participants (51.1%) being female and 408 participant (48.9%) being male. In all, 27.2%, 24.2% and 48.6% were from the security personnel, the general population and students, respectively. The majority of the participants were between 21 and 30 years of age, representing 39.3% of the participants. Alcohol consumption (4.9%) and cigarette smoking (0.4%) were very low among the participants, and the majority (77.8%) engaged in moderate physical activity. About 23% were hypertensive, while 16.4% and 22.8% were obese according to the BMI and waist circumference categories, respectively. The prevalence of DM and prediabetes among the participants were 6.4% and 12.5%, respectively (Table I).

The prevalence of diabetes stratified by BMI is given in Table II. There were statistically significant differences ($p < 0.0001$) between the various BMI categories with the overweight group having the highest prevalence of DM (10.31 ± 4.21%) (Table II). When the prevalence was stratified according to diastolic blood pressure, there was no statistically significant difference ($p = 0.121$) between normotension, prehypertension and hypertension (Table III). However, there were statistically significant differences ($p < 0.0001$) when the prevalence of DM was stratified according to the stages of hypertension with the prehypertensive group having the highest prevalence (9.44 ± 3.54%) with regards to the systolic blood pressure (Table IV). The prevalence of DM was also evaluated based on the nature of work of participants (Table V). It emerged that there was statistically significant differences in the prevalence of DM among the different categories of participants ($p < 0.0001$) with the security personnel group showing the highest number of participants with prediabetes and DM compared to the general population

Table I: General characteristics of the participants

	Freq.	(%)
Age		
≤ 20	152	18.2
21–30	328	39.3
31–40	163	19.5
> 40	191	22.9
Gender		
Female	426	51.1
Male	408	48.9
Alcohol		
Never	582	70.1
Sometimes	208	25
Yes	41	4.9
Smoke		
Never	824	98.9
Sometimes	6	0.7
Yes	3	0.4
Physical activity		
None	97	11.6
Moderate	648	77.8
High	88	10.6
SBP level		
Normotension	349	41.8
Prehypertension	288	34.5
Hypertension	197	23.6
DBP level		
Normal	382	45.8
Prehypertension	259	31.1
Hypertension	193	23.1
Diabetes status		
Hypoglycaemia	23	2.8
Normal	654	78.4
Prediabetes	104	12.5
Diabetes	53	6.4
BMI category		
Underweight	48	5.8
Normal	447	53.6
Overweight	202	24.2
Obesity class I	85	10.2
Obesity class II	37	4.4
Obesity class III	15	1.8
Waist circumference category		
Normal	644	77.2
Abdominal obesity	190	22.8
Educational level		
None	30	3.6
Basic	103	12.4
SHS	179	21.5
T/V	80	9.6
Tertiary	442	53
Participants		
Security	227	27.2
General population	202	24.2
Student	405	48.6

SBP – systolic blood pressure, DBP – diastolic blood pressure, BMI – body mass index, SHS – senior high school, T/V – trade/vocational

and the students (Table V). Further comparison revealed that 22.03% (95% CI 16.81–27.9) and 13.7% (95% CI 9.47–8.8) of participants in the security personnel group had prediabetes and DM respectively; while 16.83% (95% CI 11.95–22.7) and 8.42% (95% CI 4.93–13.1) of the general population group had prediabetes and DM, respectively (Table VI). The least prevalence of DM was observed among the participants in the student group. Further analysis of the FBG levels of the participants indicated that the security personnel group had the highest mean FBG (6.07 mmol/L) concentration, followed by 5.77 mmol/L and 5.12 mmol/L for the general population group and the student group, respectively ($p < 0.0001$) (Table VII).

Table II: The prevalence of diabetes among participants stratified by BMI category

BMI	Hypoglycaemia		Normal		Prediabetes		Diabetes		*p*-value
	n (%)	Mean ± SD	*n* (%)	Mean ± SD	*n* (%)	Mean ± SD	*n* (%)	Mean ± SD	
Total	23	3.51 ± 0.42 2.10–3.89	654	5.13 ± 0.48 3.90–6.09	104	6.42 ± 0.27 6.10–6.98	53	9.62 ± 3.335 7.00–20.70	
Underweight	0		46 (7.0)	5.12 ± 0.48 3.95–5.90	1 (1.0)	6.1 ± 0 6.10–6.10	1 (1.9)	8.2 ± 0 8.20–8.20	
Normal	18 (78.3)	3.46 ± 0.46 2.10–3.89	374 (57.2)	5.1 ± 0.47 3.98–6.03	40 (38.5)	6.46 ± 0.30 6.10–6.90	15 (28.3)	10.03 ± 3.36 7.00–17.30	
Overweight	3 (13.0)	3.65 ± 0.14 3.50–3.76	146 (22.3)	5.15 ± 0.46 3.90–6.06	32 (30.8)	6.43 ± 0.27 6.10–6.98	21 (39.6)	10.31 ± 4.21 7.00–20.70	**< 0.0001****
Obesity class I	0		57 (8.7)	5.21 ± 0.51 4.18–6.09	17 (16.3)	6.31 ± 0.21 6.10–6.80	11 (20.8)	8.31 ± 1.43 7.00–11.67	
Obesity class II	2 (8.7)	3.74 ± 0.10 3.67–3.80	22 (3.4)	5.33 ± 0.55 4.25–6.00	9 (8.7)	6.46 ± 0.26 6.1–6.8	4 (7.5)	9.05 ± 1.12 7.70–10.20	
Obesity class III	0		9 (1.4)	5.39 ± 0.43 4.80–6.00	5 (4.7)	6.38 ± 0.27 6.20–6.80	1 (1.9)	7.10 ± 0 7.10–7.10	

Fisher's exact test * Significant at 5% ** Significant at 1%
Note: There is a statistical relationship between the two variables
BMI – body mass index, SD – standard deviation

Table III: Prevalence of diabetes stratified according to diastolic blood pressure

DBP	Hypoglycaemia		Normal		Prediabetes		Diabetes		*p*-value
	n (%)	Mean ± SD	*n* (%)	Mean ± SD	*n* (%)	Mean ± SD	*n* (%)	Mean ± SD	
Total	23	3.51 ± 0.42 2.10–3.89	654	5.13 ± 0.48 3.90–6.09	104	6.42 ± 0.27 6.10–6.98	53	9.62 ± 3.335 7.00–20.70	
Normal	12 (52.2)	3.36 ± 0.52 2.10–3.89	309 (47.2)	5.10 ± 0.48 3.90–6.03	41 (39.4)	6.43 ± 0.28 6.1–6.9	20 (37.7)	10.63 ± 4.50 7.00–20.70	
Prehypertension	7 (30.4)	3.62 ± 0.18 3.30–3.80	205 (31.3)	5.13 ± 0.49 4.00–6.09	34 (32.7)	6.40 ± 0.27 6.10–6.98	13 (24.6)	8.99 ± 2.40 7.00–15.10	0.121
Hypertension	4 (17.4)	3.75–0.058 3.70–3.80	140 (21.4)	5.21 ± 0.455 4.00–6.00	29 (27.9)	6.42 ± 0.26 6.10–6.90	20 (37.7)	9.02 ± 2.21 7.00–15.28	

Chi-square test * Significant at 5% ** Significant at 1%
Note: No statistical relationship between the two variables
DBP – diastolic blood pressure, SD – standard deviation

Table IV: Prevalence of diabetes stratified by systolic blood pressure

SBP	Hypoglycaemia		Normal		Prediabetes		Diabetes		*p*-value
	n (%)	Mean ± SD	*n* (%)	Mean ± SD	*n* (%)	Mean ± SD	*n* (%)	Mean ± SD	
Total	23	3.51 ± 0.42 2.10–3.89	654	5.13 ± 0.48 3.90–6.09	104	6.42 ± 0.27 6.10–6.98	53	9.62 ± 3.335 7.00–20.70	
Normotension	14 (60.9)	3.38 ± 0.49 2.1–3.89	289 (44.2)	5.11 ± 0.49 3.90–6.030	31 (29.8)	6.44 ± 0.30 6.10–6.90	15 (28.3)	10.93 ± 4.50 7.00–20.70	
Prehypertension	7 (30.4)	3.70 ± 0.11 3.50–3.80	230 (35.2)	5.12 ± 0.46 3.98–6.09	38 (36.5)	6.39 ± 0.28 6.10–6.90	13 (24.5)	9.44 ± 3.54 7.00–18.78	**< 0.0001****
Hypertension	2 (20.6)	3.75 ± 0.07 3.70–3.80	135 (20.6)	5.22 ± 0.47 4.00–6.06	35 (33.7)	6.43 ± 0.24 6.10–6.98	25 (47.2)	8.93 ± 2.11 7.00–15.28	

Chi-square test * Significant at 5% ** Significant at 1%
Note: There is a statistical relationship between the two variables
SBP – systolic blood pressure, SD – standard deviation

Table V: Prevalence of diabetes stratified according to participants' nature of work

Groups	Hypoglycaemia		Normal		Prediabetes		Diabetes		*p*-value
	n (%)	Mean ± SD	*n* (%)	Mean ± SD	*n* (%)	Mean ± SD	*n* (%)	Mean ± SD	
Total	23	3.51 ± 0.42 2.10–3.89	654	5.13 ± 0.48 3.90–6.09	104	6.42 ± 0.27 6.10–6.98	53	9.62 ± 3.335 7.00–20.70	
Security	0 (0)		146 (22.3)	5.35 ± 0.41 4.00–6.00	50 (48.1)	6.40 ± 0.25 6.10–6.90	31 (58.5)	8.93 ± 2.38 7.00–18.78	
Others	5 (21.7)	3.76 ± 0.09 3.67–3.89	146 (22.3)	5.09 ± 0.53 3.90–6.09	34 (32.7)	6.52 ± 0.28 6.10–6.98	17 (32.1)	10.68 ± 3.85 7.00–18.78	**< 0.0001****
Students	18 (78.3)	3.44 ± 0.45 2.10–3.80	362 (55.4)	5.06 ± 0.46 4.00–6.00	20 (19.2)	6.30 ± 0.27 6.10–6.90	5 (9.4)	10.32 ± 5.82 7.00–20.70	

Fisher exact test * Significant at 5% ** Significant at 1%
Note: There is a statistical relationship between the two variables
SD – standard deviation

Table VI: Comparisons of prevalence of diabetes and prediabetes among the different groups of participants

	n	Prediabetes			Diabetes		
		Frequency	Prevalence (%)	CI	Frequency	Prevalence (%)	CI
Security	227	50	22.03 $_a$	(16.81, 27.9)	31	13.7 $_a$	(9.47, 18.8)
Others	202	34	16.83 $_a$	(11.95, 22.7)	17	8.42 $_a$	(4.93, 13.1)
Students	405	20	4.94 $_b$	(3.04, 7.52)	5	1.23 $_b$	(0.4, 2.86)
***p*-value**		**< 0.0001**			**< 0.0001**		

Categories with the same subscript letters signify no significant difference and those with different subscript letters indicate a significant difference
CI – confidence interval

Table VII: Comparison of FBG (mmol/L) levels in the three groups

Statistic	Min.	Max.	Mean	SD	*p*-value
FBG | security	4.000	17.300	6.07 $_a$	1.535	
FBG | others	3.670	18.780	5.77 $_b$	1.989	< 0.0001
FBG | students	2.100	20.700	5.12 $_c$	1.032	

* Significant at 5% ** Significant at 1%
Categories with the same subscript letters signify no significant difference and those with different subscript letters indicate a significant difference
FBG – fasting blood glucose, SD – standard deviation

Discussion

We examined 834 people from different backgrounds for DM and found its prevalence to be 6.4%, with those in the security services having the highest prevalence. The 6.4% recorded in this study is similar to what was reported two decades ago in Ghana.[13] The findings in this study is lower than the 6.9% that was reported in 2019 among the general population within the Ho municipality of Ghana.[11] The prevalence of DM is increasing all over the world, including sub-Saharan African countries. One report indicated that 463 million people between the ages of 20 and 79 years were estimated to be living with DM in 2019, representing approximately 9.3% of the global adult population; this number is expected to increase to 578 million (10.2%) in 2030 and 700 million (10.9%) in 2045.[3] However, the 6.4% recorded in this study, which is not different from what was recorded 20 years ago and also lower than 6.9% recorded in 2019 in the same geographical location, needs careful scrutiny. One of the reasons could be that this study had a large number of student participants (48.6%) whose mean FBG concentration was much lower than the general population. This could have an influence on the lower percentage of people with DM.

The participants from the security services group recorded the highest prevalence of 13.7% followed by the general population group with 8.4%, while the students had the lowest prevalence of 1.2%. DM in young adults is mostly type 1 which accounts for about 10% of DM cases worldwide.[14] This could explain the reason for the low prevalence of the disease among students in this present study. Our results is in consonance with previous studies which reported very low prevalence of DM among young people,[15,16] in contrast with a report that did not find any case of DM among high school and college students in southern India.[17] A recent study of the trend of T1DM diagnosis in Ghana indicated a gradual increase in incidence of the disease at the Konfo Anokye Teaching Hospital.[18] We did not examine retrospective data in our study and are unable to state whether there is an increasing or decreasing trend of DM among young students in this current study. The findings of the highest prevalence among security personnel is a paradox because the people in security services are expected to exercise more than people from the general population; therefore, they should have had the lower prevalence. Modern lifestyle practices such as an unhealthy diet, a sedentary lifestyle and stress contribute to the manifestation and development of DM.[19] Notwithstanding the aetiological, clinical and epidemiological differences of T1DM and T2DM, some characteristics are shared, such as the role of stress during its onset and progression, chronicity, changes in habit, psychological and social life.[20] Inadequate rest and work overload could have negative effects on the health of the security personnel. The police service in Ghana, for example, is overburdened with too many duties to perform, meaning that officers may not have ample time to do aerobic exercise and also rest adequately.[21] This puts a lot of stress on them and chronic stress may favour the onset of somatic disorders in susceptible subjects.[22,23] Prolonged stress affects hormonal balance, metabolism and immune function[24] leading to prolonged activation of the hypothalamus-pituitary-adrenal (HPA) axis. This leads to increases in glucocorticoid levels, causing pathologies related to hypercortisolism. Additionally, this condition stimulates the alteration of the immune function and enhances the development of central obesity, peripheral tissue resistance to insulin and glucose intolerance.[25] Stress is one of the causes of DM[26] and it has been linked to a higher risk of T2DM, especially in women.[27,28] Stress seems to have both a direct and an indirect influence on the probability of becoming ill. The reaction to a stressor often consists of an unhealthy lifestyle, including the disregard of physical wellbeing and unhealthy eating habits. These factors indirectly affect the risk of developing T2DM.[29] Furthermore, physiological changes activated by stress may directly affect the endocrine and immune systems.[30] Cortisol is a major mediator of stress and also an insulin counterregulatory hormone that regulate the metabolism in general, and glucose metabolism in particular. Cortisol induces hyperglycaemia by stimulating hepatic gluconeogenesis, and inhibiting the action of insulin.[31] These reactions are useful for initiating a fight or flight reaction; however, persistent elevation of cortisol levels may also lead to glucose intolerance.[20] Most often, in people with prolonged exposure to stress, the glucose mobilised from the liver is not used and remains in the bloodstream, causing a rise in blood glucose levels. Additionally, the way an individual evaluates events may influence reactions of the endocrine system. For example, anxious security personnel may anticipate difficulties and strengthen the feeling of danger with regard to their daily task of providing security of the general population. This anxiety may generate a state of continuous signal that can induce chronic hypercortisolism and consequently metabolic syndrome and T2DM.[20]

We also report significant differences in the prevalence of DM among the different BMI categories, with those who are overweight having the highest prevalence of DM compared to those with normal weight or who are underweight. This is in line with previous reports which found overweight to be a significant risk factor of diabetes.[11,32,33] This is also a cause for concern as being overweight and obese are significant features of metabolic syndrome and cardiovascular diseases as well.[34]

Our study revealed a significant relationship between systolic blood pressure and DM; 47% of the participants who had high systolic blood pressure also had DM. This is in consonance with a previous study which found that men with hypertension had almost twice the incidence of DM compared to the normotensive men.[35] The relationship between hypertension and diabetes has been reported by many studies and is because of the interplay

between hyperglycaemia and lipid metabolism. Hyperglycaemia affects lipid metabolism resulting in dyslipidaemia, and subsequently, atherosclerosis which is responsible for narrowing of blood vessels and the resultant effect is high blood pressure. Hypertension is one of the important risk factors linked to renal failure, stroke and cardiovascular disease which is the major cause of death in those with diabetes.[36] Hypertension is a strong modifiable risk factor for both macrovascular and microvascular complications of diabetes.[37] The findings in this study of the link between diabetes, obesity and hypertension, especially among security personnel, raises serious concern because these three conditions decrease patients' health-related quality of life while physical activity increases it. The coexistence of obesity and hypertension, especially, has a more negative effect on health-related quality of life.[38]

The study had some limitations, which included lack of information on nutritional and dietary habits of participants, lack of information on the stress levels of all participants and an inability to estimate cortisol levels of the participants. The strengths of the study, however, are that participants were randomly selected and so eliminates biases. We also estimated HbA1c and OGTT, which compared favourably with the FBG level and, hence, improved the accuracy of the diagnosis of participants with DM.

Future research with a larger sample size is required to conclusively determine the influence of dietary habits and stress on the prevalence of DM among different categories of workers. Such a study should include measurement of seven stress indicators, namely heart rate variability, electroencephalography or brainwaves, breathing assessment via capnometry, adrenal assessment, skin conductance, skin temperature, sleep tracking, as well as resting or passive heart rate. Another instrument for measuring stress levels that can be used in future research is the Perceived Stress Scale developed by Sheldon Cohen.

Conclusion

DM in the young is rare in the Ho municipality of Ghana but DM in security personnel is much higher than that of adults in the general population. This is possibly due to the stressful nature of the work in the security services.

Conflict of interest

The authors declare no conflict of interest.

Funding source

No funding was required

Ethical approval

The study was approved by the Research Ethics Committee at the University of Health and Allied Sciences, Institute of Health Research, Ho, Ghana (Protocol number: UHAS-REC/A.10 [4] 20-21). Also, informed consent was obtained from all individual participants included in the study and the study was conducted according to the Helsinki Declaration.

ORCID

AT Bawah https://orcid.org/0000-0002-0727-9986

S Nanga https://orcid.org/0000-0002-3712-5013

References

1. Baynest HW. Classification, pathophysiology, diagnosis and management of diabetes mellitus. J Diabetes Metab. 2015;6(5):1-9. https://doi.org/10.4172/2155-6156.1000541.
2. Ozougwu J, Obimba K, Belonwu C, Unakalamba C. The pathogenesis and pathophysiology of type 1 and type 2 diabetes mellitus. J Physiol Pathophysiol. 2013;4(4):46-57. https://doi.org/10.5897/JPAP2013.0001.
3. Saeedi P, Petersohn I, Salpea P, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res Clin Pract. 2019;157:107843. https://doi.org/10.1016/j.diabres.2019.107843.
4. Cho N, Shaw J, Karuranga S, et al. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. Diabetes Res Clin Pract. 2018;138:271-81. https://doi.org/10.1016/j.diabres.2018.02.023.
5. Zimmermann M, Bunn C, Namadingo H, Gray CM, Lwanda J. Experiences of type 2 diabetes in sub-Saharan Africa: a scoping review. Glob Health Res Policy. 2018;3(1):1-13. https://doi.org/10.1186/s41256-018-0082-y.
6. Spurr S, Bally J, Bullin C, Allan D, McNair E. The prevalence of undiagnosed Prediabetes/type 2 diabetes, prehypertension/hypertension and obesity among ethnic groups of adolescents in Western Canada. BMC Peadiatr. 2020;20(1):1-9. https://doi.org/10.1186/s12887-020-1924-6.
7. EURODIAB ACE study group. Variation and trends in incidence of childhood diabetes in Europe. Lancet. 2000;355(9207):873-6. https://doi.org/10.1016/S0140-6736(99)07125-1.
8. Maahs DM, West NA, Lawrence JM, Mayer-Davis E. Epidemiology of type 1 diabetes. Endocrinol Metab Clin North Am. 2010;39(3):481-97. https://doi.org/10.1016/j.ecl.2010.05.011.
9. Forbes JM, Cooper ME. Mechanisms of diabetic complications. Physiol Rev. 2013;93(1):137-88. https://doi.org/10.1152/physrev.00045.2011.
10. Van Belle TL, Coppieters KT, Von Herrath MG. Type 1 diabetes: etiology, immunology, and therapeutic strategies. Physiol Rev. 2011;91(1):79-118. https://doi.org/10.1152/physrev.00003.2010.
11. Bawah AT, Ngambire LT, Abaka-Yawson A, et al. A community based prevalence of type 2 diabetes mellitus in the Ho municipality of Ghana. J Public Health. 2019;29(2):403-9. https://doi.org/10.1007/s10389-019-01144-7.
12. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2010;33(Suppl 1):S62-69. https://doi.org/10.2337/dc10-S062.
13. Amoah AG, Owusu SK, Adjei S. Diabetes in Ghana: a community based prevalence study in Greater Accra. Diabetes Res Clin Pract. 2002;56(3):197-205. https://doi.org/10.1016/S0168-8227(01)00374-6.
14. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2013;36(Suppl 1):S67-74. https://doi.org/10.2337/dc13-S067.
15. Afoke AO, Ejeh NM, Nwonu EN, et al. Prevalence and clinical picture of IDDM in Nigerian Igbo schoolchildren. Diabetes Care. 1992;15(10):1310-2. https://doi.org/10.2337/diacare.15.10.1310.
16. Elamin A, Omer MI, Hofvander Y, Tuvemo T. Prevalence of IDDM in schoolchildren in Khartoum, Sudan. Diabetes Care. 1989;12(6):430-2. https://doi.org/10.2337/diacare.12.6.430.
17. Asha Bai P, Krishnaswami C, Chellamariappan M, et al. Prevalence of diabetes in the young in South India. Indian Pediatr. 1995;32(11):1173-6.
18. Sarfo-Kantanka O, Asamoah-Boaheng M, Arthur J, et al. Trends in type 1 diabetes diagnosis in Ghana. Int Health. 2020;ihz096. https://doi.org/10.1093/inthealth/ihz096.
19. Groop L. Pathogenesis of type 2 diabetes: the relative contribution of insulin resistance and impaired insulin secretion. Int J Clin Pract Suppl. 2000;(113):3-13.
20. Falco G, Pirro P, Castellano E, et al. The relationship between stress and diabetes mellitus. J Neurol Psychol. 2015;3(1):1-7. https://doi.org/10.13188/2332-3469.1000018.
21. Essien M, Lutterodt HE, Annan RA. Risk factors of cardiovascular disease among Ghanaian police officers. Cardiol Angiol Int J. 2019;8(4):1-9. https://doi.org/10.9734/ca/2019/v8i430109.
22. Fisher G. Trattato di psicologia della salute. Roma: Borla; 2006.
23. Pancheri P. Stress emozioni malattia: introduzione alla medicina psicosomatica. Milano: Edizioni scientifiche e tecniche Mondadori; 1983.

24. Nader N, Chrousos GP, Kino T. Interactions of the circadian CLOCK system and the HPA axis. Trends Endocrinol Metab. 2010;21(5):277-86. https://doi.org/10.1016/j.tem.2009.12.011.
25. Kajantie E, Phillips DIW. The effects of sex and hormonal status on the physiological response to acute psychosocial stress. Psychoneuroendocrinology. 2006;31(2):151-78. https://doi.org/10.1016/j.psyneuen.2005.07.002.
26. Li J, Jarczok MN, Loerbroks A, et al. Work stress is associated with diabetes and prediabetes: cross-sectional results from the MIPH Industrial Cohort Studies. Int J Behav Med. 2013;20(4):495-503. https://doi.org/10.1007/s12529-012-9255-0.
27. Heraclides A, Chandola T, Witte DR, Brunner E. Psychosocial stress at work doubles the risk of type 2 diabetes in middle-aged women: evidence from the Whitehall II study. Diabetes Care. 2009;32(12):2230-5. https://doi.org/10.2337/dc09-0132.
28. Heraclides AM, Chandola T, Witte DR, Brunner E. Work stress, obesity and the risk of type 2 diabetes: Gender-specific bidirectional effect in the Whitehall II study. Obesity. 2012;20(2):428-33. https://doi.org/10.1038/oby.2011.95.
29. Aschbacher K, Kornfeld S, Picard M, et al. Chronic stress increases vulnerability to diet-related abdominal fat, oxidative stress, and metabolic risk. Psychoneuroendocrinology. 2014;46:14-22. https://doi.org/10.1016/j.psyneuen.2014.04.003.
30. Beardsley G, Goldstein MG. Psychological factors affecting physical condition: Endocrine disease literature review. Psychosomatics. 1993;34(1):12-19. https://doi.org/10.1016/S0033-3182(93)71923-4.
31. Bergmann N, Gyntelberg F, Faber J. The appraisal of chronic stress and the development of the metabolic syndrome: a systematic review of prospective cohort studies. Endocr Connect. 2014;3(2):R55-R80. https://doi.org/10.1530/EC-14-0031.
32. Stumvoll M, Goldstein BJ, Van Haeften TW. Type 2 diabetes: principles of pathogenesis and therapy. Lancet. 2005;365(9467):1333-46. https://doi.org/10.1016/S0140-6736(05)61032-X.
33. Wannamethee SG, Shaper AG. Weight change and duration of overweight and obesity in the incidence of type 2 diabetes. Diabetes Care. 1999;22(8):1266-72. https://doi.org/10.2337/diacare.22.8.1266.
34. Després J-P, Lemieux I. Abdominal obesity and metabolic syndrome. Nature. 2006;444(7121):881-7. https://doi.org/10.1038/nature05488.
35. Helmrich SP, Ragland DR, Leung RW, Paffenbarger Jr, RS. Physical activity and reduced occurrence of non-insulin-dependent diabetes mellitus. N Engl J Med. 1991;325(3):147-52. https://doi.org/10.1056/NEJM199107183250302.
36. Messerli FH, Williams B, Ritz E. Essential hypertension. Lancet. 2007;370(9587):591-603. https://doi.org/10.1016/S0140-6736(07)61299-9.
37. De Boer IH, Bangalore S, Benetos A, et al. Diabetes and hypertension: A position statement by the American Diabetes Association. Diabetes Care. 2017;40(9):1273-84. https://doi.org/10.2337/dci17-0026.
38. Ucan O, Ovayolu N. Relationship between diabetes mellitus, hypertension and obesity, and health-related quality of life in Gaziantep, a central south-eastern city in Turkey. J Clin Nurs. 2010;19(17-18):2511-9. https://doi.org/10.1111/j.1365-2702.2010.03295.x.