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ARTICLE

The prevalence and risk factors for diabetes mellitus in healthcare workers at Tygerberg hospital, Cape Town, South Africa: a retrospective study

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Objectives: To assess the contribution of traditional and modifiable risk factors to the overall risk and prevalence of type 2 diabetes mellitus (T2DM) amongst health workers (HWs) in the public sector.
Design: A retrospective analysis was performed on data obtained from 260 participants.
Setting and subjects: HWs at Tygerberg Hospital, Western Cape attending the World Diabetes Day (WDD) metabolic screening and educational event.
Outcome measures: The 10-year risk stratification for T2DM was calculated in all HWs attending the WDD event. This was based on the Finnish 'Test2prevent' diabetes risk calculator endorsed by the International Diabetes Federation assessing a set of well-established metabolic risk factors. Self-reported consumption of sugar-sweetened beverages (SSBs) was added to the questionnaire but did not add to the risk calculation.
Results: The prevalence of known hyperglycaemia in this cohort is concerning (11%, $n = 62$). An additional 29 health workers were identified as at high risk to develop T2DM within 10 years. Consumption of SSBs and minimal physical activity were identified as modifiable targets for intervention.
Conclusions: Education and lifestyle interventions are of paramount importance to ensure the metabolic health of HWs and their communities. Policies and guidelines focused on limiting unhealthy/obesogenic work environments are urgently needed.

Keywords: Diabetes mellitus, health workers, obesity, risk factors, screening, HbA1c

Introduction

South Africa (SA) is a diverse country in terms of race, socioeconomic status, and other societal and structural determinants of health.[1] Rapid demographic and socioeconomic changes in SA and sub-Saharan Africa (SSA), coupled with an ageing population, are drivers of obesity and related conditions such as type 2 diabetes mellitus (T2DM). Urbanisation and access to energy-dense food, together with a sedentary lifestyle, contribute significantly.[1–6] The global increase in the prevalence of T2DM, especially in lower-income countries, is a major public health concern. The current prevalence of T2DM in SA is 5.5%, likely an underestimation,[3] and is expected to rise in the foreseeable future.

Due to the limited resources and overstrained economic climates that characterise healthcare systems in SSA, most people with T2DM are diagnosed only after the onset of overt symptoms and complications. The late presentation and diagnosis contribute significantly to health care cost.[1,2,7] Low- and middle-income countries do not have adequate resources to respond to the T2DM burden, especially considering that three-quarters of people with T2DM are of working age.[8] A proactive approach is required to impact on T2DM incidence. The focus should ideally be shifted towards well-being, disease prevention and the timely management of uncomplicated asymptomatic disease states.[1,2,8,9] Low-cost solutions are necessary to avert the predicted impact of T2DM on individuals and health systems. Addressing modifiable risk factors for T2DM through health promotion and lifestyle education could prevent disease progression and the development of secondary complications.[1,2,7]

Health workers (HWs) are critical for the optimal functioning of health systems and serve as role models within their communities. Studies have reported a concerning rate of obesity in hospital employees, a rate even higher than that reported in the background population of Africa.[10,11] A strong driver and modifiable risk factor of the obesity and T2DM epidemic is the consumption of energy-dense food and beverages in obesogenic work environments.[5,12] Personal health influences the way in which HWs advocate.[13,14] It is thus of paramount importance that the risk factors associated with T2DM are identified and addressed in this population.[11,15]

Interventions within existing public health institutions, targeted at HWs, could have a wide-reaching impact on disease prevention. As part of World Diabetes Day (WDD) an awareness campaign was launched in the public health sector of the Western Cape province of SA. The risk of participating HWs employed at Tygerberg Hospital (TH) of developing T2DM within the next 10 years was determined by using the 'Test2-prevent' T2DM risk calculator endorsed by the International Diabetes Federation (IDF).[3] Retrospective data analysis aimed to identify prominent modifiable risk factors within this population in order to inform preventative strategies and future policies to improve the health of staff members at public sector hospitals.

Methods

Participants and ethics

Data were obtained from employees at TH who participated in the WDD educational and screening event held on November 14, 2017. Participation was voluntary, and attendees could withdraw from the screening at any time without prejudice. The contribution of traditional and modifiable risk factors to the overall risk of T2DM amongst HWs in the public sector was assessed. Demographic data, anthropometric measurements and metabolic risk were evaluated and entered onto the 'Test2prevent' data sheets. 'Test2prevent' is a pre-defined and validated risk factor evaluation screening tool based on the Finnish Diabetes Risk Score (FINDRISC) and is endorsed by the IDF.[3,16] Data from non-pregnant participants, older than 18 years, who gave consent were considered for inclusion in the analysis. The metabolic risk screening survey did not specifically enquire as to the presence of known or treated T2DM in individuals with a history of hyperglycaemia, therefore the data on 62 participants who reported a history of hyperglycaemia were not included in the risk calculation. Ethical approval was obtained for the retrospective analysis of data from the Health Research Ethics committee at Stellenbosch University.

'Test2prevent' and risk stratification

The 'Test2prevent' risk tool calculates the 10-year probability of an individual to develop T2DM. Traditional risk factors for T2DM each carry a weighted score that contributes to the total risk score of each participant (Table 1). Risk is categorised as follows: low risk (LR): score < 7 (risk of 1:100), slight risk (SR): score 7–11 (risk of 1:25), moderate risk (MR): score 12–14 (risk of 1:6), high risk (HR): score 15–20 (risk of 1:3), very high risk (VHR): score > 20 (risk of 1:2).

Table 1: The 'Test2prevent' 10-year Diabetes Mellitus Risk Calculator.

Risk factor	Sub-category	Points
Age (in years)	< 45	0
	45–54	2
	> 55	3
Do you usually have daily at least 30 minutes of physical activity?	Yes	0
	No	2
How often do you eat vegetables and/or fruit?	Every day	0
	Not every day	1
Have you ever taken medication for high blood pressure on a regular basis?	No	0
	Yes	2
Have you ever been found to have high blood glucose (e.g. in a health examination, during an illness, during pregnancy)?	No	0
	Yes	5
BMI (in kg/m^2)	<25	0
	25–30	1
	>30	3
Women: waist circumference (cm)	<80	0
	80–88	3
	>88	4
Men: waist circumference (cm)	<94	0
	94–102	3
	>102	4

Demographic data, anthropometry and dietary habits

Age (in years), physical activity (inactive, < or ≥ than 30 minutes daily), dietary habits (fresh fruit and vegetable consumption), use of chronic antihypertensive medication and a family history of T2DM were documented.

Body composition measures included body mass index (BMI) and waist circumference (WC). Weight (kg) (standard platform scale), and height (m) (standard stadiometer) measurements were used to calculate each participant's BMI using the following formula: BMI = weight (kg)/height (m^2). Participants were asked to stand erect, arms at their sides, feet together and abdomen relaxed. WC (cm) was measured at the midpoint between the lateral iliac crest and lowest rib using a standard non-elastic type measure.

The self-reported consumption of sugar-sweetened beverages (SSBs) was added to the data collection questionnaire but did not contribute towards risk calculation. Intake of SSBs was reported as an intake of 250–500 ml, 500–1000 ml or more than 1 000 ml per days of the week (250 ml equivalent to one glass of SSBs).

Metabolic assessment

Participants' systolic and diastolic blood pressure was assessed after at least 10 minutes rest in the sitting position using a mercury sphygmomanometer (HiCare International, Cape Town, South Africa). Random capillary finger-prick blood glucose evaluation was performed in all participants on a hand-held glucometer (Accu-check point-of-care device, Roche Diagnostics, Mannheim, Germany). If the random finger-prick glucose level was at or above the detection limit for impaired glucose tolerance (≥ 7.8 mmol/l) and/or participants scored higher than 15 on the 'Test2prevent' tool, they were referred for point-of -care glycated haemoglobin (HbA1c) testing (A1CNow$^+$ PTS diagnostics, Indianapolis, USA). T2DM was confirmed if the HbA1c was ≥ 6.5%.

Statistical analysis

Statistical analysis was performed using Statistica software (version 13, StatSoft, Johannesburg, South Africa). Normally distributed data are presented as mean ± standard deviation (SD), whereas data that were not normally distributed are presented as median (25–75th percentile). Basic descriptive statistics and frequency tables were done for all the parameters. Parametric (one-way ANOVA with Tukey HSD) and non-parametric (Kruskal–Wallis) comparison tests were used to determine group effects. Level of significance was accepted at $p < 0.05$.

Results

A total of 329 individuals volunteered to participate in the screening event. Of these, 69 participants were excluded from data analysis, 62 due to prior hyperglycaemia, 3 because of pregnancy and 4 due to non-consents. Retrospective analysis was thus performed on data obtained from 260 participants. The participants were from diverse ethnic backgrounds representative of the TH workforce with predominantly African black and mixed-race individuals. The population was predominantly female ($n = 231$, 88%). Nursing staff represented just over half of the participants ($n = 145$, 55%). Demographic and anthropometric data of the study participants were stratified according to the 'Test2prevent' 10-year Diabetes Mellitus Risk Calculator.

Risk for diabetes mellitus amongst health workers at Tygerberg Hospital

The risk categories of study participants are given in Table 2. Most study participants had scores in excess of 7, indicative of risk categories other than low risk. In the total cohort, 42% were in the slight risk (SR) category, 27% in the moderate risk (MR) and 15% in the high-risk (HR) category.

Based on risk stratification, 29 of the 260 participants, i.e. 11% of the total population assessed, will develop incident T2DM in the next 10 years.

Traditional diabetes mellitus risk factors

Demographic and anthropometric data of the study participants were obtained and classified based on the T2DM risk factor stratification of the 'Test2prevent' 10-year Diabetes Mellitus Risk Calculator and are presented in Table 3.

Most of the HWs included in the survey were younger than 45 years of age ($n = 158$; 61%). Nearly half of the study participants older than 55 years (47%) were stratified to the high-risk category; in fact 37% of the high-risk category individuals were older than 55 years. Overall, one-third of participants (79/260) reported being sedentary, performing < 30 minutes of physical activity per day. The percentage of individuals with sedentary habits represented within each category increased stepwise from the lowest to the highest risk (LR 20%; MR 28%; MR 33%; HR 45%). The daily intake of fresh fruit and vegetables was reported by only 57% of HWs. The highest percentage of participants who reportedly do not consume fresh fruit and vegetables daily were in the HR category (58%).

Antihypertensive medication was used by 16% of the total cohort, with known hypertension on treatment reported by 55% of participants in the high-risk category. The 62 participants who reported a prior history of high blood glucose were excluded from the 'Test2prevent' risk analysis. Pre-existing or known T2DM was not specifically enquired about in those who reported prior hyperglycaemia. An accurate assessment of incident diabetes in this subgroup of participants was thus not possible.

Every single participant in the HR category had a family member with T2DM, with a first-degree relative affected in 84% ($n = 32$).

Excess bodyweight and especially visceral adiposity, as represented by an increased WC, were present in the majority of the study cohort. In the high-risk category, based on World Health Organization (WHO) BMI categories, everyone with the exception of a single participant was categorised as overweight, and of those 79% were obese. A WC indicative of metabolic risk (male > 102 cm, female > 88 cm) was present in 95% of those in the high-risk category.

Table 2: 'Test2prevent' 10-year Diabetes Mellitus Risk Categories.

Risk category	Risk score	10-year T2DM risk	Participants, *n* (%)
Low risk (LR)	< 7	1:100	41 (16)
Slight risk (SR)	7–11	1:25	111 (42)
Moderate risk (MR)	12–14	1:6	70 (27)
High risk (HR)	15–20	1:3	38 (15)

There were significant differences ($p < 0.01$) in the body composition data between the LR group and all the other risk categories. Only individuals in the LR category had a mean BMI < 25 kg/m^2 (male 23.7 ± 3.5 kg/m^2; female 24.6 ± 3.7 kg/m^2). Obesity was evident in all other risk categories (SR: male 33.3 ± 8.8 kg/m^2, female 34.1 ± 7.3 kg/m^2), (MR: male 33.2 ± 6.7 kg/m^2, female 36.2 ± 5.9 kg/m^2), (HR: male 33.1 ± 7.4 kg/m^2, 37.1 ± 6.4 female kg/m^2).

A concerning 70% of HWs reported consuming at least 250 ml of SSBs most days of the week, of whom 31 (12%) reported an intake in excess of 1000 ml daily. The percentage of individuals within the SR to HR categories with SSB consumption in excess of 500 ml most days of the week was more than double compared with the LR individuals (Figure 1).

Metabolic assessment

Blood pressure

Individuals within the HR group tended to have slightly higher mean blood pressures (141 ± 31 systolic/82 ± 22 diastolic) compared with individuals within the LR group (128 ± 15 systolic/74 ± 11 diastolic), ($p = 0.05$). Only one individual in the LR group reported the use of anti-hypertensive medication, compared with 55% (1/3 males; 20/35 females) of individuals in the HR category.

Random capillary finger-prick blood glucose and HbA1C

Impaired glucose tolerance was considered in 31 individuals with a finger-prick random blood glucose measurement ≥ 7.8 mmol/L (12% of the 260 individuals without a self-reported history of hyperglycaemia). These individuals were scattered throughout the risk categories (LR 1/41, SR 16/111, MR 8/70 and HR 6/38). Point-of-care HbA1c measurement was performed on 26 of 64 participants with a random capillary blood glucose ≥ 7.8 mmol/l and/or a total score of greater than 15 based on 'Test2prevent' risk stratification. Twenty of these participants were in the HR category. Four individuals were identified with incident T2DM on the day.

Discussion

The risk of future T2DM in HWs at TH was assessed by means of evaluating the presence of the traditional risk factors incorporated in the 'Test2prevent' risk analysis calculator and an increased number of all-risk factors was noted within ascending risk categories. The high number of self-reported prior hyperglycaemia and the projected 10-year risk of incident T2DM in 11% of this relatively young female population HWs of predominantly mixed ancestry is of great concern. A genetic predisposition (positive family history) and excess bodyweight, especially visceral adiposity, were identified as the main contributors to metabolic risk.

The global rise in the prevalence of metabolic diseases such as T2DM is a serious public health concern.[1,8,17] Limited resources in low- and middle-income countries, together with an ageing population, urbanisation, cultural perceptions regarding bodyweight and inauspicious lifestyles, exacerbate the problem.[9,18,19] Earlier studies indicated a prevalence of T2DM amongst urbanised black communities in South Africa to be in the region of 5.3–8%,[20] whereas a 1999 study in a semi-urbanised SA coloured population documented an age-adjusted prevalence of type 2 diabetes of 7.1%.[6] The IDF in 2017 projected an age-adjusted prevalence of 5.5% for SA inclusive of all ethnicities.[3] Erasmus and co-workers, however, found an alarming age-adjusted prevalence (26.3%) of T2DM in an

Table 3: Risk stratification according to traditional diabetes mellitus risk factors.

Factor	Score	All	LR	SR	MR	HR
Participants within risk categories, *n* (%)		260	41 (16)	111 (42)	70 (27)	38 (15)
Age (years):						
< 45	0	158	36	75	41	6
45–54	2	72	2	30	22	18
> 55	3	30 (12)	3 (7)	6 (5)	7 (10)	14 (37)
Physical activity (daily):						
> 30 minutes	0	181	33	80	47	21
< 30 minutes	2	79 (30)	8 (20)	31 (28)	23 (33)	17 (45)
Hypertension medication:						
No	0	217	40	102	58	17
Yes	2	43 (16)	1 (0.2)	9 (8)	12 (17)	21 (55)
Fresh fruit and vegetable intake daily:						
Yes	0	149	21	69	43	16
No	1	111 (43)	20 (49)	42 (38)	27 (39)	22 (58)
Family history:						
None	0	115	31	76	8	0
Grandparent/aunt/uncle	3	37	7	13	11	6 (16)
Parent/sibling/child	5	108 (42)	3 (7)	22 (54)	51(73)	32 (84)
BMI (kg/m^2):						
< 25	0	33	23	8	1	1
25–30	1	74	16	38	13	7
> 30	3	153 (59)	2 (5)	65 (59)	56 (80)	30 (79)
WC (cm):						
< 80 (F); < 94 (M)	0	26	20	4	1	1
80–88 (F); 94–102 (M)	3	31	14	13	3	1
> 88 (F); > 102 (M)	4	203 (78)	7 (17)	94 (85)	66 (94)	36 (95)

LR = low risk, SR = slight risk, MR = moderate risk, HR = high risk; BMI = body mass index; WC = waist circumference; data expressed as *n* (%) unless otherwise specified.

urbanised coloured population of the Western Cape, a figure substantially higher than previously reported.[19] This study reported that the mixed-ancestry population of the Western Cape is at present experiencing the imminent T2DM epidemic anticipated in developing countries. Similarly, the majority of HWs in the index study were of mixed ancestry.

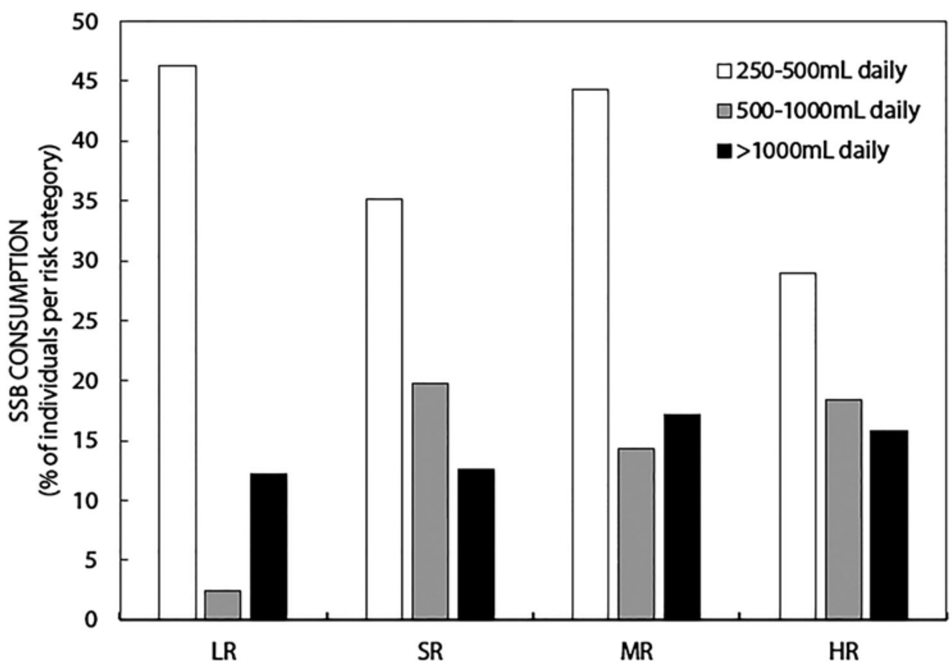

Figure 1: Sugar-sweetened beverage intake. Data are presented as percentage of individuals consuming 250–500 ml, 500–1000 ml or more than 1000 ml on most days of the week within the different 'Test2prevent' risk categories: LR = low risk, SR = slight risk, MR = moderate risk, HR = high risk.

Health advocacy by HWs depends substantially on their personal health status and has the potential to inspire wide-reaching lifestyle changes across settings.[11,21] In SA, the health status of HWs is largely undetermined and the quality of health advocacy provided is unclear. A concerning high prevalence of self-reported hyperglycaemia (62 individuals; 18%) was identified in this study and based on the 'Test2prevent' risk calculator a further 29 of the remaining 260 study participants without a history of prior hyperglycaemia (11%) will progress to T2DM within the next 10 years.

Non-modifiable risk factors that significantly contributed to T2DM risk amongst HWs included family history of T2DM and age. A large percentage of participants reported first- and second-degree relatives with T2DM; in fact every single individual in the HR category had a positive family history of T2DM (84% had a first-degree relative with T2DM). Ethnicity is not considered as an independent risk factor in the risk calculator employed. It is, however, well known that individuals with either a mixed or black African ancestry have a greater risk of developing T2DM due to a presumed genetic predisposition.[22–25] It is thus noteworthy that the predicted T2DM risk of this study population is likely to be an underestimation. Despite this limitation, the current study identified an opportunity for interventional strategies towards T2DM risk reduction by targeting specific modifiable risk factors.

Body composition distinguished individuals within the low-risk category from individuals in all the other risk categories. Obesity and especially visceral adiposity were evident in all risk categories (SR to VHR), affecting a more than 10-fold percentage of individuals within these different risk categories compared with that of the LR cohort. WC was also noted to increase stepwise from the SR to HR category with 95% of individuals in the HR category manifesting WCs in keeping with metabolic syndrome. Obesity is a significant and well-recognised causal factor for T2DM.[1,11,19,25] The prevalence of obesity in HWs assessed at WDD was almost twice the reported prevalence rates in North-West Africa (Ghana), and nearly three times higher than in HWs in other SSA countries (Nigeria and Botswana).[11,26–28] Erasmus and co-workers also noted an increase in obesity and WC in mixed-ancestry study subjects when compared with previous local reports. The mean WC in their study population was 98.5 cm in females and 94.0 cm in males, resulting in 87.9% and 42.2% central obesity rates as defined by the IDF criteria, respectively. WC was significantly associated with the development of T2DM in their cohort.[19]

An array of psychosocial and cultural factors influence weight and an individual's perception thereof. Heaviness is reportedly considered a sign of affluence and health in many cultures.[18] Even in community HWs a moderately overweight body shape has favourable connotations.[18] This perception is in part related to the stigma of human immunodeficiency virus (HIV/AIDS) and the associated thin habitus.[29] This cultural bias poses a significant challenge, especially since the inception point for T2DM risk is much lower than the average reported BMI within this cohort.[23] Lifestyle information obtained at WDD indicates that the consumption of SSBs and physical inactivity are potential modifiable factors, and if addressed may attenuate the T2DM risk in HWs.

Improved physical fitness is known to be associated with fewer metabolic complications across different weight categories and age ranges.[30] One-third of the participants in this study reported less than 30 minutes of daily physical activity. This included all daily activities and was not necessarily representative of cardiovascular exercise. The lack of physical activity was accompanied by regular intake of high volumes of SSBs. Habitual consumption of SSBs is associated with a greater incidence of T2DM, and this risk has also been shown to exist independent of obesity.[31] In alignment with global efforts towards the prevention of obesity and T2DM, a levy on SSBs has recently been adopted in SA.[32] SSBs are, however, readily available at Tygerberg Hospital (TH). Limiting the availability and access to SSBs may lead to lower consumption and impact positively on the prevalence of obesity and T2DM risk in the TH health workforce.

An increased awareness of metabolic risk factors is associated with a decreased incidence of overt T2DM.[33] South Africa, as part of the WHO country cooperation strategy, aims to promote longevity and healthier lives by prioritising the prevention and control of non-communicable diseases.[34] The WHO argues for health promotion and exercise awareness as a means of prevention of T2DM.[7,34] Migration from a reactive model of care to one based on preventative strategies is necessary in resource-limited countries such as SA.[1,7,34,35] Early screening of high-risk individuals and timely identification of modifiable risk factors for T2DM is of paramount importance and can prove to be invaluable in this context. By limiting the availability and access to SSBs and other energy-dense food and beverages reportedly consumed at TH regularly may assist with T2DM prevention.

There are limitations to the study. The 'Test2Prevent' calculator was developed in a Finnish population and the extrapolation of this risk calculator to other ethnic populations and in developing countries has not been validated. Ethnicity is not considered as an independent risk factor for T2DM in this analysis, although individuals with either a mixed or black African ancestry have a greater risk due to their genetic predisposition.[22–24] The predicted T2DM risk of this study population may thus be an underestimation.

Conclusion

This study emphasises the dire need for education and lifestyle interventions as a first step to prevent T2DM in high-risk HWs. In turn, this may lead to widespread lifestyle changes across the settings that HWs traverse. Policies and guidelines focused on improving the health of HWs are essential and should address obesogenic work environments in order to circumvent the imminent metabolic health crisis anticipated.

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Originality – To our knowledge there is no infringement of copyright and the information represented in this article is original.

Declaration of authorship – All authors made significant contributions. AC, AB, DR and SS contributed to the design and conception. All authors contributed to data acquisition. MV and AB contributed to data analysis and interpretation. AC and AB drafted this article which was subsequently critically reviewed by MC. AC and AB have contributed equally to the manuscript.

Ethics committee approval – Ethical approval was obtained for the retrospective analysis of data from the Health Research Ethics committee at Stellenbosch University (6407).

Conflicts of interest – None declared.

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