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Original Article

Closing the gap - Is type 2 diabetes awareness enough to prevent the growing epidemic?

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ABSTRACT

Background: Diabetes mellitus is a public health burden requiring a multi-sectorial approach including adequate population awareness to tackle this epidemic. The study was aimed to determine the level of diabetes awareness among a high-risk dysglycaemic population in relation to socio-demographic, lifestyle and family history of diabetes as well as to body mass index (BMI) and blood pressure measurements. Furthermore, the authors strived to explore any relationships between diabetes awareness and an oral glucose tolerance test dysglycaemia diagnosis.
Method: Participants obtaining impaired fasting blood glucose in a representative health examination survey were invited to undergo an oral glucose tolerance test (OGTT). During the OGTT session, participants were invited to take part in a diabetes awareness questionnaire as well as have their weight, height and blood pressure measured. Association between awareness scores and different parameters (age, gender, education, residential district, smoking, alcohol habit, family history, BMI and blood pressure) were explored.
Results: Being a female, ageing, non-smoker and having a family history of diabetes had a positive association with adequate diabetes awareness. Even though generally good awareness was present, the majority of the participants were obese, with an elevated blood pressure and obtained a dysglycaemic status post OGTT.
Conclusion: Diabetes awareness solely does not appear to engage individuals in preventive initiatives. Behavioural changes are required but these are only established after the motivational action gap has been overcome. Empowering community diabetes mellitus screening programs targeting the environment, social gradients and cultural norms while engaging in preventive interventions are recommended.

1. Introduction

Type 2 diabetes (T2DM) is an established global burden with an estimated 326.5 million people of working age suffering from the disease [1]. Tackling this epidemic is on every stakeholder's agenda, with most interventions focusing on lifestyle and dietary interventions [2]. However, T2DM health inequalities still exist. A multi-sectorial approach is required, combining legislations, policies, changes in the environment and increase in population awareness on the various risks of T2DM [3]. It has been reported that the greatest deterrent against diabetes development is adequate knowledge on this disease [4]. Awareness and knowledge on diabetes motivates individuals to seek medical attention [5]. It also forms the basis for taking and maintaining decisions on food intake, weight control, monitoring of blood glucose as well as identifying the presence of the established diabetes risk factors [5]. Therefore, diabetes awareness and knowledge are the sources for better control and quality of life [6].

The Mediterranean island of Malta, known for its high prevalence of diabetes mellitus, provides an ideal setting to study diabetes awareness and knowledge [7,8]. The aim of this study was to determine the level of T2DM awareness among a high-risk dysglycaemic population while relating disease awareness to demographic, socio-economic, lifestyle, presence of a first degree relative with T2DM, body mass index (BMI) and blood pressure measurements. Furthermore, the authors strived to explore any relationships between diabetes awareness and a dysglycaemia

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diagnosis established through an oral glucose tolerance test (OGTT).

2. Subjects, materials and methods

2.1. Sample population

The study's sample population was identified as having an "impaired fasting blood glucose" (5.60–6.99 mmol/L) following participation in a representative cross-sectional health examination survey exploring T2DM in Malta. The detailed methodology can be found elsewhere [9]. In brief, a representative adult population stratified by age (18–70 years), gender and locality were invited for a health examination survey. Among a number of examination measurements, a blood sample for fasting blood glucose (FBG) was obtained. Anyone scoring an FBG between 5.60 and 6.99 mmol/L was considered as at high risk for dysglycaemia and was offered an oral glucose tolerance test (OGTT) two weeks after the initial examination. This high-risk dysglycaemia subpopulation was considered as the ideal candidates to explore T2DM awareness. The calculation of sample size for the current study was based on the 'Raosoft sample size calculator' using a 95% confidence interval and 5% margin of error [http://www.raosoft.com/samplesize.html]. Out of the health examination survey IFG labelled population ($n = 380$), a sample size of 192 participants was required.

2.2. Data collection

The OGTT process consists of a 2-h waiting time between the first blood draw and the last. OGTT sessions were conducted between 2015 and 2016. During the OGTT latent period, participants were invited to take part in a diabetes awareness questionnaire based on a published questionnaire by Wee et al. [10]. The questionnaire covered general aspects of diabetes, risk factors, symptoms, complications and management. Individuals answering at least half of the awareness questions correctly were considered to have adequate/good awareness. Furthermore, participants were asked about their highest education level (following the ISCED criteria [11]), their district of residence (Southern harbour, Northern harbour, South-eastern, Western and Northern), presence of a first degree relative with family history of T2DM (Yes or No), alcohol intake in the past 12 months (Yes or No) and smoking in the past 12 months (Yes or No). Participants accepting to take part in this study gave their written informed consent and were interviewed by trained fieldworkers (MB, RS and CB). Following this, participants had their blood pressure measured using Welch Allyn® aneroid sphygmomanometer model 7670–04" sphygmomanometer. Weight and height were measured using a calibrated certified ADAM® MDW-250L physical digital scale with height rod. The body mass index (BMI) was calculated by measuring the weight in kilograms and dividing this by the height in meters squared (Kg/m^2). A BMI of <24.99 kg/m^2 was labelled as normal; 25–29.99 kg/m^2 as overweight and ≥30 kg/m^2 as obese [12].

2.3. Statistical analysis

Descriptive statistics were used for all demographic and lifestyle variables (age, gender, locality district, education level, alcohol and smoking habits). Categorical analysis was performed by chi square while correlations by Pearson correlation. Associations between awareness scores and demographic, lifestyle and examination measurements were evaluated using regression analysis. All statistical analyses were conducted using IBM SPSS software.

Ethical approval was granted by the University of Malta Research Ethical Committee (UREC). Participants gave their written informed consent prior to undergoing the questionnaire and measurements.

3. Results

The study population consisted of 155 participants (males $n = 96$) with a median age of 56 years (Interquartile range: 17). The age ranged between 20 and 70 years (69 years for females). The male and female participants exhibited similar demographic and educational levels ($p = 0.35$; $p = 0.20$ respectively), however a marginal difference was present for the recollection of a T2DM family history among first degree relatives ($p = 0.05$; 51% with no family history). The majority reported consuming alcohol within the last 12 months (90.97% CI 95%: 85.31–94.65; p=<0.01; Male $n = 93$) as well as being non-smokers (78.06% CI 95%: 70.88–83.89; $p = 0.02$; Male $n = 69$). On examination, an obese BMI predominated (41.94% CI 95%: 34.45–49.81; $p = 0.01$; Male $n = 35$), while the majority were normotensive (81.94% CI 95%: 75.08–87.24%, $p = 0.77$; Male $n = 78$).

3.1. T2DM general awareness

The participants exhibited an overall good T2DM awareness, as seen in Table 1. However, it appeared that their knowledge on insulin was limited.

It was assumed that participants that answered six or more of the general awareness questions correctly had an adequate/good awareness of T2DM. On stratification of the results by gender, age, districts, education level, family history of T2DM, alcohol and smoking habits, BMI and blood pressure measurements, limited significant differences were evident, as seen in Table 2. More females ($n = 56/59$) had an adequate awareness than males ($n = 79/96$; $p = 0.02$). Additionally, those reporting a family history of T2DM ($n = 71/76$) had an adequate awareness on T2DM than those without a family history ($n = 64/79$; $p = 0.02$). In fact, a strong positive association was evident between females and an adequate/good general awareness of T2DM (OR: 4.02 CI 95%: 1.12–14.36; $p = 0.03$) when compared to males. A similar positive association was evident for those with a family history when compared to those without (OR: 3.33 CI 95%: 1.15–9.67; $p = 0.03$) in relation to general awareness.

3.2. T2DM risk factors awareness

On evaluating awareness of T2DM risk factors, the majority reported that a family history of T2DM (92.90% CI 95%: 87.61–96.12%); being obese (83.23% CI 95%: 76.50–88.34); leading a sedentary lifestyle (89.03% CI 95%: 83.05–93.13); being above 40

Table 1
Correct general awareness responses by the study population.

Question	Number of correct responses n (%) ($n = 155$)
Is diabetes a condition of high blood sugar?	152 (98%)
Is diabetes a condition of insufficient insulin?	102 (66%)
Is diabetes a condition of the body not responding to insulin?	84 (54%)
Is diabetes non-contagious?	109 (70%)
Is there more than one type of diabetes?	101 (65%)
Is diabetes curable?	65 (42%)
Is insulin a hormone?	29 (19%)
Does insulin control blood sugar?	29 (19%)
Is insulin required for some diabetic patients?	144 (93%)
Can diabetics live a normal life?	144 (93%)

Table 2
General awareness by demographic, education, family history, lifestyle habits, BMI and blood pressure stratification.

		Adequate/Good	Poor	*p*-value
Gender	Female ($n=$)	56	3	**0.02**
	Male ($n=$)	79	17	
Age	<= 45 years ($n=$)	34	6	0.65
	>= 46 years ($n=$)	101	14	
Districts	Southern Harbour ($n=$)	38	7	0.43
	Northern Harbour ($n=$)	49	6	
	Southeastern ($n=$)	16	0	
	Western ($n=$)	20	4	
	Northern ($n=$)	12	3	
Education	Primary education ($n=$)	14	2	0.40
	Lower secondary education ($n=$)	16	2	
	Upper secondary education ($n=$)	54	12	
	Tertiary/Sixth form ($n=$)	23	3	
	Undergraduate University ($n=$)	23	1	
	Postgraduate ($n=$)	5	0	
F/H T2DM	Yes ($n=$)	71	5	**0.02**
	No ($n=$)	64	15	
Alcohol	Yes ($n=$)	122	19	0.50
	No ($n=$)	13	1	
Smoke	Yes ($n=$)	27	7	0.13
	No ($n=$)	108	13	
BMI Categories	Normal ($n=$)	25	3	0.62
	Overweight ($n=$)	52	10	
	Obese ($n=$)	58	7	
Blood pressure	High blood pressure ($n=$)	25	3	0.73
	Normotensive ($n=$)	110	17	

F/H – Family history; BMI – Body mass index.

years of age (76.13% CI 95%: 68.81–82.19); dietary intake of high sugar (90.97% CI 95%:85.31–94.65); dietary intake of high fat (70.39% CI 95%: 62.69–76.97) and a high alcohol intake (77.42% CI 95%: 70.19–83.32) were all risk factors for T2DM. However, only 38.06% (CI 95%: 30.79–45.91) considered hypertension as being a risk factor for T2DM. Of note, 35.71% (CI 95%: 20.63–54.25%) of the participants found to have a high blood pressure (>140/90 mmHg) during the OGTT session ($n=28$), reported that hypertension is a risk factor for T2DM. Interestingly, 82.95% (CI 95%: 75.46–88.53) found to have an elevated BMI (>25 kg/m^2) during the OGTT sessions reported that obesity is a risk factor for T2DM.

It was assumed that participants answering four or more of the risk factors questions correctly had an adequate/good awareness of T2DM. On stratification of the results by gender, age, districts, education level, family history of T2DM, alcohol and smoking habits and BMI measurement, no significant differences in awareness were present, as seen in Table 3. Those with a normal blood pressure ($n=126/127$) had a marginal better awareness of T2DM risk factors than those with elevated blood pressure ($n=26/28$; $p=0.03$). In fact, no significant association between blood pressure and risk factor awareness was present ($p=0.07$).

3.3. T2DM symptoms and complications

The majority of the participants were aware of the symptoms and complications of T2DM. However, only 20.65% (CI 95%: 14.98–27.73) reported that arthritis is linked with T2DM. It was assumed that participants that answered seven or more of the symptoms and complications questions correctly had an adequate/good awareness of T2DM. Stratification of the results by gender, age, districts, education level, family history of T2DM, alcohol and smoking habits, BMI and blood pressure measurements was performed as seen in Table 4.

There were several significant findings. More females ($n=55/59$) had an adequate awareness than males ($n=75/96$; $p=0.01$), as did the non-smokers ($n=106/121$) when compared to smokers ($n=24/34$; $p=0.02$). In fact, females exhibited a positive association with having adequate T2DM symptoms and complications awareness when compared to the males (OR: 3.85 CI 95%: 1.25–11.85, $p=0.02$). Conversely, the smokers had a negative association with symptom and complication awareness when compared to the non-smokers (OR: 0.34 CI 95%: 0.14–0.85, $p=0.02$).

3.4. T2DM monitoring

The majority of the participants exhibited a good awareness on ways to monitor for T2DM, as could be seen even after stratification by gender, age, districts, education level, family history of T2DM, alcohol and smoking habits, BMI and blood pressure measurements (Table 5).

3.5. Glycaemia and awareness

All participants underwent an oral glucose tolerance test (OGTT). The majority were diagnosed as having impaired fasting blood glucose (50.97% CI 95%: 43.17–58.72; male $n=53$), followed by normal glucose tolerance (27.74%CI 95%: 21.28–35.28; male $n=22$), impaired glucose tolerance (15.48% CI 95%: 10.57–22.07; male $=n=15$) and type 2 diabetes (5.81% CI 95%: 2.94–10.81, $n=6$). The males exhibited a predominant dysglycaemia diagnosis. An adequate/good T2DM awareness was observed throughout the glycaemic spectrum. In fact, no correlation was present between the glycaemic status and general awareness ($p=0.97$); risk factor awareness ($p=0.15$); symptom and complication awareness ($p=0.76$) and monitoring awareness ($p=0.99$).

3.6. Multivariant analysis for awareness

Multivariant binary logistic regressions were performed to analyse for independent factors associated with the different categories of T2DM awareness while adjusting for gender, age, education level, residential district, family history of T2DM, smoking and alcohol habits. Being female (OR: 3.96 CI 95%: 1.11–14.16,

Table 3
T2DM risk factors awareness by demographic, education, family history, lifestyle habits, BMI and blood pressure stratification.

		Risk factors		
		Adequate/Good	Poor	*p*-value
Gender	Female ($n=$)	59	0	0.17
	Male ($n=$)	93	3	
Age	<= 45 years ($n=$)	40	0	0.30
	>= 46 years ($n=$)	112	3	
Districts	Southern Harbour ($n=$)	43	2	0.63
	Northern Harbour ($n=$)	54	1	
	Southeastern ($n=$)	16	0	
	Western ($n=$)	24	0	
	Northern ($n=$)	15	0	
Education	Primary education ($n=$)	16	0	0.69
	Lower secondary education ($n=$)	17	1	
	Upper secondary education ($n=$)	65	1	
	Tertiary/Sixth form ($n=$)	25	1	
	Undergraduate University ($n=$)	24	0	
	Postgraduate ($n=$)	5	0	
F/H T2DM	Yes ($n=$)	75	1	0.58
	No ($n=$)	77	2	
Alcohol	Yes ($n=$)	138	3	0.58
	No ($n=$)	14	0	
Smoke	Yes ($n=$)	32	2	0.06
	No ($n=$)	120	1	
BMI Categories	Normal ($n=$)	28	0	0.56
	Overweight ($n=$)	60	2	
	Obese ($n=$)	64	1	
Blood pressure	High blood pressure ($n=$)	26	2	**0.03**
	Normotensive ($n=$)	126	1	

Table 4
T2DM symptoms and complications awareness by demographic, education, family history, lifestyle habits, BMI and blood pressure stratification.

		Symptoms and Complications		
		Adequate/Good	Poor	*p*-value
Gender	Female ($n=$)	55	4	**0.01**
	Male ($n=$)	75	21	
Age	<= 45 years ($n=$)	32	8	0.44
	>= 46 years ($n=$)	98	17	
Districts	Southern Harbour ($n=$)	33	12	0.08
	Northern Harbour ($n=$)	50	5	
	Southeastern ($n=$)	15	1	
	Western ($n=$)	21	3	
	Northern ($n=$)	11	4	
Education	Primary education ($n=$)	15	1	0.61
	Lower secondary education ($n=$)	15	3	
	Upper secondary education ($n=$)	52	14	
	Tertiary/Sixth form ($n=$)	22	4	
	Undergraduate University ($n=$)	21	3	
	Postgraduate ($n=$)	5	0	
F/H T2DM	Yes ($n=$)	67	9	0.16
	No ($n=$)	63	16	
Alcohol	Yes ($n=$)	117	24	0.34
	No ($n=$)	13	1	
Smoke	Yes ($n=$)	24	10	**0.02**
	No ($n=$)	106	15	
BMI Categories	Normal ($n=$)	25	3	0.38
	Overweight ($n=$)	49	13	
	Obese ($n=$)	56	9	
Blood pressure	High blood pressure ($n=$)	26	2	0.15
	Normotensive ($n=$)	104	23	

$p=0.04$) and ageing (OR: 1.05 CI 95%: 1–1.10, $p=0.05$) were significantly associated with awareness for the symptoms and complications of T2DM.

4. Discussion

This study explores T2DM awareness among a 'dysglycaemic high-risk' sample population originating from a national representative study [9]. Type 2 diabetes is a health burden. In Malta an estimated 19,558 adults out of 233,136 adults (25–64 years) suffered from T2DM in 2016 [13]. T2DM disease has a latent period of several years [14]. Hence, an adequate awareness on T2DM pathophysiology, symptoms and its related complications is a requisite among the general population.

It was observed that being a female and following a non-smoking habit had a higher degree of T2DM awareness. The

Table 5
T2DM monitoring awareness by demographic, education, family history, lifestyle habits, BMI and hypertension stratification.

		Monitoring		
		Adequate/Good	Poor	*p*-value
Gender	Female (*n* =)	59	0	0.43
	Male (*n* =)	95	1	
Age	<= 45 years (*n* =)	39	1	0.09
	>= 46 years (*n* =)	115	0	
Districts	Southern Harbour (*n* =)	44	1	0.65
	Northern Harbour (*n* =)	55	0	
	Southeastern (*n* =)	16	0	
	Western (*n* =)	24	0	
	Northern (*n* =)	15	0	
Education	Primary education (*n* =)	16	0	0.93
	Lower secondary education (*n* =)	18	0	
	Upper secondary education (*n* =)	65	1	
	Tertiary/Sixth form (*n* =)	26	0	
	Undergraduate University (*n* =)	24	0	
	Postgraduate (*n* =)	5	0	
F/H T2DM	Yes (*n* =)	75	1	0.31
	No (*n* =)	79	0	
Alcohol	Yes (*n* =)	140	1	0.75
	No (*n* =)	14	0	
Smoke	Yes (*n* =)	34	0	0.60
	No (*n* =)	120	1	
BMI Categories	Normal (*n* =)	28	0	0.49
	Overweight (*n* =)	62	0	
	Obese (*n* =)	64	1	
Blood pressure	High blood pressure (*n* =)	27	1	0.06
	Normotensive (*n* =)	127	0	

association between females and an increased T2DM awareness has been reported previously [15,16]. The Maltese females have been reported to be metabolically healthier than the males, with lower prevalence of T2DM and obesity among others [13,17,18]. This may suggest that females are more self-conscious about their health. Conversely, individuals opting to follow a non-smoking lifestyle are more likely to be aware of related complications, such as development of T2DM [19]. Ageing and having a family history of T2DM were also significantly associated with an adequate T2DM awareness. It stands to reason that having a close relative suffering from T2DM as well as getting older, an individual stands a higher chance of first-hand encounters with T2DM and its complications [20–22]. In this study, socio-economic factors, geographic location and alcohol intake did not appear to be related to T2DM awareness.

Although this study exhibits an adequate T2DM awareness, a gap in diabetes health inequalities is still evident. In fact, the study's participants were all undergoing an OGTT following an irregular fasting blood glucose test and the majority had an eventual dysglycaemia diagnosis. Moreover, the majority of the study participants reported that obesity was a risk factor for T2DM, however more than three-quarters of these participants were found to be within the obese BMI category. Furthermore, it has been reported that 10.39% of the Malta adult population suffer from T2DM [13]. Hence, awareness of T2DM alone is not sufficient to change behaviours and halt the emergence of T2DM [23]. A holistic approach needs to be followed which incorporates not just population education but also the population behaviour, culture, social gradients, society and the environment. However, implementing such changes is not effortless. In fact, high-risk individuals need to overcome both motivational barriers (the ability to feel motivated to perform a change) and volitional barriers (the power to make the choice/decision) prior to establishing any behavioural change. However, once the motivation action gap has been overcome, the individual can actually achieve a change [24]. Therefore, it is essential that interventions and strategies provide individualized intensive delivery with advice, information and motivation [25]. For an effective diabetes prevention action, individuals need to be embedded in a supportive social environment including being aware of available support groups [26]. It is essential to incorporate all available social support to engage motivation for the desired behavioural changes. These include changes in the work place environment; implementation of healthy food and drink choices in restaurants and cafeterias as well as availability of educational programs targeting healthy eating and lifestyle from very early school age up till university levels [26]. It is also important to engage the different sources of diabetes information hubs in health policy plans including non-governmental organisations and insurance companies apart from the media.

4.1. Study strengths and limitations

This study gives a good insight into the fact that T2DM awareness is not a sole player in preventing this epidemic and provides a helpful baseline for public health officials. The study explores the relationships between T2DM awareness and geographical, educational and lifestyle factors as well as relationships between awareness and examined blood pressure and BMI.

The recruited participants for this study represented only those who initially responded to the national study and obtained an impaired fasting blood glucose on examination. These were considered as a 'high-risk of dysglycaemia'. Non-responders to the national study as well those found to be normoglycaemic or having frank diabetes were excluded. Furthermore, a little less than 50% of the identified IFG population accepted to undertake the OGTT test and hence took part in the current study (convenience sample). However, following statistical sampling, the convenience sample was found to be acceptable to explore T2DM awareness among high risk dysglycaemic sub-population. Data on awareness was self-reported and is subject to recall bias and reporting bias. This data was based on quantitative options regarding T2DM general, risks, symptoms, complications and management awareness. Qualitative

research to explore in depth potential trends in awareness is recommended. Furthermore, those accepting the OGTT invitation may have exhibited potential biases on their diabetes knowledge since they might have had time to research on the disease prior to the test. The BMI measurements may have been slightly inflated since participants were asked to remove only heavy garments and shoes to maintain their privacy. The blood pressure readings might not have been accurate since participants might have felt to be in a hostile environment undergoing a medical test, resulting in higher measurements than the norm. The participants' medical and treatment histories were not taken in consideration in the analyses and may have acted as confounding factors. Cultural, social and behavioural factors were not considered.

4.2. Implementations and recommendations

Diabetes is a growing public health burden. The study population exhibited adequate awareness on the general concept of diabetes, risk factors, complications and management. However, awareness on its own is not sufficient as participants appeared to lack motivation to engage in a behavioural change and prevent the development of dysglycaemia. It is clear that empowerment is required for motivational and volitional barriers to be overcome and preventive action is undertaken. This brings forward the suggestion for community diabetes mellitus screening programs that engage in empowerment of the population, targeting the environment, social gradients and cultural norms while engagement in preventive interventions.

Declaration of conflicts of interest

The Author(s) declare(s) that there is no conflict of interest.

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