



ORIGINAL ARTICLE

Survey of Primary Care Physicians' Knowledge, Practices & Perceptions of Prediabetes in Bahrain

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Received date: February 02, 2022; **Accepted date:** June 22, 2022; **Published date:** September 30, 2022

Abstract

Background: Prediabetes is a condition that develops before diabetes and can be treated with intensive Lifestyle Modifications (LSM). This study aimed to assess the knowledge, practices, and perceptions of Primary Care Physicians (PCPs) toward prediabetes in Bahrain.

Methods: PCPs in the study were surveyed using a cross-sectional questionnaire in all 28 government-run Primary Healthcare Centres (PHCs) in Bahrain. We used descriptive statistics to analyse the data, which were then reported as percentages.

Results: From 378 PCPs, 263 completed the questionnaire. The physician's knowledge of prediabetes Risk Factors (RFs) and HbA1C laboratory criteria to diagnose prediabetes was inadequate. As an initial step to manage prediabetes, 12.5% of PCPs refer patients to Diabetes Prevention lifestyle change Programs (DPPs). Moreover, 15.6% recommend 7% minimum weight loss, 57.8% recommend 150 minutes per week of physical activity and 67.7% recommend prescribing metformin. Overall, our study revealed that General Practitioners (GPs) had inferior knowledge to Family Physicians (FPs). According to PCPs, diabetes prevention is hindered by both individual and system-level challenges (e.g., Inadequate motivation and resources to lose weight). Furthermore, PCPs consider that improved access to DPPs and coordinated referrals to them could delay diabetes.

Conclusion: Risk stratification, appropriate diagnosis, and intervention at the prediabetes stage are of critical importance for preventing diabetes. Increasing awareness of the public regarding prediabetes complications and educating healthcare providers, especially GPs, on screening guidelines, diagnostic criteria, and evidence-based management options for prediabetes can bring us one step closer to slowing the diabetes epidemic in Bahrain.

Keywords: Bahrain, Primary care physician, Knowledge, Practice, Perception, Prediabetes

Introduction

Diabetes is the epidemic of this century. In Bahrain, 66771 patients registered in non-communicable disease clinics from 2013 to 2019 were diabetics.¹ Among the tested patients in the Ministry of Health (MOH) by the year 2016-2018, 14109 adults were diagnosed with prediabetes (42% & 34 % of Bahraini females & males respectively).²

A meta-analysis to evaluate the association between prediabetes and Cardiovascular Disease (CVD) was published in the *BMJ* in July 2020.³ The study concluded that prediabetes, in the general population and patients with established atherosclerotic heart disease, is associated with a greater risk of all-cause mortality and cardiovascular complications.³ Thus, primary and secondary prevention of CVD can be improved by proper screening and management of prediabetes.³ On the other hand, moving from prediabetes to normoglycemia decreases cardiovascular complications.⁴ It was also found that prediabetes is linked to impairment in microvascular function and retinopathy.⁵⁻⁸

A study was done in Islamabad in 2018 to assess doctors' knowledge regarding screening & management of prediabetes.⁹ It demonstrated that only 71.8%, 51.7%, and 39.9% of physicians could efficiently recognize Fasting Blood Sugar (FBS), HbA1c & Oral Glucose Tolerance Test (OGTT) criteria for prediabetes, respectively.⁹ These results are consistent with the results of a study assessing the same domains of knowledge conducted in Sudan.¹⁰ The later study revealed that 82.5% and 56.5% recognized the FBS and HbA1c cutoff indicative of prediabetes, respectively.¹⁰

A study conducted by Tseng at John Hopkins University yielded that PCPs have inadequate knowledge of laboratory criteria for diagnosing prediabetes, prediabetes screening RFs, and management recommendations.¹¹ This survey also found that 36% of PCPs refer to DPP initially and 43% of them discuss metformin prescriptions with their patients.¹¹

As a pharmacologic intervention to delay diabetes, metformin has been proven safe and effective for the prevention of diabetes in people with prediabetes.¹² The DPP randomized clinical trial studied the long-

term effects of metformin in prediabetes. It revealed that metformin prevented the progression of prediabetes to diabetes by 18% compared to placebo over 15-years and that it prevented microvascular complications among those who did not develop diabetes.¹²

Since diabetes is preventable by prediabetes screening and management, improving physicians' awareness and knowledge in applying evidence-based guidelines will significantly decrease the development of diabetes and its complications. Thus, the implication of our study is to establish a baseline of prediabetes practices in PHCs in Bahrain and set recommendations to improve the outcome of prediabetes care accordingly.

Methods

Study Design

Cross-sectional study

Setting

All the governmental PHCs in Bahrain (28 PHCs).

Sample population

A list of all PCPs (FPs and GPs), attending morning or afternoon duties in PHCs, was obtained from the human resources office at the MOH in Bahrain, which included a total of 378 physicians.

Sample Size

All PCPs attended morning or afternoon duties in PHCs during the study period, from 1st of May until the 30th of June 2021. Those who declined to participate were considered non-respondents.

PCPs will be divided into 3 groups: First, the FPs who work full-time are designated FP/FT, FPs who work part-time are designated FP/PT, and finally the general practitioners are designated GPs.

Study Tool (Questionnaire)

A Self-filled questionnaire was used. The questionnaire was adapted from a previous study conducted in the USA and published by the Journal of General Internal Medicine in September 2019.¹¹ The questionnaire domains are based on American Diabetes Association (ADA) guidelines for prediabetes and literature reviews. To improve

the questionnaire, pilot tests were conducted among PCPs in community settings. Permission to use the questionnaire was obtained through a permission letter from the 1st author and key answers to the knowledge questions were provided.

There were four sections in the original questionnaire, namely:

1. Knowledge & practice about prediabetes screening
2. Knowledge & practice about prediabetes management
3. Knowledge, practices, and beliefs about treating prediabetes with medications
4. Demographic data.

The first author of the original study approved the addition of some modifications to the questionnaire. The purpose of these minor modifications was to make the questionnaire applicable to the primary care setting and population in Bahrain. The first applied modification was to the question related to RFs for prediabetes. The ethnic groups mentioned in the question were omitted as they do not apply to Bahrain's population. The omitted ethnic groups are African American, Asian American, Native American & Latino American. The second applied modification was regarding the question about FBS and HbA1C levels units. The units utilized in the MOH in Bahrain were added besides the units used by the ADA. The MOH in Bahrain uses mmol/l for FBS and IFCC unit mmol/mol for HbA1C, while ADA uses mg/dL for FBS and % for HbA1C. The third modification was concerning the demographic information. Questions related to ethnicity, race, primary care settings, and patients' insurance coverage were substituted with other questions that suit the primary care setting in Bahrain. The additional items included were the professional title, gender, age, nationality, and the number of years in Practice.

Data Collection Procedure

Total population sampling was done. Data was collected over two months using an online

survey. The study's objectives have been explained to the chiefs of each PHC. The questionnaires were then distributed by the chief to his/her center doctors electronically. A reminder message was sent to the PHCs with low response rates.

Data Processing and Analysis

Data were entered in a database program (SPSS). Descriptive analysis was carried out. The responses are displayed in frequencies and percentages.

Due to using an online survey, the respondents were unable to complete the survey without filling in all the required fields. Hence, there were no missing values in the analysis.

To determine whether PCPs' characteristics are associated with main outcomes, Chi-square and Fisher's Exact (when expected $n < 5$ in any cell) tests were used. Responses on the Likert scale were divided into two groups; strongly agree & agree responses in one group and neutral, disagree & strongly disagree responses in the other. P-value is considered significant if it is ≤ 0.05 .

Ethical Consideration and Confidentiality

Permission was obtained from the original study's corresponding author to use and modify the questionnaire. Participants gave their written consent. The questionnaires were anonymous. Permission and ethical approval were obtained from the Primary Care Research & Ethics committee in Bahrain MOH.

Results

Sample

A total of 378 PCPs received the questionnaire, of which, 263 responded, giving a response rate of 70%. Table 1 shows the respondents' characteristics. Female respondents were 81%, and 52% were between the ages of 30-40 years. Two hundred and thirty-nine (91%) were Bahraini. Full-time FPs were the majority (76%), followed by GPs (14%), and finally, part-time FPs 10% of the sample. Fifty percent (131) were in practice for more than 11 years.

Table 1: Demographic and general characteristics of participants.

Demographic Characteristics		n (%)
Sex	Female	214 (81.4)
	Male	49 (18.6)
		263 (100)
Age	20-30	7 (2.7)
	30-40	137 (52.1)
	40-50	66 (25.1)
	50-60	53 (20.2)
		263 (100)
Nationality	Bahraini	239 (90.9)
	Non-Bahraini	24 (9.1)
		263 (100)
Professional Title	Full-time FP (FP/FT)	200 (76)
	Part-time FP (FP/PT)	27 (10.3)
	General practitioner (GP)	36 (13.7)
		263 (100)
Number of Years in Practice	less than 5 years	53 (20.1)
	6-10 years	79 (30.1)
	11 and more years	131 (49.8)
		263 (100)

Knowledge of diagnostic criteria for diabetes and prediabetes based on laboratory tests.

Table 2 summarizes the correct answers to diagnostic laboratory criteria for diabetes and prediabetes using FBS and HbA1C.

Table 2: Knowledge of lab criteria to diagnose diabetes and prediabetes among PCPs in Bahrain.

Values are numbers (%). N=263

Laboratory diagnostic criteria for diabetes/ prediabetes	Correct answer	Total	95% CI	Professional Title			P value
				FP/FT n=200	FP/PT n=27	GP n=36	
A. Diabetes							
Lower limit of FBS	Correct answer	189(71.9)	66.4 to 77.3	150(75)	22(81.5)	17(47.2)	0.000
Lower limit of HbA1c	Correct answer	155(58.9)	53.0 to 65.0	126(63)	16(59.3)	13(36.1)	0.010
B. Prediabetes							
Lower limit of FBS	Correct answer	175(66.5)	61.0 to 72.2	135(67.5)	23(85.2)	17(47.2)	0.001
Upper limit of FBS	Correct answer	215(81.7)	77.1 to 86.4	174 (87)	21(77.8)	20 (55.6)	0.000

A. Diabetes

For diagnosing diabetes, 71.9% (95%CI = 66.4 to 77.3%) of the 263 participants selected the correct value for the lower limit for FBS, and 58.9% (95%CI = 53 to 65%) selected the correct value for the lower limit of HbA1C. Compared to FPs, GPs selected fewer correct values for FBS and HbA1C categories (47.2% and 36.1% respectively), resulting in a significant difference between the groups ($p = .000$ for FBS and $p = .010$ for HbA1C.)

B. Prediabetes

One hundred and seventy-five (66.5%) (95% CI = 61.2 to 72.2%) and 215(81.7%) (95% CI = 77.1 to 86.4%) of PCPs, correctly selected the lower and upper limit of FBS respectively. Significantly, full-time & part-time FPs were more familiar with the lower and upper limits of FBS than GPs ($p = .001$ and $p = .001$ respectively). PCPs were less familiar for the lower limit of HbA1c 36.5% (95% CI = 30.7 to 42.3%) and upper limit HbA1C, 49.4% (95%CI = 43.4 to 55.5%). Although non-significant, compared to FPs, GPs scored lower for the lower and upper limit of HbA1c (36.1% and 33.3% respectively).

Lower limit of HbA1C	Correct answer	96 (36.5)	30.7 to 42.3	73 (36.5)	10(37)	13 (36.1)	0.997
Upper limit of HbA1C	Correct answer	130(49.4)	43.4 to 55.5	104 (52)	14(51.9)	12 (33.3)	0.115

Knowledge of prediabetes Risk Factors (RFs) & management recommendations

Knowledge about prediabetes RFs and management is displayed in table 3.

A. Prediabetes RFs

Only 16.7% (95%CI = 12.2 to 21.2%) of PCPs correctly selected all RFs. Although not significant, GPs were less familiar with the RFs, and only 5.6% correctly selected all the RFs.

B. Management recommendations

Only 12.5% (95%CI = 8.5 to 16.6%) of PCPs

referred patients to a DPP to manage prediabetes; 15.6% (95% CI = 11.2 to 20%) recommended a weight-reduction target of 7% to delay diabetes; and 57.8% (95%CI = 51.8 to 63.8%) recommended 150 minutes of physical activity weekly. There was no significant difference between the groups of PCPs, for referrals to DPP, weight loss, and physical activity. However, part-time FPs were less aware of referrals to DPPs (3.7%) than full-timers (12.5%) and GPs (19.4%). In addition, GPs were less knowledgeable about minimum physical activity.

Table 3: Knowledge of RFs for prediabetes screening and recommendations of prediabetes management (Correct responses only) among PCPs in Bahrain. .

Values are numbers (%) N=263

		Total	95% CI	Professional Titles			P Value
				FP/FT n=200	FP/PT n=27	GP n=36	
A. Knowledge of RFs for prediabetes screening							
RFs	All RFs selected	44(16.7)	12.2 to 21.2	39(19.5)	3(11.1)	2(5.6)	.085
B. Knowledge for recommendations for prediabetes management							
Recommended initial management approach	Refer patient to DPP	33(12.5)	8.5 to 16.6	25(12.5)	1(3.7)	7(19.4)	0.175
Minimum weight loss Target	7% of body weight	41(15.6)	11.2 to 20	28 (14)	6(22.2)	7(19.4)	0.415
Minimum physical activity target	150 minutes per week	152(57.8)	51.8 to 63.8	118 (59)	18(66.7)	16(44.4)	0.330

Prediabetes-related practices.

Table 4 demonstrates the tests used for prediabetes screening, prediabetes initial management approach, prediabetes follow-up approach, and frequency of prescribing metformin for prediabetes.

A. Tests used for prediabetes screening

Majority, 90% (95%CI = 87.6 to 94.7%) of the PCPs screen for prediabetes using FBS, 52.9% (95%CI = 46.8 to 58.9%) would order 2 hours' OGTT and

66.9% (95%CI = 61.2 to 72.6%) would request HbA1c.

Significantly, compared to FPs, GPs identified less correctly FBS as a diagnostic criterion (75% of GPs Vs 96.3% of FP/PT and 94% of FP/FT (p = .001)).

B. Prediabetes initial management

The majority of PCPs considered prediabetes as a major condition that required management. One hundred and eight, (41%) (95% CI 35.0 to 47.0%)

would refer to DPP for further management, 94.7% (95%CI 91.2 to 97.1%) would counsel on diet and physical activity, 51% (95% CI 45.3 to 57.4%) would refer to a nutritionist, 67.7% (95% CI=62.0 to 73.3%) would discuss starting Metformin and only 14.4% (95% CI 10.2 to 18.7%) would recommend Bariatric surgery. Significantly, FP/PT (25.9%) were less likely to refer patients to nutritionists than FP/FT and GPs (55% and 47.2%, respectively $p=.02$). Compared to GPs (44.4%), significantly, full-time FPs (71.5%) and part-time FPs (70.4%), would start Metformin $p=.006$.

C. Prediabetes follow-up approach

Eighty-eight (33.5%) (95% CI 27.8 to 39.2) of PCPs would repeat lab test after one year and 108(41.1%) (95% CI= 35.1 to 47.0%) would request follow-up after 6 months.

D. Frequency of prescribing metformin for pre-diabetes.

Eighty-eight (33.5%) (95%CI = 27.8 to 39.2%) of PCPs prescribed metformin for 1-5% of their prediabetes patients. However, 22.4% (95%CI = 17.4 to 27.5%) stated that they prescribed metformin to more than 75% of their patients, with GPs making up the largest prescribers (47.2%).

Table 4: Prediabetes-related practices among PCPs in Bahrain. Values are numbers (%). N=263

	Total	95% CI	Professional Title			P Value
			FP/FT n=200	FP/PT n=27	GP n=36	
*A. Tests for pre-diabetes screening						
RBS	34(12.9)	8.9 to 17.0	25(12.5)	2(7.4)	7(19.4)	0.346
FBS	241(91.6)	87.6 to 94.7	188 (94)	26(96.3)	27 (75)	0.000
2-hour OGTT	139(52.9)	46.8 to 58.9	108 (54)	11(40.7)	20(55.6)	0.406
HbA1c	176(66.9)	61.2 to 72.6	137(68.5)	15(55.6)	24(66.7)	0.406
Other	0(0)	0	0(0)	0(0)	0(0)	NA
Do not screen routinely	0(0)	0	0(0)	0(0)	0(0)	NA
*B. Initial management approach to a patient with prediabetes						
Don't consider prediabetes a condition that requires management	3 (1.1)	0.24 to 3.3	2(1)	0(0)	1(2.8)	0.548
Refer to DPP	108(41.1)	35.1 to 47.0	81 (40.5)	11(40.7)	16(44.4)	0.906
Counsel on diet & physical activity	249(94.7)	91.2 to 97.1	189(94.5)	26(96.3)	34(94.4)	0.925
Refer to nutritionists	134 (51)	45.3 to 57.4	110 (55)	7(25.9)	17(47.2)	0.016
Discuss starting metformin	178(67.7)	62.0 to 73.3	143(71.5)	19(70.4)	16(44.4)	.006
Refer for bariatric surgery	38 (14.4)	10.2 to 18.7	34 (17)	3(11.1)	1(2.8)	.072
C. Follow up approach to patients with prediabetes						
Repeat lab tests after:	3 Months	77(29.3)	23.8 to 34.8	52(26.0)	9(33.3)	16(44.4)
	6 Months	82(31.2)	25.6 to 36.8	65(32.5)	4(14.8)	13(6.1)
	One year	88(33.5)	27.8 to 39.2	70(35)	13(48.1)	5(13.9)
	Two years	3(1.1)	0.24 to 3.3	3(1.5)	0(0)	0(0)
	No specific recommendation	7(2.7)	1.1 to 5.4	6(3)	0(0)	1(2.8)
	Others	6(2.3)	0.8 to 4.9	4(2)	1(3.7)	1(2.8)

Request Follow-up after:	1 Month	0(0)		0 (0)	0(0)	0(0)
	3 Months	95(36.1)	30.3 to 41.9	67 (33.5)	8(29.6)	20(55.6)
	6 Months	108(41.1)	35.1 to 47.0	88 (44)	11(40.7)	9(25)
	One year	42(16)	11.5 to 20.4	31(15.5)	6(22.2)	5(13.9)
	Two years	0(0)		0(0)	0(0)	0(0)
	No specific recommendation	10 (3.8)	1.8 to 6.9	9(4.5)	1(3.7)	0(0)
	Others	8(3)	1.3 to 5.9	5(2.5)	1(3.7)	2(5.6)

D. Frequency of Metformin Prescription for patients with prediabetes

0%	0(0)		0(0)	0(0)	0(0)
1-5%	88 (33.5)	27.8 to 39.2	69 (34.5)	11(40.7)	8 (22.2)
> 5-25%	67 (25.5)	20.2 to 30.7	57 (28.5)	6(22.2)	4 (11.1)
> 25-50%	26(9.9)	6.6 to 14.2	20 (10)	4(14.8)	2(5.6)
> 50-75%	23 (8.8)	5.6 to 13.0	17 (8.5)	1(3.7)	5 (13.9)
> 75%	59 (22.4)	17.4 to 27.5	37 (18.5)	5(18.5)	17(47.2)

*All the 263 participants responded, only the YES responses are displayed in the table.

Perception of prediabetes

The majority of physicians (77.9%) (95%CI=72.9 to 83.0%) agreed that patients with prediabetes would progress to diabetes more rapidly than those with normoglycemia and that lifestyle changes minimize the risk of that progression (80.2%) (95%CI = 75.4

to 85.0%). Almost three-quarters of the physicians (74.9%) (95%CI = 69.7 to 80.1%) agreed that metformin may help patients with prediabetes reduce their risk of developing diabetes (Table 5). Although non-significant, 63.9% of GPs believed less than FP/FT (77.5%) and FP/PT (70.4%) in the effects of metformin on preventing diabetes.

Table 5: Perception of prediabetes. Values are numbers (%). N=263

		Total	95% CI	Professional Title			P Value
				FP/FT n=200	FP/PT n=27	GP n=36	
Patients with prediabetes progress to diabetes more quickly than those with normoglycemia	Agree	205 (77.9)	72.9 to 83.0	156 (78)	19 (70.4)	30 (83.3)	0.47
LSM can reduce the risk of diabetes in prediabetes	Agree	211 (80.2)	75.4 to 85.0	160 (80)	20 (74.1)	31 (86.1)	0.488
Metformin can reduce the risk of diabetes in prediabetes	Agree	197 (74.9)	69.7 to 80.1	155 (77.5)	19 (70.4)	23 (63.9)	0.189

Prediabetes management barriers and interventions on both the patient and system levels.

A. Life style modification barriers

PCPs acknowledged that the top barriers to lifestyle changes for patients are lack of motivation (84.8%),

limited or no success with prior LSM (73.8%), the stress in their lives (73.4%), and lack of weight loss and nutrition resources (72.6%). The least perceived barriers perceived by patients were, financial limitations (38%) and limited access to healthy food options (33.8%). (Figure 1).

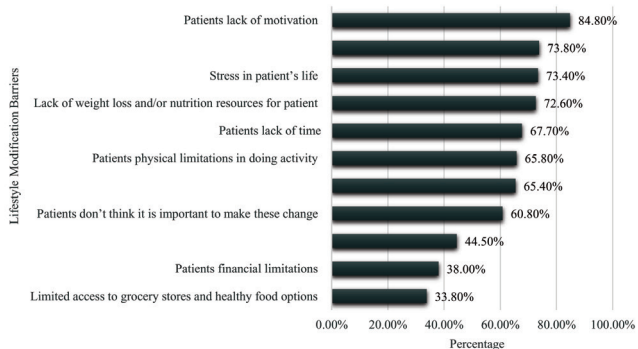


Figure 1: LSM Barriers for Prediabetes Patients

B. Barriers to starting Metformin

PCPs reported patients' dislike of taking medications (82.5%), anticipated poor adherence (77.6%), and potential side effects (62%) as being of great influence (Figure 2).

Nevertheless, medications costs (21.3%) and lack of FDA approval (23.2%) were the least appreciated barriers.

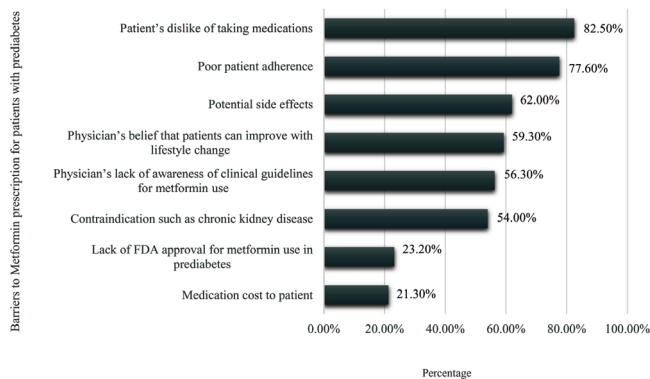


Figure 2: Barriers to Metformin prescription for patients with prediabetes

C. Interventions to improve prediabetes management

PCPs provided several suggestions regarding potential approaches to managing prediabetes, including improved access to weight loss programs (89.7%), increased availability of DPP (88.2%), coordinating patient referral to lifestyle change programs (87.8%), enhanced physician education about prediabetes (87.1%), providing educational material for patients (86.3%), and providing more time for patient counseling by the physician (85.6%). Physician's incentives were the least favored (70.3%).

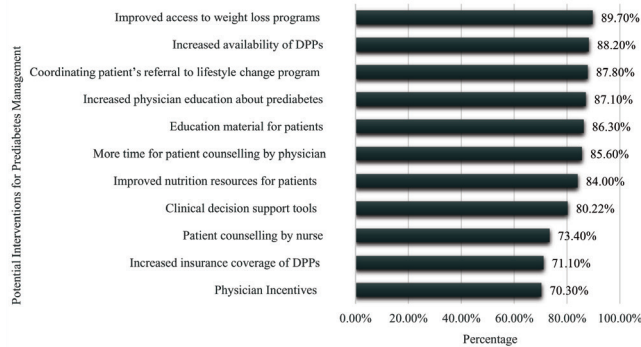


Figure 3: Potential interventions for providing prediabetes management

Discussion

This is the first survey to evaluate PCPs' knowledge and practices related to prediabetes in the Gulf Cooperation Council (GCC). The result from the study shows that PCPs in Bahrain have adequate knowledge (>50%) of the laboratory criteria (FBS and HbA1C) to diagnose diabetes and FBS criteria to diagnose prediabetes but they were less familiar with the HbA1C criteria to diagnose prediabetes. Except for the HbA1C criteria to diagnose prediabetes, the performance of PCPs in Bahrain was better than that of Eva Tseng's study in the USA.¹¹ The GPs in Bahrain, however, were far less aware of diagnostic criteria than the FPs.

Lack of knowledge about the HbA1C criteria to diagnose prediabetes may contribute to underdiagnosis. The Centers for Disease Control and Prevention (CDC) confirms this finding, stating that approximately 90% of people with laboratory values in the prediabetes range are not aware of their condition.¹³ As a step towards assisting physicians incorrectly labeling patients as diabetic or prediabetes, Bahrain MOH laboratories have provided glycemic control ranges and diagnostic criteria for prediabetes and diabetes with every FBS and HbA1C test result.

PCPs' knowledge about RFs was consistent with the results of the Tseng Study,¹¹ as both study results indicated that PCPs are unaware of all the proven RFs (15% and 16.7% respectively). Again, GPs exhibited less expertise in this area than FPs. A lack of knowledge about RFs often leads to diabetes and

prediabetes being overlooked or detected too late, which increases morbidity rates.

Present study results showed that most prediabetes evidence-based recommendations were less known, especially in referral to DPPs (12.5%) and minimum weight loss recommendations (15.6%), but PCPs had sufficient knowledge about the minimum physical activity recommendations (57.8%). Although inadequate, the knowledge of PCPs in the USA,¹¹ regarding referral to DPPs, was better than those in Bahrain (around 30%). This may be explained by the unavailability of such structured programs in Bahrain. However, PCPs in Bahrain outperformed their US counterparts (7.6%) regarding the weight loss recommendation. Evidence suggests that small thresholds (5-7%) are sufficient for achieving clinical benefit.^{14, 15, 16} Improving physicians' knowledge about this reasonable weight loss target is vital to providing patients with practically achievable goals.

The majority of PCPs were conversant with laboratory diagnostic criteria tests used for screening; the majority requested FBS (90%) while 66.9% requested HbA1C as well. Only 75% of GPs ordered FBS for screening. Moreover, 52.9% of PCPs in Bahrain recommend 2-hour OGTTs, a number significantly higher than that in the USA (8%).¹¹ This indicates that the use of OGTT is limited and that many people with isolated Impaired Glucose Tolerance (IGT) (without Impaired Fasting Glucose (IFG)) go undiagnosed and untreated. This is unfortunate because it is vital to identify prediabetes with (IGT), who are vulnerable to CVD and diabetes.¹⁷

PCPs in Bahrain would re-order blood tests after 1 year (33.5%) and request a follow-up after 6 months (41.1%), while PCPs in the USA mostly call for follow-up and repeat lab after 3-6 months (around 40%).¹¹ GPs in Bahrain, however, tend to request follow-up, and repeat lab works after 3 months (44.4% and 55.6% respectively). Testing and following-up frequently are cost-ineffective and are a waste of resources. Further, ordering extra tests is considered a positive defensive medicine strategy, aimed at reducing physician liability for malpractice.

When it comes to prescribing metformin to pre-diabetic patients, our findings were less consistent with those of the 2019 study at the University of Kentucky,¹⁸ and the USA study.¹¹ PCPs in Bahrain prescribe metformin for 1-5% of their pre-diabetic patients; those in Kentucky prescribe it for 75-100% of their patients; and in the United States, for 5-25%. Nonetheless, around half of the GPs in Bahrain indicated that they prescribed metformin to >75% of their pre-diabetic patients, although they were not as sure that metformin could reduce the risk of diabetes in prediabetes as the FPs. These contradictory findings about using metformin in prediabetes may be attributed to responses not reflecting their actual practice, a lack of knowledge of diagnostic criteria, or ignorance of the guidelines.

Besides the study conducted in the USA,¹¹ we found other studies in the literature assessing PCPs' knowledge regarding prediabetes,^{9,10,17,18,19,20} however, the results cannot be compared since the instruments used were different.

The findings of our study showed that GPs' knowledge of prediabetes seemed to lag behind that of FPs. An explanation for this gap in knowledge may be attributed to the fact that FPs undergo in-depth training compared to GPs, their performance is continuously evaluated by supervisory consultants, and are board-certified. GPs in Bahrain only possess a bachelor's degree in medicine and do not undergo formal training. They are only obliged to attend 30 hours of Continuing Medical Education (CME) hours yearly, without end-of-course assessments.

Our findings in relation to barriers to LSM were in line with those from the study conducted in the USA,¹¹ as PCPs in both studies reported that the most important patient barriers are lack of motivation, limited or failed attempts at LSM in the past, and stress in their lives. PCPs in Bahrain also identified a lack of weight loss resources for patients as a significant system-level barrier, likewise the original survey,¹¹ although central nutrition clinics, dealing with obesity issues, are provided by the MOH in Bahrain and are readily accessible in the PHCs.²¹

The reported barriers to metformin prescription for prediabetes patients in our study were also

compatible with the original survey,¹¹ including patients' disliking medications, lack of adherence to medications, and possible side effects. In New York, a study examined the barriers to using Metformin in diabetes, in which both patients and providers cited gastrointestinal side effects as the primary barrier to metformin use.²² As a means to deal with metformin's side effects, both groups offered several widely known strategies. Patients emphasized adaptability and providers suggested extended-release formulation, dose titration, and careful counseling.²² It is noteworthy that the least perceived barrier is the cost of medication since metformin is dispensed free to patients in PHCs. Our understanding of these barriers will assist us in developing strategies to overcome them, resulting in better care for this population. In relation to the interventions to improve prediabetes management, the majority of PCPs in our study believed that system-level interventions should include improved access to weight loss programs and increased availability of DPPs. Studies were conducted in Singapore to explore the facilitators of physical activity and healthy eating among patients with prediabetes in primary care, from the patients' perspective.^{23, 24} The observed facilitators were family/peer influence, self-discipline, fear of disease complications, education by healthcare professionals, mass media influence, and health promotion campaigns.

Strengths and weakness

Strengths of this study include the global target population including all the PCPs working in all PHCs in Bahrain and the survey was comprehensive in scope. The general response rate was acceptable. We found a relatively low response rate from the GPs in this study, which may limit our ability to generalize our findings to this population. Another limitation of the study was the relatively lengthy questionnaire, which may negatively influence the response quality.

Recommendations

These findings have important practice and policy implications, including increasing healthcare professionals and public awareness of prediabetes,

its complications, and evidence-based management strategies through workshops targeting providers, awareness campaigns targeting the public, and social media influence. A greater focus should be kept on GPs since they demonstrated less knowledge of prediabetes compared with FPs. As measuring the effectiveness of training has proved to be a powerful tool to improve employee engagement & retention,²⁵ we suggest compelling GPs to attend workshops applying post-training evaluation metrics, such as quizzes or performance audits, to check how effectively they assimilated the information. Moreover, there should be regular communication with physicians about services provided by MOH to the prediabetes population and encouragement to use them, as the central nutrition clinics in PHCs. Additionally, policymakers and stakeholders should give priority to implementing the recommendations of ADA regarding developing CDC-recognized DPPs in Bahrain and/or adopting well-recognized online programs and resources. In regards to online programs, a study was conducted in Canada to investigate the effects of a digital therapeutic DPP (Transform) on weight loss, Body Mass Index (BMI), exercise frequency, and work absenteeism.²⁶ It was observed that the Transform DPP significantly reduces BMI, body weight, and work absenteeism and increases exercise frequency.²⁶

Conclusion

Risk stratification, appropriate diagnosis, and intervention at the prediabetes stage are of critical importance for preventing diabetes. Increasing awareness of the public regarding prediabetes complications and educating healthcare providers on screening guidelines, criteria for diagnosis, and evidence-based management recommendations for prediabetes can bring us one step closer to slowing the diabetes epidemic in Bahrain.

Conflict of Interest

The authors declared no conflict of interest.

Acknowledgment

Special thanks to Dr. Zahra Zabar, Senior Family Physician, for creating the online version of the survey.

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