Type 2 diabetes mellitus patients, profile, achievement and complications in primary health care in Surabaya, Indonesia

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ABSTRACT

INTRODUCTION The prevalence of type 2 diabetes mellitus (T2DM) continues to increase worldwide. Indonesia is no exception. The diagnoses of prediabetes and diabetes are increasing and seen in ever younger patients. Primary Health Care (PHC) plays a pivotal role in managing this disease in the community. This study aimed to determine the achievement therapy of T2DM patients in a PHC center in Surabaya, the second most populous city in Indonesia.

METHODS The design of this study was cross-sectional. T2DM patients who made regular visits to a PHC center in 2018 were included in this study after providing informed consent. Respondent characteristics (age, education level, family history of T2DM, physical activity, nutrient intake), as well as BMI, blood pressure, and laboratory data, including fasting plasma glucose (FPG), haemoglobin A1c (HbA1c), serum creatinine, and albumin to creatinine ratio (ACR), were collected. Simple correlation and multiple regression analyses were performed by SPSS 17.0.0

RESULTS The mean age of the patients was 60.9 ± 10.0 years, and participants had been diagnosed with T2DM for a mean of 6.9 ± 8.3 years. The therapeutic goal (FPG ≤130 mg/dL and HbA1c <7%) was achieved in 30.9% and 23.8% of patients, respectively. Early microvascular abnormality screening (ACR) showed that 70.9% of the patients had increased ACR, while serum creatinine level was found to be high in 22.8% of the patients. FPG correlated to HbA1c, serum creatinine and ACR (r=0.64, p<0.001; r=0.39, p=0.001; and r=0.25, p=0.03, respectively).

CONCLUSIONS The majority of T2DM patients in our sample did not achieve their therapeutic goals in terms of FPG and HbA1c. Those who did not achieve FPG goals were less likely to meet ACR goals and were less likely to have normal serum creatinine, most probably reflecting a pattern of poor long-term follow-up.

ABBREVIATIONS ACR: albumin creatinine ratio, BMI: body mass index, BP: blood pressure, CKD: chronic kidney disease, FPG: fasting plasma glucose, HbA1c: hemoglobin A1c, NCDs: non-communicable diseases, PHC: Primary Health Care, T2DM: type 2 diabetes mellitus, WHO: World Health Organization

INTRODUCTION

Non-communicable diseases (NCDs) are the leading cause of death worldwide. According to the World Health Organization (WHO) report, NCDs were responsible for 74% of the global deaths, of which diabetes mellitus itself was responsible for 2 million deaths[1]. People with type 2 diabetes mellitus (T2DM) have a higher risk of heart, lung, blood vessel, retina, renal, and nervous system complications, which contributes to higher premature mortality. The prevalence of T2DM increased from 108 million in 1980 to 422 million in 2014[2]. Increasing rate of diabetes and prediabetes was higher in Asian countries and disproportionately affected the young population in these countries[3].

The success rate of controlling blood glucose, indicated by a HbA1c below 7%, varies among countries. Patients in Kuwait (in 2012), Illinois, USA (in 2015) and Spain (in 2017) achieved therapeutic goals 54%, 50%, and 67% of the time, respectively[4-6]. Failure to achieve prevention and therapeutic goals has a disproportionate impact on low- and middle-

income countries with disease onset at a relatively young age of 40 years[7,8].

In Indonesia, T2DM was a major health problem and was categorized as a catastrophic disease, accounting for 11% of total health expenditures[9]. In 2012, more than 50% of T2DM cases in Indonesia were undiagnosed, and the success rate controlling the glycemic level of patients (HbA1c <7%) by endocrinologists was approximately 30%[10].

Considering the high risk of T2DM in Indonesia, Primary Health Care (PHC), known as 'Puskesmas' in Bahasa Indonesia, play an important role in early prevention and management of the disease (primary and secondary prevention). Normally, patients attend PHC centers every ten days to pick up a supply of their diabetes medications. This might be a barrier for T2DM patients to do T2DM management. It is important to know the success rate of T2DM treatment at the PHC level since most T2DM patients visit PHC centers to get their medications. Such data are not yet available. The objective of the study was to describe the result of T2DM patient management at the PHC level in Indonesia since the majority of T2DM patients accessed PHC for treatment.

METHODS

Out of 121 T2DM patients of PHC in Surabaya, Indonesia, who visited from July to November 2018, only the T2DM patients who visited regularly were asked to participate in this study after signing informed consent. For the 81 T2DM patients, characteristics [sex, diet, physical activity, socio-economic status, therapy, co-morbidities), blood pressure (BP), body mass index (BMI)]; and laboratory data, i.e. fasting plasma glucose (FPG), whole blood for hemoglobin A1c (HbA1c), creatinine serum and albumin to creatinine ratio (ACR) from spot urine sample, were collected. Questionnaire about nutrient intake (frequency of carbohydrate consumption per day with options one time/day, two times/day, three times/day), adding sugar in their beverages per day (yes/no), doing regular exercise (with the options never, sometimes, regularly) were asked for the patients. HbA1c was taken one time since the test could estimate glucose level in the bloodstream over the last three months. FPG at the time of the study showed recent FPG and FPG in the previous period were collected from medical records (secondary data) and reported as mean FPG in the last six months. The therapeutic goal of T2DM patients in this study was set based on an FPG level 80–130 mg/dL and HbA1c <7.0%[11].

Scale Camry BR2015 and Microtoise Staturmeter 2M were used to measure body weight and height. Fasting plasma glucose was measured by a glucose oxidase method (reagent supplied by Roche Diagnostic, Mannheim, Germany) in a Hitachi 902 autoanalyzer. Ichroma Bodytechmed Inc. was used to read HbA1c levels from EDTA-containing blood samples (a fluorescence immunoassay method), and Hitachi 902 was used to measure serum creatinine levels. MicroalbuPHAN® Laura strip test was used to determine albumin and creatinine in urine (read by urine analyzers LAURA®Smart).

Data were analyzed by SPSS 17.0.0 software for Windows, 2007, SPSS Inc. Chicago, IL, USA. Significance was set at $p<0.05$. Correlation between two variables was done by Pearson correlation (if the data met normality criteria by Kolmogorov-Smirnov test) and by Spearman correlation if the data did not meet normality criteria. Multiple regression was performed when more than one independent variable correlated to the dependent variable. This study was approved by the institutional review board of Universitas Airlangga.

RESULTS

The age range of T2DM patients within our sample was 28–85 (mean: 60.9 ± 10.0) years. The majority (85.1%) had a basic education and low income (<200 US$ per month). Thirty-six per cent of the respondents were male, and 64% were female. More than half had no family history of T2DM and were diagnosed with T2DM at 54.0 ± 10.8 years. Most patients ate rice three times a day and still put sugar in their beverages. Their BMI was 24.9 ± 4.4 (kg/m^2). Most of them (61.7%) had high blood pressure (BP) (Table 1).

Table 1. Characteristics of T2DM patients in the PHC center in Surabaya, Indonesia in 2018 (N=81)

Characteristics	n (%)
Age (years)	
20–30	1 (1.2)
31–40	1 (1.2)
41–50	9 (11.1)
51–60	26 (32.1)
61–70	32 (39.5)
71–80	11 (13.6)
>80	1 (1.2)
Sex	
Male	29 (35.8)
Female	52 (64.2)
Education level	
Never went to school	6 (7.4)
Elementary school	18 (22.2)
Junior high school	24 (29.6)
Senior high school	27 (33.3)
University	6 (7.4)
Occupation	
Unemployed	53 (65.4)
Professional	28 (34.6)

Continued

Table 1. Continued

Characteristics	n (%)
Family income per month (US$)	
<211	58 (71.6)
211–352	17 (21.0)
>352	6 (7.4)
History of T2DM in patient family	
Yes	38 (46.9)
No	43 (53.1)
Patient duration of suffering T2DM (years), mean (SD)	6.9 (8.3)
Frequency of exercise (self-rated)	
Never	40 (49.4)
Sometimes	22 (27.1)
Regularly	19 (23.5)
Number of meals per day (self-rated)	
1	1 (1.2)
2	23 (28.4)
3	57 (70.4)
Beverages	
No sugar	24 (29.6)
Adding sugar	
BMI (kg/m2), mean (SD)	57 (70.4)
BMI (kg/m2)*	24.9 (4.4)
Severely underweight (<17.0)	2 (2.5)
Underweight (17.0–18.4)	1 (1.2)
Normal (18.5–25.0)	44 (54.3)
Overweight (25.1–27.0)	9 (11.1)
Obese (>27.0)	25 (30.9)
Comorbid of hypertension	
Yes	50 (61.7)
No	31 (38.3)

*BMI categorization for Indonesian people (Indonesian Ministry of Health, Prevention and Control for Non-communicable Disease, 2019). PHC: Primary Health Care.

Table 2. Blood glucose level, HbA1c level, creatinine serum and albumin creatinine ratio (ACR) of T2DM patients in the PHC center in Surabaya, Indonesia in 2018 (N=81)

Variable	n (%)
FPG in the last six months§ (mg/dL), mean (SD) (range)	188.3 (68.2) (102–459)
FPG at present (mg/dL), mean (SD) (range)	93.4 (90.8) (66–508)
FPG at present (mg/dL)	
80–130	25 (30.9)
>130	56 (69.1)
HbA1c (%), mean (SD) (range)	8.6 (1.8) (5.2–12.9)
HbA1c (%)	
≤6.4	13 (15.5)
6.5–6.9	7 (8.3)
7.0–7.9	13 (15.5)
8.0–8.9	16 (19.0)
≥9	35 (41.7)
Serum creatinine (mg/dL), mean (SD) (range)	1.0 (0.5) (0.4–3.4)
Serum creatinine (mg/dL)	
Normal	61 (77.2)
High	18 (22.8)
ACR (mg/g), mean (SD) (range)	214.0 (426.9) (7.7–2000)
ACR (mg/g)	
<30 (normal to mildly increased)	23 (29.1)
30–300 (moderately increased)	45 (57.0)
>300 (severely increased)	11 (13.9)

§ FPG in the last six months of the study participants (from the medical record). Serum creatinine: normal level: 0.6–1.1 mg/dL (female) and 0.7–1.3 mg/dL (male). Recommended goal therapy (American Diabetes Association, 2018): HbA1c level <7.0% and FPG level 80–130 mg/dL. ACR category: <30 mg/g (normal to mildly increased); 30–300 mg/g moderately increased; if persists for three months, moderately indicates CKD; >300 mg/g: severely increased (including nephrotic syndrome ACR >2220 mg/g).

Laboratory data showed that the mean FPG of patients in the last six months was 188.3 ± 68.2, and the recent values of FPG, HbA1c, creatinine serum and ACR were 193.4 ± 90.8, 8.6 ± 1.8, 1.0 ± 0.5 and 214.0 ± 426.9, respectively. According to guidance for therapeutic goals, 69.1% and 76.2% of the patients did not achieve the goal based on FPG and HbA1c, respectively. Blood sugar of T2DM patient (FPG or random blood glucose) was routinely checked once a month during their visit to the PHC center, but no other laboratory tests, such as HbA1c or ACR, were routinely done. Those with national health insurance (BPJS insurance) who actively followed PROLANIS (a chronic disease management program organized by BPJS and PHC for BPJS members) had HbA1c monitored every three months. In the study PHC center, 15–20% of BPJS members followed PROLANIS.

Creatinine serum ranged from 0.4 to 3.4 mg/dL, and 22.8% of the patients exceeded the normal value (Table 2). In this study, screening of microvascular complications using the ACR showed that 70.9% of patients had a higher level of ACR than normal, and 13.9% of patients had severely

Table 3. Correlation between patient characteristics and FPG, HbA1c levels, creatinine serum levels and albumin creatinine ratio (ACR) of T2DM patients in the PHC center in Surabaya, Indonesia in 2018 (N=81)

Characteristics	Coefficient correlation (p)			
	FPG levels	HbA1c levels	Creatinine serum levels	ACR
Age (years)	-0.10 (0.39)[a]	-0.26 (0.02)*[a]	0.242 (0.04)*[a]	-0.08 (0.48)[a]
Duration of suffering T2DM	0.22 (0.05)[b]	0.13 (0.27)[b]	0.17 (0.15)[b]	0.15 (0.20)[b]
Frequency of visiting PHC center in the last three months (from medical record)	-0.254 (0.02)*[a]	-0.25 (0.02)*[a]	-0.17 (0.14)[a]	-0.02 (0.89)[a]
BMI (kg/m^2)	0.04 (0.69)[a]	0.02 (0.88)[a]	-0.06 (0.64)[a]	-0.13 (0.25)[a]
Carbohydrate intake per day (frequency × number of tablespoons per serving)	-0.09 (0.44)[b]	0.03 (0.80)[b]	0.07 (0.55)[b]	-0.15 (0.19)[b]
Exercise amount per week (frequency × duration)	0.20 (0.07)[b]	0.04 (0.75)[b]	0.09 (0.43)[b]	-0.01 (0.96)[b]

a Pearson correlation. b Spearman correlation. Normality test (Kolmogorov-Smirnov test). Normal distribution: age, frequency of visiting PHC center in the last three months, BMI, HbA1c levels, creatinine serum levels, FPG levels. Non-normal distribution: duration of suffering T2DM, carbohydrate intake per day, exercise amount per week. *p<0.05 (significantly correlated).

Table 4. Correlation between age, frequency of visits to the PHC center in the last three months, and recent FPG or recent HbA1c by multiple regression analysis of T2DM patients in Surabaya, Indonesia in 2018 (N=81)

	B	t	p
Predictors of recent HBA1c (adjusted R^2=0.44 for the model)			
Age (years)	-0.21	-2.43	0.018
Frequency of visits to PHC center in the last 3 months	-0.10	-1.10	0.239
Recent FPG	0.60	6.77	<0.001
Predictors of recent FPG (adjusted R^2=0.40 for the model)			
Age (years)	0.07	0.76	0.448
Frequency of visits to PHC center in the last 3 months	-0.09	-1.02	0.313
Recent HbA1c	0.64	6.77	<0.001

Table 5. Correlation between recent HbA1c and FPG, and HbA1c, creatinine serum and ACR of T2DM patients in the PHC center in Surabaya, Indonesia in 2018 (N=81)

	HbA1c r (p)	Creatinine serum r (p)	ACR r (p)
Recent HbA1c		NS	0.43 (<0.001)[b]
Mean of FPG in the last 6 months	0.50 (<0.001)		
Recent FPG	0.64 (<0.001)[a]	0.39 (0.001)[a]	0.25 (0.030)[b]

a Pearson correlation. b Spearman correlation. NS: not significant. ACR: albumin creatinine ratio.

increased ACR. Considering the higher level of ACR, it is recommended to check creatinine serum and ACR regularly in PHC centers to be more alert to diabetic kidney disease.

Correlation between patient characteristics and outcome therapy parameter of T2DM

BMI, intake of carbohydrates per day and exercise did not correlate to outcome therapy of T2DM in this study (Table 3). The age of patients was negatively correlated to HbA1c (r= -0.26; p=0.02) and was correlated to an increase in creatinine serum (r=0.24; p=0.04). There was no difference in HbA1c level between men and women (men, 8.4 ± 1.8%; women, 8.7 ± 1.8%; independent t-test, p=0.5). Frequency of visits to the PHC center in the last three months, which represents a punctual time schedule for getting medication, correlated with FPG and to HbA1c levels (Pearson correlation, r= - 0.25,

p=0.02; and r= -0.253, p=0.024, respectively), shown in Table 3. After being adjusted for age and FPG by multiple regression analysis, the frequency of visits to the PHC center in the last three months was no longer significantly correlated with HbA1c. The same result was obtained when age, frequency of visits to the PHC center in the last three months, and HbA1c were used as independent variables to predict FPG level. The frequency of visits to the PHC center in the last three months was no longer correlated to FPG (Table 4).

Correlation between HbA1c, FPG, serum creatinine and ACR

This study found that HbA1c level was correlated to ACR (spearman correlation, r=0.43, p<0.001). While FPG level correlated to HbA1c, serum creatinine, and ACR (Pearson correlation, r=0.5, p<0.001; Pearson correlation, r=0.39, p=0.001; Spearman correlation, r=0.25, p=0.03, respectively), shown in Table 5. The mean of FPG in the last six months was correlated to the present FPG and the present HbA1c (Pearson correlation, r=0.73, p<0.001 and Pearson correlation, r=0.50, p<0.001, respectively).

DISCUSSION

This study found that 23.8 % and 30.9% of T2DM patients achieved therapeutic goals marked by HbA1c and FPG, respectively. Interestingly, there was no large difference in HbA1c goal achievement when patients handled by endocrinologists (30%) compared to treatment in this study place[10]. However, this study was not designed to do a formal analysis of this difference.

This study was conducted in a PHC center. In Indonesia, PHC centers are the most utilized health facilities. Surabaya is the second biggest city in Indonesia. According to the 2018 Indonesian Basic Health Research (RISKESDAS), the prevalence of T2DM in urban areas was twice that of rural areas[12]. In this study (Table 1), only patients who visit the PHC center regularly were recruited, and the majority (72.8%) were not able to visit on the scheduled day organized by the doctor (delayed a couple of days). They considered a ten-day interval to re-visit the PHC center was difficult to implement. We recommend that PHC teams review the required interval time of the patient's visit. Increasing the number of days of medication dispensed would likely increase compliance with hypoglycemic regimens. As it is, 72.8% of the respondents would have run out of their medications based on the inability to adhere to the required visit interval. The majority of the patients (70.4%) ate rice three times daily, still added sugar to their beverages and did not exercise regularly (Table 1).

In this study, 30.9% of the respondents were categorized as obese, and 61.7% had hypertension. More intensive lifestyle intervention programs should be carried out to manage these diseases. Normal BMI should be included as one of the T2DM goal therapies, as suggested in obesity management as a standard of medical care in diabetes by the American Diabetes Association[13,14]. Modest persistent weight loss correlated to the slow progression of prediabetes to T2DM[15-17]. Calorie reduction correlated to a 0.3-2.0% decrease of HbA1c, reduced dosage medication and improved quality of life[18]. Maintaining weight loss over a period of 5 years correlated to a stable decrease of HbA1c levels and lipid levels[18].

Considering 76.2% of patients in this study did not achieve the goal therapy of T2DM, 13.7% had ACR >300 mg/g, and 13.9% of patients had severely increased ACR (Table 2); thus, a strategy for improving T2DM management in primary care is urgently needed. The percentage of female T2DM patients was higher than in males (64.2% vs 35.8%). This result was in accordance with the National data of T2DM[19] (Indonesian Ministry of Health, 2020), in which the prevalence of T2DM in females was higher compared to males (10.3% vs 1.01%). It could be due to the fact that among the Indonesian adult population, females had a higher prevalence than males of being overweight or obese (overweight 15.1% vs 12.1%; obese 29.3% vs 14.5%; respectively) and insufficient physical activity was also found to be more prevalent among female compared to male adolescents, 87.7% versus 86.6%[20] (WHO, 2018). It is believed that being physically active and getting 150 min of moderate-intensity exercise per week will improve glucose regulation[21] (American Diabetes Association, 2021). A previous study found that people of low socio-economic status are more physically inactive than those of high socio-economic status[22]. Hence, providing public facilities (free access) for daily exercise is important for the community.

Since 2011, PHC in Indonesia has had a special program called 'posbindu' (integrated guidance post), the purpose of which was to find out and manage the risk factors of non-communicable diseases for residents aged ≥15 years. The 'posbindu' is available in 60.8% of all subdistricts in Indonesia[19] (Indonesian Ministry of Health, 2020), but there is no further data on the percentage of the covered population in the activities. In this study, although the majority of T2DM patients (71.6%) were aged 51–70 years, and they had been diagnosed for the first time with T2DM at 54.0 ± 10.8 years, the potential problem due to the disease might be even more serious than the show-up data. Participants of this study were the T2DM patients who regularly visited a PHC center, while T2DM patients who did not regularly visit the PHC center or patients who did not want to be treated in healthcare were not included. According to a national survey, 9.3% of T2DM patients in Indonesia did not seek treatment in healthcare facilities (Indonesian Ministry of Health, 2019). The prevalence of fasting blood glucose level ≥100 mg/dL and prevalence of oral glucose tolerance test ≥140 mg/dL among Indonesian people aged <25 years were 10.7% and 16.8%, respectively[12] (Indonesian Ministry of Health, 2019). In this study, the youngest patient, aged 20 years, had no family history of

T2DM as well as the majority of patients (53.1%). The above data, together with National data, which revealed that 33.5% of Indonesian people had low physical activity and 35.4% based on their BMI were categorized as overweight or obese, strongly suggest that the increased T2DM prevalence majority might be due to an unhealthy lifestyle. PHC should make rigorous efforts to do both primary and secondary prevention as early as possible in the community; otherwise, T2DM becomes a more devastating health problem. Prevention is crucial, at any rate, to delay the onset of T2DM. Young-onset T2DM patients were found to be poorer in metabolic control, and this led to impending diabetic complications compared to those with late-onset[7].

Table 3 shows that age correlated negatively with HbA1c and correlated with creatinine serum (r= -0.26, p=0.02; and r=0.24, p=0.04). The result was the same as the study, which revealed that young-onset T2DM patients had poorer metabolic control compared to late-onset patients[7].

Limitations

There are several limitations in this study. First, our goal measurements were taken at one point in time. The consequences of diabetes are the result of a long-term process. We do not know how the HbA1c tracked over time, but with over 70% not meeting their goal, it is not likely that longer follow-up without a significant intervention would change our outcome. Second, we chose an HbA1c of 7% as our marker for good diabetes control. We do recognize that target HbA1c levels vary based on age, the presence of end-organ disease, predicted life span, etc.

CONCLUSIONS

The majority of T2DM patients in this study did not achieve goal therapy in terms of FPG and HbA1c. Unsuccessful goal therapy (FPG) correlated to ACR and an increased serum creatinine level. The correlation most probably reflected a pattern of poor long-term follow-up.

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CONFLICTS OF INTEREST
The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

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ETHICAL APPROVAL AND INFORMED CONSENT
Ethical approval was obtained from the Institutional Review Board of Universitas Airlangga (Approval number: No. 166/EC/KEPK/FKUA/2018; Date: 29 June 2018). Participants provided informed consent.

DATA AVAILABILITY
The data supporting this research cannot be made available for privacy or other reasons.

PROVENANCE AND PEER REVIEW
Not commissioned; externally peer reviewed.