Sociodemographic and clinical risk factors associated with suboptimal glycemic control among patients with type 2 diabetes attending Mansoura Specialized Medical Hospital, Egypt

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Research Article

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Abstract

Background/Aim: Diabetes is a major contributor to global mortality. Poor glycemic control is the major risk factor of diabetes-related complications and deaths. The implicated risk factors of poor glycemic control vary between countries and different ethnic groups. In Egypt, limited data are currently available therefore, the present study was conducted to evaluate the frequency and predictors of suboptimal glycemic control in patients with T2DM attending Outpatient Diabetes Clinic at Mansoura Specialized Medical Hospital, Mansoura, Egypt.

Methods: This cross-sectional study was conducted on 250 patients with T2DM. Glycemic status was detected via glycated hemoglobin (HbA1c) and suboptimal glycemic control" was defined as HbA1c level ≥7%. Predictors of suboptimal glycemic control were identified using a multivariate regression analysis.

Results: Of the total T2DM participants, 80.4% had suboptimal glycemic control. Irregular anti-diabetic drug intake was detected in 52.9% of patients. With multivariate analysis, earlier age at diabetes diagnosis, inadequate physical activity and increased body mass index (BMI) were the independent predictors of suboptimal glycemic control.

Conclusion: A high proportion of the analyzed study population has suboptimal glycemic control. Among all the studied sociodemographic and clinical risk factors, earlier age at diabetes diagnosis, inadequate physical activity and increased BMI are the independent predictors of suboptimal glycemic control.

Background

Diabetes mellitus is a global pandemic; it affects 415 million people worldwide, of whom 90% have type 2 diabetes mellitus (T2DM) [1]. In Middle East and North Africa region, the prevalence of diabetes is raised to greater than 34.6 million patients and this is expected to rich 67.9 million by 2035. In Egypt, 7.5 million patients with diabetes have been reported in 2013 and this is expected to rich 13.1 million by 2035 [2] and 16.9 million by 2045 [3]. Diabetes is a major contributor to global mortality [1] with poor glycemic control is the major risk factor for diabetes-related complications and deaths. This is greatly increases healthcare costs, reduces life expectancy and quality of life [4, 5]. Therefore, glycemic control is the ultimate goal of diabetes management [6].

Good glycemic control is difficult to achieve and remains challenging all over the world [7-9]. Poor glycemic control is complex and multi-factorial [10]. Factors influencing glycemic status vary between countries and different ethnic groups; previous reports outside Egypt have been illustrated different predictors for poor glycemic control in patients with T2DM including age, level of education, weight, marital status, duration of diabetes, anti-diabetic agents and numerous other factors [11-13]. In Egypt, limited data are currently available which is highly important for achievement of tailored intervention and prevention program. Therefore, this study was conducted to evaluate the frequency and predictors of suboptimal glycemic control in patients with T2DM attending Outpatient Diabetes Clinic at Mansoura Specialized Medical Hospital, Mansoura, Egypt.

Methods

This cross sectional study was conducted on 250 patients with T2DM. Inclusion criteria were patients with confirmed diagnosis of T2DM receiving treatment as outpatients for a minimum of 1 year. Exclusion criteria were diagnosed mental and psychological illness, anemia, haemoglobinopathies, pregnancy, renal failure, hepatic failure, connective tissue disorders and malignancy.

A thorough medical history, a clinical examination and anthropometric measurements including weight, height and body mass index (BMI) [calculated as weight/height^2 (kg/m^2)] were assessed. Sociodemographic status and clinical factors were evaluated by a questionnaire specially designed for the study which included age, gender, marital status, residency, smoking, alcohol consumption, education level, occupation, income, number of children/room, duration of diabetes, age at diabetes diagnosis, family history of T2DM, hospitalization due to diabetes complications, self-monitoring of blood glucose, known hypertension, other self-reported diabetes-related complications, treatment characteristics and physical activity. Adequate physical activity was defined as > 150 minutes of aerobic moderate-intensity physical activity per week. Glycated hemoglobin (HbA1c) was measured as an index of metabolic control on a DCA 2000 analyzer, fast ion exchange resin (Roche Diagnostic, Germany). Suboptimal glycemic control was defined as HbA1c ≥ 7% [14].

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS Corp. Released 2013, IBM SPSS Statistics for Windows and Version 22, Armonk, NY: IBM Corp. Qualitative data were described as numbers and percentages. Quantitative data were described as median (minimum - maximum) for non-parametric data and M ± SD for parametric data after testing normality by Kolmogrov-Smirnov test. A chi-square test was performed to compare categorical data. Monte Carlo and Fischer Exact tests were used as corrections for chi-square test when more than 25% of cells have count less than 5 in tables >2x2 and 2x2, respectively. Student t-test was performed to compare 2 independent groups. Binary stepwise logistic regression analysis was performed to detect independent predictor variables of binary outcome. Significant predictors in the univariate analysis were entered into regression model using forward Wald method/Enter. Adjusted odds ratios (OR) and 95% confidence interval (CI) were calculated. P ≤ 0.05 was considered to be significant.

Results

Table 1 illustrates the sociodemographic characteristics of the analyzed study population. The mean age was 54.52 (55.6% aged from 33 to 56 years and 44.4% aged from 57 to 80 years), 66% were females, 66.8% were married and 58% were of rural residence, 10% were smokers, 52.8% were illiterate and 70.8% were unemployed. The median income was 800 LE. None of the studied patients were alcoholic.

Table 1

Socio-demographic characteristics of the study participants (n=250)

Age/years , M ± SD	54.52 ± 9.98
Age groups n (%)	
33-56	139 (55.6%)
57-80	111 (44.4%)
Gender n (%)	
Men	85 (34%)
Women	165 (66%)
Marital status n (%)	
Single	6 (2.4%)
Married	167 (66.8%)
Divorced	17 (6.8%)
Widow	60 (24%)
Residence n (%)	
Urban	105 (42%)
Rural	145 (58%)
Smoking	25 (10%)
Alcohol intake n (%)	0 (0%)
Education level n (%)	
Illiterate	132 (52.8%)
Elementary education	60 (24%)
Secondary school	54 (21.6%)
University	4 (1.6%)
Occupation n (%)	
Unemployed	177 (70.8%)
Employed	73 (29.2%)
Income LE, median (Min-Max)	800 (200-5000)
Number of children/room n (%)	
1	73 (29.2%)
2	149 (59.6%)
3	23 (9.2%)

4	3 (1.2%)
5	2 (0.8%)

Data are expressed as means ± standard deviation, numbers percentages or median (minimum-maximum).

Among the studied participants with T2DM, diabetes duration of the majority (36%) was 11 to 20 years, the mean age at T2DM diagnosis was 43.24 years, 54% had family history of T2DM, 17.6% had self-monitored blood glucose, 36.8% had a history of hospitalization due to diabetes complications, 76% were obese, 64% had hypertension, 7.6% had cardiovascular complications, 6.4% had cerebrovascular complications, 26.4% had peripheral arterial disease, 34.8% had retinopathy, 3.2% had nephropathy, 23.2% had neuropathy, 40.4% performed adequate physical activity, 1.6% received dietary modifications alone, 6% received metformin alone, 26% received metformin and sulfonylurea, 1.2% received metformin and sulfonylurea and glitazon, 4.8% received metformin and incretins, 34% received insulin alone, 27.6% received insulin and metformin, 52.9% had reported irregular anti-diabetic drug intake, 6.8% received statins and 59.6% received anti-hypertensive drugs Table 2. Of the total patients, 80.4% had suboptimal glycemic control (HbA1c ≥ 7%) Figure1.

Table 2

Clinical and diabetes-related characteristics of the study participants (n=250)

Duration of diabetes/Years n (%)	
<5	64 (25.6%)
6-10	70 (28%)
11-20	90 (36%)
>20	26 (10.4%)
Age at diabetes diagnosis/years, M ± SD	43.24 ± 10.22
Family history of T2DM n (%)	135 (54%)
Self-monitored blood glucose n (%)	44 (17.6%)
Hospitalization due to diabetic complications n (%)	92 (36.8%)
Obesity n (%)	(190) 76%
Hypertension n (%)	160 (64%)
Cardiovascular complications n (%)	19 (7.6%)
Cerebrovascular complications n (%)	16 (6.4%)
Peripheral arterial disease n (%)	66 (26.4%)
Retinopathy n (%)	87 (34.8%)
Nephropathy n (%)	8 (3.2%)
Neuropathy n (%)	58 (23.2%)
Treatment	
Adequate physical activity n (%)	101 (40.4%)
Diet alone n (%)	4 (1.6%)
Metformin alone n (%)	15 (6%)
Metformin & SU n (%)	65 (26%)
Metformin & SU &TZD n (%)	3 (1.2%)
Metformin & incretins n (%)	12 (4.8%)
Insulin alone n (%)	85 (34%)
Insulin & metformin n (%)	69 (27.6%)
Irregular anti-diabetic drug intake n (%)	146 (58.4%)
Statins n (%)	17 (6.8%)
Anti-hypertensive drugs n (%)	149 (59.6%)

Data are expressed as means ± standard deviation, numbers or percentages.

Compared with optimal glycemic control, patients with suboptimal glycemic control had significantly lower age, earlier age at T2DM diagnosis (≤ 45 years), higher frequency of urban residence, family history of T2DM, obesity, retinopathy, nephropathy, neuropathy, lower physical activity and irregular anti-diabetic drug intake (all cases with suboptimal glycemic control have history of irregular anti-diabetic drug intake). No significant differences between optimal and suboptimal glycemic control states with regard to all other sociodemographic and clinical characteristics. Table 3

Table 3

Comparison between optimal and suboptimal glycemic state with regard to socio-demographic and clinical characteristics

Characteristics	Total Number (n= 250)	Optimal glycemic control (n= 49) n (%)	Suboptimal glycemic control (n= 201) n (%)	OR (95% CI)	P-value
Age groups					
33-56 y	139	21(15.11%)	118 (84.89%)	1.89 (1.01-3.57)	0.04*
57-80	111	28 (41.29%)	83 (25.23%)		
Gender					
Men	85	21 (24.7%)	64 (75.3%)	1.61(0.847-3.04)	0.14
Women	165	28 (17.0%)	137 (83.0%)		
Marital status					
Single	6	1(16.7%)	5 (83.3%)	0.78 (0.09-6.92)	0.58
Married	167	34 (20.4%)	133 (79.6%)	0.48 (0.04-5.22)	
Divorced	17	5 (29.4%)	12 (70.6%)	1.13 (0.12-10.87)	
Widow	60	9 (15.0%)	51(85.0%)		
Residence					
Urban	105	14 (13.3%)	91(86.7%)	2.07 (1.05-4.08)	0.03*
Rural	145	35 (24.1%)	110 (75.9%)		
Smoking	25	7 (28.0%)	18 (72.0	1.69 (0.67-4.30)	0.26
Education level					
Illiterate	132	32 (24.2%)	100 (75.8%)	1.04 (0.10-10.37)	0.08
Elementary education	60	5 (8.3%)	55 (91.7%)	3.67 (0.32-42.13)	
Secondary school	54	11(20.4%)	43 (79.6%)	1.30 (0.12-13.77)	
University	4	1(25.0%)	3 (75.0%)		
Occupation					
Unemployed	177	35 (19.8%)	142 (80.2%)	1.04 (0.52-2.07)	0.91
	73	14 (19.2%)	59 (80.8%)		

Employed					
Income					
≤ Median (800 LE)	114	20 (17.5%)	94 (82.5%)	1.27 (0.68-2.4)	0.45
> Median (800 LE)	136	29 (21.3%)	107 (78.7%)		
Number of children/room					
<3	222	45 (20.3%)	177 (79.7%)	1.52 (0.50-4.62)	0.45
≥3	28	4 (14.3%)	24 (85.7%)		

Table 3 (continued)

Duration of diabetes/Years					
<5	64	20 (31.2%)	44 (68.8%)	2.44 (1.06-5.61)	
6-10	70	11 (15.7%)	59 (84.3%)	2.27 (1.06-4.89)	0.052
11-20	90	15 (16.7%)	75 (83.3%)	2.38 (0.93-12.97)	
>20	26	3 (11.5%)	23 (88.5%)		
Age at diabetes diagnosis/years					
≤45 (median)	159	17 (10.7%)	142 (89.3%)	4.53 (2.34-8.78)	0.001*
>45 (median)	91	32 (35.2%)	59 (64.8%)		
Family history of T2DM	115	13 (11.3%)	102 (88.7%)	2.85 (1.43-5.69)	0.002*
Hospitalization due to complications	92	13 (14.1%)	79 (85.9%)	1.79 (0.89-3.59)	0.09
Self-monitored blood glucose	44	13 (29.5%)	31(70.5%)	1.98 (0.94-4.15)	0.07
Obesity	190	32 (65.3%)	158 (78.6%)	1.95 (0.99-3.85)	0.05*
Hypertension	160	28 (17.5%)	132 (82.5%)	1.44 (0.75-2.71)	0.26
Cardiovascular complication	19	2 (10.5%)	17 (89.5%)	2.17 (0.49-9.73)	0.30
Cerebrovascular complications	16	1 (6.2%)	15 (93.8%)	3.87 (0.49-30.04)	0.16
Peripheral arterial disease	184	35 (19.0%)	149 (81.0%)	1.15 (0.57-2.29)	0.70
Retinopathy	87	924.5%)	78 (75.5%)	2.82 (1.29-6.13)	0.007*
Nephropathy	8	4 (50%)	4 (50.0%)	0.23 (0.05-0.95)	0.05*
Neuropathy	192	44 (22.9%)	148 (77.1%)	0.31(0.12-0.84)	0.01*
Diet alone	4	2 (50.0%)	2 (50.0%)	0.24 (0.03-1.72)	0.17
Adequate physical activity	101	27 (26.7%)	74 (73.3%)	2.11 (1.12-3.96)	0.01*
Metformin alone	15	5 (33.3%)	10 (66.7%)	0.46 (0.15-1.42)	0.17
Metformin & sulfonyl urea	65	10	55 (84.6%)	1.47 (0.69-3.14)	0.32

		(15.4%)			
Metformin & sulfonyl urea & glitazon	3	0 (0.0%)	3 (100.0%)	Undefined	1.0
Metformin &incretins	12	3 (25%)	9 (75.0%)	0.71 (0.19-2.76)	0.63
Insulin alone	85	18 (21.2%)	67 (78.8%)	0.86 (0.45-1.65)	0.65
Insulin & metformin	69	13 (18.8%)	56 (81.2%)	1.07 (0.53-2.16)	0.85
Irregular anti-diabetic drug intake	146	0 (100.0%)	146 (100.0%)	Undefined	<0.001*
Statins	17	4 (23.5%)	13 (76.5%)	0.78 (0.24-2.49)	0.67
Anti-hypertensive drugs	149	25 (16.8%)	124 (83.2%)	1.55 (0.83-2.89)	0.17
T2DM: type 2 diabetes mellitus, OR: odds ratio, CI: confidence interval, *P is significant if ≤ 0.05.					

With multivariate analysis, younger age at diabetes diagnosis (≤ 45 years) {OR: 4.73, 95% CI: 1.81-11.71, P = 0.001), inadequate physical activity {OR: 2.48, 95% CI: 1.28-4.82, P = 0.006) and increased BMI {OR: 2.11, 95% CI: 1.85-3.02, P = 0.02} were the independent predictors of suboptimal glycemic control. The previous detected factors can predict 80.8% of the suboptimal glycemic control among the studied patients. Table 4

Table 4

Multivariate analysis of factors associated with suboptimal glycemic control

Characteristics	β	OR (95% CI)	P-value
Age/year	0.62	1.98 (0.891-16.15)	0.25
Residence	0.55	1.73 (0.83-3.60)	0.14
Age at diagnosis/years	1.55	4.73 (1.81-11.71)	0.001*
Family history of T2DM	0.67	1.95 (0.92-4.24)	0.08
Retinopathy	0.55	1.24 (1.02-4.8)	0.15
Nephropathy	1.32	3.78 (0.87-16.37)	0.08
Neuropathy	1.26	3.54 (0.3-9.64)	0.09
Physical activity	0.92	2.48 (1.28-4.82)	0.006*
BMI	1.25	2.11 (1.85-3.02)	0.02*

T2DM: type 2 diabetes mellitus, BMI: body mass index, OR: odds ratio, CI: confidence interval, *P is significant if ≤ 0.05

Discussion

The main findings of the present study were the high frequency of suboptimal glycemic control among the analyzed study Egyptian population. The identified independent predictors of suboptimal glycemic control were earlier age at diabetes diagnosis (≤ 45 years), insufficient physical activity and increased BMI.

In the current study, 80.4% of the analyzed study population had suboptimal glycemic control (Hb1Ac ≥ 7%). This is comparable with the most global studies where the proportions of patients achieving the target HbA1c remains low [9, 15-18]; the reported frequencies of suboptimal glycemic control were 73.52%, 80%, 70.9%, 70.8% and 68.3%, respectively. However, our finding is much higher than the ADA recommendation [14] and some previous estimates from studies in US (12.9 %) [19] and Costa Rica (37%) [20]. The variability in the frequency of suboptimal glycemic control could be attributed to the differences in health insurance coverage and access to primary care [19]. Indeed, Heidemann et al. [21] identified race as an independent variable of glycemic control after adjusting for socio-demographic status. Differences in studies with regard to sample size, methods of data collection and assay for defining glycemic control should be considered. It should also be noted that our study population was recruited from a tertiary referral diabetes clinic where moderate to severe disease is expected.

Of the current study population, 58.4% had reported irregular anti-diabetic drug intake and as expected all of those patients had suboptimal glycemic control. In agreement, Kassahun et al. [16] and Demoz et al. [18] found an inverse association between medications adherence and poor glycemic control. Poor compliance might be owing to the low monthly income and disease unawareness among the majority of patients. Accordingly, counseling, improving financial challenges and medications adherence have been suggested [22].

With multivariate analysis, earlier age at diabetes diagnosis, inadequate physical activity and increased BMI were the independent predictors of suboptimal glycemic control in our study participants. Similarly, many studies found an association between younger age in patients with T2DM and poor glycemic control [12, 19, 23] whereas, Souliotis et al. [13] did not report any association. The potential explanations are the financial challenges, work and family responsibilities and diabetes-related distress in adults with DM [24, 25].

We found more than half of patients with T2DM (59.6%) did not practice adequate physical activity. This is in parallel with Fiseha et al. [17] who found that 66.9% of diabetic participants were physically inactive. Tekalegn et al. [26] also estimated that only 54.4% of the total respondents were performing adequate physical activity. Moreover, the lack of physical activity was a potential risk factor for poor glycemic control [15]. On the other hand, the association between physical activity and improvement in glycemic control had been reported by several studies [27-29]. The underlying mechanism is attributed to increase insulin sensitivity [30], improvement in oxidative capacity of skeletal muscle [31] and modulating glycemic control by increasing HDL [32].

Our results are consistent with Souliotis et al. [13] who found an independent association between BMI and poor glycemic control in a study sample of 1141 patients with T2DM. Our results are also in harmony with a recent meta-analysis conducted by Cheng et al. [12]. Additionally, Mellergård et al. identified BMI as a factor that may affect HbA1c variability [33]. In contrast, Rwegerera et al. [34] found no association between BMI and glycemic control. The link between obesity and T2DM is a well-known fact which is attributed to a common pathophysiology such as impaired insulin production and action, impaired vascular function, and other metabolic disorders [35]. Furthermore, excessive storage of fat and high glucose levels due to carbohydrate over consumption lead to difficult achievement of good glycemic control [36].

We did not observe any independent association between sociodemographic factors and suboptimal glycemic control. This is in accordance with Tan et al. [37] but in contrast with Cheng et al. and Kassahun et al. [12, 16]. In contrary with us, other studies detected different predictors of poor glycemic control such as duration of treatment [12, 26], duration of diabetes [38], gender [33], family history of diabetes [13] and anti-diabetic agents [9, 34]. The reason of poor glycemic control in almost 50% of occasions cannot be explained [39] whereas, genetics, dietary patterns, and cultural backgrounds may play a role.

Although achievement of good glycemic control is well-known to be associated with reduced microvascular and macrovascular diabetic complications in the long-term, a significant proportion of patients with poor glycemic control still reported all over the world. From the previous discussion, we found 2 modifiable risk factors influencing suboptimal glycemic control which are the physical inactivity and obesity thus, the need to design strategies encouraging physical activity and body weight reduction are recommended in order to improve glycemic control and hence delay diabetes-related complications.

Conclusion

A high proportion of the analyzed study population has suboptimal glycemic control. Among all the studied sociodemographic and clinical risk factors, earlier age at diabetes diagnosis, inadequate physical activity and increased BMI are the independent predictors of suboptimal glycemic control. Our findings highlight the importance of lifestyle intervention targeting physical inactivity and obesity in patients with T2DM.

Declarations

Ethics approval and consent to participate

All procedures performed in the study were in accordance with Mansoura university institution and the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study complies with current research ethics standards and was approved by the institutional Research Ethics

Board of the University of Mansoura. A written informed consent was obtained from literate participants and legal guardian for illiterate participants.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests.

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Author’s contributions

MME, GS, HM, AAN, and NM contributed to the study concept, design, drafting and critical revision of the manuscript. All authors have read and approved the final version of manuscript.

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References

1. Ogurtsova K, da Rocha FJ, Huang Y, et al. IDF diabetes atlas: global estimates for the prevalence of diabetes for 2015 and 2040. Diabetes Res Clin Pract. 2017; 128: 40–50. 2. Guariguata L, Whiting DR, Hambleton I, Beagley J, Linnenkamp U, Shaw JE. Global estimates of diabetes prevalence for 2013 and projections for 2035. Diabetes Res Clin Pract. 2014; 103(2), 137-149. 3. Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, Colagiuri S, Guariguata L, Motala AA, Ogurtsova K, Shaw JE, Bright D, Williams R; IDF Diabetes Atlas Committee. Global and regional diabetes prevalence estimates for 2019

and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res Clin Pract. 2019; 157: 107843. 4. Stratton IM, Adler AI, Neil HAW, Matthews DR, Manley SE, Cull CA, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ. 2000; 321: 405–412. 5. Lloyd A, Sawyer W, Hopkinson P. Impact of long-term complications on quality of life in patients with type 2 diabetes not using insulin. Value Health. 2001; 4(5):392–400. 6. American Diabetes Association. Classification and diagnosis of diabetes: standards of medical care in diabetes—2018. ADA Diabetes Care J Clin Appl Res Educ. 2018; 41(Supplement 1): S13–27. 7. Kemp TM, Barr EL, Zimmet PZ, Cameron AJ, Welborn TA, Colagiuri S, Phillips P, Shaw JE. Glucose, lipid, and blood pressure control in Australian adults with type 2 diabetes: the 1999–2000 Aus Diab. Diabetes Care. 2005; 28(6):1490–1492. 8. Mastura I, Chew BH, Lee PY, et al. Control and treatment profiles of 70,889 adult type 2 diabetes mellitus patients in Malaysia – a cross sectional survey in 2009. Int J Collab Res Intern Med Public Health. 2011; 3(1):98–113. 9. Kibirige D, Akabwai GP, Kampiire L, Kiggundu DS, Lumu W. Frequency and predictors of suboptimal glycemic control in an African diabetic population. Int J Gen Med. 2017; 10:33-38. 10. Wallace TM, Matthews DR. Poor glycaemic control in type 2 diabetes: a conspiracy of disease, suboptimal therapy and attitude. QJM. 2000; 93(6):369-74. 11. Angamo MT, Melese BH, Ayen WY. Determinants of glycemic control among insulin treated diabetic patients in Southwest Ethiopia: hospital based cross sectional study. PloS One. 2013; 8 (4): e61759. 12. Cheng LJ, Wang W, Lim ST, Wu VX. Factors associated with glycaemic control in patients with diabetes mellitus: A systematic literature review. J Clin Nurs. 2019; 28(9-10):1433-1450. 13. Souliotis K, Koutsovasilis A, Vatheia G, et al. (2020). Profile and factors associated with glycaemic control of patients with type 2 diabetes in Greece: results from the diabetes registry. BMC Endocr Disord. 20(1), 16. 14. American Diabetes Association: Glycemic Targets: Standards of Medical Care in Diabetes-2019. Diabetes Care. 2019; 42(Suppl 1): S61-S70. 15. Firouzi S, Barakatun-Nisak MY, Azmi KN. Nutritional status, glycemic control and its associated risk factors among a sample of type 2 diabetic individuals, a pilot study. J Res Med Sci. 2015; 20(1):40-46. 16. Kassahun T, Eshetie T, Gesesew H. Factors associated with glycemic control among adult patients with type 2 diabetes mellitus: a cross-sectional survey in Ethiopia. BMC Res Notes. 2016; 9(1), 78. 17. Fiseha T, Alemayehu E, Kassahun W, Adamu A, Gebreweld A. Factors associated with glycemic control among diabetic adult out-patients in Northeast Ethiopia. BMC Res Notes. 2018; 11:316 18. Demoz GT, Gebremariam A, Yifter H, Alebachew M, Niriayo YL, Gebreslassie G, Woldu G, Bahrey D, Shibeshi W. Predictors of poor glycemic control among patients with type 2 diabetes on follow-up care at a tertiary healthcare setting in Ethiopia. BMC Res Notes. 2019: 4;12(1):207. 19. Ali MK, McKeever Bullard K, Imperatore G, Barker L, Gregg EW. Characteristics associated with poor glycemic control among adults with self-reported diagnosed diabetes--National Health and Nutrition Examination Survey, United States, 2007-2010. MMWR Suppl. 2012; 61(2):32-37. 20. Brenes-Camacho G, Rosero-Bixby L. Metabolic control in a nationally representative diabetic elderly sample in Costa Rica: patients at community health centers vs. patients at other health care settings. BMC Int Health Hum Rights. 2008; 8(5):1–13. 21. Heidemann DL, Joseph NA, Kuchipudi A, Perkins DW, Drake S. Racial and Economic Disparities in Diabetes in a Large Primary Care Patient Population. Ethn Dis. 2016; 26(1):85-90. 22. Leichter S. Making outpatient care of diabetes more efficient: analyzing noncompliance. Clin Diabet. 2005; 23:187–90. 23. Juarez DT, Sentell T,

Tokumaru S, Goo R, Davis JW, Mau MM. Factors associated with poor glycemic control or wide glycemic variability among diabetes patients in Hawaii, 2006-2009. Prev Chronic Dis. 2012; 9: 120065. 24. Wardian J, Sun F. Factors associated with diabetes-related distress: Implications for diabetes self-management. Soc Work Health Care. 2014; 53(4), 364–381. 25. Aghili R, Polonsky WH, Valojerdi AE, Malek M, Keshtkar AA, Esteghamati A, Heyman M, Khamseh ME. Type 2 diabetes: Model of factors associated with glycemic control. Can J Diabetes. 2016; 40(5), 424–430. 26. Tekalegn Y, Addissie A, Kebede T, Ayele W. Magnitude of glycemic control and its associated factors among patients with type 2 diabetes at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. PLoS One. 2018; 5: 13(3): e0193442. 27. Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C, White RD. Physical activity/exercise and type 2 diabetes: a consensus statement from the American Diabetes Association. Diabetes Care. 2006; 29(6):1433-8. 28. Avery L, Flynn D, Dombrowski SU, van Wersch A, Sniehotta FF, Trenell MI. A systematic review of behavior change interventions targeting physical activity, exercise and HbA1c in adults with type 2 diabetes. Diabetes Care. 2012; 35: 2681–2689. 29. Aylin K, Arzu D, Sabri S, Handan TE, Ridvan A. The effect of combined resistance and home-based walking exercise in type 2 diabetes patients. Int J Diabetes Dev Ctries. 2009; 29(4):159-165. 30. Shivananda N, Arun M, Manjunath H. Influence of aerobic treadmill exercise on blood glucose homeostasis in noninsulin-dependent diabetes mellitus patients. Indian J Clin Biochem. 2005; 20(1):47–51. 31. Toledo FG, Menshikova EV, Ritov VB, Azuma K, Radikova Z, DeLany J, Kelley DE. Effects of physical activity and weight loss on skeletal muscle mitochondria and relationship with glucose control in type 2 diabetes. Diabetes. 2007; 56(8):2142-7. 32. Kodama S, Tanaka S, Saito K, Shu M, Sone Y, Onitake F, Suzuki E, Shimano H, Yamamoto S, Kondo K, Ohashi Y, Yamada N, Sone H. Effect of aerobic exercise training on serum levels of high-density lipoprotein cholesterol: a meta-analysis. Arch Intern Med. 2007; 28:167(10):999-1008. 33. Mellergård E, Johnsson P, Eek F. Sociodemographic factors associated with HbA1c variability in type 2 diabetes: a prospective exploratory cohort study. BMC Endocr Disord. 2020; 20(1):102. 34. Rwegerera GM, Masaka A, Pina-Rivera Y, Moshomo T, Gaenamong M, Godman B, Oyewo TA, Massele A, Habte D. Determinants of glycemic control among diabetes mellitus patients in a tertiary clinic in Gaborone, Botswana: findings and implications Hosp Pract (1995). 2019; 47(1):34-41. 35. Haslam D. Obesity and diabetes: the links and common approaches. Prim Care Diabetes. 2010; 4: 105–12. 36. Mahmood MI, Daud F, Ismail A. Glycaemic control and associated factors among patients with diabetes at public health clinics in Johor, Malaysia. Public Health. 2016; 135:56–65. 37. Tan ML, Manski-Nankervis JA, Thuraisingam S, Jenkins A, O'Neal D, Furler J. Socioeconomic status and time in glucose target range in people with type 2 diabetes: a baseline analysis of the GP-OSMOTIC study. BMC Endocr Disord. 2018; 18(1):47. 38. Mamo Y, Bekele F, Nigussie T, Zewudie A. Determinants of poor glycemic control among adult patients with type 2 diabetes mellitus in Jimma University Medical Center, Jimma zone, south west Ethiopia: a case control study. BMC Endocr Disord. 2019; 19: 91. 39. Goudswaard AN, Stolk RP, Zuithoff P, Rutten GE. Patient characteristics do not predict poor glycaemic control in type 2 diabetes patients treated in primary care. Eur J Epidemiol. 2004, 19:541-45.

Figures

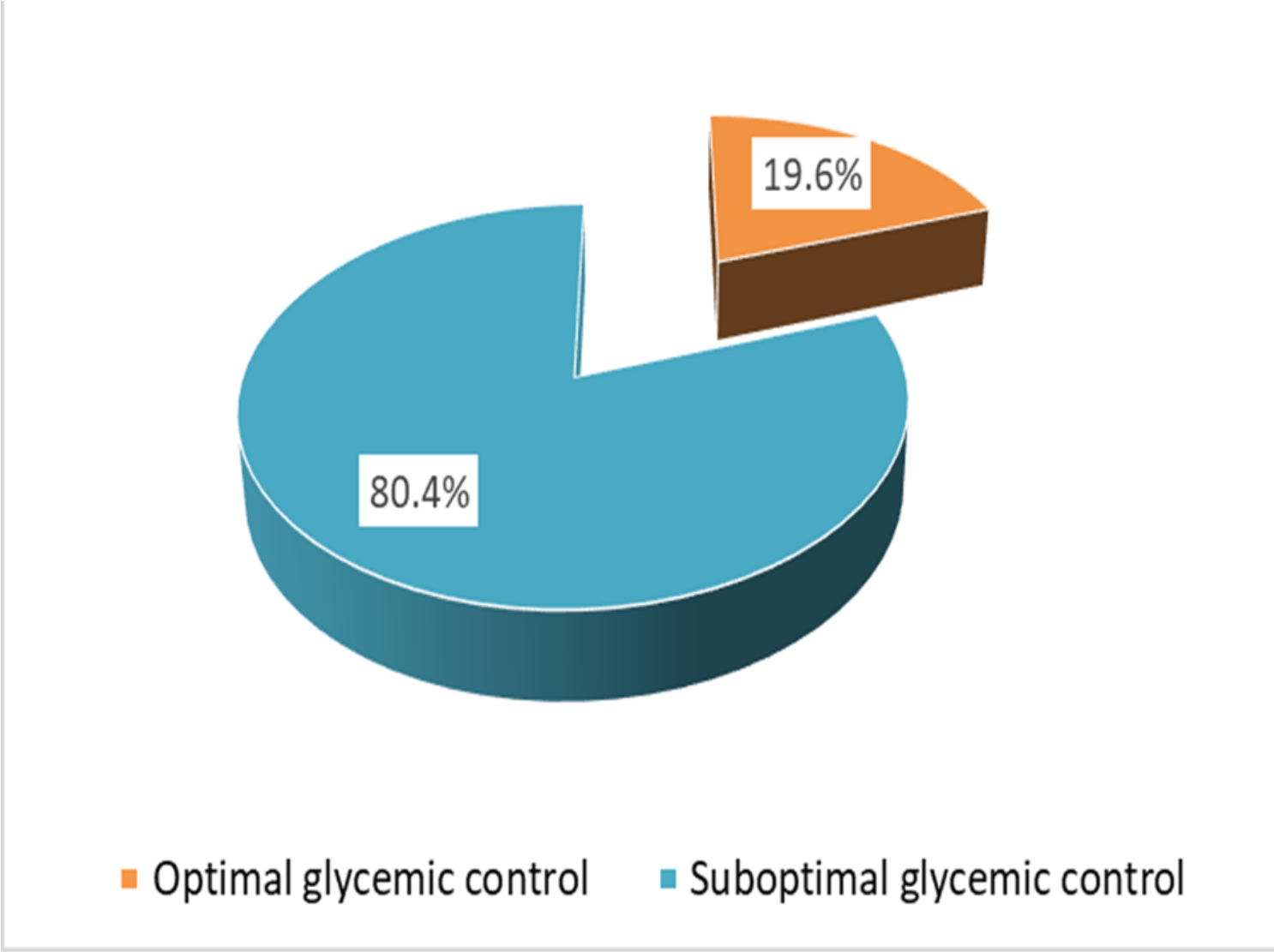

Figure 1

Frequency of optimal and suboptimal glycemic control in patients with type 2 diabetes