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ORIGINAL ARTICLE

Medication adherence, its associated factors and implication on glycaemic control in patients with type 2 diabetes mellitus: A cross-sectional study in a Malaysian primary care clinic

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Abstract

Introduction: Medication adherence and metabolic control remain suboptimal among patients with diabetes mellitus in Malaysia despite the clear benefits of reduced vascular complications and mortality risk. This study examined the factors associated with medication adherence and glycaemic control in patients with type 2 diabetes mellitus in a primary care clinic.

Methods: This cross-sectional study was conducted in a public health clinic in Pagoh, Johor, among 386 patients recruited via systematic random sampling. Data were obtained using a validated 7-item structured questionnaire, glycated haemoglobin (HbA1c) test and medical record review. Logistic regression analysis was performed to determine the factors associated with medication adherence.

Results: The mean patient age was 60.04±10.75 years, and the mean HbA1c level was 8.3±2.0%. Approximately 60.3% of the participants were adherent to their medication, and an increasing age was significantly associated with medication nonadherence (adjusted odds ratio [OR]: 0.959; confidence interval [CI]: 0.934–0.985). Medication adherence (adjusted OR: 2.688; CI: 1.534–4.708) and use of combined oral medications (adjusted OR: 5.604; CI: 3.078–10.203), combined oral medications with insulin (adjusted OR: 23.466; CI: 8.208–67.085) and insulin only (adjusted OR: 6.528; CI: 1.876–22.717) were associated with good glycaemic control. Older age (adjusted OR: 0.954; CI: 0.923–0.986) and Malay ethnicity (adjusted OR: 0.284; CI: 0.101–0.794) were associated with poor glycaemic control.

Conclusion: Suboptimal medication adherence and glycaemic control are prevalent in primary care settings, especially among elderly patients. Counselling should be targeted to patients and their caretakers to improve medication adherence and optimise metabolic control.

Introduction

Diabetes mellitus is a major metabolic chronic disease affecting patients from all age groups worldwide. The Southeast Asian region has been predicted to have the highest prevalence of diabetes mellitus by 2025.[1] The World Health Organization had previously estimated that Malaysia would have 2.48 million patients with diabetes mellitus by 2030, but this number was surpassed in 2011 with 2.6 million Malaysians diagnosed with the disease. Alarmingly, the point of diagnosis is occurring at an increasingly younger age.[2,3]

Effective management of diabetes mellitus involves a combination of lifestyle changes and pharmacologic therapy.[4] Glycaemic control via lifestyle modification alone is difficult in a majority of cases; thus, medication is often crucial for effective blood sugar control. Previous randomised trials have shown a reduction in the risk of vascular complications among patients with type 2 diabetes mellitus using glucose-lowering agents.[5,6] However, the proven effectiveness of these agents is heavily dependent on the adherence of patients in consuming them as prescribed by their physicians.

Good medication adherence has been shown to improve glycaemic control and reduce complications and healthcare utilisation among patients. A previous study has reported a reduction of 0.34% in the glycated haemoglobin (HbA1c) level for every 25% increase in medication adherence.[7] Past studies have documented factors influencing medication adherence among patients with diabetes mellitus, including age, medication knowledge, presence of comorbidities, family

support, stress, medical care satisfaction and religious coping.[8–13]

In Malaysia, glycaemic control among patients with diabetes mellitus has been documented to be suboptimal over the years,[8–10] and medication adherence appears to be at a similar state despite the clear benefits of glucose-lowering agents in reducing disease progression and mortality. Local studies have investigated the level and factors affecting medication adherence among patients with chronic diseases, including diabetes mellitus,[8–11] but there are few reports at the primary care level within states of the south peninsula of Malaysia. Furthermore, many of these studies had collected data before 2013; thus, an update of the current medication adherence status would be beneficial for intervention planning.

Medication adherence in patients with diabetes mellitus is crucial to achieve optimal glycaemic control, and assessment of the factors associated with adherence is therefore paramount to determine the challenges of diabetes mellitus management at the primary care level. This study was then conducted to fill the gap in epidemiological data and assess the current status of medication adherence and metabolic control among patients with type 2 diabetes mellitus in one of the southern region districts of Peninsula Malaysia. It also investigated the factors associated with medication adherence and glycaemic control among the same population of patients. Mapping of factors that may influence medication adherence could provide a clearer view of the sociodemographic and disease profiles that may be useful for targeted intervention and education for patients at the primary care level to achieve better metabolic control and reduce disease progression in the future.

Methods

Study design and population

This cross-sectional study was conducted from March to October 2018 in Pagoh Health Clinic in Muar, Johor. The doctor workforce in this clinic generally includes one visiting family physician, one medical officer with a postgraduate qualification in family medicine and two medical officers. The health clinic supports patients within the subdistrict for various chronic diseases, including type 2 diabetes mellitus, and outpatient cases. Patients with diabetes mellitus who attend follow-up appointments with the doctor are also seen at regular intervals by a diabetes mellitus educator nurse.

The study participants consisted of patients with type 2 diabetes mellitus who were under routine follow-up in Pagoh Health Clinic for at least 3 months, consented to participate in the study, had underwent an HbA1c test within the last 3 months and were able to understand the English or Malay language. Pregnant patients, patients presenting to the clinic with acute critical conditions and patients with severe psychiatric illness that rendered them unable to adhere regularly to medication or to answer the questionnaire were excluded. Systematic sampling was performed, with every third patient attending their diabetes mellitus follow-up appointments (Monday to Wednesday) recruited as the research participants across the study period.

The educational level was categorised into no formal education (participant having received no form of education within the formal school system), primary education (completed formal education in primary school from age 7 to 12 years), secondary education (completed formal education in high school from age 13 to 17 years) and tertiary education (completed any formal education after high school in formal educational institutions, including undergraduate and graduate credentials). Occupation categories included professional (occupation requiring specific advanced education or training to be able to practice, such as accountants or lawyers), non-professional (occupation not requiring specific education or training, such as cashiers or mechanics), unemployed (available for work but has not found employment) and retired (completed or ceased his or her occupation). A comorbidity was defined as the simultaneous presence of one or more chronic medical conditions alongside type 2 diabetes mellitus. Good glycaemic control was defined as an HbA1c level of ≤7% in the last 3 months.

Sample size determination

The sample size was calculated using a single-proportion formula at a 95% confidence interval (CI) and a 5% margin of error considering the estimated proportion of 60% of adherent patients with diabetes mellitus in the local population.[10] A final sample size of 386 participants was calculated for this study, with consideration for a 5% non-response rate.

Study procedure

The data were collected using a combination of self-administered questionnaires and review of medical records and HbA1c test results in the clinic. Prior to questionnaire completion, all respondents were given a written and oral explanation on the purpose and methodology of the research and assurance of confidentiality. They were also assured that participation was voluntary, and they may withdraw from the study at any time during questionnaire completion without any effect to their follow-up in the clinic. Written informed consent was obtained prior to questionnaire completion.

Study instrument

There is currently no gold standard tool for evaluating medication adherence. Available methods include the use of pill counts, medication diaries and electronic drug database refills, but these methods are mostly labour-intensive and may show incomplete data. Adherence questionnaires have been utilised in past studies to evaluate medication adherence, which have shown good sensitivity and specificity as a reliable assessment technique.[14,15]

This study utilised the validated Medication Compliance Questionnaire, which was developed in 2012 with a Cronbach's α of 0.782 and obtained with prior formal permission from the lead author.[8] The questionnaire is a 7-item questionnaire with a 4-point Likert-scale format (**Table 1**): 4=none of the time, 3=some of the time, 2=most of the time and 1=all the time. The questions assess patients' intentional and unintentional nonadherence to medication. The total score can range from 7 to 28 points. A score of 27–28 points indicates adherence, while a score of ≤26 points indicates nonadherence.[16]

Table 1. Adherence scores by question percentage and mean scores.

Question	Adherence score; n (%)				Mean score
	1	2	3	4	
1. How often do you forget to take your medicine?					
2. How often do you decide not to take your medicine?					
3. How often do you miss taking your medicine because you feel better?					
4. How often do you decide to take less of your medicine?					
5. How often do you stop taking your medicine because you feel sick owing to the effects of the medicine?					
6. How often do you forget to bring along your medicine when you travel away from home?					
7. How often do you not take your medicine because you run out of it at home?					

Data analysis

The data were analysed using SPSS version 16.0 for Windows, developed by IBM Corporation, New York, United States of America. Categorical data, including sex and ethnicity, were presented as frequencies and percentages and numerical data, including the HbA1c level, as means and standard deviations. Simple logistic regression analysis was conducted to test for the factors associated with medication adherence and glycaemic control, with the CI set at 95%. Variables with a P-value of <0.25 in the univariate analysis were subsequently included in the multiple logistic regression model for further analysis to determine significant associations with medication adherence and good glycaemic control. The final results were presented as adjusted odds ratios (ORs), and a P-value of <0.05 was considered statistically significant.

Ethical considerations

Ethical approval for the study was obtained from the Medical Research and Ethics Committee, National Institute of Health Malaysia (ID NMRR-18-899-40999).

Results

Patient demographics

A total of 390 patients were approached for the study, and 386 participated, yielding a response rate of 99%. The mean age and disease duration of the respondents were 60.04±10.75 and 6.4±5.4 years, respectively. The study participants were predominantly women (59.1%), were of Malay ethnicity (73.1%), had primary education (49.7%), were retired (35.2%) and used a single oral glucose-lowering agent (39.4%). The mean HbA1c level was 8.3±2.0% (**Table 2**).

Table 2. Sociodemographic and disease characteristics of the participants (N=386).

Variable	n
Age	Mean: 60.04±10.75
<40 years	12 (3.1)
40–49 years	52 (13.5)
50–59 years	120 (31.1)
60–69 years	132 (34.2)
≥70 years	70 (18.1)
Sex	
Male	158 (40.9)
Female	228 (59.1)
Ethnicity	
Malay	282 (73.1)
Chinese	61 (15.8)
Indian	43 (11.1)
Educational level	
No formal education	52 (13.5)
Primary education	192 (49.7)
Secondary education	111 (28.8)
Tertiary education	31 (8.0)
Occupation	
Professional	24 (6.2)
Non-professional	131 (34.0)
Unemployed	95 (24.6)
Retired	136 (35.2
Marital status	
Single	11 (2.8)
Married	298 (77.2)
Widowed/divorced	77 (20.0)
Duration of diabetes mellitus	Mean: 6.4±5.4
<5 years	165 (42.8)
5–10 years	149 (38.6)
11–15 years	41 (10.6)
>15 years	31 (8.0)
Body mass index	Mean: 27.71±5.94
Underweight (<18.5 kg/m^2)	6 (1.6)
Normal (18.5–22.9 kg/m^2)	71 (18.4)
Overweight (23.0–27.4 kg/m^2)	131 (33.9)
Obese (≥27.5 kg/m^2)	178 (46.1)
Comorbidities	
Yes	370 (95.9)
No	16 (4.1)
No. of drugs currently taken	Mean: 5.3±2.1
1	4 (1.0)
2	24 (6.2)
3	44 (11.4)
>3	314 (81.4)
Antidiabetic agents	
Single oral glucose-lowering agent	152 (39.4)
Combination oral glucose-lowering agents	144 (37.3)
Combination oral glucose-lowering agents and insulin	69 (17.9)
Insulin	21 (5.4)
HbA1c level	Mean: 8.3±2.0
≤6.5%	79 (20.5)
6.6–7.0%	49 (12.7)
7.1–8.0%	78 (20.2)
>8.0%	180 (46.6)

Medication adherence

Approximately 60.3% of the participants were adherent to their medication, with 35.2% and 25.1% achieving 100% and >95% questionnaire scores, respectively.

The multiple logistic regression analysis showed that an increasing age was significantly associated with nonadherence among the patients with diabetes mellitus in Pagoh Health Clinic (adjusted OR: 0.959; 95% CI: 0.934–0.985) (**Table 3**).

Table 3. Factors associated with medication adherence among the patients with type 2 diabetes mellitus in Pagoh Health Clinic.

Variable	Medication adherence		Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
	Adherent n (%)	Nonadherent n (%)				
Age (year)	60.04±10.75		0.967 (0.948–0.986)	0.001	0.959 (0.934–0.985)	0.002
Sex						
Male	90 (57.0)	68 (43.50)	1.271 (0.840–1.923)	0.256	1.249 (0.753–2.071)	0.389
Female	143 (62.7)	85 (37.3)	ref.			
Ethnicity						
Malay	164 (58.2)	118 (41.8)	1.214 (0.626–2.354)	0.566		
Chinese	42 (68.9)	19 (31.1)	0.763 (0.335–1.737)	0.520		
Indian	11 (62.8)	16 (37.2)	ref.			
Educational level						
No formal education	37 (71.2)	15 (28.8)	ref.			
Primary education	112 (58.3)	80 (41.7)	1.762 (0.906–3.426)	0.095	1.209 (0.590–2.478)	0.604
Secondary education	67 (60.4)	44 (39.6)	1.620 (0.796–3.296)	0.183	0.801 (0.353–1.816)	0.595
Tertiary education	17 (54.8)	14 (45.2)	2.031 (0.803–5.136)	0.134	0.727 (0.417–1.455)	0.596
Occupation						
Professional	11 (45.8)	13 (54.2)	2.098 (0.874–5.038)	0.097	1.507 (0.497–4.567)	0.469
Non-professional	76 (58.0)	55 (42.0)	1.285 (0.785–2.103)	0.319	0.711 (0.394–1.285)	0.259
Unemployed	59 (62.1)	36 (37.9)	1.083 (0.630–1.864)	0.772	0.778 (0.417–1.455)	0.433
Retired	87 (64.0)	49 (36.0)	ref.			
Marital status						
Single	6 (54.5)	5 (45.5)	ref.			
Married	177 (59.4)	121 (40.6)	0.820 (0.245–2.749)	0.748		
Divorced/ widowed	50 (64.9)	27 (35.1)	0.648 (0.181–2.321)	0.505		
Duration of diabetes mellitus						
<5 years	100 (60.6)	65 (39.4)	ref.			
5–10 years	86 (57.7)	63 (42.3)	1.127 (0.718–1.769)	0.603		
11–15 years	28 (68.3)	13 (31.7)	0.714 (0.345–1.479)	0.365		
>15 years	19 (61.3)	12 (38.7)	0.972 (0.442–2.135)	0.943		
Body mass index						
Underweight	4 (66.7)	2 (33.3)	0.828 (0.148–4.646)	0.831		
Normal	41 (57.7)	30 (42.3)	1.212 (0.692–2.122)	0.501		
Overweight	77 (58.8)	54 (41.2)	1.162 (0.732–1.843)	0.524		
Obese	111 (62.4)	67 (37.26)	ref.			
Comorbidity						
Yes	224 (60.5)	146 (39.5)	0.838 (0.305–2.300)	0.732		
No	9 (56.3)	7 (43.7)	ref.			
No. of drugs						
1	1 (25.0)	3 (75.0)	ref.			
2	12 (50.0)	12 (50.0)	0.333 (0.030–3.676)	0.370	0.189 (0.015–2.310)	0.192
3	25 (56.8)	19 (43.2)	0.253 (0.024–2.631)	0.250	0.230 (0.019–2.840)	0.253
>3	195 (62.1)	119 (37.9)	0.203 (0.021–1.978)	0.170	0.198 (0.016–2.502)	0.211

Table 3. Continued

Variable	Medication adherence		Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
	Adherent n (%)	Nonadherent n (%)				
Antidiabetic agents						
Single glucose-lowering agent	95 (62.5)	57 (37.5)	ref.			
Combination oral glucose-lowering	77 (53.5)	67 (46.5)	1.450 (0.912–2.306)	0.116	1.427 (0.856–2.380)	0.173
Combination oral glucose-lowering agents and insulin	45 (65.2)	24 (34.8)	0.889 (0.491–1.611)	0.698	0.787 (0.410–1.513)	0.473
Insulin	16 (76.2)	5 (23.8)	0.521 (0.181–1.498)	0.226	0.528 (0.176–1.588)	0.256

The 'Enter' method was applied. No multicollinearity was present. No significant interactions were found. Hosmer–Lemeshow test: P=0.337. Nagelkerke R square: 0.413.

Glycaemic control

The mean HbA1c level among the participants remained suboptimal at 8.3±2.0% (Table 1). Medication adherence was significantly associated with good glycaemic control (adjusted OR: 2.688; 95% CI: 1.534–4.708) (Table 3), with better glycaemic control observed among the adherers (mean HbA1c level: 7.9±1.9%) than among the nonadherers (mean HbA1c level: 8.7±2.1%). The use of combination medications (combination oral medications: adjusted OR: 5.604; 95% CI: 3.078–10.203; combination oral medications and insulin: adjusted OR: 23.466; 95% CI: 8.208–67.085) and insulin only (adjusted OR: 6.528; 95% CI: 1.876–22.717) was also significantly associated with good glycaemic control. Increasing age (adjusted OR: 0.954; 95% CI: 0.923–0.986) and Malay ethnicity (adjusted OR: 0.284; 95% CI: 0.101–0.794) were associated with poor glycaemic control (**Table 4**).

Table 4. Factors associated with good glycaemic control among the patients with type 2 diabetes mellitus in Pagoh Health Clinic.

Variable	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Age (year)	0.958 (0.938–0.979)	<0.005	0.954 (0.923–0.986)	0.005
Sex				
Male	1.239 (0.802–1.913)	0.334		
Female	ref.			
Ethnicity				
Malay	0.273 (0.112–0.669)	0.005	0.284 (0.101–0.794)	0.016
Chinese	0.420 (0.150–1.174)	0.098	0.420 (0.273–2.941)	0.856
Indian	ref.			
Educational level				
No formal education	ref.			
Primary education	1.293 (0.690–2.426)	0.423	0.809 (0.354–1.846)	0.614
Secondary education	1.620 (0.796–3.296)	0.183	0.898 (0.348–2.318)	0.824
Tertiary education	2.031 (0.803–5.136)	0.134	1.512 (0.349–6.553)	0.581
Occupation				
Professional	1.412 (0.548–3.639)	0.475	0.364 (0.087–1.518)	0.166
Non-professional	1.190 (0.718–1.970)	0.499	0.744 (0.369–1.501)	0.409
Unemployed	1.391 (0.793–2.441)	0.250	0.729 (0.345–1.538)	0.406
Retired	ref.			

Table 4. Continued

Variable	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Marital status				
Single	ref.		0.284 (0.101–0.794)	
Married	0.801 (0.208–3.088)	0.748	0.420 (0.273–2.941)	
Divorced/widowed	0.588 (0.144–2.391)	0.458		
Duration of diabetes mellitus				
<5 years	ref.			
5–10 years	1.293 (0.813–2.056)	0.277	1.094 (0.588–2.036)	0.777
11–15 years	2.614 (1.136–6.015)	0.024	1.532 (0.528–4.443)	0.432
>15 years	2.173 (0.885–5.334)	0.090	1.179 (0.346–4.012)	0.792
Body mass index				
Underweight	0.097 (0.011–0.846)	0.035	0.122 (0.004–3.451)	0.217
Normal	1.009 (0.560–1.815)	0.977	0.097 (0.011–0.846)	0.936
Overweight	1.024 (0.632–1.659)	0.923	0.097 (0.011–0.846)	0.916
Obese	ref.			
Comorbidity				
Yes	0.452 (0.127–1.617)	0.222	0.769 (0.184–3.216)	0.719
No	ref.			
No. of drugs				
1	ref.			
2	0.333 (0.030–3.676)	0.742		
3	0.253 (0.024–2.631)	0.652		
>3	0.203 (0.021–1.978)	0.742		
Antidiabetic agents				
Single oral glucose-lowering agent	ref.			
Combination oral glucose-lowering agents	6.644 (3.911–11.288)	<0.001	5.604 (3.078–10.203)	<0.001
Combination oral glucose-lowering agents and insulin	19.627 (7.466–51.592)	<0.001	23.466 (8.208–67.085)	<0.001
Insulin	6.517 (2.091–20.309)	0.001	6.528 (1.876–22.717)	0.003
Medication adherence				
Adherent	2.240 (1.415–3.546)	0.001	2.688 (1.534–4.708)	0.001
Nonadherent	ref.			

The 'Enter' method was applied. No multicollinearity was present. No significant interactions were found. Hosmer–Lemeshow test: P=0.841. Nagelkerke R square: 0.381.

Discussion

In this study, 60.3% of the participants reported good medication adherence, consistent with the general adherence level among patients with diabetes mellitus in Malaysia and with a previously reported suboptimal adherence rate ranging from 40% to 60%.[8–10] This finding highlights a potential lack of importance with which local patients with diabetes mellitus view their disease, making them feel certain resistance to medication and adherence as shown in several local qualitative studies.[12,13] Diabetes mellitus is often asymptomatic in the early to mid-phases of progression, and proper education on disease management is especially crucial at this stage to ensure medication adherence and metabolic control.

Previous studies have reported conflicting results on the factors related to medication adherence.[8–10,17] The sociodemographic characteristics, including sex, ethnicity, educational level, occupation and marital status, were not significantly associated with medication adherence in this study. These findings generally echo those of earlier local and international studies.[8–10,17]

One surprising finding in our research was that the older patients were more likely to be nonadherent than their younger counterparts, a contrast to previous findings.[8,9,18,19] However, an Iranian study showed similar findings wherein elderly patients with diabetes mellitus were found to be nonadherent.[20] The present findings could be attributed to the extent of polypharmacy among the participants, as the large majority reported a daily consumption of more than three medications. Previous evidence has also linked the likelihood of age-related cognitive impairment and lack of self-efficacy to medication nonadherence among elderly patients, which may play a factor in the results of this study.[21,22]

The other characteristics, such as the duration of diabetes mellitus, body mass index, comorbidity, number of drugs taken and type of glucose-lowering agent, did not show any significant association to medication adherence. An increased number of drugs and presence of comorbidities have typically been reported to reduce adherence but had no effect in this study.[8,11] A local study conducted in urban Selangor also reported no association between the number of drugs and medication adherence.[8] This interesting finding could point to a general lack of awareness on the importance of medication in patients as reported by several local qualitative studies.[12,13] The finding highlights a key role of physicians in proper and constant education on disease control for patients.

This study examined glycaemic control among the patients with type 2 diabetes mellitus. The mean HbA1c level among the participants was suboptimal at 8.3%, with local studies reporting similar HbA1c levels ranging from 7.8% to 9.1%.[23-26] This finding reflects the persistent lack of metabolic control among patients with diabetes mellitus in Malaysia despite being one of the regions in Southeast Asia with a high prevalence of the disease.

Our study showed that the adherent patients with diabetes mellitus had twice the odds of having good glycaemic control compared with the nonadherent patients. This is in agreement with findings of both local and international studies.[7,23,24,26,27] A previous study performed in the United States has also reported a 0.34% reduction in the HbA1c level for every 25% increase in medication adherence.[7] Our study findings re-emphasise the importance of medication adherence in optimising glycaemic control and reducing subsequent disease complications among patients with diabetes mellitus.

The use of combination agents or insulin only was also significantly associated with good glycaemic control as compared with monotherapy. This is in contrast with local findings of a better control for patients on monotherapy, although these findings may have been confounded by the initiation of insulin in later stages of diabetes mellitus wherein control may already be poor despite oral pharmacotherapy.[24,25,28] The wide CI of the OR obtained for the use of combination agents with insulin herein may be attributed to the small sample size of the study. However, our findings echo those of studies performed in developed countries where insulin or combination therapy is not considered a late-stage management for patients.[5,6] Clinical practice guidelines in Malaysia highly recommend early initiation of insulin or combination therapy, as it has been shown to improve glycaemic control.[29] Insulin use has remained low in Malaysia in the past two decades but gradually increased in hospitals over time.[30] Our findings re-emphasise the benefits of combination or insulin therapy in controlling blood glucose levels, which may reflect earlier initiation of insulin and combination therapies at the primary care level.

To our knowledge, this study is one of the first investigations conducted in a suburban setting in Southern Peninsula Malaysia to evaluate the level and factors affecting medication adherence and glycaemic control. The study utilised self-administered questionnaires and is therefore open to response bias, although we aimed to minimise such bias by maintaining anonymity of the respondents. The concurrent use of an additional adherence measurement tool, such as pill counts, alongside the questionnaires would lend better strength to the results. The research findings should be interpreted with caution owing to the cross-sectional nature of the study, which may not reflect a causal relationship between factors. As the study was limited to patients attending the health clinic in one district, it may be difficult to generalise the study findings to other populations. The study also did not further investigate other behavioural or environmental factors that may influence medication adherence, which can serve as an interesting area for future studies.

Conclusion

In conclusion, our study showed that medication adherence and glycaemic control remained suboptimal in Pagoh, consistent with the findings in other regions in Malaysia. An increasing age was associated with reduced medication adherence. Medication adherence and use of either combination or insulin therapy were also associated with good glycaemic control, whereas older age and Malay ethnicity were related to poor glycaemic control.

It is therefore vital for primary care physicians to emphasise medication adherence counselling to all patients with diabetes mellitus, particularly elderly patients, and their caregivers. Diabetes mellitus control and adherence education should also be especially targeted to those on monotherapy and predisposed ethnic groups.

The identification of the associated factors in this study can aid in ensuring that better health initiatives are put into place for effective education regarding medication adherence, that good glycaemic control is achieved and that morbidity and mortality are reduced among patients with diabetes mellitus.

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Author contributions

Suzane Chin Shiyun, as lead investigator, was involved in the conceptualisation of the study, proposal drafting, data collection, data analysis, and writing of the original manuscript. Lau Siau Wee and Lim Pey Ling were involved in the conceptualisation of the study and data collection. Wong Ching Mun and Noorhaida Ujang were involved in the conceptualisation of the study, proposal drafting and paper revision. All authors have agreed to the manuscript publication.

Ethical approval

This study was approved by the Medical Research And Ethics Committee (MREC), National Institute of Health Malaysia (ID NMRR-18-899-40999).

Conflicts of interest

All authors declare no conflicts of interest.

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Data sharing statement

Data generated and analysed during the study are available from the corresponding author upon reasonable request.

How does this paper make a difference in general practice?

- This study provides insights into the factors associated with medication adherence in patients with diabetes mellitus, which may be targeted to improve adherence and glycaemic control, especially at the primary care level.
- The findings emphasise the importance of active individualised counselling among patients predisposed to poor adherence and glycaemic control, such as elderly patients and patients on oral monotherapy.
- This study adds to the literature investigating medication adherence among patients with diabetes mellitus in Pagoh. The current adherence level and glycaemic control in the subdistrict remain suboptimal and therefore need improvement.

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