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RESEARCH ARTICLE

Impact of pharmacist-led education on knowledge, adherence, and glycaemic control of type 2 diabetic outpatients

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Abstract

Objectives: This study aimed to evaluate the effect of a pharmacist-led education programme on knowledge, adherence, and glycaemic control of type 2 diabetic outpatients. **Methods:** A prospective cohort study was conducted among adult type 2 diabetes mellitus (DM) outpatients. The pharmacist-led education programme was delivered to patients and their family members. Patient knowledge and adherence were assessed using questionnaires. Plasma glucose levels were also monitored during the study. **Results:** 26 patients completed the study (median (IQR) age 61.5 (58.3 – 65.0) years, female 57.7%, median (IQR) duration of DM 5.0 (3.0 – 15.0) years). At the end of study, the education programme improved patient's knowledge by 19.2% (p = 0.409) and medication adherence by 46.1% (p = 0.002). Glycaemic control in fasting plasma and postprandial glucose levels were achieved in 19.2% and 23.1% of patients, respectively. **Conclusion:** An education programme led by pharmacists may improve diabetic outpatient's knowledge, adherence to therapy, and glycaemic control.

Introduction

Diabetes mellitus (DM) is a chronic disease and one of major health problems in many countries (Gregg *et al.*, 2021). The significant impact of DM and its acute and long-term complications on individuals and their families, health expenditures, and national economies are well known (Williams *et al.*, 2020). DM prevalence is increasing more rapidly in low- and middle-income countries. In Indonesia, 10.3 million DM cases were reported in 2017, while in East Java it was estimated that people with DM reached 2.0% of the total population (Ministry of Health, 2018).

Based on the Indonesian Basic Health Survey in 2018, it was estimated that there are still many (about 50%) people with DM in Indonesia who have not been diagnosed (Ministry of Health, 2018). In addition, only two thirds of those diagnosed were undergoing both non-pharmacological and pharmacological treatment. Of those who underwent the treatment, only a third achieved glycaemic control (Soelistijo *et al.*, 2015). A study involving 165 elderly patients with type 2 DM at the outpatient clinic in Surabaya, Indonesia, showed that the target blood glucose was achieved only in 53.3% patients, 40.6% did not reach the target and 6.1% were at risk of hypoglycaemia (Suprapti *et al.*, 2014). Another study related to the insulin use of 240 outpatients showed that the target blood glucose was only achieved in 20.8%

patients, 75.1% failed to reach the therapeutic target and 4.1% experienced side effects of antidiabetic agents (Suprapti *et al.*, 2017). Problems related to antidiabetic use included hypoglycaemia, nausea, abdominal fullness, and flatulence. Moreover, another recent study revealed that out of 321 type 2 diabetic outpatients who had received up to four antidiabetic agents and other drugs, most of them had probable low adherent (62.6%) or low adherent levels (20.9%) to the treatment (Suprapti *et al.*, 2018).

The management of DM is complicated and requires continuity of therapy for a long time. In addition, with various complications, patients often receive poly-pharmacy which leads to drug-related problems (DRPs). A study involving 2898 patients (aged 56.6 ± 13.5 years) identified a total DRPs of 32348, with a mean of 11.2 DRP per patient (Al-Azzam *et al.*, 2016). The most common DRPs is the need for additional or more frequent monitoring due to adverse events, low adherence to treatment, and lack of patients understanding on therapy instructions or self-care advice. Factors contributing to those problems include age, marriage status, education level, and certain clinical conditions (Al-Azzam *et al.*, 2016).

Diabetes experts in Indonesia represented by the Indonesian Society of Endocrinology have developed the guidelines for managing and preventing DM in Indonesia (Rudijanto *et al.*, 2011; Soelistijo *et al.*, 2015). These guidelines emphasise the important roles of healthcare professionals, patients, and their family members in the proper management of DM. Most people with DM receive their initial treatment at the primary health centres (*puskesmas*) as the first point of contact for people seeking care in the public health system in Indonesia (Seuring *et al*., 2019). Patients experiencing complications, requiring complex interventions, and/or having low adherence to medications are commonly referred to the hospital.

Education of diabetic patients is a paramount strategy to promote self-care management which should have an interactive approach, including sharing of information between patients and healthcare providers (Widayanti *et al.*, 2021). The strategies also need to consider the perspective of patients and the involvement of their families in managing the disease and preventing further complications (Pamungkas, Chamroonsawasdi, & Vatana-somboon, 2017). In Indonesia, diabetes education conducted by healthcare professionals (doctors and nurses) as part of their daily work is however delivered in an unstructured programme and mainly limited to the use of medication to control the disease (Ligita *et al.*, 2019). Follow-up sessions are rarely carried out due to the imbalance numbers between patients and doctors or nurses.

Improving patient adherence plays an important role for optimising diabetes control. Among different strategies, providing patient's education integrated with family support is effective to lead the patients' involvement in their care and better self-management (Pamungkas, Chamroonsawasdi, & Vatanasomboon, 2017). Pharmacists are positioned to educate patients regarding medication related knowledge and adherence. They become an important element in the multidis-ciplinary diabetes management programme (van Eikenhorst *et al.*, 2017; Hughes *et al.*, 2017; Malathy *et al.*, 2011). Pharmacist-led interventions in diabetes care have been intensively studied in several countries (Al Assaf, Zelko, & Hanko, 2022), including Egypt (Ebid *et al.*, 2022), French (Delage *et al.*, 2021), Nigeria (David *et al.*, 2021), and Pakistan (Bukhsh *et al.*, 2022). These studies showed that patients' education and counseling were the most common interventions that could be adapted to specific country contexts and cultural settings, and positive findings were demonstrated in enhancing clinical outcomes and adherence to treatment. Furthermore, the presence of family and peers could help patients feel that their health condition is something that they can share with others. To the authors knowledge, studies on pharmacist-led education with the involvement of family support for type 2 diabetic patients in the Indonesian context are scarce. In addition, there is still limited evidence on the effectiveness of pharmacist-led intervention in the management of diabetes in Indonesia. Therefore, this study presents a new model of implementing clinical pharmacy service for management of diabetes in Indonesia to improve the expected outcomes.

Methods

Study design

A prospective cohort study was conducted at the internal medicine clinic of a secondary referral teaching hospital in Surabaya, Indonesia, to evaluate the effect of pharmacist-led education programme on patient knowledge,

adherence to therapy, and glycaemic control from September to December 2019. The study protocol was reviewed and ethically approved by the ethics research committee of Airlangga University Hospital in Surabaya, Indonesia (ethical clearance statement No: 168/KEP/2019, approved on 4th September 2019).

The participants who took part in the study were patients from the earlier survey in September to December 2018. The survey aimed to identify determinants of medication adherence among type 2 diabetic outpatients at the same study site. 67 out of 321 patients were classified previously as having low adherence to medications, and therefore were approached selectively to participate in this cohort study. Patients aged > 18 years old, diagnosed with type 2 DM, received antidiabetic agents (mono or combination therapy), had any comorbid disease(s), and provided informed consents were included in the study. Patients were excluded if they withdrew the participation or did not complete the study. In addition, during the study period a family member (e.g. spouse, parents, children) acceptable to the patient and the internists or pharmacists was encouraged to make sure the patient takes the medicine at home and record the timing in a medication chart. Both patients and their family members signed informed consents prior to participation in the study.

Pharmacist-led education

After providing written informed consents, the pharmacist-led diabetes education programme was delivered to patients and their family members for the three-month period. The programme consisted of education by the pharmacists and the internists, and pharmacist counselling was performed every month during patients' visits. The programme covered, but was not limited to: areas of definition of DM, signs and symptoms, controlling measures for DM, non-pharmacological therapy (physical activities, diet, foot care), antidiabetic agents (type, mechanism of action, route of administration, instructions for use, storage), symptoms and treatment approaches to hypoglycaemia and uncontrolled hyperglycaemia, and complications. Any identified and reported problems related to medications use, including polypharmacy, were discussed during the counselling. Motivation and advice on managing the medication use and lifestyle modifications were also offered by the pharmacists. Additional take-home materials (booklets) containing information about DM (definition, signs and symptoms, complications) and medications (type, mechanism of action, instructions for use, storage, common side effects) were also supplied to patients and their family members, so they could recall the information at home. In addition, a medication chart was provided to each family member to record the drug's name, indication, and timing of drug intake.

Data collection

Data were kept secure and confidential. All patient details were de-identified. Demographic characteristics (gender, age, education level, duration of DM, comorbidities, medications used), clinical (body weight, height, blood pressure, reported adverse events) and laboratory test data were extracted from the medical records. Data on drug therapy were retrieved from the pharmacy records. Patient knowledge and adherence were assessed using the validated Diabetes Medication Knowledge Questionnaire (DMKQ) (McPherson *et al.*, 2008) and Brief Medication Questionnaire (BMQ) (Svarstad *et al.*, 1999) prior to the delivery of the education programme and at the end of the study period. Fasting plasma glucose (FPG) and postprandial glucose (PPG) levels were measured at initiation and every month during the three-month study period; glycosylated haemoglobin (HbA1c) measurements could not be performed because of unavailability issue at the study site and financial constricts.

The study was preceded by a forward-backward translation from the original version of DMKQ (McPherson *et al.*, 2008) and BMQ (Svarstad *et al.*, 1999) to obtain the Indonesian version of DMKQ and BMQ. Permissions for the questionnaires use were granted from the original authors. The forward translation was performed by two Indonesian translators who were experts in English. The results were discussed to compare the two translations and make an agreement. The Indonesian version was then backward translated by an English native speaker who understood Indonesian language. The result from the backward translation and the original version were compared and discussed, and the Indonesian version was obtained with the same context as the original version. A pilot testing and a reliability and validity test of the Indonesian version were performed in 10 DM patients. The Indonesian version of DMKQ and BMQ had Cronbach's alpha coefficients of 0.792 and 0.742, respectively, which met the criteria for reliability (> 0.70), and correlation coefficients (r value) with $p < 0.05$ which met the construct validity (data not shown).

DMKQ consists of five questions that assess five important knowledge that patients should know about the medications they are taking (see Appendix 1). The questionnaire was evaluated with a score of 0, 1, or 2 for

each answer provided. The level of knowledge was based on the total score (range 0 to 8) and evaluated through the total score of the questionnaire range from 0 to 8, with a cut-off value of 5 (i.e. < 5 low and ≥ 5 high) and a higher score denoting a better medications-related knowledge.

BMQ consists of seven questions on regimen screen that asks subjects how they took their medications in the past week, two questions on belief screen about drug efficacy and bothersome features, and two questions on recall screen about remembering difficulties (see Appendix 2). Each answer was scored 0 for 'No' (indicates the absence of any self-reported nonadherence) and 1 for 'Yes' (positive response, indicates the presence of any nonadherence or barriers). The adherence level was evaluated from the positive responses of three screens: adherent (no positive response from the three screens), probable adherence (positive response at one screen), probable low adherence (positive responses at two screens), and low adherence (positive responses at three screens).

FPG and PPG levels were categorised based on the therapeutic target levels stated in the clinical guideline applicable at the study site. Mean FPG levels were divided into < 80 mg/dL (below), 80 – 130 mg/dL (within target), and >130 mg/dL (above), while PPG levels were classified into ≤ 180 mg/dL (within target) and > 180 mg/dL (above).

Data analysis

Descriptive statistics were used to describe subjects' characteristics. All questionnaire data were tabulated using Microsoft Excel (2016) and results are presented using tables. Data are described in numbers, percentages, mean ± standard deviation (SD), or median (interquartile range, IQR) when appropriate. The normal distribution of variables was determined by the Kolmogorov-Smirnov test. The Wilcoxon signed rank test was performed to compare differences in DMKQ and BMQ scores at baseline and after three months. The student paired t-test was carried out to compare means of FPG and PPG before and after the programme. The statistical analysis was executed using the IBM SPSS Statistics 25.0 for Windows with a significant value set at $p < 0.05$. The reporting of this cohort study conforms to STROBE guidelines (von Elm *et al.*, 2007).

Results

67 subjects were included, but 11 withdrew the participation prior to completion and 30 were lost to follow-up. A total of 26 patients completed the study protocol. Of those, 57.7% were female and 23.1% were in higher education levels. Patient median age was 61.5 years (IQR 58.3 – 65.0) and median duration of DM was 5.0 years (IQR 3.0 – 15.0). More than half of subjects were prescribed combination therapy for DM treatment. Some subjects had comorbidities (e.g. hypertension, dyslipidaemia, coronary heart disease) and received other medications (e.g. antihypertensive agents, antihyperlipidemic drugs, neuropathic pain medications). Distribution of subject characteristics was presented in Table I.

Table I: Subject characteristics (n = 26)

Variables	n (%)	Median (IQR)
Gender		
Male	11 (42.3)	
Female	15 (57.7)	
Age (years)		
> 18 – 65	20 (76.9)	
> 65	6 (23.1)	61.5 (58.3 – 65.0)
Body mass index (kg/m²)		
< 23.0	4 (15.4)	
≥ 23.0	19 (73.1)	
Unknown	3 (11.5)	26.3 (23.3 – 28.9)
Education level		
Primary school	6 (23.1)	
Middle school	5 (19.2)	
High school	8 (30.8)	
College or university	6 (23.1)	
Unknown	1 (3.8)	
Comorbid disease*		
Hypertension	9 (34.6)	
Dyslipidaemia	6 (23.1)	
Coronary heart disease	4 (15.4)	
Hyperuricemia	2 (7.7)	
Benign prostate hyperplasia	1 (3.8)	
Duration of type 2 DM (years)		
0 – 10	16 (61.5)	
>10 – 20	9 (34.6)	
>20 – 30	1 (3.8)	5.0 (3.0 – 15.0)
Antidiabetic medications		
Monotherapy	12 (46.1)	
Combination therapy	14 (53.8)	
Other medications		
Antihypertensive agents	18 (69.2)	
Antihyperlipidemic drugs	13 (50.0)	
Neuropathic pain medications	7 (26.9)	
Platelet-aggregation inhibitors	5 (19.2)	
Antianginal drugs	3 (11.5)	
Analgesics	3 (11.5)	
Antihyperuricemic drugs	2 (7.7)	

* Subject could have one or more comorbid disease(s)
DM, diabetes mellitus
IQR, interquartile range

More than 70% subjects had a high level of knowledge on diabetes and its medication at the beginning of study, as shown in Table II. However, at the end of study almost all subjects (92.3%) had improved their knowledge on

Table II: Diabetes medication knowledge levels before and after the implementation of education programme

	n (%)		
	Initiation	Post-intervention	*P* value
Knowledge level			
Low (DMKQ scores < 5)	7 (26.9)	2 (7.7)	
High (DMKQ scores ≥ 5)	19 (73.1)	24 (92.3)	0.409

DMKQ, diabetes medication knowledge questionnaire

medication's name, indication, how and when to take the medications, the important side effects and what to do if a dose is missed ($p > 0.05$).

Regarding the medication adherence levels (Table III), fewer subjects reported potential problems with the current regimen at the end of the study period compared to the initiation (34.6% versus 69.2%, respectively, $p < 0.05$). Furthermore, fewer subjects identified their medications as bothersome and addressed doubts about the efficacy of medications and concerns about unwanted short-term or long-term side effects on study completion (19.2% versus 38.5%, respectively, $p > 0.05$). Nevertheless, a higher number of subjects still reported problems in remembering all doses at the end of study (92.3% versus 84.6%, respectively, $p > 0.05$). Despite that problem, there were more subjects had significant high adherence levels after the implementation of the educational programme compared to those at the beginning (65.3% versus 19.2%, respectively, $p < 0.05$).

Table III: Medication adherence levels before and after the implementation of education programme

	n (%)		
	Initiation	Post-intervention	*p* value
Drug use compliance			
Regimen screen			
No positive response (compliant)	8 (30.8)	17 (65.4)	
Positive response	18 (69.2)	9 (34.6)	0.013
Barriers to drug use			
Belief screen			
No positive response	16 (61.5)	21 (80.8)	
Positive response (barriers present)	10 (38.5)	5 (19.2)	0.059
Recall screen			
No positive response	2 (7.7)	4 (15.4)	
Positive response (barriers present)	24 (92.3)	22 (84.6)	0.157
Adherence level			
Adherent (no positive response from the three screens)	2 (7.7)	3 (11.5)	
Probable adherence (positive response at one screen)	3 (11.5)	14 (53.8)	
Probable low adherence (positive responses at two screens)	14 (53.8)	5 (19.2)	
Low adherence (positive responses at three screens)	7 (26.9)	4 (15.3)	0.002

Although HbA1c is the internationally accepted test, FPG and PPG measurements were performed to assess glycaemic control due to limitations in the availability of test during the study period. In addition, the results of glucose measurements could not be retrieved from 19.2 – 34.6% patients' medical records. Thus, only around 80% data could be evaluated. Baseline mean FPG and PPG were 176.9 ± 71.3 mg/dL and 264.1 ± 94.4 mg/dL, respectively. There was a slight increase in glucose levels in the first and second month, followed by a decrease on study completion (Table IV). As can be seen in Table V, more subjects experienced the initial FPG (50.0%) and PPG (65.4%) levels above the therapeutic target. After the implementation of programme, there were slightly reductions in patients having FPG and PPG above the target levels, 46.2% and 42.3% respectively ($p > 0.05$). At the end of study, the glycaemic control was achieved in 19.2% subjects with FPG levels 80 – 130 mg/dL and 23.1% subjects with PPG levels ≤ 180 mg/dL.

Table IV: Fasting plasma glucose and postprandial glucose levels before and during the education programme period

	Mean fasting plasma glucose, mg/dL (SD)	Mean postprandial glucose, mg/dL (SD)
Initiation	176.9 (71.3)	264.1 (94.4)
First month	201.7 (42.0)	265.5 (93.0)
Second month	208.7 (52.5)	272.2 (38.7)
Third month	172.1 (53.8)	231.1 (96.4)

Table V: Glycaemic control before and after the implementation of education programme

	n (%)		*p* value
	Initiation	Post-intervention	
Fasting plasma glucose (mg/dL)			
< 80	1 (3.8)	0 (0)	
80 – 130	7 (26.9)	5 (19.2)	
> 130	13 (50.0)	12 (46.2)	
No records	5 (19.2)	9 (34.6)	0.838
Postprandial glucose (mg/dL)			
≤ 180	3 (11.5)	6 (23.1)	
> 180	17 (65.4)	11 (42.3)	
No records	6 (23.1)	9 (34.6)	0.432

Discussion

This study demonstrated that an active role of pharmacists in providing diabetes education programme integrated with family support and take-home written materials may improve patients' knowledge on diabetes and its medications, adherence to therapy, and glycaemic control among type 2 diabetic outpatients in Indonesia. There was

a positive shift in participants' knowledge, adherence, and targeted plasma glucose levels from before the educational programme compared to afterwards.

The results are consistent with previous studies which revealed that the educational interventions included pharmacist-led, individual diabetes education provided by nurses, and diabetes group education based on a self-management approach were effective in promoting medication adherence compared to usual care (Lun Gan, Brammer, & Creedy, 2011). Education programmes including diabetes self-management education (DSME) models with family engagement improved self-management behaviours and better glycaemic control among type 2 DM patients (Lun Gan, Brammer, & Creedy, 2011; Pamungkas, Chamroonsawasdi, & Vatanasomboon, 2017). However, these interventions addressed the need for regular education sessions which allow individuals to reinforce information and educators to identify barriers to medication adherence.

This study has a unique characteristic in which pharmacists educated diabetic patients and their family members individually how to use and manage their medications properly, identified and solved the problems that patients or their family members encountered during patients' regular visits, which further improved adherence. A family member assigned to each patient observed the patient taking every dose of their medication at home and recorded this for the internists or pharmacists to monitor. This practice has been implemented successfully for chronically ill patients in real practice, for example cancer (Bordonaro *et al.,* 2014), tuberculosis (Story *et al.*, 2019), and human immunodeficiency virus-infected patients (Ngcobo & Rossouw, 2022), and hence adopted to this study. This continuous follow-up as a part of the educational programme may develop a trustable professional relationship between the pharmacists and patients and might have contributed to a better diabetes control (Farsaei *et al.*, 2011). In addition, written information related to DM, its medications, and self-care activities also helped participants learn how to manage their daily self-practices better. Interestingly, a mutual collaborative work between the internists and pharmacists during the implementation of educational programme was also observed, even though the impact on the clinical outcomes was not assessed. A previous study showed that a physician-pharmacist collaborative management has a positive impact on DM-related measures of control (HbA1c levels and episodes of hypoglycaemia) (Farland *et al.*, 2013). Therefore, further in-depth research on implementation of a structured physician-pharmacist collaboration can be performed to explore the benefits in improving patients' disease state management and health-related quality of life.

The involvement of pharmacists, as part of the multi-disciplinary healthcare team, in the medication therapy management service for type 2 DM patients has been shown to improve diabetes care and outcomes (HbA1c, blood glucose, blood pressure, lipid profile, medication adherence, and health related quality of life) (Bukhsh *et al*., 2018; Collins *et al.*, 2011; Erku *et al.*, 2017; Farsaei *et al.*, 2011; Pousinho *et al.*, 2016). In this study, however, the improvement was only slightly shown at the end of study as there was an inconsistency trend in the mean of FPG and PPG observed during the study period. This finding is in contrast with the previous study which showed that there was a significant reduction in the mean of HbA1c and FPG of patients with uncontrolled type 2 DM after a three-month follow-up intervention in the outpatient clinics (Farsaei *et al.*, 2011). Pharmacists helped in increasing medication compliance to antidiabetic medications and reducing hospital admission rates after three- and six-month follow-up interventions (Erku *et al.*, 2017). Furthermore, a recent meta-analysis showed that pharmacist-led educational interventions ranging from education on diabetes, complications, self-management, medication adherence, and pharmaceutical care planning within duration ranged from four months to 12 months were effective in reducing the HbA1c levels in 11 studies and improvement of self-care activities (self-monitoring of blood glucose, foot care, and overall diet) in eight studies in comparison to usual care among type 2 DM patients (Bukhsh *et al.,* 2018). Another diabetes education programme delivered by 66 community pharmacists resulted in improved self-management and better knowledge of diabetes after six months (Mehuys *et al.*, 2011). Nevertheless, 18 months after completion of the study, the mean of FPG was significantly lower, but this was not the case for HbA1c which did not differ between the intervention and control groups (7.4% versus 7.2%). Thus, this lack of sustainability of effect requires more research to identify the most effective long-term intervention by pharmacists.

Furthermore, family is an important social support in the care of diabetic patients (Withidpanyawong, Lerkiat-bundit, & Saengcharoen, 2019). However, there were still many family members had inadequate awareness on disease management and their roles in caring for their relatives. In the present study, the pharmacists also provided family members with information on DM and its management and their role in supporting diabetes care. Family-involvement in the pharmacist-delivered educational session appeared more likely to achieve positive

outcomes, although the study did not evaluate the value of the involvement of family support during the study period. Family members as caregivers were encouraged to take an active role in self-management practices for patients. It is therefore not surprising to find the present results are in line with previous findings which highlighted significant increases in diabetes knowledge and health-related outcomes (family support, medication adherence, self-management and self-efficacy) and better metabolic control (HbA1c, lipid profile, blood pressure and BMI) (Withidpanyawong *et al.*, 2019).

This study has provided evidence for the involvement of pharmacists in patient care and health promotion in Indonesia. The educational programme has comprehensively integrated family support in caring for people with type 2 DM, patients' engagement in better self-care, additional take-home materials, and interprofessional collaboration of health care providers (pharmacists and physicians) to improve diabetes care. This study has also extensively investigated the outcomes covering diabetes knowledge of patients, medication adherence, and glycaemic control.

However, the study has limitations that should be taken into account when interpreting the results. This study was conducted in a single teaching hospital with small sample size and short monitoring period, thus limited generalisation of results. Although there is a change in the magnitude of some variables such as knowledge level and clinical outcomes, the results are not statistically significant. This might be due to sample size insufficiency and given that the observational study is not designed to provide any definite conclusion. Large-scale studies with long-term follow-up (six to 12 months or more) are therefore warranted (Bukhsh *et al.*, 2018; Mehuys *et al.*, 2011). All subjects completed the study protocol were familiar with educational programmes and every month regularly visited the outpatient clinic, thus they might be more motivated than other patients for participating in the pharmacist educational sessions and follow-up evaluation. Inability to access HbA1c measurement during the study period also limited the assessment of the clinical outcomes. FPG and PPG levels could also be affected by various factors (e.g. diet, physical exercise, comorbidities), but this study did not evaluate the association between those factors and clinical outcomes. In addition, self-monitoring of blood glucose was not routinely performed among study population. They preferred to measure blood glucose levels during their visit in the hospital. Therefore, further trials involving larger samples and populations with easy access to standard glycaemic measurements are needed. This study did not investigate the impact and role of family members in achieving the expected outcomes. Therefore, randomised controlled trials comparing the intervention group with family support and the usual care without family support might be conducted. Patients and their family members' satisfaction with the programme may be further assessed to ensure the continuity of service in the future. In addition, the optimal interval length of follow-up, duration of education sessions, and specific processes of individual or group education need further exploration.

Conclusion

An education programme led by pharmacists may improve patient's knowledge on diabetes and its medication, adherence to therapy, and glycaemic control. Large-scale studies with long-term follow-up are needed to further evaluate the impact of pharmacist-led education programme on the clinical outcomes of diabetic patients.

Author contributions

BS and ZI contributed equally and share first authorship. BS, ZI and AP designed the study protocol. BS, AP, and CN performed the study and data collection. ZI and MY performed data analysis and wrote the draft of the manuscript. BS, ZI, MY, AP, and CN contributed to data interpretation, editing and critically reviewed the manuscript for important intellectual content. All authors have proofread and approved the final manuscript.

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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References

Al-Azzam, S.I., Alzoubi, K.H., Aburuz, S., & Alefan, Q. (2016). Drug-related problems in a sample of outpatients with chronic diseases: A cross-sectional study from Jordan. *Therapeutics and Clinical Risk Management*, **12**, 233–9

Al Assaf, S., Zelko, R., & Hanko, B. (2022). The effect of interventions led by community pharmacists in primary care for adults with type 2 diabetes mellitus on therapeutic adherence and HbA1c levels: a systematic review. *International Journal of Environmental Research and Public Health*, **19**(6188), 1–16

Bordonaro, S., Romano, F., Lanteri, E., Cappuccio, F., Indorato, R., Butera, A., D'Angelo, A., Ferraù, F., & Tralongo, P. (2014). Effect of a structured, active, home-based cancer-treatment program for the management of patients on oral chemotherapy. *Patient preference and adherence*, **8**, 917–923. https://doi.org/10.2147/PPA.S62666

Bukhsh, A., Khan, T.M., Phisalprapa, P., Duangjai, A., Saokaew, S., Nawaz, M. S., Ahmed, H. S., & Goh, B-.H. (2022). Impact of pharmacist-led diabetes self-care education on patients with type 2 diabetes in Pakistan: a randomized controlled trial. *Frontiers in Pharmacology*, **13**(February), 1–9. https://doi.org/10.3389/fphar.2022.754999

Bukhsh, A., Tan, X.Y., Chan, K.G., Lee, L.H., Goh, B.H., & Khan, T.M. (2018). Effectiveness of pharmacist-led educational interventions on self-care activities and glycemic control of type 2 diabetes patients: A systematic review and meta-analysis. *Patient Preference and Adherence*, **12**, 2457–74

Collins, C., Limone, B.L., Scholle, J.M., & Coleman, C.I. (2011). Effect of pharmacist intervention on glycemic control in diabetes. *Diabetes Research and Clinical Practice*, **92**(2), 145–152

David, E.A., Soremekun, R.O., Abah, I. O., & Aderemi-Williams, R.I. (2021). Impact of pharmacist-led care on glycaemic control of patients with uncontrolled type 2 diabetes: a randomised controlled trial in Nigeria. *Pharmacy Practice*, **19**(3), 2402

Delage, C., Lelong, H., Brion, F., & Blacher, J. (2021). Effect of a pharmacist-led educational intervention on clinical outcomes: A randomised controlled study in patients with hypertension, type 2 diabetes and hypercholesterolaemia. *European Journal of Hospital Pharmacy*, **28**(e1)

Ebid, A.-H.I., Mobarez, M.A., Ramadan, R.A., & Mahmoud, M.A. (2022). Impact of a clinical pharmacist intervention program on the follow-up of type-2 diabetic patients. *Hospital Pharmacy*, **57**(1), 76–82

van Eikenhorst, L., Taxis, K., van Dijk, L., & de Gier, H. (2017). Pharmacist-led self-management interventions to improve diabetes outcomes. A systematic literature review and meta-analysis. *Frontiers in Pharmacology*, **8**, 891

von Elm, E., Altman, D.G., Egger, M., Pocock, S.J., Gøtzsche, P.C., Vandenbroucke, J.P., & STROBE Initiative (2007). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Bulletin of the World Health Organization*, **85**(11), 867–872. https://doi.org/10.2471/blt.07.045120

Erku, D.A., Ayele, A.A., Mekuria, A.B., Belachew, S.A., Hailemeskel, B., & Tegegn, H.G. (2017). The impact of pharmacist-led medication therapy management on medication adherence in patients with type 2 diabetes mellitus: A randomized controlled study. *Pharmacy Practice*, **15**(3), 1–7

Farland, M.Z., Byrd, D.C., Shawn McFarland, M., Thomas, J., Franks, A.S., George, C.M., Gross, B.N., Cassidy, R., & Morgan, T. (2013). Pharmacist-physician collaboration for diabetes care: the diabetes initiative program. *Annals of Pharmacotherapy*, **47**(6), 781–9

Farsaei, S., Sabzghabaee, A. M., Zargarzadeh, A. H., & Amini, M. (2011). Effect of pharmacist-led patient education on glycemic control of type 2 diabetics: A randomized controlled trial. *Journal of Research in Medical Sciences*, **16**(1), 43–49

Gregg, E., Buckley, J., Ali, M., Davies, J., Flood, D., Griffiths, B., Lim, L.-L.,Manne-Goehler, J., Pearson-Stuttard, J., & Shaw, J. (2021). *Improving health outcomes of people with diabetes mellitus: target setting to reduce the global burden of diabetes mellitus by 2030. Glennis Andall-Brereton*

Hughes, J.D., Wibowo, Y., Sunderland, B., & Hoti, K. (2017). The role of the pharmacist in the management of type 2 diabetes: current insights and future directions. *Integrated Pharmacy Research and Practice*, **6**, 15–27

Ligita, T., Wicking, K., Francis, K., Harvey, N., & Nurjannah, I. (2019). How people living with diabetes in Indonesia learn about their disease: A grounded theory study. *PLoS ONE*, **14**(2), 1–19

Lun Gan, J.K., Brammer, J.D., & Creedy, D.K. (2011). Effectiveness of educational interventions to promote oral hypoglycaemic adherence in adults with type 2 diabetes: a systematic review. *JBI Library of Systematic Reviews*, **9**(9), 269–312

Malathy, R., Narmadha, M.P., Ramesh, S., Alvin, J.M., & Dinesh, B.N. (2011). Effect of a diabetes counseling programme on knowledge, attitude and practice among diabetic patients in Erode district of South India. *Journal of Young Pharmacists*, **3**(1), 65–72

McPherson, M.L., Smith, S.W., Powers, A., & Zuckerman, I.H. (2008). Association between diabetes patients' knowledge about medications and their blood glucose control. *Research in Social and Administrative Pharmacy*, **4**(1), 37–45

Mehuys, E., Van Bortel, L., De Bolle, L., Van Tongelen, I., Annemans, L., Remon, JP., & Giri, M. (2011). Effectiveness of a community pharmacist intervention in diabetes care: A randomized controlled trial. *Journal of Clinical Pharmacy and Therapeutics*, **36**(5), 602–613

Ministry of Health. (2018). Riset Kesehatan Dasar (Basic Health Survey) 2018. *Badan Penelitian dan Pengembangan Kesehatan (National Centre for Health Research and Development), Kementerian Kesehatan (Ministry of Health), Republic of Indonesia*. Jakarta

Ngcobo, S., & Rossouw, T. (2022). Acceptability of home-based HIV care offered by community health workers in Tshwane District, South Africa: a survey. *AIDS Patient Care and STDs*, **36**(2), 55–63

Pamungkas, R.A., Chamroonsawasdi, K., & Vatanasomboon, P. (2017). A systematic review: Family support integrated with diabetes self-management among uncontrolled type II diabetes mellitus patients. *Behavioral Sciences*, **7**(3), 1–17

Pousinho, S., Morgado, M., Falcão, A., & Alves, G. (2016). Pharmacist interventions in the management of type 2 diabetes mellitus: A systematic review of randomized controlled trials. *Journal of Managed Care and Specialty Pharmacy*, **22**(5), 493–515

Rudijanto, A., Soewondo, P., Waspadji, S., Yunir, E., & Purnamasari, D. (2011). The Indonesian Society of Endocrinology's summary article of diabetes mellitus national clinical practice guidelines. *Journal of the ASEAN Federation of Endocrine Societies*, **26**(1), 17–19

Seuring, T., Marthoenis, Rhode, S., Rogge, L., Rau, H., Besançon, S., Zufry, H., Sofyian, H., & Vollmer, S. (2019). Using peer education to improve diabetes management and outcomes in a low-income setting: A randomized controlled trial. *Trials*, **20**(1), 1–8

Soelistijo, S.A., Novida, H., Rudijanto, A., Soewondo, P., Suastika, K., Manaf, A., Sanusi, H., Lindarto, D., Shahab, A., Pramono, B., Langi Y.A., Purnamasari, D., Soetedjo, N.N., Saraswati, M.R., Dwipayana, M.P., Yuwono, A., Sasiarini, L., Sugiarto, Sucipto, K.W., & Zufry, H. (2015). *Konsensus pengendalian dan pencegahan diabetes melitus tipe 2 di Indonesia (Consensus in controlling and preventing type 2 diabetes mellitus in Indonesia)*. *Perkumpulan Endokrinologi Indonesia (Indonesian Society of Endocrinology)*. Jakarta

Story, A., Aldridge, R. W., Smith, C. M., Garber, E., Hall, J., Ferenando, G., Possas, L., Hemming, S., Wurrie, F., Luchenski, S., Abubakar, I., McHugh, T.D., White, P.J., Watson, J.M., Lipman, M., Garfein, R., & Hayward, A.C. (2019). Smartphone-enabled video-observed versus directly observed treatment for tuberculosis: a multicentre, analyst-blinded, randomised, controlled superiority trial. *The Lancet*, **393**(10177), 1216–1224

Suprapti, B., Izzah, Z., Nugroho, C.W., & Andarsari, M.R. (2018). *Factors related to the incidence of drug-related problems and achievement of therapeutic targets among type 2 diabetic outpatients: a research report*. Surabaya

Suprapti, B., Vilaningtyas, N., Nilamsari, W.P., & Ichwani, J. (2014). Blood glucose target achievement and antidiabetes regimen in type-2 diabetic geriatric patients. *Indonesian Journal of Pharmacy*, **25**(2), 98–104

Suprapti, B., Widyasari, N., Rahmadi, M., & Wibisono, C. (2017). Review of insulin therapy in type 2 diabetes mellitus ambulatory patients. *Indonesian Journal of Pharmacy*, **28**(4), 221–231

Svarstad, B.L., Chewning, B.A., Sleath, B.L., & Claesson, C. (1999). The Brief Medication Questionnaire : A tool for screening patient adherence and barriers to adherence. *Patient Education and Counseling*, **37**, 113–124

Widayanti, A.W., Heydon, S., Green, J.A., & Norris, P. (2021). Effectiveness of an intensive community-based intervention for people with type 2 diabetes in Indonesia: A pilot study. *Diabetes Research and Clinical Practice*, **181**, 109087.

Williams, R., Karuranga, S., Malanda, B., Saeedi, P., Basit, A., Besançon, S., Bommer, C., Esteghamati, A., Ogurtsova, K., Zhang, P., & Colagiuri, S. (2020). Global and regional estimates and projections of diabetes-related health expenditure: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. *Diabetes research and clinical practice*, **162**, 108072. https://doi.org/10.1016/j.diabres.2020.108072

Withidpanyawong, U., Lerkiatbundit, S., & Saengcharoen, W. (2019). Family-based intervention by pharmacists for type 2 diabetes: a randomised controlled trial. *Patient Education and Counseling*, **102**(1), 85–92

Appendix

Appendix 1 - Diabetes medication knowledge questionnaire (DMKQ)

Response	Score
Question 1. Can you tell me the name of the medication you are taking?	
Don't know	0
Knows the name of the medication	1
Question 2. Can you tell me why you are on this medication?	
Don't know	0
To lower blood sugar	1
Can describe exactly how the medication works	2
Question 3. Do you know how and when to take your medication?	
Don't know	0
Know when but don't know how, or know how but don't know when	1
Know how and when to take medication	2
Question 4. Can you tell me what side effects your medication may cause, and what to do if they occur?	
Don't know	0
Know the side effects but don't know what to do, or know what to do but don't know what the side effects are	1
Know the side effects and what to do if they occur	2
Question 5. Do you know what to do if you miss a dose of your medication?	
Don't know or says 'double the dose'	0
Never misses a dose or says 'carry on as usual' or 'ask doctor or pharmacist for advice'	1

Adapted with permission from McPherson ML, Smith SW, Powers A, et al. Association between diabetes patients' knowledge about medications and their blood glucose control. Res Soc Adm Pharm. 2008;4(1):37–45.

Appendix 2 - Brief Medication Questionnaire (BMQ)

1. Please list below all medications you took in the past week. For each medication you list, please answer each of the questions in the boxes below.

a. Medication name	b. How many days did you take it?	c. How many times per day did you take it?	d. How much did you take each time?	e. How many times did you miss taking it?	f. For what reason were you taking it?	g. How well does this medicine work for you? 1= very 2= somewhat 3= not at all 4= don't know

2. Do any of your medications bother you in any way?

Yes [ ] No [ ]

a. If Yes, please name the medication and explain how it bothers you.

Medication name	**How much does it bother you?**				
	A lot	**Some**	**A little**	**Never**	**In what way does it bother you?**

3. How much problem or concern are you having in the following areas?

	A lot	A little	None
a. It is hard to open the container	[ ]	[ ]	[ ]
b. It is hard to read the print on the container	[ ]	[ ]	[ ]
c. It is hard to remember all the doses	[ ]	[ ]	[ ]
d. It is hard to get my refill on time	[ ]	[ ]	[ ]
e. It is hard to take many pills at the same time	[ ]	[ ]	[ ]

4. Did you stop or interrupt taking any medications due to a late refill or other reason? Yes [ ] No [ ]

5. Did you reduce or take less than prescribed amount per dose for any reason? Yes [ ] No [ ]

6. Did you take extra dose(s) or more medication than prescribed for any reason? Yes [ ] No [ ]

Adapted with permission from Svarstad BL, Chewning BA, Sleath BL, et al. The Brief Medication Questionnaire : A tool for screening patient adherence and barriers to adherence. Patient Educ Couns. 1999;37:113–24 (the original copyrighted instrument is available from Svarstad BL).