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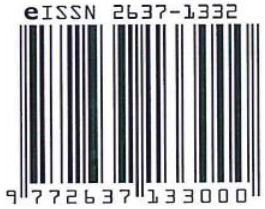

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Assessment of Insulin Injection Techniques among Diabetic Patients: in Hospital Setiu, Terengganu

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Abstract

Introduction: The effectiveness of insulin therapy in diabetic patients depends on proper administration of insulin to improve glycaemic control and minimise diabetes complications.

Objective: This study aimed to determine the prevalence of poor insulin injection technique among diabetic patients in Hospital Setiu, Terengganu and to identify common errors in insulin administration.

Methods: A cross-sectional study was conducted among inpatients and outpatients at Hospital Setiu from August to December 2023. Patients who were on insulin therapy and had previously received counselling on insulin administration were recruited using convenience sampling. Patients' insulin injection technique was assessed through in-person interviews and practical demonstrations using a structured checklist comprising 16 dichotomous (correct / incorrect) items. A total score of less than 14 indicated poor technique, while a score of 14 and above was considered good insulin injection technique.

Results: A total of 63 patients were enrolled in the study, with a median age of 57 years [interquartile range (IQR): 17]. The majority were male (58.7%) and 46.0% had attained secondary education. The median duration of insulin therapy was 4 years (IQR: 7). Overall, 12.7% of patients (n=8) exhibited poor insulin injection technique. The most common errors observed were failure to replace and unscrew the outer needle cap (n=14, 22.2%) and the failure to adequately mix the insulin by rolling the cartridge between the palms or inverting it (n=12, 19.0%).

Conclusion: While only a small proportion of diabetic patients in this study demonstrated poor insulin injection techniques, specific errors were consistently identified. These commonly observed incorrect techniques should be given particular emphasis during counselling and dispensing sessions by pharmacists to optimise insulin administration and improve clinical outcomes.

Keywords: Assessment of errors, insulin injection technique, diabetic patients

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Introduction

Diabetes mellitus is a chronic metabolic disorder characterised by persistent hyperglycaemia resulting from defects in insulin secretion, insulin action, or both (1). In Malaysia, diabetes poses a substantial burden on healthcare resources and socioeconomic development. National surveys have demonstrated a rising prevalence over the past decade, increasing from 11.2% in 2011, 13.4% in 2015 and peaking at 18.3% in 2019, before showing a slight decline to 15.6% in 2023 (2). Despite this recent reduction, the overall prevalence remains alarmingly high, underscoring the need for continued efforts in prevention and optimal disease management.

Insulin therapy is an essential treatment in the management of diabetes. Patients with Type 1 Diabetes Mellitus (T1DM) require lifelong insulin, while most individuals with Type 2 Diabetes Mellitus (T2DM) may eventually need insulin treatment due to progressive pancreatic beta cell (β cell) dysfunction and declining endogenous insulin secretion (3). As the glycaemic control becomes more difficult to achieve, insulin therapy is typically initiated when oral hypoglycaemic agents fail to maintain target glycaemic levels (4). However, the effectiveness of insulin therapy among diabetic patients depends not only on the pharmacological properties of insulin but also on proper administration

techniques. Correct insulin injection technique ensures accurate dosing and appropriate delivery into the subcutaneous tissue, which is essential for optimal absorption and glycaemic control (4). Poor injection practices may result in unpredictable insulin absorption, leading to hyperglycaemia, hypoglycaemia, lipohypertrophy, and other injection-related complications. In addition, achieving and maintaining optimal glycaemic control is crucial in preventing microvascular and macrovascular complications, thereby improving long-term clinical outcomes and quality of life (5).

Improper insulin injection technique represents a common yet modifiable factor contributing to poor glycaemic control (6). Despite the availability of educational resources, inappropriate practices remain prevalent. A study conducted in a semi-urban health clinic in Selangor, Malaysia, found that 86.8% of the participants demonstrated inappropriate insulin injection techniques (7). Similarly, a study at Teluk Intan Hospital in Perak showed that only 5.1% from 137 participants exhibited good understanding and practice regarding insulin injection (8). International evidence further supports this concern. A study conducted in Iran found that none of the 301 surveyed patients fully adhered to the recommended injection guidelines, leading to complications such as hyperglycaemia, elevated HbA1c levels, lipohypertrophy, and injection-related pain (9). Collectively, these findings highlight that improper insulin injection technique can lead to significant clinical complications, underscoring the need for targeted and timely interventions to address this issue.

Educational interventions, particularly those involving regular counselling by pharmacists, have shown beneficial effects (7). Structured, repeated education such as monthly sessions using insulin injection kits has been associated with significant reductions in HbA1c levels (10). Continuous assessment of patients' injection techniques enables healthcare professionals to identify and correct errors, thereby optimising therapeutic outcomes. Given the limited availability of local data on insulin injection practices, this study was conducted to determine the prevalence of improper insulin injection techniques and to identify common injection errors among patients with diabetes attending Hospital Setiu, Terengganu. The findings are expected to provide valuable insights for improving patient education strategies and enhancing glycaemic control within this population.

Method

Study design and setting

A cross-sectional study was conducted among inpatients and outpatients with diabetes in Hospital Setiu from August to December 2023. The study was registered with the National Medical Research Register (NMRR) and received approval from the Medical Research and Ethics Committee (MREC), Ministry of Health (MOH) with reference number NMRR-23-01389-ETD.

Study population

The sample size was estimated using a sample size calculator by Raosoft Inc. for estimating a single proportion (11). Assuming that 50% of the population had the factor of interest and with a total population of 171 patients on insulin therapy for at least three months, a minimum of 119 participants was required to achieve a 5% margin of error with 95% confidence interval. This number was rounded to 120 subjects.

Diabetic patients were recruited into the study using convenience sampling during medical outpatient department (MOPD) clinic follow-up visits or inpatient admissions. The eligible candidates from outpatient and inpatient settings were identified by a pharmacist during prescription screening and admission case clerking, respectively.

Inclusion criteria comprised patients aged 18 years or older who were currently receiving insulin therapy and had attended at least one counselling session on insulin use. Patients with gestational diabetes mellitus (GDM), those discharged to other healthcare facilities, those who defaulted on follow-up appointments, clinically stable patients, individuals with severe physical or psychological conditions, and those who had exclusively used prefilled insulin devices were excluded. Clinically stable patients were excluded because they were unlikely to be available for assessment within the study period. This included inpatients whose insulin therapy was anticipated to be de-escalated to oral hypoglycaemic agents during admission or before discharge, and outpatients whose follow-up intervals had been

extended from three to six months, exceeding the five-month study period. Severe physical conditions were defined as significant visual impairment, upper limb disability, or neurological deficits that could interfere with proper insulin injection technique. Severe psychological conditions were defined as disorders that substantially impair cognition, comprehension, or communication, as documented in the medical records based on clinical judgement.

Data collection

Patients or their caregivers were approached and provided with information regarding the objectives and procedures of this study. Written informed consent was obtained from the patients or caregivers who participated in the assessment. The potential respondents were assured that their participation is voluntary, and they could withdraw from the study at any time. Patients were withdrawn if the investigator identified potential risks, including significant physical discomfort, psychological distress, or inability to safely complete the demonstration of insulin injection based on clinical judgement during the session. Withdrawn patients were not replaced. Each respondent was assigned an anonymous ID, referred to as “Respondent No.” in the data collection form.

Each face-to-face assessment required approximately 15 minutes. Although differences may exist between inpatients and outpatients in terms of disease severity, insulin experience, and injection practices, these were minimised by using a standardised assessment checklist for all patients, and by ensuring that all had received prior insulin counselling before the evaluation. Demographic data of the patients were collected during the session and recorded in the data collection form. Insulin administration techniques were evaluated through in-person interviews and practical demonstrations using a structured checklist. The checklist comprised 16 dichotomous (correct / incorrect) items on the techniques of using non-prefilled insulin pens that were adopted from the Medication Counselling Guidelines 3rd Edition (2019) published by the Pharmaceutical Services Programme, Ministry of Health Malaysia (12). During the evaluation, the pharmacist verbally translated each checklist item and prompted the participants to demonstrate the corresponding injection step. As the guideline was originally developed for healthcare professionals, each checklist item was verbally translated into language that was easily understood by participants. For patients whose insulin injections were routinely administered by a caregiver, the caregiver performed the demonstration instead. The pharmacist assessed each step and recorded whether it was performed correctly. A checklist item was considered incorrect if either the participant's verbal response or physical demonstration was incorrect. Formal face, content, and language validation of the translated administration, as well as pilot testing of the assessment procedure, were not undertaken because an existing guideline rather than a newly developed instrument was used.

Data analysis

As no published study has established a validated scoring threshold for this checklist, a practical classification method was applied. In this study, patients scoring fewer than 14 correct steps were classified as having poor insulin injection technique, while those who performed 14 or more correct steps were considered to have good technique. This cut-off was determined based on the proportion of steps deemed necessary for safe and effective insulin administration and was used to help descriptive comparison within the study population. Although individual checklist steps may differ in their clinical importance, the use of an overall score allowed for a standardised and reproducible assessment of injection technique across all participants.

Data were analysed using Statistical Package for the Social Sciences (SPSS) version 27. Descriptive statistics were used to summarise participant characteristics and insulin injection technique. Categorical variables were presented as frequencies and percentages, while continuous variables were presented using medians and interquartile ranges (IQR). Inferential statistical analysis was not performed as the primary objective of the study was descriptive in nature, focusing on the assessment of insulin injection techniques rather than hypothesis testing.

Results

A total of 171 patients with diabetes were initially identified. Of these, 96 were excluded based on the predefined inclusion and exclusion criteria. Among the remaining 75 eligible patients, a further 12 were excluded because of repeated visits during the study period (to avoid duplicate enrolment), refusal to participate, or inability to complete the insulin injection demonstration due to time constraints. Consequently, 63 participants were included in the final analysis.

Detailed socio-demographic characteristics of study respondents are presented in Table 1. The median age of the patients was 57 years (IQR: 17). The majority were male (n=37, 58.7%), Malay (n=63, 100%), and married (n=57, 90.5%). Almost half had attained secondary education (n=29, 46.0%) and had been receiving insulin therapy for a median duration of 4 years (IQR: 7).

Table 1: Socio-demographic characteristics of the respondents (n=63)

Characteristics	n (%)
Age	
< 60 years old	39 (61.9)
≥ 60 years old	24 (38.1)
Gender	
Male	37 (58.7)
Female	26 (41.3)
Race	
Malay	63 (100)
Chinese	0 (0)
Indian	0 (0)
Others	0 (0)
Education level	
No formal education	4 (6.3)
Primary education	21 (33.3)
Secondary education	29 (46.0)
Tertiary education	9 (14.3)
Marital Status	
Married	57 (90.5)
Single	4 (6.3)
Divorce/Widowed	2 (3.2)
Duration of insulin therapy	
< 1 year	11 (17.5)
1-5 years	32 (50.8)
> 5 years	20 (31.7)
Frequency of insulin injection per day	
1	7 (11.1)
2	21 (33.3)
3	1 (1.6)
4	34 (54.0)

Overall, most patients (n=55, 87.3%) demonstrated good insulin injection technique, defined as achieving at least 14 correct steps, while 8 patients (12.7%) were classified as having poor technique (Table 2). The most frequently observed error was unscrewing the needle cap without the outer needle cap in place (n=14, 22.2%). This was followed by the failure to warm the insulin cartridge by rolling it between the palms and not inverting the cartridge for proper resuspension when required (n=12, 19.0%). The third most commonly identified errors included failure to pinch the skin to create a fold, not applying pressure with an alcohol swab in the event of bleeding, not replacing the cap after injection, and inadequate knowledge on managing insufficient remaining insulin in the cartridge. Each of these errors was observed in nine patients (Table 3).

Table 2: Prevalence of patients with poor insulin injection technique (n=63)

Number of correct steps in insulin injection technique	n (%)
Less than 14 correct steps (Poor technique)	8 (12.7)
14 and more correct steps (Good technique)	55 (87.3)

Table 3: Assessment of insulin injection technique among participants (n=63)

No.	Checklist item	Total	
		Correct technique	Incorrect technique
1	Roll insulin cartridge between palms gently to warm it (for Mixtard/Insugen 30/70 and Insugen N/Insulatard, invert the cartridge to mix the insulin until it is uniformly cloudy).	51	12
2	Push the piston rod down using the finger until the piston rod is completely inside the pen body (Insupen/Novopen).	63	0
3	Insert the cartridge into the cartridge holder.	62	1
4	Screw the cartridge holder to the pen body tightly.	61	2
5	Remove the paper tab, screw the needle to the pen and remove inner and outer cap (do not keep inner cap).	58	5
6	Priming: For newly opened insulin cartridge, dial 2 units and hold the insulin pen with the needle upwards. Flick the cartridge holder gently. For in use insulin, dial 1 unit.	57	6
7	Push the injection button. Look for a stream of insulin at the needle tip. A new cartridge may need to be primed several times to get a stream of insulin.	61	2
8	Dial the appropriate dose for injection by turning the dose knob.	63	0
9	If overdial, dial backwards.	63	0
10	Gently pinch the skin that has been cleaned to make a fold. Hold the fold between the thumb and the forefinger of one hand during the entire injection. Hold the insulin pen firmly in your other hand using the finger grip. Insert the full length of the needle (at an angle of 90°) into the skin fold.	54	9
11	Press the injection button until the figure in the dose window return to 0.	62	1
12	Hold the needle for at least 10 seconds, then remove the needle from your skin.	61	2
13	If a slight bleeding occurs after injection, gently press the injection site with the alcohol swab.	54	9
14	Put the outer needle cap on and unscrew the needle.	49	14
15	Replace the pen cap.	54	9

16	The cartridge scale on the penfill cartridge holder shows the approximate number of insulin units left in the cartridge. Do not try to inject an insulin suspension (cloudy-looking insulin) if the rubber stopper is below the white line on the cartridge holder. If more insulin is needed than the amount left in the penfill cartridge, either (a) inject the insulin left in the cartridge, then inject the balance needed using new cartridge, or (b) inject the full dose with a new cartridge.	54	9

Discussion

The findings of this study provide valuable insight into insulin injection techniques among diabetic patients at Hospital Setiu. Only 12.7% of study population demonstrated poor insulin injection techniques, indicating that most patients were able to practise proper insulin administration. Notably, this proportion is lower than that reported in two local studies in Selangor and Teluk Intan (7-8), as well as in several international studies. For example, 34.3% of participants in Northwest Ethiopia and 45.5% in Southern Ethiopia exhibited poor practices (13–14). Several factors may explain these discrepancies. First, differences in study populations and settings are likely contributors. All participants in the present study were recruited from a hospital setting and had previously received insulin injection counselling, which may have enhanced their technique. The relatively low prevalence of poor injection technique observed in this study may suggest that structured insulin counselling, including pharmacist-led education routinely provided in the hospital, is associated with appropriate insulin injection practices. However, this study was not designed to evaluate the effectiveness of such interventions.

Differences in assessment methods may also play a role in the variations of findings across studies. This study utilised a checklist adopted from national counselling guidelines, whereas the other studies relied on knowledge-based questionnaires or self-reported practices, which may capture different aspects of injection behaviour. Hence, these methodological differences should be considered when comparing findings across studies. Another characteristic of this study was related to the evaluation process. During the evaluation, the pharmacist verbally translated each checklist item and prompted the participants to demonstrate the corresponding injection step. Although this standardised approach ensured consistent assessment of all checklist items, it may have resulted in an overestimation of participants' actual injection technique, as their performance was assessed following prompts rather than based solely on unaided recall and routine practice. Future studies may consider incorporating unprompted demonstrations or direct observation during routine insulin administration to better reflect patients' usual injection practices.

Among the errors observed, the most common was failure to replace the outer needle cap and remove the needle after injection (22.2%). This rate was lower than reported in Hulu Langat, Selangor (79%) and Teluk Intan Hospital (89.8%), but higher than in Saudi Arabia (3.2%) (7, 8, 15). Removing and replacing the outer needle cap is important to avoid air clogging and to ensure correct dose delivery (4). Moreover, needles must be handled and disposed properly to maintain safety while preventing the risk of transmitting blood-borne infection and other potential injuries (16). The second most frequent error was failure to roll or invert the insulin cartridge before injection (19.0%). This proportion was lower than the 50.9% reported in Selangor and 48.6% in India, yet higher than rates observed in Saudi Arabia (25%) and Canada (27.5%) (7, 17–19). Proper mixing is essential for intermediate-acting and pre-mixed insulin to ensure uniform suspension and accurate dosing. Inadequate mixing can lead to reduced therapeutic response and an increased need for insulin due to suboptimal glycaemic control (4). Another common error was not forming a skin fold before injection (n=9, 14.3%). Higher adherence to this step was reported in India (83.5%), Northwest Ethiopia (65.1%), Belgium (63.7%), and Saudi Arabia (63%) (4, 13, 17, 20). While in Canada, only 45.1% followed this practice (18). Proper subcutaneous administration is essential to prevent accidental intramuscular injection, which can lead to erratic insulin absorption and an increased risk of hypoglycemia. Therefore, a gentle skin-fold technique is recommended, particularly for children and lean individuals using needles ≥ 6 mm (3, 21).

Overall, the patterns of injection errors vary across studies. These errors may be attributed to variations in local insulin counselling practice and patient background, specifically patient age and educational level. For example, older patients may experience impaired vision, reduced dexterity, or memory difficulties, which can affect their ability to perform multi-step injection techniques consistently (22). Similarly, a study in Labuan, Malaysia, found that practice level was significantly associated with education, indicating that patients with lower education may require additional support to correctly perform injection techniques (23). These findings suggest that educational programs should be tailored to the specific needs of each institution, with a primary focus on the most frequent errors in insulin administration to improve both safety and treatment outcomes. Nevertheless, the relationship between these factors and insulin injection practices was not assessed in this study, and this represents an important area for future research.

Incorrect insulin injection technique negatively affects glycaemic control and overall diabetes management (20). Patients with poor technique often have higher HbA1c levels and require increased insulin doses to achieve glycaemic targets (20). Additionally, improper injection practices can lead to metabolic instability, glycaemic variability, and unintentional hypoglycaemic events. Consequently, these complications may precipitate hospitalisation, further increase the socioeconomic burden and reduce quality of life (24). Structured and repeated education programs led by pharmacists or diabetes educators are effective in addressing these issues. Individualised training has been shown to improve injection technique, enhance glycaemic control, increase patient satisfaction, and potentially reduce insulin administration (10). A survey involving 158 individuals with T2DM demonstrated that patients who received a second follow-up with refresher education maintained improved outcomes compared to those without additional support (25). These findings highlight the importance of regularly assessing insulin injection technique during follow-up to reinforce proper practices and sustain optimal diabetes management.

Several limitations of this study should be acknowledged. First, this study was conducted at a single centre, which may limit the generalisability of the findings to the broader population of patients with diabetes. In addition, the exclusion of clinically stable patients may have introduced selection bias by underrepresenting individuals with well-controlled diabetes who required less frequent clinical follow-up. Consequently, the findings may not be generalisable to all patients receiving insulin therapy. Furthermore, the relatively small sample size may not have captured the full spectrum of insulin injection practices and may have limited the representativeness of the findings. Future studies should consider conducting multi-centre research involving multiple healthcare facilities and recruiting a larger sample size to improve the generalisability and robustness of findings.

In addition, although the checklist was adopted from the Medication Counselling Guideline, 3rd Edition (2019), the verbally translated administration was not formally validated before use, and no pilot study was conducted prior to data collection (12). Therefore, the consistency and clarity of the translated assessment procedure could not be formally established, which may have influenced participants' interpretation of certain checklist items. Future studies should consider formal validation of translated assessment procedures and pilot testing before data collection to ensure feasibility and consistency within the target population. Finally, the classification of insulin injection technique into "good" and "poor" was based on an investigator-defined cut-off score, with equal weighting assigned to all checklist items. This approach may oversimplify clinically important errors, as individual steps differ in their clinical significance. For example, an error in insulin dose selection is likely to have greater clinical consequences than some other procedural errors. Future research may consider weighting checklist items according to their clinical importance or reporting critical errors separately to provide a more clinically meaningful assessment of insulin injection technique.

Conclusion

This study found only a minority of diabetic patients in Hospital Setiu demonstrated poor insulin injection technique, indicating that most patients were administering insulin correctly. Additionally, the study identified the commonly incorrect techniques, highlighting specific areas for improvement. It is therefore essential for pharmacists to emphasise these aspects during counselling and medication dispensing

sessions. Enhancing patients' proficiency in insulin injection is critical for achieving better glycaemic control and reducing the long-term risk of diabetes-related complications. A proactive approach by pharmacists can improve insulin administration practices, promote patient adherence, and ultimately optimise insulin therapy and overall health outcomes for diabetic patients.

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Conflict of Interest
The authors declare that there is no conflict of interest.

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Handling of Unused Medications: Knowledge, Attitudes, and Practices among Outpatients at Hospital Tuanku Fauziah

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Abstract

Introduction: Unused medications refer to pharmaceuticals that are no longer being used because of discontinuation or abandonment by patients. These medications pose serious risks to both public health and environmental safety, including the potential for misuse and accidental poisoning when improperly disposed of.

Objective: The study aimed to assess knowledge, attitudes, and practices of handling unused medication among outpatients at Hospital Tuanku Fauziah (HTF) and its associated factors.

Methods: A cross-sectional study was carried out between 1 October 2022 and 28 February 2023 among patients who visited outpatient department of HTF using a validated questionnaire. Participants included individuals aged 18 years and above who were prescribed chronic medications. Associations between demographic characteristics and knowledge, attitude and practice scores were analysed using Chi-Square and Fisher's Exact tests. Spearman's correlation coefficient was employed to determine the relationship between knowledge, attitudes, and practices.

Results: A total of 384 respondents participated in this study. Most of the respondents were female (n=227, 59.1%), married (n=297, 77.3%), aged 50 years and above (n=179, 46.6%), and Malay (n=354, 92.2%). Respondents with good knowledge, attitudes and practices score were 40.1%, 18.7% and 4.2% respectively. Only 34.2% of respondents reported the correct handling of unused medications. Those who were aware of proper disposal methods or had received advice from healthcare professionals to return unused medications to the pharmacy were significantly associated with higher knowledge scores. There was a statistically significant but weak positive correlation between attitudes and practices.

Conclusion: Knowledge, attitudes, and practices regarding the proper handling of unused medications among chronic medication users remain suboptimal. Implementation of well-structured educational programs is essential to raise public awareness and promote safe medication disposal practices.

Keywords: Disposal, knowledge, attitudes, practices, unused medications

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Introduction

Unused medications is a growing concern in healthcare systems all over the world. These medications, whether expired, discontinued, or leftover due to changes in treatment, are often improperly stored or discarded (1). Studies have shown that a large proportion of the public dispose of unused medications by throwing them into household garbage, flushing them down the toilet, or pouring them into the sink (2-4). These practices contribute to environmental pollution, particularly contamination of water systems, which may lead to the development of antibiotic resistance and disruption of aquatic ecosystems (5). In addition, there are safety concerns associated with the unintentional ingestion of medications by children, the elderly, or pets, as well as the misuse or abuse of leftover controlled substances (6,7). Additionally, the environmental management of these pharmacological compounds is both difficult and costly (8).

Globally, almost one-third of adults are affected by multiple chronic conditions (MCCs) (9). In Malaysia, the National Health and Morbidity Survey (NHMS) 2015 reported a rising prevalence of chronic illnesses and a rise in the population's use of medications (10). Patients with chronic conditions often require long-term pharmacotherapy, which usually involves multiple medications to manage their illnesses, prevent both short-term and long-term complications, and ensure a good quality of life (11). Chronic medications are generally defined as those that must be taken daily for at least 30 consecutive days or used on an "as needed" basis for a total of six months or more (12).

Hospital Tuanku Fauziah (HTF), a key referral centre in the state of Perlis, caters to many patients with chronic diseases who are prescribed long-term therapies. This population is particularly susceptible to the accumulation of unused medications. However, proper disposal of unused medications among outpatients is still an unexplored area, as there is no related study done in Perlis. Therefore, it is essential to assess patients' knowledge, attitudes and practices concerning the handling of unused medications. Such an assessment will help to identify existing gaps and inform the development of targeted interventions to promote safer medication disposal practices and enhance public awareness. Therefore, this study aimed to evaluate the knowledge, attitudes, and practices of handling unused medication among patients attending the outpatient pharmacy at HTF. In addition, it seeks to identify sociodemographic and other factors associated with better knowledge, attitudes and practices of proper disposal methods. Furthermore, this study aimed to determine the relationship between knowledge, attitude and practice regarding unused medication disposal. The findings of this study are expected to assist in developing more effective educational strategies and support policy initiatives aimed at improving pharmaceutical waste management in Malaysia.

Method

A cross-sectional study was conducted to evaluate the knowledge, attitudes, and practices of handling unused medication among patients with chronic illnesses at the outpatient pharmacy of HTF. The study was conducted from 1 October 2022 to 28 February 2023. Eligible participants were patients aged 18 years and above who were currently taking or had previously taken chronic medications for a minimum duration of one month. Patients who were not on follow-up at HTF, caregivers collecting medications on behalf of others, and individuals who were unable to read or understand the Malay language were excluded from participation.

A convenience sampling method was employed to recruit participants at the outpatient pharmacy. The study was explained to the patients, and they were invited to participate. A Malay version of the questionnaire was distributed to the respondents after written informed consent was obtained. The investigator-assisted questionnaire administration took approximately 20 minutes to complete, and respondents returned it to the pharmacy upon completion. Based on an estimated 70,119 outpatient prescriptions dispensed between August and December 2021, the required sample size was calculated as 383 using the Raosoft sample size calculator, with parameters set at a 5% margin of error, 95% confidence level, and a 50% response distribution.

Data were collected using a validated questionnaire adopted from a previous study (13). The questionnaire consisted of five sections. Section A collected demographic information, including gender, age, ethnicity, marital status, employment status, and educational level. Ten items in section B were designed to assess respondents' knowledge of proper medication disposal. There were three choices of responses included: "True," "False," and "Do Not Know," with each correct response assigned one point and incorrect or "Do Not Know" responses assigned zero points. The values were then presented as percentages. The maximum scores in this section were 10 points or 100%. According to Bloom's cut-off, respondents scoring above or equal to 60% indicated good knowledge, and scores below 60% indicated poor knowledge (14). Sections C and D each consisted of 10 questions assessing attitudes and practices using a five-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree", One to five points were assigned to the answers accordingly, with "Strongly Disagree" being assigned 1 point, 5 points for "Strongly Agree". Higher scores represented more appropriate attitudes or practices towards medication disposal. Negatively worded items were reversely scored. The expected maximum total score per section was fifty (14). The scores were presented as percentages. Good attitude or

practice was considered as having a score of at least 80%, while poor attitude or practice was defined as obtaining a score of less than 80% (14,15). In Section E, the actual practices of whether respondents dispose of the unused medication correctly according to the recommended guideline by returning it to the pharmacy and the reported reasons were evaluated (16). This section is a multiple-choice question where respondents are allowed to report more than one type of medication disposal methods based on their practice.

Data were entered into Microsoft Excel and categorised according to the domains of knowledge, attitudes, and practices. The statistical analysis was conducted using IBM® SPSS version 21.0. The demographic information was compiled using descriptive statistics, including frequencies (n) and percentages. Chi-Square and Fisher's Exact tests were applied to assess the factors associated with knowledge, attitudes and practices scores, with significance set at $p<0.05$. Spearman's correlation coefficient was used to determine correlations between knowledge, attitudes, and practice.

The study (NMRR-22-02285-ZKW) was approved by the Medical Research and Ethics Committee of the Ministry of Health Malaysia. The respondents were informed of their voluntary participation and right to withdraw at any time. All responses were kept anonymous and confidential.

Results

Demographic data

Out of 450 outpatients invited to participate, 384 completed the questionnaire, yielding a response rate of 85.3%. The majority of the respondents were over 50 years (46.6%) and identified as Malay (92.2%). Female respondents comprised a larger proportion of the sample (59.1%), and most respondents were married (77.3%). Regarding educational background, 220 respondents (57.3%) had received formal education up to secondary school, while 213 respondents (55.5%) were still employed.

Less than half of the respondents demonstrated good knowledge (40.1%), attitude (18.7%) and practice (4.2%) regarding the correct handling of unused medications. More than half of the respondents (62.0%) reported that they were aware of proper medication disposal methods and had been advised by healthcare providers to return unused medications to a pharmacy (59.9%). Over 90% of respondents reported checking the expiry date before purchasing or consuming medication, whereas 40.4% indicated that they still kept unwanted medications at home. A summary of the sociodemographic characteristics and respondents' feedback on their handling of unused medications is presented in Table 1.

Table 1: Sociodemographic characteristics of the respondents and responses on their handling of unused medications (n=384)

Variables	Frequency, n (%)
Age, mean (SD)	47.4 (15.1)
18 to 29	63 (16.4)
30 to 49	142 (37.0)
≥50	179 (46.6)
Gender	
Male	157 (40.9)
Female	227 (59.1)
Ethnicity	
Malay	354 (92.2)
Chinese	14 (3.6)
Indian	11 (2.9)
Others	5 (1.3)
Marital status	
Single	63 (16.4)
Married	297 (77.3)
Widowed	20 (5.2)
Divorce	4 (1.0)

Level of education	
No formal education	4 (1.0)
Primary education	11 (2.9)
Secondary education	220 (57.3)
College/Pre-university/Diploma	80 (20.8)
Degree	52 (13.5)
Master	17 (4.4)
Working status	
Working	213 (55.5)
Not working	171 (44.5)
Knowledge score, mean (SD)	49.5 (17.4)
Poor (<60)	230 (59.9)
Good (⩾60)	154 (40.1)
Attitude score, mean (SD)	35.8 (4.1)
Poor (<80)	312 (81.3)
Good (⩾80)	72 (18.7)
Practice score, mean (SD)	32.9 (4.0)
Poor (<80)	368 (95.8)
Good (⩾80)	16 (4.2)
Aware of the proper disposal of medications	
Yes	238 (62.0)
No	145 (37.8)
Have unused medications at home	
Yes	155 (40.4)
No	229 (59.6)
Check the expiry date before purchasing or consuming the medications	
Yes	350 (91.1)
No	34 (8.9)

Abbreviation: SD = standard deviation

Knowledge on correct handling of unused medications

A significant number of respondents (84.9%) responded that inappropriate disposal of medications can harm the environment and ecosystem. Most respondents were aware that solid medications (56.3%) and needles, including syringes (70.3%), should not be disposed of in the garbage. Regarding liquid medications, 164 respondents (42.7%) believed that disposing of them in the sink was unacceptable, while 255 respondents (66.4%) rejected flushing them down the toilet. A large majority (83.9%) reported that returning or disposing of unused medications at a local pharmacy or healthcare facility is an acceptable practice. However, respondents were largely unaware of the proper disposal of medications through incineration (14.3%), the disposal of metered-dose inhalers (15.9%), as well as creams and ointments (45.1%). The respondents' correct responses to the knowledge statements are summarised in Table 2.

Table 2: Correct responses for knowledge statements among the respondents

No.	Questions	Correct answer	No. of correct responses, n (%)
1.	Improper drug disposal has harmful effects on the environment and ecosystem.	TRUE	326 (84.9)
2.	Wastewater treatment removes most of the medications from the environment and ecosystem.	FALSE	71 (18.5)
3.	It is acceptable to dispose solid medications (such as tablets, capsules, and patches) in the garbage.	FALSE	216 (56.3)

4.	It is acceptable to dispose liquid medications by throwing down the sink.	FALSE	164 (42.7)
5.	It is acceptable to dispose medications by flushing down the toilet.	FALSE	255 (66.4)
6.	Incineration is the environmentally sound way of disposing unwanted medications.	TRUE	55 (14.3)
7.	It is acceptable to dispose needles and syringes in the garbage.	FALSE	270 (70.3)
8.	It is acceptable to return or dispose unused medications to a local pharmacy or healthcare facility.	TRUE	322 (83.9)
9.	It is acceptable to dispose pressurised aerosol metered-dose inhalers (like the Ventolin inhaler) in the garbage.	TRUE	61 (15.9)
10.	It is acceptable to dispose creams and ointments in the garbage.	FALSE	173 (45.1)

Attitudes towards handling unused medications

The respondents' attitudes toward the handling of unused medications are presented in Table 3. The majority of respondents recognised that it was their responsibility to protect the environment (91.5%), as well as all living species on earth (89.9%), and their household members (91.4%) from the detrimental impact of unused and expired medications. When asked whether they would continue to collect prescribed medicines from pharmacies if they were free or heavily subsidised, even when they had sufficient medications at home, more than half of the respondents (66.6%) indicated they would not. Approximately three-quarters (74.5%) agreed that disposing of unused medications that are still in good condition constitutes a waste of resources. Of those who responded, 50.8% of respondents agreed or strongly agreed that unused medications should be donated to prevent waste, while 36.8% disagreed or strongly disagreed. Additionally, 286 respondents (74.5%) claimed that they were more willing to return unused medications to the pharmacy as a result of media campaigns and reports. Furthermore, 156 respondents (40.6%) indicated they would be more likely to return unused medications if a monetary incentive was offered, while 154 respondents (40.1%) expected a refund if they had paid for the prescribed medications.

Practices on handling of unused medications

Table 3 summarises the respondents' practices regarding the handling of unused medications. The most common reason for having unused medications was stopping medications when feeling better (45.3%). Other reasons included experiencing unwanted side effects (33.4%), the doctor changing the treatment regimen (41.7%), not feeling better after taking the medications (34.2%) and not taking the medications as directed (33.6%). The majority of respondents reported that they dispose of unused medications when the medications have expired (75.0%), when they experience unwanted side effects (34.6%), when they smell, taste, or look bad (73.1%) or when they are improperly stored or have turned bad (67.8%).

Table 3: Responses for the attitudes and practices section regarding the handling of unused medications (n=384)

Section	Frequency, n (%)				
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Attitudes					
1. It is my responsibility to protect the environment even if others are unconcerned or irresponsible.	6 (1.6%)	10 (2.6%)	17 (4.4%)	221 (57.6%)	130 (33.9%)
2. It is my responsibility to ensure the safety of other living species on earth.	6 (1.6%)	7 (1.8%)	26 (6.8%)	220 (57.3%)	125 (32.6%)
3. It is my responsibility to protect my household members from unintended harmful exposure to unused medications.	3 (0.8%)	9 (2.3%)	21 (5.5%)	195 (50.8%)	156 (40.6%)
4. If medications are free or heavily subsidised by the government, I will collect all the prescribed medications even if I have sufficient medications at home.	52 (13.5%)	204 (53.1%)	35 (9.1%)	78 (20.3%)	15 (3.9%)
5. Media reports and campaigns can influence my willingness to return unused medications.	5 (1.3%)	60 (15.6%)	33 (8.6%)	200 (52.1%)	86 (22.4%)
6. I believe discarding unused medications that are still in good condition is a waste of resources.	12 (3.1%)	48 (12.5%)	38 (9.9%)	212 (55.2%)	74 (19.3%)
7. I am willing to donate my unused medications before expiry to reduce wastage.	21 (5.5%)	120 (31.3%)	48 (12.5%)	142 (37.0%)	53 (13.8%)
8. If there is monetary incentive for me to return unused medications, I am more likely to do so.	26 (6.8%)	113 (29.4%)	89 (23.2%)	126 (32.8%)	30 (7.8%)
9. If I have paid for my prescribed medications, I expect a refund when I return my unused medications.	28 (7.3%)	113 (29.4%)	89 (23.2%)	122 (31.8%)	32 (8.3%)
10. If I have excess medications, I will share my medications with others.	49 (12.8%)	180 (46.9%)	56 (14.6%)	79 (20.6%)	20 (5.2%)
Practices					
1. I have unused medications because I stop taking the medications when I feel better.	23 (6.0%)	114 (29.7%)	73 (19.0%)	155 (40.4%)	19 (4.9%)
2. I dispose my medications when the medications have expired.	10 (2.6%)	38 (9.9%)	48 (12.5%)	238 (62.0%)	50 (13.0%)
3. I have unused medications because I experience unwanted side effects.	25 (6.5%)	143 (37.2%)	88 (22.9%)	117 (30.5%)	11 (2.9%)

4.	I dispose my medications when I experience unwanted side effects.	25 (6.5%)	148 (38.5%)	78 (20.3%)	114 (29.7%)	19 (4.9%)
5.	I have unused medications because my doctor has changed my treatment.	24 (6.3%)	109 (28.4%)	91 (23.7%)	150 (39.1%)	10 (2.6%)
6.	I dispose my medications when they smell bad, taste bad, or look bad.	12 (3.1%)	40 (10.4%)	51 (13.3%)	229 (59.6%)	52 (13.5%)
7.	I have unused medications because I do not feel better as I have expected.	24 (6.3%)	127 (33.1%)	102 (26.6%)	125 (32.6%)	6 (1.6%)
8.	I dispose my medications when I have not stored them correctly and my medications turned bad.	8 (2.1%)	57 (14.8%)	59 (15.4%)	226 (58.9%)	34 (8.9%)
9.	I have unused medications because I have not taken the medications as instructed/prescribed.	31 (8.1%)	148 (38.5%)	76 (19.8%)	122 (31.8%)	7 (1.8%)
10.	I keep medications that I no longer require just in case I need them in the future.	57 (14.8%)	164 (42.7%)	53 (13.8%)	102 (26.6%)	8 (2.1%)

Correlation between knowledge, attitudes, and practices

As shown in Table 4, a weak but statistically significant positive correlation was observed between attitude-practice (rs=0.278). There was no correlation found between knowledge and attitudes (rs=-0.310), as well as knowledge and practice (rs = -0.910).

Table 4: Correlation between knowledge, attitude and practice

Variable	Correlation Coefficient (rs)	p-value
Knowledge-Attitude	-0.310	0.543
Knowledge-Practice	-0.910	0.075*
Attitude-Practice	0.278	<0.001#

*Correlation is significant at the 0.05 level (2-tailed).
#Correlation is significant at the 0.01 level (2-tailed).
Abbreviation: rs = Spearman's rank correlation coefficient

Actual disposal practices and reason of disposing unused medications

Only 34.2% of respondents reported the correct disposal methods of unused medications. Improper disposal of oral medications showed the highest rate of 41.5%, consisting of 79.8% of liquid medications and 60.2% tablets/capsules, respectively. However, 11.8% of respondents indicated the proper disposal method for inhalers and insulin compared to improper disposal methods (8.4%). This may be explained by the exchange basis policy ensuring continuity of medication supply. Among the 43.8% of respondents who responded to the reason for disposal of unused medications, the five common reasons were medications getting expired (44.6%), health improvements (44.0%), change in medication regimen (30.4%), and experiencing unpleasant adverse effects (22.6%), followed by oversupply of medications (20.8%). Table 5 summarises the actual disposal methods and reasons for disposal reported by respondents.

Table 5: Actual medicines disposal methods and reason for disposal of medicines

Disposal methods	Frequency, n (%)					
	Liquid medications	Tablets/ capsules	Ointments/ creams	Inhaler	Insulin	Total
Pouring it into the sink	128 (30.0)	7 (1.6)	3 (1.0)	0 (0.0)	5 (3.3)	143
Flushing it into the toilet	67 (15.7)	18 (4.2)	4 (1.4)	1 (0.7)	4 (2.7)	94
Throw into rubbish bin	114 (26.8)	177 (41.0)	168 (56.8)	40 (28.2)	33 (22.0)	532
Give away or donate to friends/relatives/others	18 (4.2)	31 (7.2)	33 (11.1)	8 (5.6)	9 (6.9)	99
By burning	13 (3.1)	27 (6.3)	22 (7.4)	11 (7.7)	11 (7.3)	84
Improper disposal	**340 (79.8)**	**260 (60.2)**	**230 (77.7)**	**60 (42.3)**	**62 (41.3)**	**952 (65.8)**
Return to the pharmacy	64 (15.0)	149 (34.5)	46 (15.5)	51 (35.9)	46 (30.7)	356
Dispose into biomedical waste bin	22 (5.2)	23 (5.3)	20 (6.8)	31 (21.8)	42 (28.0)	138
Proper disposal	**86 (20.2)**	**172 (39.8)**	**66 (22.3)**	**82 (57.7)**	**88 (58.7)**	**494 (34.2)**
Total Responses	426 (100)	432 (100)	296 (100)	142 (100)	150 (100)	1446 (100)

Reasons	Frequency, n (%)
Change to other drug regimens	51 (30.4)
No clear instructions on the label	23 (13.7)
The health condition is getting better	74 (44.0)
Unknown reason the medications are being prescribed	11 (6.5)
Oversupply of medications	35 (20.8)
Medications expired	75 (44.6)
Difficulty in following the instructions	17 (10.1)
Unpleasant adverse effect	38 (22.6)
Other	1 (0.6)

Factors associated with knowledge, attitudes, and practice of medication disposal

Table 6 indicated that there was no significant difference between the sociodemographic characteristics (gender, age, ethnicity, marital status, employment status, and educational level) and the respondents' knowledge scores. However, this study showed a statistically significant association between age and disposal practices ($p=0.0189$). In addition, respondents who were aware of proper medication disposal methods ($p<0.001$) or had been advised by a healthcare professional to return unused medications to the pharmacy ($p=0.002$) demonstrated significantly higher knowledge scores. On the other hand, there was no statistically significant association between respondents who were checking the expiry date of a medication before buying or using it with the knowledge score.

Table 6: The association between total sociodemographic characteristics and respondents with knowledge, attitudes, and practice of handling unused medication

Variables	Knowledge		p-value	Attitude		p-value	Practice		p-value
	Poor	Good		Poor	Good		Poor	Good	
Age (years)			0.09[9]			0.659[a]			**0.0189[a]**
18 to 29	40 (63.5)	23 (36.5)		52 (83.9)	10 (16.1)		61 (98.4)	1 (1.6)	
30 to 49	93 (65.5)	49 (34.5)		113 (79.0)	30 (21.0)		141 (98.6)	2 (1.4)	
⩾50	97 (54.2)	82 (45.8)		147 (82.1)	32 (17.9)		166 (92.7)	13 (7.3)	
Gender			0.826[a]			0.361[a]			0.812[a]
Male	93 (59.2)	64 (40.8)		131 (83.4)	26 (16.6)		150 (95.5)	7 45.0)	
Female	137 (60.4)	90 (39.6)		181 (79.7)	46 (20.3)		218 (96.0)	9 (4.0)	
Marital status			0.143[a]			0.505[a]			0.799[a]
Single	58 (66.7)	29 (33.3)		72 (83.7)	14 16.3)		82 (95.3)	4 (4.7)	
Married	172 (57.9)	125 (42.1)		240 (80.5)	58 (19.5)		286 (96.0)	12 (4.0)	
Ethnicity			0.431[a]			0.761[a]			0.812[a]
Malay	210 (59.3)	144 (40.7)		287 (81.1)	67 (18.9)		339 (95.8)	15 (4.2)	
Non-Malay	20 (66.7)	10 (33.3)		25 (83.3)	5 (16.7)		29 (96.7)	1 (3.3)	
Working status			0.589[a]			0.122[a]			0.324[a]
Working	125 (58.7)	88 (41.3)		168 (78.5)	46 (21.5)		207 (96.7)	7 (3.3)	
Not working	105 (61.4)	66 (38.6)		144 (84.7)	26 (15.3)		161 (94.7)	9 (5.3)	
Level of education			0.054[b]			0.661[b]			0.197[b]
No	3 (75.0)	1 (25.0)		3 (75.0)	1 (25.0)		3 (75.0)	1 (25.0)	
Primary	8 (81.8)	2 (18.2)		10 (90.9)	1 (9.1)		11 (100.0)	0 (0.0)	
Secondary	140 (63.6)	80 (36.4)		180 (82.2)	39 (17.8)		212 (96.8)	7 (3.2)	
Tertiary	78 (52.3)	71 (47.7)		119 (79.3)	31 (20.7)		142 (94.7)	8 (5.3)	
Aware of the proper disposal of medications			**<0.001[a]**			**0.047[a]**			0.630[a]
Yes	124 (52.1)	114 (47.9)		186 (78.2)	52 (21.8)		229 (96.2)	9 (3.8)	
No	106 (72.6)	40 (27.4)		126 (86.3)	20 (13.7)		139 (95.2)	7 (4.8)	

Advised by a healthcare professional to return unused medications to the pharmacy			**0.002[a]**			0.060[a]			0.448[a]
Yes	123 (53.5)	107 (46.5)		179 (78.2)	50 (21.8)		218 (95.2)	11 (4.8)	
No	107 (69.5)	47 (30.5)		133 (85.8)	22 (14.2)		150 (96.8)	5 (3.2)	
Check the expiry date before purchasing or consuming the medications			0.549[a]			0.527[a]			0.428[a]
Yes	208 (59.4)	142 (40.6)		283 (80.9)	67 (19.1)		336 (96.0)	14 (4.0)	
No	22 (64.7)	12 (35.3)		29 (85.3)	5 (14.7)		32 (94.1)	2 (5.9)	

[a]Chi-Square test
[b]Fisher's Exact test
p<0.05 indicates a significant difference.

Discussion

Medication is essential for disease prevention, illness treatment, and symptom relief. However, how the medication is handled is equally crucial because improper disposal can have harmful impacts on the environment and human health. In our study, outpatients had an overall low knowledge about how to properly dispose of unused medication. Jha et al. (2018) reported similar results, where 65.2% of households in Nepal lacked awareness of proper handling of their medications. This points out the need for improved education and awareness regarding the proper handling of unused medications (17).

In this study, the majority of respondents were aware that improper handling of unused medication could harm the environment. Nevertheless, a large number of respondents believed that pouring medications down the sink or flushing them down the toilet was acceptable and more than half of the respondents reported disposing of liquid medications through these methods. In contrast to what many respondents may have believed, wastewater treatment does not eliminate drugs from the environment. Pharmaceuticals are rarely eliminated from the wastewater systems even with advanced treatment technology, (18). As these medications get into the water systems and eventually contaminate groundwater, rivers, and lakes, they pose serious environmental risks. Human health and aquatic life might be impacted greatly as a result of such contamination.

In our findings, there was a statistically significant but weak correlation between attitude and practice. This suggested that respondents with positive attitudes tend to demonstrate better practices in handling unused medications. Respondents who were aware of the harmful effects of improper disposal of unused medications on the environment, as well as the risk of accidental ingestion by young children, were more likely to comply with the proper disposal method, such as returning unused medications to the pharmacy. However, there was no significant relationship between knowledge and attitudes or practices regarding the correct disposal of medications, indicating that good knowledge among respondents does not necessarily show a more positive attitude or proper disposal practice.

Discarding medications in the trash was the most common disposal method for tablets, capsules, and ointments. Similar findings were observed in other studies conducted in Malaysia (19-21). The popularity of this method may be due to its convenience, but it remains an improper disposal method. Undoubtedly, medication waste disposal contributes to the increasing volume of solid waste in landfills, which is the way most waste is managed in Malaysia. In addition to potential health risks such as drug abuse, toxicity, and even death, this practice may pollute the environment (22). Thus, specialised incineration is the recommended disposal method of solid and liquid medication (16).

Only a minority of respondents returned unused medications to pharmacies or healthcare facilities, even though most of them were aware of this option. The finding is consistent with a study

carried out in a tertiary care hospital, where only 6% of respondents returned unused medications to the pharmacy (23). Intending to reduce medication waste, the Malaysian Ministry of Health (MOH) launched the Medicine Return Programme (MRP) in 2010 and the Patient's Own Medicines campaign in 2016. A recent study carried out in Sabah found that only half of the respondents were aware of the MRP, suggesting that awareness and utilisation rates remain low despite these initiatives (19).

Globally, with successful examples in developed nations like the USA, UK, and Australia, community-oriented “take-back” programs, which allow patients to return unused medications to pharmacies, are considered the safest and most environmentally friendly disposal method (24). In Sweden, 85% of the population supports a formal program that has been in place since 1971 regarding the return of unused medications to pharmacies for safe disposal and incineration (25). Nonetheless, not all patients can easily access or take part in these programs. In Malaysia, raising awareness among the public as well as making take-back programs easily accessible are strategies to improve medication disposal practice. Since there is a lack of clear instructions for individuals on how to safely handling of unwanted medications at home, thus, national and international standards governing the safe handling of medical waste are primarily applicable at the organisational level (26-28). Some organisations recommend using alternative disposal methods, such as mixing medications with coffee grounds or cat litter before throwing them in the trash, to prevent misuse. Nevertheless, these approaches may not fully address the broader environmental concern related to medication disposal (16).

From our study, older age was associated with better medicines disposal practice. A more frequent visit to health facility due to chronic disease increased the exposure to healthcare information and also experience (11). Besides, more than half of the respondents stated that they had been given information about the return of unused medications to the pharmacy and were more inclined to participate in the medication return activities due to the campaign disseminated through the mass media and reports. Thus, healthcare professionals play an important role in raising awareness, especially through initiatives such as the "Know Your Medicines" campaign, encouraging patients to return unused medications for proper disposal. This information can be disseminated through the ‘‘Know Your Medicine’’ programme at school and university levels as an early exposure to the community. Besides that, a standard medication disposal guideline should be developed by the relevant authorities (29) and medication disposal infographics should be disseminated to the public.

During the medication dispensing and counselling process, pharmacists can play a vital role in educating patients about appropriate medicines disposal methods. A brief education on stock management, such as First Expired, First Out (FEFO) should be provided as the majority of the respondents reported checking the expiration date before consuming and disposing when the medications have expired. In addition, more designated bins for the safe disposal of medications should be made available. Collaboration between government and the private sector needs to be strengthened where efforts to promote awareness should be enhanced. These efforts are key to reducing environmental pollution as well as the related expenses of healthcare and environmental management depend on these initiatives.

Apart from that, an integrated computerised system throughout the health facility is recommended as a patient confidentiality-protected system with only authorised personnel who can access the medication profile while patients visit different health facilities to seek medical advice. This is where the risk of duplicated prescriptions could be reduced which may lead to an oversupply of medications and thus reduce the cost of unused medication disposal.

There are several limitations in this study. First, self-reports were the method for data collection, which might lead to inaccurate and biased recall. In addition, the time frame for respondents’ disposal practice was not specified, which may lead to different interpretations. Apart from that, certain disposal methods practiced by respondents, such as burying tablets in the soil, were not included in the limited choice of responses, which may not capture the actual disposal practice among respondents. Additionally, eye drops and ear drops were not included in this study. A proper handling of eye and ear drops was crucial since the shelf life of these topical medications only lasts for 28 days after opening, regardless of their expiry date, which will lead to the need for proper disposal. Therefore, it is crucial that studies related to how to properly dispose of eye and ear medications can be conducted in the

future. Despite those limitations, this study provides valuable information regarding knowledge and medication handling practices among outpatients at Perlis Hospital. To ensure the safe and environmentally responsible management of unused medications, this study points out the importance of increasing public awareness regarding the proper handling of unused medications.

Conclusion

This study found that the knowledge, attitudes, and practices on handling unused medications among outpatients were suboptimal. To address these gaps, continuous public education initiatives such as mass media campaigns and targeted pharmacy counselling are essential. Furthermore, implementing integrated computerised prescription management systems could potentially minimise medication over-dispensing and waste at the source, ultimately protecting the environment. Future research should evaluate medication handling practices among caregivers of paediatric patients, particularly concerning liquid dosage forms, which pose distinct risks of environmental contamination, accidental ingestion, and toxicity.

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Conflict of Interest

The authors declare that they have no conflicts of interest and they did not receive any financial support or funding that is relevant to this study.

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The Usage of Vildagliptin as an Adjuvant Therapy in Patients with Type 2 Diabetes Mellitus in Public Health Clinics in Penang

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Abstract

Introduction: Diabetes mellitus is an increasing public health burden in Malaysia, with type 2 diabetes mellitus (T2DM) accounting for most adult cases. Vildagliptin, a dipeptidyl peptidase-4 (DPP-4) inhibitor, is widely used as adjunctive therapy for T2DM in public primary care settings. However, local real-world evidence on its effectiveness in routine primary care remains limited, with demographic factors potentially influencing the glycaemic response.

Objectives: To compare glycated haemoglobin (HbA1c) and fasting blood glucose (FBG) levels in patients with T2DM before and after addition of vildagliptin to existing antidiabetic regimen, and to identify demographic factors associated with changes in HbA1c levels.

Methods: A retrospective study was conducted from 1st January 2019 to 31st December 2022 to observe the changes of HbA1c and FBG in T2DM patients treated with vildagliptin in six public health clinics in South Seberang Perai. Demographic and clinical data were extracted from medical records. Changes in HbA1c and FBG following vildagliptin initiation were evaluated using paired t-tests, while independent t-tests and one-way analysis of variance (ANOVA) were used to assess associations between demographic factors and HbA1c changes.

Results: A total of 325 patients were included. The majority were female (64.6%, n=210) and 66.8% were receiving concomitant vildagliptin and insulin therapy (n=217). The mean age was 60.6 ± 10.9 years, and the mean duration of T2DM was 13.19 ± 6.70 years. At baseline, more than half of the patients (54.4%) had HbA1c more than 10.0% with a mean of 10.2 ± 2.2%. The mean FBG was 10.0 ± 4.3 mmol/L before the initiation of vildagliptin. Following vildagliptin initiation, mean HbA1c decreased by 0.61% ($p<0.001$) and mean FBG decreased by 1.08 mmol/L ($p<0.001$). Male patients demonstrated a significantly greater reduction in HbA1c than female patients ($p=0.022$).

Conclusion: Vildagliptin, when added to existing antidiabetic therapy, was associated with significant improvements in glycaemic control among patients with inadequately controlled T2DM in public primary care settings. These findings support its role as an effective add-on treatment option in routine clinical practice, while further studies are warranted to determine whether the observed sex-related difference in HbA1c reduction persists after adjustment for potential confounding factors.

Keywords: Vildagliptin, DPP-4 inhibitors, HbA1c, FBG, type 2 diabetes mellitus

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Introduction

Diabetes mellitus continues to pose a major global health challenge, with its prevalence rising sharply in many countries, including Malaysia. Within the Western Pacific region, Malaysia is among the nations with the fastest-growing burden of diabetes (1). According to the National Health and Morbidity Survey (NHMS) 2019, the prevalence of diabetes among Malaysians aged 18 years and above was 18.3%, representing a 4% increase compared with year 2015. Furthermore, 48.6% of individuals with diabetes remained undiagnosed while the prevalence among young adults aged 18-29 years increased by approximately 5% (2). Type 2 diabetes mellitus (T2DM) remains the predominant form of diabetes, accounting for almost all cases of newly diagnosed adult diabetes according to the National Diabetes Registry Report 2023.

Globally, an estimated USD 727 billion was spent on diabetes management in 2017 with healthcare expenditure expected to increase further in the future (1). Effective management of T2DM is therefore essential to mitigate its growing public health burden. It requires sustained lifestyle modification and long-term pharmacotherapy when indicated to achieve and maintain optimal glycaemic control. Oral antidiabetic drugs (OADs) such as metformin and sulfonylureas are commonly used as first-line treatments in primary care, with dipeptidyl peptidase-4 (DPP-4) inhibitors generally prescribed as an adjunct to existing glucose-lowering therapy when glycaemic targets are not achieved. In fact, DPP-4 inhibitors have been increasingly valued for their glucose-dependent mechanism, low incidence of hypoglycaemia, and weight-neutral profile, making them suitable for a broad range of patients in routine clinical practice (2).

DPP-4 inhibitors, particularly vildagliptin, have been widely prescribed as part of routine diabetes management in South Seberang Perai public health clinics since 2019. However, local data on glycaemic outcomes following addition of vildagliptin to the existing antidiabetic regimen remains limited. Meanwhile, studies have reported that glycaemic response to OADs including DPP-4 inhibitors may vary among individuals with distinct demographic characteristics such as age, sex, ethnicity and duration of diabetes (3-6). Given the multi-ethnic population of South Seberang Perai, this setting provides an ideal opportunity to examine whether demographic factors influence treatment response to OADs including vildagliptin in addition to its primary objective to evaluate changes in glycated haemoglobin (HbA1c) and fasting blood glucose (FBG) with the use of vildagliptin as adjunctive therapy among individuals with T2DM attending public health clinics in South Seberang Perai.

Method

A retrospective study was designed to evaluate changes in glycaemic parameters among patients who were initiated on vildagliptin in addition to existing OADs between 1st January 2019 and 31st December 2022. This study was conducted across six public health clinics in the South Seberang Perai District, which included Bukit Panchor, Bandar Tasek Mutiara, Sungai Bakap, Sungai Acheh, Nibong Tebal, and Valdor. The study received approval from the Medical Research Ethics Committee (MREC), Ministry of Health Malaysia, and was registered with the National Medical Research Registry (NMRR ID-23-03281-SJX).

Universal sampling was employed, whereby all patients who fulfilled the inclusion criteria during the study period were included. Therefore, no sample size calculation was performed for this study. Patients were eligible for inclusion if they had a diagnosis of T2DM, aged 18 years or older, had been receiving first-line antidiabetic therapy prior to the initiation of vildagliptin, received follow-up care at any of the participating clinics during the study period, and had vildagliptin added to their usual diabetes regimen within the specified timeframe of this study. Patients were excluded if they discontinued vildagliptin due to intolerance, had incomplete or missing clinical records, or defaulted follow-up during the three-month post-initiation period.

Patient records were retrieved manually from medical records maintained at the participating clinics. A structured data collection form was developed to ensure standardised data extraction, which consisted of three sections. The first section captured demographic information, including age, sex, ethnicity, height, and duration of diagnosed T2DM. The second section collected baseline information of the participants and three-month post-vildagliptin measurements, including HbA1c, FBG, body

weight, and body mass index (BMI). The third section documented concurrent medication regimen such as metformin, sulfonylureas, insulin, sodium-glucose cotransporter 2 (SGLT2) inhibitors. All data were obtained directly from physician-documented clinical records to ensure accuracy and consistency.

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version 20.0. Descriptive statistics were used to summarise patient characteristics. Categorical variables were presented as frequencies and percentages, whereas numerical variables were reported as means with standard deviations (SD) for normally distributed data or medians with interquartile ranges (IQR) for skewed data. Paired t-tests were used to compare HbA1c and FBG values before and three months after vildagliptin initiation. Independent t-tests were employed to assess differences in HbA1c reduction between dichotomous variables, such as sex and insulin use. One-way analysis of variance (ANOVA) was used to evaluate differences across variables with more than two categories, including ethnicity and duration of diabetes. A p-value of less than 0.05 was considered statistically significant (7).

Results

Of the 460 patients who received vildagliptin during the study period, 135 were excluded due to incomplete or missing clinical data, discontinuation due to intolerance, or defaulted follow-up. Consequently, 325 patients were included in the final analysis. Among these patients, 35.4% (n=115) were male and 64.6% (n=210) were female. The age of patients ranged from 22 to 90 years, with a mean age of 60.6 ± 10.9 years. More than half of the study population (56.6%) were aged 60 years or older. The mean duration of T2DM was 13.19 ± 6.70 years, with 60.7% of patients having lived with diabetes for more than 10 years. Concurrent insulin therapy was prescribed in 66.8% (n=217) of patients receiving vildagliptin (Table 1).

Table 1: Demographic factors associated with changes in HbA1c with adjunctive vildagliptin usage, n=325

Variable	n (%)	Mean HbA1c changes (SD)	p-value
Age[a] (years old)			
< 60	141 (43.4)	-0.53 (2.03)	0.550
⩾ 60	184 (56.6)	-0.67 (2.21)	
Gender[a]			
Male	115 (35.4)	-0.98 (2.20)	**0.022**
Female	210 (64.6)	-0.41(2.07)	
Ethnicity[b]			
Malay	138 (42.5)	-0.46(2.34)	0.533
Chinese	39 (12.0)	-0.79 (1.72)	
Indian	148 (45.5)	-0.71 (2.03)	
Duration of T2DM[b] (years)			
⩽10	128 (39.4)	-0.47 (2.23)	0.689
11 - 20	164 (50.5)	-0.66 (2.05)	
21 - 30	26 (8.0)	-0.80 (2.25)	
> 30	7 (2.2)	-1.26 (2.04)	
Insulin[a]			
No	108 (33.2)	-0.46 (1.85)	0.343
Yes	217 (66.8)	-0.69 (2.26)	

[a]Independent t -test was conducted to compare age, gender and insulin usage between the groups.
[b]One-way ANOVA was conducted to compare the ethnicity and duration of T2DM between the groups.
Abbreviation: HbA1c = glycated haemoglobin; SD = standard deviation; CI = confidence interval; df = degrees of freedom; T2DM = type 2 diabetes mellitus

Inspection of histograms revealed that HbA1c differences were normally distributed for both gender groups. The assumption of homogeneity of variances was met, as assessed by Levene's test for equality of variances. Therefore, an independent t-test was run to compare the mean change in HbA1c between males and females, and 95% confidence interval (CI) for the mean difference were calculated.

On average, males showed a greater mean reduction in HbA1c (-0.98 ± 2.20) compared with females (-0.41 ± 2.07), with a mean difference of -0.56 (95% CI: -1.05 to -0.08) and p=0.022 (Table 1). These findings suggest a significant association between HbA1c reduction and gender. Independent t-tests were also run to evaluate the associations between HbA1c change and age group as well as concurrent insulin use. However, neither analysis demonstrated a statistically significant difference. Similarly, one-way ANOVA was used to assess differences in HbA1c reduction across ethnic groups and categories of diabetes duration, but no significant associations were identified (Table 1).

Table 2: HbA1c categories distribution before and after vildagliptin use, n=325

HbA1c	Pre vildagliptin, n (%)	Post vildagliptin, n (%)
< 6.5%	7 (2.2)	19 (5.8)
6.5 - 9.9%	141 (43.4)	177 (54.4)
⩾10.0%	177 (54.5)	129 (39.7)

Abbreviation: HbA1c = glycated haemoglobin

Table 3: Changes in HbA1c and FBG following vildagliptin initiation, n=325

Parameters[a]	Pre vildagliptin	Post vildagliptin	Mean difference (95% CI)	p-value
HbA1c (%)	10.15 ± 2.20	9.54 ± 2.30	-0.61 (0.38, 0.84)	**<0.001**
FBG (mmol/L)	10.00 ± 4.30	8.92 ± 3.60	-1.08 (0.60, 1.56)	**<0.001**

[a] Paired T-test was conducted.
Values reported as mean ± SD
Abbreviation: CI = confidence interval; HbA1c = glycated haemoglobin; FBG = fasting blood glucose

More than half of the patients (54.5%) had a baseline HbA1c of more than 10% (Table 2). Prior to the initiation of vildagliptin, the mean HbA1c was 10.15 ± 2.20%, whereas the mean FBG was 10.00 ± 4.30 mmol/L (Table 3). Histogram inspection confirmed that the changes in HbA1c and FBG were normally distributed. Therefore, paired-t tests were performed to compare glycaemic parameters before and after vildagliptin initiation. Mean HbA1c decreased significantly to 9.54 ± 2.30% after treatment, representing a mean reduction of 0.61% (p<0.001). Similarly, mean FBG decreased significantly to 8.92 ± 3.60 mmol/L, corresponding to a mean reduction of 1.08 mmol/L (p<0.001) (Table 3).

Discussion

Prior to treatment, more than half of the cohort presented with markedly elevated HbA1c values (≥10.0%), reflecting poor glycaemic control and the need of treatment modification. After three months of adjunctive therapy with vildagliptin, significant reductions were observed in both HbA1c and FBG, demonstrating the clinical benefit of adding vildagliptin to existing treatment regimens which typically included metformin, gliclazide and insulin. This finding was consistent with previous observational studies and clinical trials demonstrating improvements in glycaemic control following the addition of vildagliptin to existing treatment regimens, including metformin-based combinations (8–11). Similar benefits have also been reported when DPP-4 inhibitors were added to insulin therapy, with improvements in glycaemic control without a substantial increase in hypoglycaemia or weight gain (12). Fonseca et al. likewise demonstrated the efficacy of vildagliptin in patients with inadequately controlled HbA1c despite insulin therapy (13). Collectively, these findings support the effectiveness of vildagliptin as an adjunctive therapy for improving glycaemic control among patients with T2DM receiving existing antidiabetic treatment in routine primary care.

The clinical relevance of these findings may be considered in the context of the progressive nature of T2DM. The Malaysian Clinical Practice Guidelines recommend an HbA1c target of <7% for most adults with individualised goals based on age, comorbidities, and hypoglycaemia risk (2). As beta cell function progressively declines in T2DM, treatment intensification may be necessary when glycaemic targets are no longer achieved with existing therapy (14). This may involve adding another OAD or initiating injectable therapy. In this context, vildagliptin offers an alternative oral option, particularly for patients reluctant to use injectables due to needle anxiety or self-administration challenges. Its glucose-dependent mechanism, low risk of hypoglycaemia, and weight-neutral profile may also support treatment acceptance and adherence (15–18). Overall, the glycaemic benefits and established safety profile of vildagliptin support its role as a potential option for treatment intensification in patients with suboptimal glycaemic control.

A notable finding of this study was the significantly greater reduction in HbA1c observed among male patients compared with female patients when vildagliptin was used in adjunct with other OADs. This aligns with previous reports by Hassan et al. and Choe et al., which suggested that men were more likely to achieve glycaemic targets than women when vildagliptin is used as part of the OADs regimen (19-20). Biological differences may potentially contribute to variation in treatment response. Differences in body fat distribution, insulin sensitivity, β-cell function, and sex hormones may influence glucose metabolism and potentially modify the response to incretin-based therapies (21-22). Nevertheless, these mechanisms remain speculative in the absence of direct measurements of hormonal status, insulin sensitivity, or β-cell function in the present study. As vildagliptin was used as an adjunct with other OADs, the observed reduction in HbA1c cannot be attributed to vildagliptin alone, and the potential contribution of concomitant therapies to the observed sex-related difference cannot be excluded. Overall, while the observed sex-related difference in glycaemic response warrants further investigation, it should be interpreted as a difference in HbA1c reduction among patients receiving vildagliptin-containing regimens rather than as evidence of a sex-specific difference in the efficacy of vildagliptin. From a clinical perspective, gender alone should not be used as a determinant for prescribing vildagliptin, and treatment selection should continue to be guided by individual patient characteristics, treatment goals, comorbidities, and the overall suitability of the therapeutic regimen.

Several limitations must be acknowledged when interpreting the findings of this study. First, the impact of different combinations of OADs was not evaluated separately because of the substantial heterogeneity and large number of possible treatment regimens. Hence, this may have limited the ability of this study to determine whether treatment response varied according to concomitant therapy. Differences in concomitant therapy may also have contributed to the observed sex-related difference in HbA1c reduction and cannot be excluded. Second, the retrospective study design limited the availability of potentially important clinical information, particularly medication adherence, which may have influenced the observed changes in HbA1c and FBG and introduced potential bias. Other factors that may affect glycaemic response, such as lifestyle-related factors, may also not have been consistently captured in this study. Third, although universal sampling was employed, the relatively small number of eligible patients may have reduced the statistical power and limited the generalisability of the findings in this study. Fourth, the follow-up duration was limited to three months, which may not adequately capture the long-term durability of glycaemic improvements or changes in treatment requirements over time. A longer observation period would allow for assessment of HbA1c stability, sustained treatment response, and the need for subsequent therapeutic adjustments.

Given these limitations, future studies should adopt prospective, multicentre designs with larger sample sizes to improve the robustness and generalisability of the findings and assess the sustained effectiveness of vildagliptin. Treatment response should be evaluated according to concomitant antidiabetic regimens, with adjustment for potential confounding factors, including medication adherence, lifestyle factors, and subsequent treatment modifications. Serial assessments of HbA1c and FBG, together with systematic evaluation of medication adherence, adverse events, and patient-reported outcomes, would provide a more comprehensive assessment of treatment response. Longer follow-up would also allow evaluation of the durability of glycaemic improvement and subsequent treatment intensification or modification. In addition, adequately powered analyses should further investigate the observed sex-related difference in HbA1c reduction and determine whether this association persists after adjustment for potential confounding factors.

Conclusion

The addition of vildagliptin to existing antidiabetic therapy was associated with significant reductions in HbA1c and FBG over three months among patients with T2DM attending public health clinics in South Seberang Perai. These findings suggested a potential benefit of vildagliptin as an adjunctive therapy for patients requiring additional glycaemic control. Male patients demonstrated greater HbA1c reductions than female patients, although this finding should be interpreted cautiously given the potential influence of unmeasured factors. Larger prospective studies and longer follow-up are warranted to confirm these findings and assess the durability of treatment response.

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Conflict of Interest

The authors declare that they have no conflicts of interest and they did not receive any financial support or funding that is relevant to this study.

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Trend in Drug Information Resources (DIR) on Using Online Medical Databases or Hardcopy References Among Ministry of Health Prescribers and Pharmacists: A Single District Study

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Abstract

Introduction: As access to drug information resources (DIR) expands for prescribers, concerns have grown regarding the reliability of information used to support safe and appropriate treatment decisions in patient care.

Objective: To evaluate the utilisation patterns, preferences, and factors influencing the use of DIR, including online and hardcopy references, among Ministry of Health (MOH) prescribers and pharmacists.

Methods: A cross-sectional study using a validated questionnaire was conducted among MOH prescribers and pharmacists in Tangkak District in April 2023. Data were analysed using SPSS version 22, with descriptive statistics presented as frequencies and percentages.

Results: Of the 114 respondents, the highest proportions were male (56.1%) and medical officers (36.8%). A substantial proportion (35.1%) had five or fewer years of work experience. Across all respondents, mobile applications and online medical databases were the most preferred sources of DIR due to their accessibility (82.5%), immediacy (68.4%), and cost-free nature (57.0%), followed by pharmacist consultation (among prescribers) and hardcopy references. The most commonly used digital resources were My Blue Book (53.5%), National Antibiotic Guidelines (NAG) (47.4%), and Medscape (34.2%). Among hardcopy references, the most frequently used were Clinical Practice Guidelines (CPGs) (44.7%), Frank Shann Drug Doses (31.6%), and MIMS Drug Reference (18.4%). Regarding willingness to pay for drug references, a higher proportion of respondents were willing to pay for hardcopy references (79.8%) compared with softcopy (64.9%).

Conclusion: This study revealed a shift towards digital DIR, while highlighting the continued value of hardcopy references for in-depth learning and clinical practice. Findings also emphasised the need for accessible, up-to-date, and freely available resources. Further research across diverse districts and healthcare levels is warranted to validate these findings and inform national strategies for digital resource provision.

Keywords: Drug information resources, prescribers, pharmacist, online medical database, hardcopy references

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Introduction

In view of the rapid expansion of pharmaceutical markets, coupled with increasing therapeutic complexity and a growing emphasis on evidence-based patient care, access to accurate, current, and reliable drug information is essential for healthcare professionals to support safe, effective, and rational use of medicines (1-4). Prescribers and pharmacists frequently require drug information to make clinical decisions, including those related to drug selection, dosing, contraindications, drug interactions,

adverse drug reactions, and appropriate use in specific patient populations (2-3). The availability and accessibility of reliable drug information resources therefore play an important role, particularly when errors such as incorrect dosage, route or frequency, and polypharmacy can result in adverse drug events such as drug toxicity, drug–drug interactions, hospitalisation, morbidity, and mortality (4-5).

Traditionally, drug information has been obtained from hardcopy references such as pharmacopoeias, drug formularies, textbooks, treatment guidelines, and drug information manuals. Although these resources remain important, advances in information technology have substantially changed the way healthcare professionals access and retrieve drug-related information. The proliferation of health-related mobile applications illustrates the scale of this expansion, with more than 318,000 applications reported to be available as of March 2020 and approximately 200 new applications being introduced daily (6). Online medical databases and electronic resources now provide rapid access to a large volume of information and can offer advantages such as ease of searching, frequent updating, portability, and access to multiple sources through a single platform. Consequently, electronic resources have increasingly become integrated into clinical practice and may influence healthcare professionals' preferences and patterns of drug information-seeking behaviour.

Nevertheless, the choice of drug information resource (DIR) may vary according to professional role, clinical needs, familiarity with available resources, accessibility, and confidence in the reliability of the information obtained. While online resources may provide greater convenience and speed, hardcopy references continue to have a role in healthcare settings, particularly where established institutional references and printed guidelines are routinely used. Understanding how healthcare professionals use and perceive these different resources is therefore important for ensuring that appropriate and reliable drug information is readily available to support clinical decision-making.

Within Ministry of Health (MOH) healthcare facilities, prescribers and pharmacists are key users of drug information in the provision of patient care. However, there is limited local evidence on the utilisation patterns and preferences for different DIR among these healthcare professionals, particularly at the district level. Understanding the factors that influence the selection and use of different DIR, as well as their utilisation patterns, may provide insights into evolving drug information-seeking practices and identify potential gaps in access, training, or institutional support. Therefore, this study aimed to evaluate the utilisation patterns, preferences, and factors influencing the use of DIR, including online and hardcopy references, among MOH prescribers and pharmacists.

Method

Study design

A cross-sectional study was conducted from early- to mid-April 2023 using a validated questionnaire. The facilities involved were Hospital Tangkak, Payamas Health Clinic, Sagil Health Clinic, Sungai Mati Health Clinic, Bukit Gambir Health Clinic, Bukit Serampang Health Clinic and Gersik Health Clinic. Ethical approval was obtained from the National Medical Research and Ethics Committee (MREC) via the National Medical Research Registry (NMRR ID-22-02304-YLX (IIR)) before the commencement of research.

Study population

The sample size was calculated using a single-proportion sample size formula with finite population correction (7). During the study development phase, the total population size was identified as 156, encompassing all pharmacists, medical officers and medical assistants stationed across the Tangkak District Health Office and Hospital Tangkak. Assuming a 95% confidence level (Z=1.96), a 5% margin of error (d=0.05), a finite population of 156, and an estimated proportion of 74%, the minimum required sample size was calculated to be 93 participants. The estimated proportion of 74% was based on a published study reporting that online sources of drug information were preferred by 74% of physicians (8).

This study utilised convenience sampling which involved all MOH prescribers, medical assistants, and pharmacists who were involved in prescribing medications at the time of data collection in Tangkak District. Medical assistants were included and categorised as prescribers in this study to

provide a comprehensive view of drug information–seeking practices in the Tangkak district. Medical assistants are authorised to prescribe a restricted range of medications, primarily Group C poisons under the Poisons Act 1952 and existing MOH clinical administrative circulars (9). This authorisation supports healthcare delivery by alleviating physicians' prescribing burden, improving patient flow, and reducing delays in care, particularly in health clinics and understaffed facilities. Healthcare personnel who refused to take part in this survey were excluded from the start.

Study instrument

The questionnaire was adapted from a previously validated survey developed by Pui et al., with permission obtained from the original author (10). Several study-specific modifications were made to ensure its relevance to the local context. Specifically, pharmacists were added as a professional category in the demographic section and as a consultation option for prescribers in the resource preference section. In addition, the multiple-choice options for commonly used reference sources in Sections 3 and 4 were revised to reflect resources commonly used in local district healthcare settings. These included My Blue Book, the National Antibiotic Guidelines (NAG), and Frank Shann Drug Doses.

The adapted questionnaire was subsequently revalidated for content and face validity by a panel of fifteen experts working in MOH facilities, comprising three medical officers, five medical assistants, and seven pharmacists. Internal consistency reliability testing was not conducted, as the survey primarily comprised categorical and multiple-choice items designed to identify specific resource preferences rather than Likert-scale items intended for psychometric construct measurement. A pilot study was conducted and no modifications to the study protocol or data collection instrument were deemed necessary. Therefore, data collected during the pilot study were included in the final analysis.

Generally, the questionnaire was divided into four sections. Section 1 collected the demographic information of respondents, while Section 2 explored their preferences and the factors influencing their choice of DIR. Sections 3 and 4 assessed the frequency of use and subscription status of online medical databases/mobile applications and hardcopy references, respectively. The latter two sections also examined the willingness to pay for subscriptions among the respondents and their preferences for institutional subscriptions (online DIR only). Sections 1 and 2 consisted of multiple-choice questions, while open-ended questions were included in sections 3 and 4 according to the data requirements. Since all subjects involved were healthcare professionals, the questionnaire was designed in the English language only.

Data collection and analysis

The final questionnaire was printed in hardcopy and distributed to participating facilities by the respective investigators, who visited each site and provided it directly to eligible healthcare professionals. Upon providing consent, respondents completed and immediately returned the questionnaire, which took approximately 10–15 minutes.

All data were entered into a password-protected computer for further analysis, with access restricted to the research investigators only. The raw data was retained for two years before being securely disposed of in accordance with relevant guidelines. No personal information was disclosed during communication between the relevant departments.

Data analysis was performed using the Statistical Package for Social Sciences (SPSS) version 22. Descriptive analysis was used to present the results of this study. Numerical data were presented in mean (standard deviation, SD) or median (interquartile range, IQR). Categorical data were presented as frequency and percentage.

Results

Of the 154 eligible healthcare personnel approached, 114 agreed to participate and completed the questionnaire, resulting in a response rate of 74.0%. Among the 114 respondents, the highest proportions were male (n=64, 56.1%), while medical officers constituted the largest professional group (n=42, 36.8%), with an average age of 34.0 years (SD ± 6.0). The distribution of work experience was skewed toward early-career practitioners. Although no single group constituted a majority, those with

ten years or less of experience comprised the largest proportion (68.4%), including 35.1% with five years or less of experience (Table 1). Accessibility (n=94; 82.5%) was the most influential factor in respondents' preferences for DIR, followed by urgency (n=78; 68.4%) and free access (n=65; 57.0%), as shown in Table 2. The three most preferred resources were consistent across all types of drug-related information. Online medical databases and mobile applications (apps) ranked highest, followed by pharmacist consultation (among prescribers) and hardcopy references, as shown in Table 3.

Table 1: Demographic characteristics of respondents (n=114)

Characteristics	n (%)
Gender	
Male	64 (56.1)
Female	50 (43.9)
Age group (year)	
18-30	42 (36.8)
31-45	67 (58.8)
46-60	5 (4.4)
Profession	
Specialist / Medical officer	42 (36.8)
Medical assistant	41 (36.0)
Pharmacist	31 (27.2)
Working Experience	
0-5	40 (35.1)
6-10	38 (33.3)
11-20	31 (27.2)
>21	5 (4.4)

Table 2: Factors affecting choices for drug information used (n=114)

Factors [a]	n (%)
Accessibility	94 (82.5)
Urgency	78 (68.4)
Free subscription	65 (57.0)
Comprehensiveness	56 (49.1)
Type of drug-related information	49 (43.0)
Type of pharmacotherapy	27 (23.7)

[a]Multiple responses were allowed

Table 3: DIR used by prescribers and pharmacists by type of drug-related information

Types of drug-related information	Types of DIR used[a]						
	Online medical databases/mobile apps	Hardcopy references	Pharmacist consultation[b]	Consult colleague/senior	Product information leaflet	Journal	Non-medical website
Dose regime	**104 (91.2)**	75 (65.8)	67 (80.7)	43 (37.7)	46 (40.4)	5 (4.4)	**2 (1.8)**
Renal/Hepatic adjustment	**95 (83.3)**	75 (65.8)	67 (80.7)	44 (38.6)	44 (38.6)	10 (8.8)	**7 (6.1)**
Pregnancy/Lactation	**97 (85.1)**	69 (60.5)	65 (78.3)	47 (41.2)	50 (43.9)	**6 (5.3)**	7 (6.1)
Drug interactions	**98 (86.0)**	70 (61.4)	63 (75.9)	42 (36.8)	50 (43.9)	10 (8.8)	**8 (7.0)**
Drug availability	**95 (83.3)**	71 (62.3)	69 (83.1)	61 (53.5)	32 (28.1)	**1 (0.9)**	8 (7.0)
Therapeutic drug monitoring	**97 (85.1)**	69 (60.5)	69 (83.1)	56 (49.1)	40 (35.1)	7 (6.1)	**6 (5.3)**
Side effects & Contraindications	**102 (89.5)**	66 (57.9)	59 (71.1)	41 (36.0)	54 (47.4)	**8 (7.0)**	13 (11.4)
Drug administration	**96 (84.2)**	68 (59.6)	65 (78.3)	50 (43.9)	52 (45.6)	7 (6.1)	**4 (3.5)**
Compatibility	**104 (91.2)**	57 (50.0)	67 (80.7)	46 (40.4)	47 (41.2)	12 (10.5)	**10 (8.8)**
Pharmacotherapy choices	**104 (91.2)**	71 (62.3)	67 (80.7)	49 (43.0)	34 (29.8)	13 (11.4)	**7 (6.1)**

[a] Multiple responses were allowed with a maximum of three options. Percentages were calculated based on the total number of eligible respondents for each category (n=114 for all resources, except n=83 for pharmacist consultation).
[b] For prescribers only (Denominator: n=83).
Abbreviation: DIR = Drug information resources; apps = applications

The most frequently used online medical databases and mobile apps were My Blue Book (n=61; 53.5%), National Antibiotic Guidelines (NAG) (n=54; 47.4%) and Medscape (n=39; 34.2%) (Table 4). Only eleven respondents (9.7%) reported subscribing to paid online or mobile resources, all of whom were subscribed to UpToDate. A total of 79 respondents (69.3%) expressed a desire for their hospital or MOH to provide institutional subscriptions to online databases to improve accessibility. Among these, UpToDate was the most requested resource (n=39; 49.4%), cited for its comprehensiveness and frequent updates. Other requested platforms included MIMS Malaysia (n=26; 32.9%), My Blue Book (n=4; 5.1%), Lexicomp (n=3; 3.8%), and Medscape (n=2; 2.5%). Single requests (n=1; 1.3% each) were also made for PubMed, NAG, and the MySejahtera application.

For hardcopy references, Clinical Practice Guidelines (CPGs) (n=51; 44.7%), Frank Shann Drug Doses (n=36; 31.6%) and MIMS Drug Reference (n=21; 18.4%) were the most frequently used (Table 4). Fifteen respondents (13.2%) reported personally purchasing hardcopy materials, with Frank Shann Drug Doses being the most commonly acquired across all three professions (n=8; 53.3%). The remaining respondents purchased a range of less commonly used clinical texts, with the Sarawak Handbook of Medical Emergencies and the Oxford Handbook of Clinical Medicine accounting for two each, while the British National Formulary (BNF), John Murtagh's General Practice, and 200 Single Best Answer Questions in Family Medicine (SBAQ) accounted for one each. Generally, more respondents (n= 91; 79.8%) were willing to pay for hardcopy references compared to softcopy references (n=74; 64.9%) as shown in Table 5.

Table 4: Frequency of use for online and hardcopy DIR (n=114)

Types of DIR	Frequency of use			
	Never	Rarely	Sometimes	Always
Online medical databases/mobile apps				
My Blue Book	14 (12.3)	18 (15.8)	21 (18.4)	61 (53.5)
NAG	30 (26.3)	13 (11.4)	17 (14.9)	54 (47.4)
Medscape	17 (14.9)	27 (23.7)	31 (27.2)	39 (34.2)
MIMS Malaysia	10 (8.8)	26 (22.8)	40 (35.1)	38 (33.3)
UpToDate	36 (31.6)	25 (21.9)	30 (26.3)	23 (20.2)
Micromedex	63 (55.3)	22 (19.3)	15 (13.2)	14 (12.3)
Lexicomp	69 (60.5)	26 (22.8)	11 (9.6)	8 (7.0)
Sanford Guide to Antimicrobial Therapy	71 (62.3)	23 (20.2)	15 (13.2)	5 (4.4)
Hardcopy references				
CPGs	5 (4.4)	15 (13.2)	43 (37.7)	51 (44.7)
Frank Shann Drug Doses	19 (16.7)	18 (15.8)	41 (36.0)	36 (31.6)
MIMS Drug Reference	23 (20.2)	28 (24.6)	42 (36.8)	21 (18.4)
Oxford Handbook of Clinical Medicine	51 (44.7)	29 (25.4)	28 (24.6)	6 (5.3)
BNF	57 (50.0)	33 (28.9)	20 (17.5)	4 (3.5)
CURRENT Medical Diagnosis and Treatment	57 (50.0)	26 (22.8)	28 (24.6)	3 (2.6)

Abbreviation: DIR = Drug information resources; apps = applications; NAG = National Antibiotic Guidelines; CPGs = Clinical Practice Guidelines; BNF = British National Formulary

Table 5: Willingness to pay for DIR among respondents (n=114)

Responses	Number of respondents, n (%)			Total, n (%)
	Medical officer	Medical assistant	Pharmacist	
Online references				
Yes	28 (66.7)	20 (48.8)	26 (83.9)	74 (64.9)
No	14 (33.3)	21 (51.2)	5 (16.1)	40 (35.1)
Hardcopy references				
Yes	34 (81.0)	31 (75.6)	26 (83.9)	91 (79.8)
No	8 (19.0)	10 (24.4)	5 (16.1)	23 (20.2)

Discussion

This study found a clear preference for online medical databases and mobile apps among prescribers and pharmacists in the Tangkak district across all types of drug-related inquiries. By including both prescribers and pharmacists, the present study demonstrates that this shift towards digital resources extends across multiple professional groups. Resources such as My Blue Book (53.5%), NAG (47.4%), and Medscape (34.2%) were the most frequently used digital tools. This shift towards digital platforms for their comprehensiveness and efficiency is a central theme in modern medical practice and reflects the trends observed in both local and international literature. A study conducted in Sabah involving only prescribers in a tertiary care setting similarly identified Medscape and MIMS as among the most commonly used DIR (9). Internationally, a multicentre study in the United Arab Emirates (UAE) also highlighted a similar transition from traditional textbooks to online platforms, reflecting a universal demand for point-of-care tools that enable rapid access to comprehensive medical information to support decision-making in high-pressure clinical settings (11). Notably, when accounting for eligible respondents, pharmacist consultation emerged as a highly preferred resource among prescribers (ranging from 71.1% to 83.1% across various drug inquiries), underscoring the vital collaborative role of pharmacists in clinical decision-making at the district level.

Reliable drug information is essential for appropriate medication use and the prevention of medication errors that may lead to adverse drug events. In the context of a district healthcare setting, where practitioners often face heavy workloads, limited specialist support, and resource constraints, the ability to make quick and informed clinical decisions is paramount. The strong preference for digital resources reflects this need, as such platforms enable rapid and convenient access to up-to-date information. This is further supported by the key factors influencing the choice of DIR, where accessibility (82.5%) and urgency (68.4%) ranked highest, followed by the availability of free access (57.0%).

In Malaysia, locally-adapted guidelines (online and hardcopy) are more often used than international references. The study by Hisham et al. reported that rural doctors in Pahang relied primarily on CPGs as a source of information for patient management as they perceived these recommendations to be grounded in rigorously appraised evidence by MOH and therefore should be adhered to (12). Similarly, My Blue Book facilitates medicine prescribing by ensuring adherence to MOH formulary restrictions, while the NAG provides a clear framework for the rational use of antimicrobials to strengthen national antibiotic stewardship (13-14). This pattern of DIR utilisation differs from that reported internationally such as the UAE cohort that demonstrated a high reliance on international databases. Overall, these findings suggest that DIR utilisation in Malaysia is strongly shaped by the availability and relevance of locally developed, MOH-endorsed resources to ensure clinical relevance within the national healthcare framework.

However, an increased reliance on digital platforms also introduces potential risks such as information inconsistency, information overload, and concerns regarding the quality and reliability of these platforms (15). In fact, many physicians now face challenges in the process of searching information online due to the overwhelming volume of available data, the time required to scan large amounts of information, and the lack of specificity in the results provided (16). These concerns are closely linked to the study's next key finding, which has clear institutional implications. A substantial proportion of respondents (69.3%) expressed a desire for MOH or their institutions to provide free subscriptions to premium online databases, particularly UpToDate. This preference is likely driven by its provision of synthesised, physician-authored, and graded evidence-based recommendations that are specifically optimised for rapid clinical decision-making at the point of care (17). This breadth of information within a single platform is particularly valuable to prescribers when multiple aspects of drug therapy must be considered simultaneously.

Institutional subscriptions to vetted, evidence-based DIR, including clinical decision support tools and peer-reviewed databases, are essential for ensuring consistent access to reliable, up-to-date clinical knowledge. However, cost remains a significant barrier, particularly for smaller or rural healthcare facilities potentially contributing to disparities in database access between well-resourced urban centres and lower-resourced settings (17). Therefore, institutional licensing is a critical strategy to ensure equitable access to high-quality resources across all facilities, thereby narrowing the "digital divide" (18). In addition, centralising access through institutionally licensed, vendor-regulated platforms with rigorous editorial oversight can reduce reliance on unverified sources, promotes standardised

clinical practice, and may help mitigate information overload by directing healthcare professionals toward designated trusted resources. Collectively, these findings support the development of a national guidance framework to curate and provide standardised, evidence-based DIR to all healthcare practitioners. Such a digital health strategy could improve equitable access to reliable information, reduce the risks associated with unverified sources, and should be complemented by training programmes that strengthen digital literacy and critical appraisal skills for evaluating online health information (19-20).

Despite the strong demand for institutional support, our findings also reveal gaps in the awareness of existing resources among practitioners. For example, although MIMS Malaysia was the second most requested subscription (32.9%), it is already centrally provided by MOH and accessible to government healthcare staffs (21). Similarly, subscription to NAG and My Blue Book were still requested, despite them being provided as free-access resources without additional institutional funding. These findings suggest that perceived accessibility issues may stem from limited awareness or inadequate dissemination rather than actual lack of provision. The inclusion of MySejahtera (1.3%) as a desired drug information resource further indicates possible misunderstanding of its primary role as a public health management tool rather than a clinical reference. These discrepancies highlight the need for improved communication and structured digital literacy initiatives to ensure healthcare professionals are aware of and able to effectively utilise the full range of existing resources available to them.

A unique and paradoxical finding of this study was the expressed willingness of respondents to pay for access to DIR. Despite a clear preference for free softcopy resources in daily practice, a significantly higher percentage of respondents were willing to pay for hardcopy references (79.8%) compared to softcopy subscriptions (64.9%). This trend aligns with previous studies suggesting that while digital tools are favoured for rapid screening, physical books are still highly valued for more in-depth learning (22-23). In clinical settings, printed references are often perceived as more dependable, quick-access tools as they are not constrained to device availability, internet connectivity, or subscription validity - factors that can compromise confidence in digital platforms during critical decision-making. Beyond mere reliability, hardcopy reading is often credited with superior knowledge retention and a more thorough, focused educational experience (23-24). Notably, Frank Shann's Drug Doses emerged as the most frequently purchased hardcopy reference across all three professions. This preference likely highlights its specialised utility in paediatric dosing, where precision is paramount, as well as its pocket-sized convenience, enabling practitioners to maintain a portable, "gold-standard" resource for bedside use without technological limitations (25).

This study has a few limitations that must be acknowledged. The primary limitation of this research lies in its limited scope, as it was conducted in a single district and restricted to non-specialist government healthcare facilities. Consequently, the findings may not be generalised to large tertiary centres or other regions in Malaysia. Future studies involving additional districts such as Mersing and Pontian are recommended to validate these trends and offer a broader, more representative understanding of DIR utilisation, thereby informing national healthcare policy.

Conclusion

This study demonstrated a clear shift towards digital DIR, while also revealing a continued appreciation for traditional hardcopy references. Although softcopy resources were preferred for daily use, the greater willingness to purchase hardcopy materials highlights their enduring role in supporting in-depth learning and clinical practice. The findings also emphasised the importance of accessible, up-to-date, and freely available information, alongside a strong demand for institutionally funded subscriptions to comprehensive databases such as UpToDate to ensure equitable access to high-quality resources. Future research should be conducted across multiple districts and levels of healthcare to validate these findings and inform national strategies for digital resource provision.

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Conflict of Interest

The authors declare that they have no conflicts of interest and they did not receive any financial support or funding that is relevant to this study.

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