



The Role of Written Education in Advancing Medication Storage Knowledge: Insights from a Malaysian Public Survey

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ABSTRACT

Background: Medicines for the treatment of acute and chronic diseases are often stored at home, which may lead to improper storage of medicines and various detrimental effects due to potency reduction. This study aimed to investigate baseline knowledge and the effect of education on the proper storage of medications among the public. **Method:** A cross-sectional study among 929 Malaysian adults was conducted. It employed both online and face-to-face survey distribution methods. Participants, aged 18 years and above, were recruited from diverse public settings including malls, train stations, and through social media platforms like WhatsApp and Facebook. Data collection involved a questionnaire covering demographic details, current medication storage practices, and knowledge assessment on proper storage methods. An intervention utilizing Ministry of Health guidelines on medication storage was conducted with 255 respondents. **Results:** The mean number of times a respondent visited a clinic/hospital was 3.4 ± 3.9 times a year, with 3.5 ± 4.5 medicines prescribed per year. Medicines that were usually stored at home were those used for fever ($n=813$, 87.5%), cream/ointments ($n=711$, 76.5%), as well as cough ($n=625$, 67.3%) and pain medications ($n=597$, 64.3%). Average baseline knowledge scores on medication storage were 7.57 ± 2.012 (maximum score=12, a higher score indicated better knowledge). A written education material was then introduced to 255 respondents. The post-education ($n=255$) knowledge score significantly increased to an average of 10.67 ± 0.949 (maximum score=12, a higher score indicated better knowledge) ($t\text{-test}=0.328$, $p<0.001$). **Conclusion:** Written educational materials were found to be beneficial in improving medication storage knowledge. Pharmacists should actively use written education materials during their practice to improve knowledge of medication storage among the public.

INTRODUCTION

The global pharmaceutical industry is reported to be worth an estimated \$1.2 trillion in 2018 with medicines spending expected to exceed \$1.5 trillion by 2023 [1]. Similarly in Malaysia, the pharmaceutical expenditure has grown from RM 38.63 billion in 2011 to RM 44.78 billion by the end of 2013 [2]. Such an accelerated pace in pharmaceutical sales statistics in both the global market and Malaysia shows that pharmaceutical products are in great demand. In light of the known epidemiology within Malaysia, the Malaysian pharmaceutical market is mainly dominated by medicines

indicated for acute management such as pain and infection, as well as chronic diseases for the treatment of cardiovascular, endocrine disorders, central nervous system, and musculoskeletal disorders [3]. However, with various medications being prescribed to the population, appropriate storage is vital to ensure the safe use of medicines.

Medication received by the public, whether for acute or chronic illness is often stored at home. Most of these medications are used to treat acute and chronic diseases, for emergency use, self-medication, and possibly unused medications from previous illnesses [3,4]. Such easy availability of medications

at home becomes a significant risk factor for improper medicine storage, and also irrational use due to limited information and knowledge offered on safe storage. Correct storage of medication is crucial to ensure that upon administration medicines are at maximum effectiveness and safety.

Improper storage of medications can lead to a reduction in the efficiency and safety of medicinal treatment [5]. Medications are most often recommended to be kept away from heat or high temperatures as it may accelerate the degradation of medicines. Exposure of medicines to high temperatures such as antibiotics will result in decomposition [6]. In addition to this, low temperatures can also affect the drug stability especially liquid preparations that are prone to freezing [5,6]. Moisture is also known to compromise the bioavailability of a medication. This occurs via the formation of a monolayer surrounding the tablet or capsule leading to a decrease in the rate of inter-particle separation, slowing down the disintegration time [7]. Safety is also compromised if medicines are not appropriately stored. Oral and external medicines should be kept separately to avoid confusion and possible ingestion of external-only medicines. Most concerning is the storage of medicines away from the reach of children. Placing medicines in areas that are easy to reach may cause unintentional poisoning among children [8].

Various programs have been introduced in Malaysia to spread awareness of medicines' storage. One of the initiatives includes active posts on tips on proper storage of medicines via the MyHEALTH, Ministry of Health portal [9]. Tips consist of examples of designated places to store medicines, suitable temperature, packaging, the need to separate oral from external-use medicines, and where not to keep medications [10]. The 'Know your medication campaign' is another programme available in Malaysia that highlights the issue of rational use of quality medicines among the public. The programme includes activities such as talks, seminars, as well as radio and television interviews. To aid in better public understanding, campaign kits such as brochures, calendars, bookmarks, banner posters, Meditips booklets, and posters are distributed during state-level campaign activities. Publishing health articles in magazines and newspapers is also one of the campaigns that channel public awareness on the proper storage of medicines.

Previous studies in other settings have shown improvement in patient knowledge of medication storage when provided with structured information. In Sri Lanka, written information were shown to improve patient knowledge (from 19% to 74%) post-intervention more significantly ($p < 0.05$) than verbal information (from 19% to 58%) (10). In Taiwan, a 4-month education program, inclusive of proper medication storage component, improved patient medication knowledge significantly (11.3%, $p < 0.001$) pre-to-post intervention [11].

Although various programs on medication storage are available in Malaysia, there is a lack of data that looks at the effects of public education on the community. Furthermore, despite the availability of these programs online, not many are aware of their presence. The direct effects of these programs are also limited. Therefore, the objective of this cross-sectional study is to determine baseline knowledge on medication storage and the effect the available educational tools have on the public in Malaysia.

METHODS

Study design

A questionnaire-based, cross-sectional study was performed amongst the public. The survey was distributed using online and face-to-face distribution. The survey was distributed through popular online social media platforms such as WhatsApp, Instagram, and Facebook. Links to the survey were shared on public forums, groups, and individual profiles to reach a wide audience. For face-to-face distribution, the study researcher was stationed at high-traffic public areas such as malls, train stations, and bus stops. Individuals passing by were approached and invited to participate in the study.

Inclusion criteria were adults aged 18 years and individuals who reported using any form of medication, including both prescription and over-the-counter drugs, as well as herbal supplements or vitamins. This criterion aimed to capture a diverse range of healthcare consumers. Respondents who did not complete the questionnaire were excluded from the final analysis to ensure data integrity and reliability.

The sample size was calculated based on previous work [12] and the population size of approximately 20 million adults in Malaysia [13]. Initially, a total of 384 respondents were planned, but to account for potential exclusions and to ensure a robust sample size, the target was increased to a minimum of approximately 600 respondents.

The study aimed to reach a diverse demographic cross-section of the Malaysian adult population by employing a combination of online and face-to-face distribution methods. Online distribution leveraged the widespread usage of social media platforms, while face-to-face distribution targeted individuals who might not be as active online or have limited internet access. Despite efforts to diversify participant recruitment methods, it's essential to acknowledge potential biases. For instance, individuals with limited internet access or those who are less inclined to participate in face-to-face surveys might be underrepresented. Additionally, the study may inadvertently exclude certain demographics, such as individuals with mobility limitations who may frequent public areas less often.

Ethical approval

Ethical approval was obtained from the Universiti Kebangsaan Malaysia Research Committee (UKM PPI/111/8/JEP-2019-580). The respondents were ensured that their identity was kept confidential throughout the study. Informed consent was obtained before the respondents were enrolled in the study.

Data collection

Data were collected using a questionnaire that consisted of three sections. The first section collected demographic data such as age, gender, ethnicity, educational background, occupation, and monthly salary. Other information such as the presence of chronic diseases, frequency of visits, and receiving medications at clinics or hospitals, and the frequency of obtaining advice from pharmacists with regards to appropriate storage and disposal of medications were also collected.

The second section assessed current practices on medication storage [14]. This section consisted of 6 questions including types, location, height and temperature, containers used, and frequency of checking stored medications. Each question came with multiple answers and respondents were allowed to choose more than 1 answer.

The final section assessed knowledge of proper ways to store medications [15]. This section consisted of 12 questions with possible responses: yes, no, and not sure. Correct answers were given a score of '1' and incorrect or 'Unsure' answers were given a score of '0'. A total score was calculated, with a maximum score of 12. A higher score indicates better knowledge.

An intervention was then performed on a subset of respondents. The intervention was performed using a pamphlet on the storage of medication developed based on information from the Ministry of Health website [9]. The pamphlet consisted of information on where and where not to store medications to aid understanding during the intervention. Education on the proper storage of medications was done face-to-face, and the same questionnaire was administered after ten minutes.

Data analysis

The data collected were entered and analyzed using IBM SPSS Statistics for Windows, Version 21 (Armonk, NY: IBM Corp. IBM Corp). Descriptive data were analysed using frequency and percentages, mean and standard deviation (SD). A Chi-Square test was used to analyse categorical data, whilst a paired-sample t-test was used to determine the difference between pre-education and post-education scores. A p-value <0.05 was considered statistically significant.

RESULTS

Demographic data

A total of 929 respondents participated in the study as shown in Table I. Respondents were between 18-95 years old with a majority being females (n=686, 73.8%) and Malays (n=694, 74.7%). There was also a higher number of respondents with tertiary education (n=760, 81.8%), with only a third (n=313, 33.7%) currently employed. The mean monthly income of the respondents was RM 936.49 ± RM 1676.972. Health information revealed that respondents visited a clinic or hospital an average 3.4±3.9 times a year and admitted to taking 3.5±4.5 medicines per year. A total of 101 (10.9%) stated that they have chronic diseases with 96 (10.3%) taking medicines. Approximately, two-thirds (n=627, 67.5%) stated that they received advice from pharmacists regarding the proper way to use medicines. More than half stated that they have never received advice regarding proper drug storage (n=518, 55.8%) or medicine disposal (n=722, 77.7%).

Medication storage practices

Table II shows current practices for storing medicines. Approximately half stated that medicines were stored in the refrigerator (n=475, 51.1%) or the kitchen (n=460, 49.5%). Medicines were mostly kept above one metre (n=736, 79.2%) in room temperature (n=777, 83.6%). When storing medicines, respondents usually kept them in hard plastic containers (n=516, 55.5%), and plastic bags (n=445, 47.9%). Once stored, medicines were usually checked every day (n=116, 12.5%), once a month (n=132, 14.2%), once a year (n=16, 1.7%), every

Table I. Demographic data of the study population (n=929).

Characteristics	Value
Age, mean ± SD	28.23 ± 12.62
Gender, n (%)	
Male	243 (26.2)
Female	686 (73.8)
Ethnicity, n (%)	
Malay	694 (74.7)
Chinese	85 (9.1)
Indian	35 (3.8)
Others	115 (12.4)
Education Level, n (%)	
None	6 (0.6)
Primary education	17 (1.8)
Secondary education	146 (15.7)
Tertiary education	760 (81.8)
Occupation, n (%)	
Student	507 (54.6)
Unemployed	94 (10.1)
Employed	313 (33.7)
Retired	15 (1.6)

Table II. Practices on medication storage of the study population (n=929).

No	Statements	n (%)
1	I store my medicines in	
	Bedroom	402 (43.3)
	Sitting room	153 (16.5)
	Toilet	2 (0.2)
	Refrigerator	475 (51.1)
2.	I store my medicines at the height of	
	Below 1 metre	219 (23.6)
3.	I store my medicines at the temperature of	
	Refrigerator	424 (45.6)
4.	I store my medicine in containers like	
	Paper bag	80 (8.6)
	Bottles	151 (16.3)
	Plastic bag	445 (47.9)
	Metal container	24 (2.6)
	Hard plastic container	516 (55.5)

six months (n=56, 6.0%) or when required (n=692, 74.5%). Medicines that are usually stored at home were those used for fever (n=813, 87.5%), cream/ointments (n=711, 76.5%), as well as cough (n=625, 67.3%) and pain medications (n=597, 64.3%) and antibiotics (n=233, 25.1%).

Medication storage knowledge

Respondents’ baseline knowledge of proper medication storage is reported in Table III. The average score of the study population was 7.6±2.0 (score range 0–12). When comparing knowledge scores with demographics, it was found that

Table III. Baseline knowledge of medication storage among the study population (n=929).

No	Statements	Yes	No	Unsure
1	Each medicine has a recommended storage condition.	778 (83.7)	11 (1.2)	140 (15.1)
2	Improper storage of medicine will damage the quality of medicine.	863 (92.9)	9 (1.0)	57 (6.1)
3	Cabinets in the kitchen are suitable for storing medicines.	384 (41.3)	223 (24.0)	322 (34.7)
4	Cabinets in the toilet are suitable for storing medicines	44 (4.7)	695 (74.8)	190 (20.5)
5	Medicines can be stored with food and other valuables.	52 (5.6)	677 (72.9)	200 (21.5)
6	Medication can be stored at temperature >25°C.	154 (16.6)	442 (47.6)	333 (35.8)
7	Eye drops can be stored in a refrigerator.	328 (35.3)	306 (32.9)	295 (31.8)
8	Insulins should be stored in a refrigerator.	416 (44.8)	97 (10.4)	416 (44.8)
9	Tablets should be stored in a refrigerator.	106 (11.4)	586 (63.1)	237 (25.5)
10	Medications have expiry dates.	894 (96.2)	17 (1.8)	18 (1.9)
11	Inhalers can be stored in a car.	68 (7.3)	600 (64.6)	261 (28.1)
12	Expired drugs can be hazardous to children.	850 (91.5)	11 (1.2)	68 (7.3)

Chinese respondents (8.4±1.8) had a significantly higher score than other ethnicities (7.2±2.1) (p<0.001).

Those that were retired also demonstrated a higher knowledge score (8.8±1.1) compared to students (7.4±1.9) (p=0.005). The majority knew that improper storage of medicine will damage the quality of medicines (n=863, 92.9%), medicines have expiry dates (n=894, 96.2%) and that expired drugs are hazardous to children (n=850, 91.5%).

A total of 255 respondents were included in the post-education intervention. Overall, the average total knowledge score post-intervention was 10.7±0.9 (range 8-12), significantly higher than pre-intervention 7.9±1.9 (range 2-12) (p<0.001). When comparing demographic data with knowledge scores post-intervention, it was demonstrated that scores were significantly different when between education background, occupation, and monthly income. Respondents from a tertiary education background scored better (10.8±0.9) than those with no formal education (9.0±1.4) (p<0.001). Students demonstrated a significantly higher knowledge score (10.9± 0.9) compared to retirees (10.0±0.00). No other significant findings were observed. In the post-intervention group, there was better knowledge with the majority knowing that each medicine had a recommended storage condition (n=254, 99.6%), improper storage of medicine will damage the quality of medicine (n=254, 99.6%) and medications do have expiry dates (n=254, 99.6%) as shown in Table IV. Furthermore, most knew that storing medicines in the toilet (96.1% (n=245, 96.1%) and with food, and other valuables was wrong (n=248, 97.3%), expired drugs can be hazardous to

Table IV. Effect of education on knowledge of medication storage among the study population (n=255).

No	Statements	Yes	No	Unsure
1	Each medicine has a recommended storage condition.	254 (99.6)	1 (0.4)	0 (0)
2	Improper storage of medicine will damage the quality of medicine.	254 (99.6)	1 (0.4)	0 (0)
3	Cabinets in the kitchen are suitable for storing medicines.	28 (11.0)	223 (87.5)	4 (1.6)
4	Cabinets in the toilet are suitable for storing medicines	7 (2.7)	245 (96.1)	3 (1.2)
5	Medicines can be stored with food and other valuables.	5 (2.0)	248 (97.3)	2 (0.8)
6	Medication can be stored at temperature >25°C.	135 (52.9)	106 (41.6)	14 (5.5)
7	Eye drops can be stored in a refrigerator.	101 (39.6)	114 (44.7)	40 (15.7)
8	Insulins should be stored in a refrigerator.	248 (97.3)	3 (1.2)	4 (1.6)
9	Tablets should be stored in a refrigerator.	7 (2.7)	248 (97.3)	0 (0)
10	Medications have expiry dates.	254 (99.6)	1 (0.4)	0 (0)
11	Inhalers can be stored in a car.	0 (0)	248 (97.3)	7 (2.7)
12	Expired drugs can be hazardous to children.	248 (97.3)	0 (0)	7 (2.7)

children (n=248, 97.3%), insulin (n=248, 97.3%), and not tablets should be in the refrigerator (n=248, 97.3%), and inhalers should not be kept in the car (n=248, 97.3%).

DISCUSSION

The improper storage of medications poses significant risks, including reduced potency and potential harm [5], particularly in households where medications are often stored incorrectly. Despite frequent healthcare visits among respondents within Malaysia's accessible public healthcare system, a notable proportion reported lacking advice from pharmacists on medication use, storage, and disposal methods [16,17]. This gap underscores the need to enhance public awareness and education regarding proper medication storage practices.

To understand the extent of public awareness regarding proper medication storage, the current practice of keeping medications was taken into account. Unfortunately, quite a number were still unsure of appropriate storage with the most common places used to keep medications being the refrigerator, and kitchen, similar to previous studies [14]. Furthermore, many still do not understand the risk of unintentional poisoning among children when medications are kept below one metre, within reach of younger children [14]. Hard plastic containers and plastic bags were also a major choice for keeping medicines. However, not all medicines can be repackaged. Certain medications must be stored in their original containers to ensure efficacy is not compromised [18]. These practices, however, can be improved with appropriate exposure to medication storage education.

This poor practice of medication storage was further supported by the lack of knowledge on proper medication storage. Approximately half of the study population agreed that medications can be stored in the cabinets in the kitchen, when in fact moisture and heat can greatly deteriorate a drug's stability [7]. Not many were aware of how to store eye drops, insulin, syrups, or tablets, which was unsurprising given the poor practice demonstrated. Medicines that should be kept in the refrigerator are antibiotic suspensions, insulin, certain ointments as well as syrups to ensure efficacy is retained [19]. However, tablets do not necessarily need to be kept in refrigerators as most only require a cool, dry place [18]. Given the lack of knowledge demonstrated by the respondents it is vital that appropriate steps are taken to improve this current situation. One such method is through education, as theory-based health campaign materials [20] and written information in the form of a pamphlet or brochure can enhance patient knowledge [21].

As such, an intervention was performed on a sub-set of the respondents to demonstrate the effects of education on knowledge of medication storage. The knowledge score improved significantly after education using standard storage

of medicine information brochures used for health campaigns, similar to previous work [20]. Almost all respondents were aware, post-education, of the different storage conditions for various medications such as eye drops, insulin, inhalers, and tablets. Of the various sections of the pamphlets, insulin storage was found to be the most effective with a two-fold increase in respondents from baseline, with almost all achieving correct answers post-education. Inappropriate storage of medication in kitchen cabinets and at higher temperatures was also better understood, although only half of the respondents were able to achieve correct answers post-education. Interestingly, the improvement was observed particularly among those with higher education as well as students. It has been reported that those with higher education have a deeper understanding of their medications as they are more inclined to self-medicate and store medications for a later day [5], which possibly accounts for a better understanding of the education material given. This may make them much more willing to learn and retain information regarding medication storage. Thus, education plays an important role in influencing the way medications are stored and can indeed be used to improve the safe storage of medicines amongst the public. In light of the current findings, there is still a great need to improve public awareness toward proper drug storage, with appropriate thought taken into methods used.

Generally, written education materials are the most used tool for patient education associated with healthcare [22]. Despite the various programmes available in Malaysia, pamphlets were chosen due to the ease of use, and the possible simple administration in community pharmacies. However, it should be noted that some respondents were still unable to grasp the right storage practices despite education delivered to them using pamphlets. The use of pictures may significantly improve this [23]. This can be incorporated into the pamphlets, as they are relatively cheap, easier to distribute in various settings, and can be made using various graphics to attract the public's attention [24]. Among those that do not seem to understand the current use of education, the use of motion pictures such as videos should also be considered during the intervention as videos accelerate perception and shorten learning time while enhancing the retention of a particular idea [25]. Seminars have also been shown to effectively highlight the dangers of inappropriate storage behavior [26]. As such, the current method using pamphlets could be improved using graphics, and among those who do not find this helpful, a combination of methods such as a short video could also be considered.

Considering the study findings, the impact of these findings on policy could possibly include health education initiatives, regulatory guidelines and pharmacist role enhancement. Policymakers can use these findings to advocate for the integration of medication storage education into existing public health programs. This could include incorporating medication

storage guidance into school curricula, community health initiatives, and public service announcements. Based on the identified gaps in public knowledge, regulatory agencies could consider enhancing guidelines or regulations regarding medication labelling. This may involve mandating clearer instructions on medication packaging regarding proper storage conditions to mitigate the risk of degradation and ensure efficacy. Policymakers may explore strategies to empower pharmacists in educating patients about medication storage. This could involve integrating medication storage education into pharmacy training programs and continuing education requirements. In terms of implications on practice, pharmacists can leverage the study findings to prioritize medication storage discussions during patient consultations. This may involve implementing structured counselling protocols that include tailored advice on proper storage practices based on the type of medication being dispensed. Building upon the effectiveness of pamphlets, pharmacy practices could incorporate multimedia tools such as educational videos and interactive online modules. Pharmacies and healthcare facilities can collaborate on community outreach initiatives aimed at raising awareness about medication storage. This could involve hosting workshops, health fairs, or seminars focused on medication safety and storage best practices.

There were several limitations in this study. Firstly, as with all questionnaire-based studies, the results are dependent on the honesty of the respondents when answering. Furthermore, the sample size post-education was small due to the time constraint among respondents, as well as the lack of respondents who were willing to participate in the intervention process. Therefore, the generalizability of the study should be done with caution. Overall, the large majority of the respondents were also found to be Malay since Malays are the predominant ethnic group in Malaysia [13]. While the study included a substantial representation of ethnicities beyond Chinese and Indian, the results may not be generalizable to the entire Malaysian population. This is because the sample underrepresents the country's ethnic makeup and caution is warranted when interpreting the findings in this context. Addressing the limitations of the study, potential strategies for future research include implementing measures to mitigate response bias, enhancing participant recruitment post-education to increase sample size, and expanding the study's scope to encompass a more diverse population. Additionally, future research directions may involve longitudinally assessing the sustained impact of education interventions on medication storage knowledge and behavior, as well as exploring qualitative methodologies to gain deeper insights into underlying factors influencing medication storage practices among different demographic groups.

Future research could explore integrating digital tools to supplement pamphlet-based interventions, leveraging online

distribution channels utilized in the survey. Additionally, longitudinal studies could assess the sustained impact of educational interventions on medication storage knowledge and behavior, aiming to bridge the gap between improved awareness and lasting behavior change. These proactive steps to address this study's limitations and improve future work could enhance the effectiveness and scalability of interventions aimed at promoting medication safety within the Malaysian population.

CONCLUSION

In conclusion, Malaysians still lack knowledge on the proper storage of medicines despite several efforts performed by the government. Education using a simple pamphlet was able to significantly improve the public's knowledge on proper storage of medication as seen from the difference between pre-education and post-education scores. Policymakers should prioritize integrating medication storage guidance into existing health education initiatives, while pharmacists can play a pivotal role in delivering tailored counselling and utilizing multimedia tools to improve patient understanding and adherence.

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