Scientific Research Publishing

Pharmacology & Pharmacy, 2020, 11, 316-329
https://www.scirp.org/journal/pp
ISSN Online: 2157-9431
ISSN Print: 2157-9423

Household Disposal and Recycling of Medication in Saudi Arabia: A Call for Introducing Drug Take-Back Programs

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How to cite this paper: Alqurshi, A. (2020) Household Disposal and Recycling of Medication in Saudi Arabia: A Call for Introducing Drug Take-Back Programs. *Pharmacology & Pharmacy*, **11**, 316-329.
https://doi.org/10.4236/pp.2020.1111026

Received: October 14, 2020
Accepted: November 24, 2020
Published: November 27, 2020

Abstract

Background: Inappropriate disposal practices of medicinal products by households can harm nature. Alternatively, passing unused medications to friends and family members can have undesirable consequences as the quality of the product is in question. **Objective:** To investigate the disposal and recycling practices of medicinal products by households in Saudi Arabia. **Methods**: A cross-sectional questionnaire designed to investigate disposal and recycling practices aimed at households in Saudi Arabia. Phone interviews were conducted with healthcare providers from hospitals and community pharmacies as well as medical charity representatives. A thorough search (Jun-September 2020) for disposal and recycling policies was performed on the Saudi Food and Drug Authority (SFDA) and the Ministry of Health websites. **Results:** More than 900 participants were included in this study. Approximately 40% of respondents claimed to follow the SFDA recommendations for the disposal of unwanted medications in the wastebasket, whilst ≥6% preferred disposal via the toilet. On the other hand, 10% and 5% of households donated their unwanted over-the-counter and prescription-only medication products, respectively, to a person in need, without referring to healthcare professionals. Interviews with healthcare providers and medical charities revealed no drug take-back programs were currently available for households. The SFDA website provides a brief guide on the disposal of unwanted or expired medication. **Conclusions:** The absence of a clear drug disposal policy for households has created a gap allowing incorrect disposal practices that may lead to harming patients and/or the environment. The launching of drug take-back programs may lead to the provision of a clear consensus of governing bodies and healthcare providers on patient guidance for a safe drug disposal policy.

Keywords

Medication Disposal, Medication Recycling, Drug Take-Back Programs

1. Introduction

Inappropriate disposal practices of unwanted or expired medications can result in serious harm to nature, animals, and humans in turn [1] [2]. Although disposal of medications is generally thought of as the discarding of a medicinal product, households may also pass on their previously-stored, unwanted medications to other patients such as friends and family members. Such a practice may be the result of patient non-compliance to therapy, excessive prescribing by physicians, a change in the treatment course, improvement of patient health, or their death [3] [4].

Recycling unused medications returned by patients is discouraged by the World Health Organization (WHO) in their guidelines for medicine donation [5]. The justification for the lack of recycling is that the quality of returned medicines cannot be guaranteed. This could be especially accurate when household storage conditions are subject to hot and humid climates [6] [7] [8]. In a previous study, the author investigated various medication storage conditions adopted by households across the country [9]. Unless stored in a refrigerator, most medications were frequently exposed to temperatures above the manufacturer instructed ranges. Such temperature excursions cause degradation of Active Pharmaceutical Ingredients (APIs), leading to the production of harmful degradation products [6]. Alternatively, the partial loss of APIs or the degradation of excipients results in diminished product specifications and thus drug effectiveness [10] [11]. Therefore, storing medicinal products outside the recommended temperature range can result in a shortening of shelf-life, and medicine decay prior to the expiry date printed by the manufacturer, rendering drugs unsuitable for re-use [12]. Nevertheless, recent advancements in smart packaging, and the use of time-temperature indicators, as well as time-temperature humidity sensors, have potential in providing visual indications of product expected quality based on the accumulated thermal history the product has been exposed to. Hence, offering consumers and healthcare providers the ability to assess the quality of medicinal products [13] and preventing the use of less-than-effective medications. This is in alignment with the objectives of "The Quality of Life Program 2020" published by the Council of Economic and Development Affairs (CEDA), as part of the Saudi Vision 2030 [14].

The absence of take-back drug programs and the lack of published studies on disposal and wastage of medications in Saudi Arabia [3], have made it very difficult to monitor and investigate disposal practices of households. The results of such investigations can give insight into the degree of patient compliance and the rate of drug wastage. Abou-Auda [15] estimated the wastage of medications

in the country, based on a cross-sectional questionnaire, to amount to approximately $150 million annually; unfortunately, more recent publications were not found. Although this may be a small portion of the Ministry of Health's (MOH) annual budget (approximately $2.5 billion) for medical products and services [16], the reduction of medication wastage may lead to more cost-effective expenditures, a goal the MOH strives to achieve in alignment with the Saudi 2030 vision of economic reforms [17]. Furthermore, investigating the types of dosage forms disposed of, and their storage history, may provide the MOH and related governmental bodies with vital information on the possibility of initiating safe drug recycling programs.

This study investigated practices of medicine disposal and recycling by households in Saudi Arabia. In addition, this study discusses the potential benefits of introducing drug take-back programs.

2. Methods

2.1. Cross-Sectional Questionnaire

A cross-sectional questionnaire was designed to investigate the disposal and recycling practices of unwanted medicines by households in Saudi Arabia. The status of such medicinal products was further investigated by identifying commonly stored dosage forms. In addition, the frequency of receiving professional advice on appropriate storage conditions was examined. Participants with storage room thermometers were also queried about the highest temperature observed.

Participants were asked to choose from a list of disposal and recycling methods for expired and unwanted medication, such as discard in a refuse bin or flushing down the toilet, as well as recycling by donation to medical charities or passing them on to family and/or friends. Separate answers were required for over-the-counter (OTC) medicinal products and for prescription only medicines (POM).

To ensure response bias was limited, a pilot test was completed by several volunteers. Based on feedback, questionnaire revision and optimization ensured the use of clear and plain language. Participants were also given the option of skipping non-essential questions to avoid limiting their progress in completing the questionnaire, which in turn could limit further response bias [18] [19].

Using Cochran's formula [20] the target sample size was calculated in the range of 385 - 1068 participants. This sample size was based on a 95% level of confidence, 0.5 population proportion, and 5-3% margin of error (respective to 385 - 1068 participant numbers) to account for categorical and continuous data [21].

Data Collection

The questionnaire was distributed via online platforms where participants from all areas of Saudi Arabia were encouraged to participate. Using preliminary questions, participants from other countries were filtered out.

2.2. Interviews with Health Care Providers

Interviews were conducted over the phone with health care providers from various sectors including hospital and community pharmacies, as well as local medical charity organizations. These professionals were asked to comment on observed disposal practices by households as well as their involvement in any recycling processes.

2.3. Searching for Disposal Policies Targeted at Households

The Saudi Food and Drug Authority (SFDA) and the MOH websites were searched for a detailed disposal policy for medications that were previously dispensed to households. The search was performed in the period Jun-September 2020.

2.4. Data Analysis

Data collected was analyzed using various software including Microsoft Excel. In addition to demographic details, participants were grouped based on type of dosage form commonly stored, frequency of receiving storage advice, highest room temperature observed (only for participants with storage room thermometer) and disposal and recycling practices. Margin of error for each group was calculated using the percentage occurrence of each group and a confidence level of 95%.

3. Results

More than 900 households participated in answering the cross-sectional questionnaire (**Table 1**). The sampled population included participants of both genders, different age groups and levels of education. Participants also included households from all regions of the country, with the majority residing in the Makkah, Madinah, and Riyadh regions (**Table 1**). Based on the sample size, the margin of error equaled 3.2% [20].

3.1. Commonly Stored Dosage Forms

The most common dosage forms (≥90%) stored by households included solids (e.g., tablets and capsules), liquids (such as cough syrups), eye drops and semisolids (creams and ointments). As a result, these dosage forms may be the most disposed of and/or recycled. Comparatively, intravenous injections (IV) and inhalers were less commonly stored by participants (≤50%) (**Figure 1**).

3.2. Advice on Medication Storage by Pharmacists

According to 40% of participants, pharmacists never advised them on appropriate medication storage conditions (**Figure 2**). Though this may be influenced by the type of dosage form dispensed, the observed climate in the country may put most medications at risk of decomposition [22].

Table 1. Demographic details of participant households in Saudi Arabia (n = 924). The questionnaire was provided on an electronic platform (Google forms) to allow easy and quick access. Distribution of the questionnaire link was performed via several online platforms. Data were collected during June-July 2020. The questionnaire initiated with a question on storage practices to ensure that only participants claiming to store medications at home could take part. All participants consented to the use of their data for research purposes.

Variables	No. of participants (%)
Gender	
Male	532 (57.58)
Female	392 (42.42)
Age group (years of age)	
$X \leq 20$	54 (5.84)
$20 < X \leq 30$	253 (27.38)
$30 < X \leq 40$	269 (29.11)
$40 < X \leq 50$	193 (20.89)
$50 < X \leq 60$	115 (12.45)
$60 < X$	40 (4.33)
Education qualifications	
None	8 (0.87)
High school qualification	115 (12.45)
Diploma	82 (8.87)
Currently studying Bachelor's degree	88 (9.52)
Bachelor's degree qualification	479 (51.84)
Master's degree qualification	90 (9.74)
Doctoral (PhD) degree qualification	62 (6.71)
Regions	11 (1.19)
Asir	5 (0.54)
Bahah	58 (6.28)
Eastern Province	58 (6.28)
Hail	8 (0.87)
Jouf	2 (0.22)
Jizan	7 (0.76)
Madinah	261 (28.25)
Makkah	325 (35.17)
Najran	1 (0.11)
Northern Borders	2 (0.22)
Qassim	34 (3.68)
Riyadh	198 (21.43)
Tabuk	12 (1.30)

Questionnaire was distributed via the online platforms WhatsApp and twitter.com.

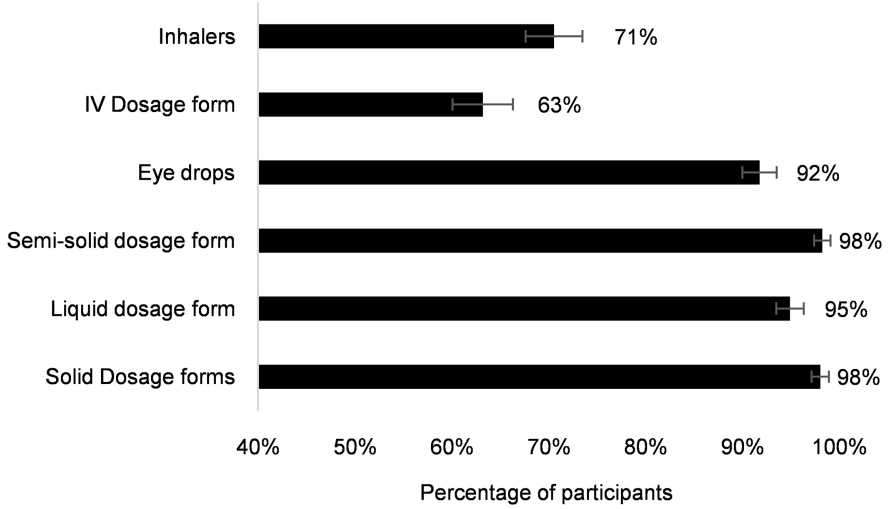

Figure 1. Commonly stored dosage forms by households in Saudi Arabia subject to disposal. Participants were able to select multiple dosage forms. The most common dosage forms stored included solids and semi-solid products. Storage duration in this study is defined as > 30 days. Error bars represent the margin of error based on a 95% confidence level and the percentage occurrence of each dosage form.

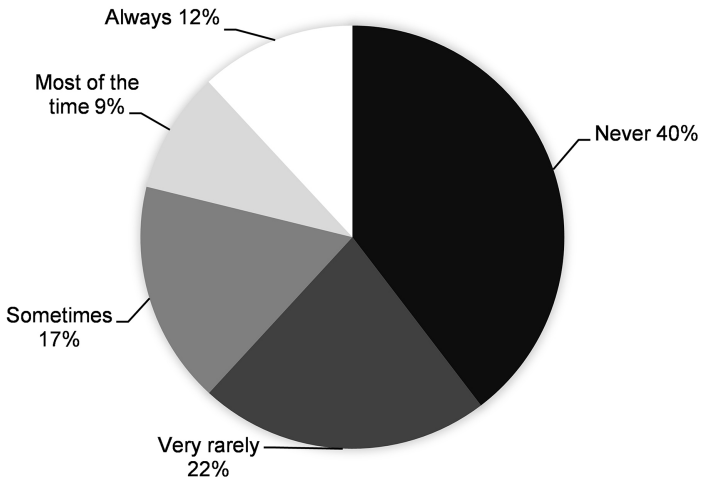

Figure 2. The frequency of storage advice for medicinal products given by pharmacists, as reported by households across Saudi Arabia (n = 924). More than half of participants claimed pharmacists "never or very rarely" give advice on appropriate drug storage conditions. Reported frequencies were not based on a particular dosage form, but rather on the overall interaction between the patient and pharmacist.

3.3. Indoor Temperatures

Over 250 participants claimed to own a storage room thermometer. Those households were asked to report the highest indoor temperatures observed in their homes. A normal distribution was generated from these reported measurements (**Figure 3**). Over 60% of participants reported the highest temperature observed surpassed 25˚C, and approximately 40% of participants reported temperatures above 30˚C (**Figure 3**). Such temperatures exceeded the manufacturer recommended storage conditions of many products [23].

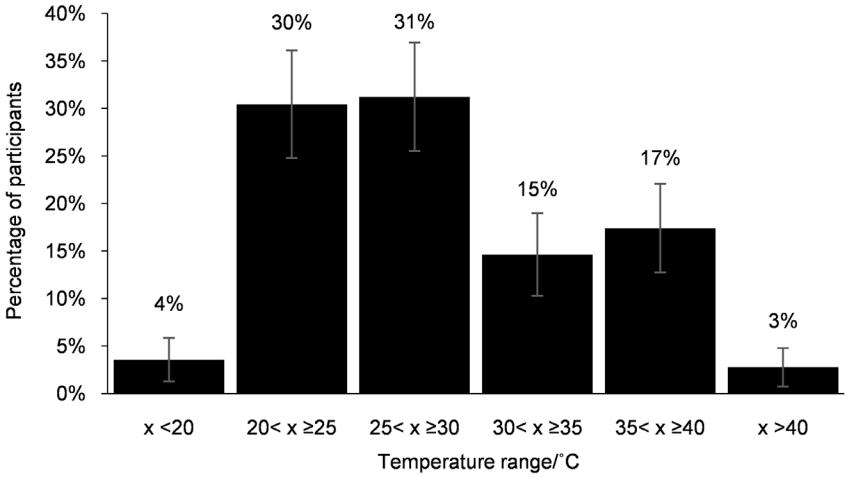

Figure 3. Distribution of the highest observed indoor temperatures as reported by households in Saudi Arabia (n = 253). Only households claiming to own a storage room thermometer were included. The average highest temperature observed by households participating in this study equaled 29.4˚C ± 6.6˚C, whereas the median equaled 29˚C. A normal distribution is suggested by the closeness of the mean and median values [24]. The highest indoor temperatures were observed by households in Qassim with an average of 33.3˚C ± 4.7˚C, and the lowest observed was in the regions Bahah and Jouf with averages of 24˚C ± 5.7˚C and 24˚C ± 1.4˚C, respectively. Error bars represent the margins of error based on a 95% confidence level and the percentage occurrence for each temperature range group.

3.4. Disposal and Recycling Practices

In assessment of disposal and recycling practices, participants were asked to choose from several options. Disposal of medications is defined in this study as discarding unwanted excess medicinal products. Even though recycling medications can take place by either passing on the medication to be used by friends and family or by medical charities. Separate answers were required from participants for OTC medicinal products and for POMs.

Approximately 10% of participants claimed to give POM and OTC products to a friend or a family member (who had been prescribed the same medication). On the other hand, 5% of participants asserted giving POM products to friends and family members without referring first to healthcare providers (**Figure 4**).

Few participants (≈6%) donated their unwanted and unexpired OTC and POM products to charities. Representatives from various medical charities explained, during phone interviews, that this practice no longer takes place, as it is difficult to assess the quality of the returned product. However, unwanted medications are still dropped at charity locations, or are discarded via the services of the closest hospital pharmacy.

Approximately 10% and 6% of participants claimed to return POM and OTC products, respectively, to hospitals, healthcare centers, and pharmacies. Several healthcare providers, during phone interviews, explained that few households attempt to return unwanted medications to be destroyed, but are refused. Respondents elaborated that such services are not provided for households, and that

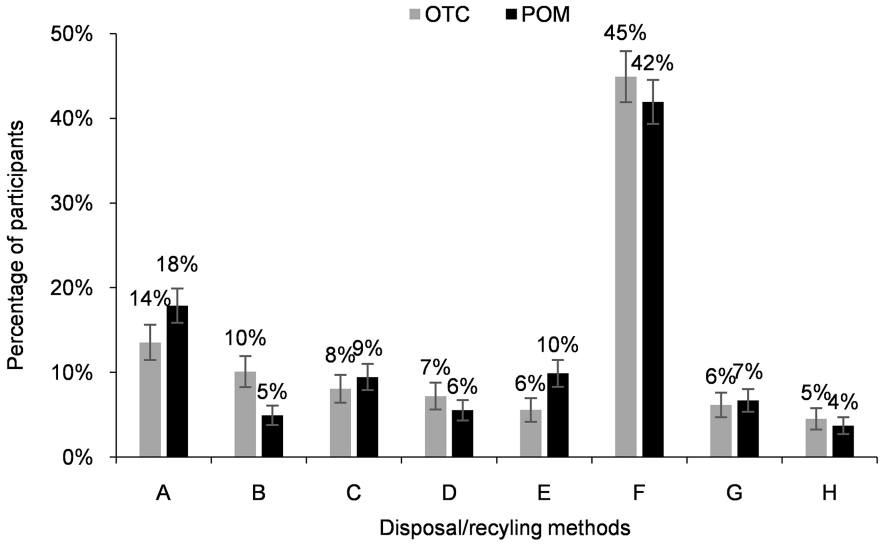

Figure 4. Methods of medication disposal claimed by households in Saudi Arabia (n = 924). A (Never had any excess medications); B (By passing on to family/friends without referring to healthcare providers); C (By passing on to family/friend who had been prescribed the same medication by a doctor); D (By donating to medical charity); E (By handing it over to healthcare facilities such as hospitals and healthcare centers); F (By discarding in refuse once expired); G (By flushing it down the toilet once expired); H (Never disposing of medications regardless of expiration date due to difficulties of obtaining them). Error bars represent the margin of error based on a 95% confidence level and the percentage occurrence for each group.

a strict disposal policy is provided only for healthcare centers and pharmacies. Disposal policies are in coordination with the regulations followed by manufacturers, and authorized companies specialize in the destruction of medicinal products, which limits the disposal/recycling choices for individuals.

Furthermore, concerns with such services were raised, including the current arrangements with manufacturers. Many community pharmacies are compensated by manufacturers when returning unsold expired medicinal products. Take-back drug programs, if implemented but not organized properly, could lead to unlawful compensation for returned medications, if those drugs are mistaken for the unsold expired products.

Approximately 40% of participants claim to dispose of unwanted OTC and POM products by simple refuse discardment. Alternatively, around 7% of participants dispose of unwanted OTC and POM products by flushing them down the toilet. A low percentage of households (≤5%) claim to store and use medications regardless of their expiration date, due to difficulties in originally acquiring the medications.

3.5. Disposal Policies

Upon searching the MOH websites, no clear policy exists on the disposal of previously dispensed medications. However, the SFDA website provides households with a brief guide on safe disposal of unwanted or expired medication [25]. For-

tunately, this includes the discouragement of using toilets in the disposal process, as this may harm plants watered with sewage treatment, in turn causing harm to animals and humans [25]. As an alternative, the SFDA recommends disposal of unwanted medications into the wastebasket, after properly sealing the medicines (in their original packaging) into plastic bags [25].

4. Discussion

Households in Saudi Arabia dispose of unwanted medications through several methods. Although a great percentage claimed to follow SFDA guidelines of throwing unwanted medicinal products in the wastebasket, a significant percentage of households (≈60%) implemented disposal practices that may result in harm to the environment. Additionally, the sharing of medications with friends and family can directly damage others' health, as in many cases this takes place without consultation with medical experts [26] [27] [28]. Not only could this lead to the use of unsuitable medications for patients, but their use may also cause symptoms to worsen through potential complications [26] [29]. The medication "donors" are unlikely to be aware of the possible repercussions of wrong dosage or wrong medication for the recipient patient. Ensuring the right medicinal products are dispensed via a pharmacist is essential, after referral to a doctor or a medical expert for correct treatment [26].

The recycling of medications by donating unused medicinal products to charities could be unsafe. Results from this study and others show that a great proportion of households rarely receive advice on appropriate storage conditions for medicinal products. In addition, more than 60% of participants reported indoor storage temperatures above 25˚C, which exceeds most manufacturer recommended temperature ranges for safe storage of solid pharmaceutical dosage forms [23] [30]. Even though this is in agreement with previous findings [9], it further confirms that a high proportion of home-stored medicinal products are exposed to harmful conditions, which may lead to the loss of performance specifications. In a previous study, temperatures inside a parked car can rapidly exceed 70˚C [9], and leaving medicines such temperatures even for a few hours, can induce the degradation of its active pharmaceutical ingredients or excipients, and potentially harmful products. In the absence of reliable assurance that the quality of a donated medicinal product is intact, it may not be safe for administration it to other patients.

It is worth noting that the short-term return of medicinal products to pharmacies, within 3 to 7 days from the dispensing date, can take place in accordance with the return and exchange policies of major pharmacy retailers in Saudi Arabia [31] [32]. However, this is subject to the type of product. Refrigerator-stored products for example, are not accepted due to potential risks. Furthermore, policies need to be created to safely regulate the return of medications.

Ensuring the quality of returned products via performing quality control (QC) tests may not be a feasible or cost effective option, as returned drugs from one

household must be treated as a single batch. Nevertheless, recent advancements in smart packaging may allow reliable information of the storage conditions that returned products have been kept under to be recorded. This is possible through continuous monitoring of storage conditions of products stored by households [13]. Time-temperature indicators are smart packaging solutions extensively researched in the food industry [33] [34] [35] [36] [37]. Such tools may come in the form of cost-effective labels that present clear indication of the accumulated thermal history for a medicinal product. Hui *et al.* [13] recently published a novel design for a time temperature and humidity indicator, which was proposed as a key technology in quality assurance of returned medications. Their design was based on an "Internet of Pharmaceutical Things" concept, where storage conditions may be monitored via smart sensors with cloud connectivity [13]. Such solutions may help improve confidence in drug recycling programs and in turn minimize drug wastage.

Although it may take several years to implement smart packaging solutions, it may be appropriate to launch drug take-back services for safe disposal now. Not only would such a service minimize the harmful disposal practices that some households have adopted, but it may also provide governing bodies with vital information to investigate medicinal wastage caused by mismanagement and improve patients' lack of awareness and/or non-compliance [38]. Such actions could lead to a clear consensus by governing bodies and healthcare providers on patient guidance for a safe disposal policy. Privacy and confidentiality of health records of patients are of concern, but must be assured in drug take-back programs to avoid discouragement of participation from the public. The general information gleaned from these programs can help the MOH to better utilize their budget as well as understanding and improvement of patient compliance through pharmacy counselling and awareness campaigns.

5. Conclusion

Disposal of medicinal products by households in Saudi Arabia include practices that may lead to harm to the patient and/or environmental damage. Households reported sharing or donating previously dispensed medications, which may have been stored outside manufacturer-recommended conditions. Hot and humid climate settings observed in Saudi Arabia could result in drug degradation which may be harmful to patients. Performing quality control tests to guarantee returned product quality may not be a cost-effective solution. Nevertheless, the utilization of smart packaging solutions, such as time-temperature indicators and time-temperature and humidity indicators based on the "Internet of Pharmaceutical Things" concept may allow continuous monitoring of storage conditions, thus paving the way for quality monitoring of returned or donated drugs and the possibility of safe recycling of unused medications. Although the recycling or re-dispensing of returned, unused medications may not be a feasible option in the interim, drug take-back programs for safe disposal are a more imme-

diate possibility. A clear policy by governing bodies and healthcare providers must be implemented to oversee such programs, as well as the regulation of safe, short term return of medications.

Limitations

Data was collected using online platforms which limits the study to households with access to the internet. While this may represent a great proportion of the population, it does not take into consideration households with limited resources.

Declaration of Competing Interests

The author of this study declares no competing financial interests or personal relationships that may have influenced the study performed and described in this paper.

Acknowledgements

The author would like to thank Mrs Faida Al-jawhari, Dr. Fatma Alqudsi, Mr. Yahya Alqurashi, Mr. Saad Alqurashi, Mr. Moath Alqurashi and Mr. Muhanad Algamdi for their tremendous input in designing and optimising the questionnaire. The author is also very thankful to Drs. Osamah M. Albassam YaserAlahmadi, Abdullah Almatrafi, Mahmud Fahmy, AbdulnasirBatouk, and Mohammed Alghanmi for their input and contributions in the conduct of phone interviews. Finally, the author is very appreciative to all who have participated in distributing and completing the questionnaire.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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