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SMARTPHONE APPLICATIONS FOR IMPROVED PHARMACEUTICAL CARE

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ABSTRACT: Advancement in mobile technologies are seen with introduction of many smartphone applications. These advancements in the field of smartphone applications can be exploited to improve pharmaceutical care practice ultimately leading to betterment of patients. Objectives of the study were to identify, evaluate and review current smartphone applications available at various platforms and recommended for pharmaceutical care. Data was extracted from platforms Android's Google play store, Nokia's Ovi store, Windows and marketplace for smartphone applications pertinent to pharmaceutical care. From all the applications accessed through various platforms the five stars rated freely downloadable smart phone applications were selected, tabulated and further evaluated by using standard questionnaire. In this study a total of 194 apps were identified in android, windows and ovi store mobile platforms of which 99 applications were from Android's Google Play Store, 48 applications from Windows store and 47 applications were available in Ovi stores. 74% of them were free to download and 132 of 194 apps i.e. 68% had customer satisfaction ratings and only nine apps had five star ratings. We conclude from this study that patient centered pharmaceutical care can be cost effective and possible via smart phone applications. However, careful evaluation for their reliability and validity of the information is required before adopting them. We recommend involving expertise pharmacists and pharmacologists from academic and practicing in development of such smartphone applications to make apps both attractive and practical

INTRODUCTION: 21st century belongs to development of information and communication technologies if these new technologies applied appropriately then they can be useful in disease surveillance, control, self-care, population screening, chronic disease, health intervention and injury prevention and control [1]. Information technology is currently used worldwide by primary care physicians especially in United States and other developed countries [2].

A Java and DoJa based cellphone medical recorder called MedData developed for patients with chronic diseases is proven to facilitate self-control in chronic diseases, and observe one's own condition objectively and continuously. It helps as scheduler with a calendar, prescription recordings, laboratory data, such as BP, BUN, creatinine, HbA1c, and other pertinent comments [3]. Home electronic assistive or smart house technologies with the potential to improve the health and quality of life of selected clients have supported clinical reasoning of community occupational therapists [4].

Technologies having ability of biological profiling of individuals at the molecular level have been shown promising results to initiate personalised medicine through integration and harmonization of scientific practices in different research sites,

healthcare and the ethical and regulatory frameworks [5]. Digitalization of healthcare system is not only enabling to facilitate two-way communication between physician and patient, but it is also useful for the caregivers to maximize efficiency in running daily activities. The use of HeartPals, a low-cost Android-based integrated wearable electrocardiography (ECG) monitoring system that enables ischemia patients to be remotely monitored by their physicians [6].

The integration of Radio Frequency Identification and Internet of Things within a suitable system, promote a better physician-patient interaction. These technologies enabled to easily and remotely establish a medication control system, beginning from physicians prescription to pharmaceutical drug administration [7].

Recently, it has been reported that up to one half of patients do not take their medications as prescribed, which undermines treatment outcomes and increases burden and cost of healthcare [8]. Therefore, there is a need to develop and implement digital systems to address this problem. In this direction several major initiatives are taken up to develop mobile applications. These applications are meant to manually record information on their prescription and medications regimens [9]. It is also noted that web-based intervention support system provided tailored interventions to reduce multiplesclerotic patients' medication discontinuation rate and move more patients to a stage where dropout is least likely to occur [10]. In cancer patients adherence to regular oral therapies can have improvement in overall survival and life expectancy, improved safety and quality of life and also, reduced recurrence [11]. Use of personal health records on various digital platforms impacting daily medical practice, as well as the care pathways and services provided to patients, and helping in the renewal of health assistance and the simplification of patients' access to care [12].

These information systems are reducing Adverse Drug Events by improving the communications between patients and healthcare professionals [13]. A study carried out in Sweden has seen a new level of functioning in rheumatology patients [14] and cloud computing contributed to the advancement of healthcare provision [15].

We have witnessed increased use of smartphones by general public as well as health care providers as they not only offers the basic communication functions, but provides advanced computing and communication capabilities including internet access, navigation and smaller computer programs applications.

Therefore, they are becoming increasingly popular across the profession [16]. These smartphone applications are used as a tool for healthcare information delivery [17], in colorectal diseases [18], smoking cessation [19], HIV and other sexually transmitted diseases [20], pain management [21], microbiology [22], pediatric anesthesia [23] and orthopedic surgery [24] thereby improving health outcomes and care processes [25]. Use of these applications by pharmacists have shown promising results in enhancing medication adherence, improve drug efficacy and reduce side-effects/toxicity [26].

Pharmacist can also recommend these applications to patients and incorporate into their self- care. However, to our knowledge, there has been no work carried out in Oman to evaluate or compare the growing number of smartphone applications that can be used for better pharmaceutical care. The development and distribution of smartphone applications will provide a new platform for health care professionals especially to pharmacists to integrate cutting-edge information technology to improve pharmaceutical care.

Objectives of the study were to identify and evaluate current smartphone applications recommended for pharmaceutical care as well as to review and put forward some suggestions for further improvement of applications. In particular, the present study is four-folded. First, it provides applications for pharmaceutical care available at various platforms. Second, it highlights the most important free applications available to improve pharmaceutical care. Third, it describes the technological contents available in identified applications. Fourth, it professionally evaluates

rated applications for independent and unbiased views.

MATERIAL AND METHODS:
Data Extraction:
Search was performed April to May 2014 on platforms Android's Google play, Nokia's Ovi store, windows and marketplace for smartphone applications pertinent to pharmaceutical care. The search was conducted using search key works; Pharmacy, pharmacist, drug, medication, medicine, medical care, dosage form, drug dose, pharmaceutical care, pharmacy, pill, tablets and capsules. Detailed descriptions like name, platform, category, updates, ratings, price, language, content, recommendations of each eligible applications were obtained. The information on each applications were entered directly into simple EXCEL sheet for analysis of data, tabulation and presentation.

Evaluation of Freely Downloadable Rated Applications:
From all the applications accessed through various platforms the most rated i.e. 5 stars rated freely downloadable smart phone applications were selected, tabulated and further evaluated by the students of final year B. Pharmacy students at Oman medical College, Muscat. A standard questionnaire was developed to have uniform evaluation pattern across all applications. There were totally nine Google Store smart phone applications who meets the criteria of inclusion includes free to download, updated more frequently, give full description of the application and common.

RESULTS:
Categories of Smartphone Applications by Store Manager:
Most of the apps were found to be from health and fitness category, followed by medical, utilities, books and references and others (**Fig. 1**). As shown in **Fig. 2**, 74% of apps are free to download.

Classification of applications based on main content:
Fig.3 shows that maximum number of apps are developed towards recording the medications and reminding the medications. It has also been seen

that many number of specialized apps are developed for tracking health and fertility, pediatric, medication and health information, first aid and continued professional education.
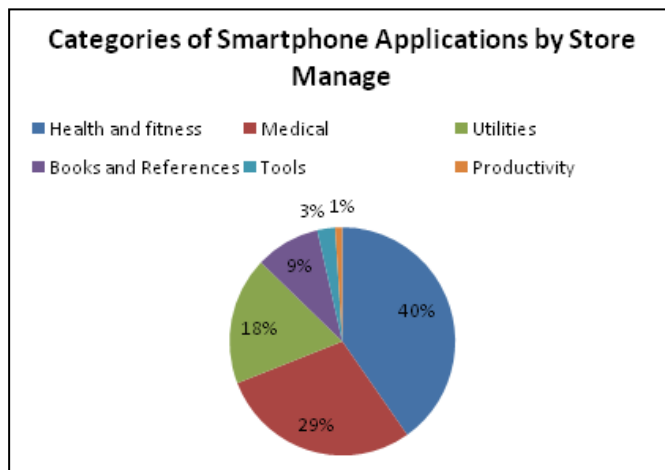

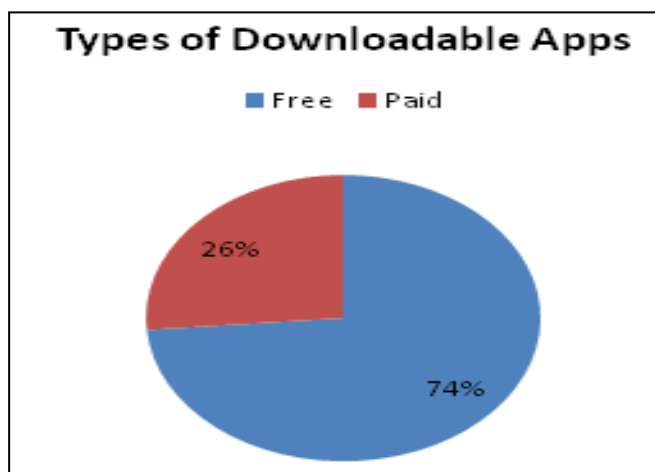**FIG. 1: CATEGORIES OF SMARTPHONE APPLICATIONS BY STORE MANAGER**

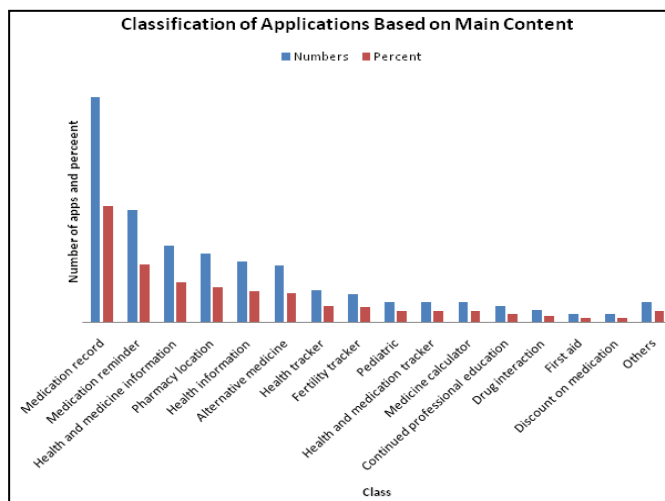**FIG. 2: TYPE OF DOWNLOADABLE APPLICATIONS**

FIG. 3: CLASSIFICATION OF APPLICATIONS BASED ON MAIN CONTENT

Evaluation of Free to Download Five Star Rated Applications

In our study we found only nine free to download applications meeting the criteria of inclusion in this study (Fig 4). The reliability of the content given in description of each applications were evaluated by the final year B. Pharmacy students studying at Oman Medical College Bausher Campus, Muscat. Results indicates that pharmacy location have the most reliable information in its description followed by Mobi Pharmacy. Home care pharmacy and my medicines have maintained 57% and 52% satisfaction of the users. However, Pharmacy, pill pro, pharmacy today, Phone pharmacy Rx discount and esophageal cancer care did not satisfy 50% of the users with respect to the content of apps description.
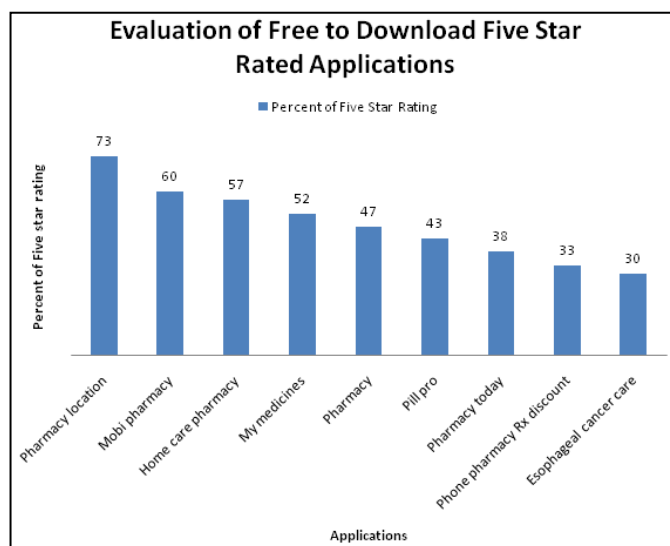

FIG. 4: EVALUATION OF FREE TO DOWNLOAD FIVE STAR RATED APPLICATIONS

DISCUSSION: In this study total of 194 apps were identified in android, windows and ovi store mobile platforms. Apple based iTune Store applications for pharmaceutical care are not considered in this study as number of iphone users are comparatively very less.

A summary of the characteristics are shown in **Fig 1**, 99 applications were from Android's Google Play Store, 48 applications were unique from Windows store and 47 applications were available in Ovi stores. 74% were free to download and 132 of 194 apps i.e. 68% had customer satisfaction ratings and only nine apps had five star ratings. Most of these applications were in English. The

purpose of the present study was to review Ovi store, Windows and Android operating system based smart phone applications available in Oman. It was also aimed to identify the most reliable and valid applications which can be recommended for better pharmaceutical care.

The five most reliable and valid five star rated applications experienced by the authors and reviewers were Mobi Pharmacy, Home care pharmacy, My medicines, Pharmacy and Pill Pro. Mobi Pharmacy is available in Android google play store providing information on medications in simple language on indication & usage, dosage & administration, drug interactions, adverse drug reactions, contraindications, warnings and over-dosage. Another play store application Home care pharmacy is maintained by experienced pharmacists providing daily health care tips and advice.

Third smart phone application we found better was My medicines available in Windows store is designed to maintain pharmacy at home by registering medicines available at home, its expiration date and quantity available. The fourth application found in Android google store was Pharmacy provides valuable information on medicines including its price. And the fifth application we recommend is Pill Pro which is again available on google store developed with a special emphasis on remembering and reminding medication administration in elders.

Diverse set of smart phone applications are developed to meet the diverse health needs as shown by the results of this study. Our study indicates that there is ample opportunity to use them for medication reminding, remembering, recording, information, alternatives, interaction, calculation, supplier and tracking. They can also be used in disease information, management, health tracking, pharmacy location, hospital location, female health indication, pediatric information, and monitoring therapeutic effect of digoxin.

Previous study explored apps to improve low-density lipoprotein cholesterol (LDL-C) treatment and also other chronic conditions like diabetes and hypertension[27]. Very recently, several applications

specifically themed to major vascular diseases were evaluated and reviewed for their possible integration into practice. It concluded that the integration of smart phone applications into the delivery of medical care has the potential to benefit vascular health care workers and patients [28]. Three text messaging based smoking cessation interventions yielded smoking cessation outcomes greater than the control condition [29]. 63 of 194 smart phone applications are targeted to improve medication adherence similar to an extensive review of smart phone applications. Where 160 apps were to improve medication adherence and ranked them most number of apps were prevalent in Android platform but apps with advanced functionality were more prevalent on the Apple store [30]. A total of 111 apps were identified and reviewed for pain education and management or relief in 2010 [31].

There are strong recommendations to evaluate these applications for their validity and reliability before application. In United States a review of all apps specifically created for orthopedic cases only one had greater than 100 reviews, and the majority of apps had very few reviews[32]. So called high-quality apps designed by clinicians with vascular expertise are currently lacking and represent an area of concern in the mobile health market. Recommended for improvement in the quality and reliability of these apps and also advised for development of robust regulation [28].

It has been observed that a low level of stated health care professionals involvement in 111 apps focussed on pain. It was also worried on possibility of misleading an individual due to lack of information on effectiveness of the product, or for possible adverse effects of product use [31]. Similar kind of results were concluded from evaluation of five star rated applications in this study.

The pharmaceutical care can be optimized to improve patient's health-related quality of life and achieve positive clinical outcomes [33]. These objectives can be achieved either through traditional short message service via cell phone or tailor-made medication reminder device [34-35]. In this new era of technological advancement smartphone applications are offering health care

professionals and especially pharmacists a platform to provide pharmaceutical care more conveniently, comprehensively and economically than ever before. However, there is a need to work together by all healthcare professionals for patient centered medical care by integrating smartphone technology with pharmaceutical care. These applications also bring self awareness among patients on medication indication, drug interaction, contraindication, adverse reaction and etc [36].

Medication reminders are ideal to improve medication adherence in elderly patients, patients with amnesia and poor memory, lonely patients and other patients who needs to be reminded. In this way adherence can be improved in 20% to 86% of patients [37]. Adherence to medicine will also improve through patient education on health and medicine and reason to take medicine on time. Applications on health, disease, disorder, lifestyle, medications and monitoring information would help in achieving this goal of pharmaceutical care [38].

Patients with different diseases have different desires for information due to indications, contraindications, co-indication, cautions, precautions about their drugs [40]. Individualization of pharmaceutical care going forward will also be a key feature to design successful app for pharmaceutical care. Thus, complex information on drugs will get simplified for better understanding of patients, health care professionals and pharmacists there by it can attract the attention of users. Based on the results of our study we found that more efforts are needed to input in the development of reliable and valid pharmaceutical care applications. Expertise pharmacists must be a part of the team in the design and development of such applications [20, 39].

Present study was a graduation research project carried out for a period of six months along with other regular courses. Our research was focused only on Google Play, Windows store and Ovi store. We are unable to experience and evaluate each smart phone applications one by one for the reason that the number of applications and time required for the same is slightly more. Thus, for descriptive

purposes, a selection of five star rated applications and free to download were evaluated for recommendation for consideration in pharmaceutical care.

CONCLUSION: We conclude from this study that patient centered pharmaceutical care can be cost effective and possible via smart phone applications. However, careful evaluation for their reliability and validity of the information is required before adopting them. Providing pharmaceutical care service via smartphone is both feasible and economic. We recommend to involve expertise pharmacists and pharmacologists in development of such smartphone applications to make apps both attractive and practical.

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