Optimising Medication Adherence with Mobile App: Perspectives of Irish Community Pharmacists and Their Acceptability

Dissertation submitted in partial fulfilment of the requirements for M. Sc.in Pharmaceutical Business & Technology (QQI)

Griffith College Dublin

Submitted by

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May 2024

CANDIDATE DECLARATION

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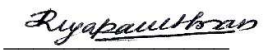
I certify that the dissertation entitled: **OPTIMISING MEDICATION ADHERENCE WITH MOBILE APP: PERSPECTIVES OF IRISH COMMUNITY PHARMACISTS AND THEIR ACCEPTABILITY** submitted for the degree of MSc in Pharmaceutical Business and Technology is the result of my own work and that where reference is made to the work of others, due acknowledgment is given.

Candidate signature: 

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DEDICATION

First and foremost, I would like to express my deepest gratitude to my supervisor Áine Behan, PhD for their unwavering support, guidance, and encouragement throughout this research project. Your invaluable insights and feedback have been instrumental in shaping this thesis.

I am profoundly grateful to all the Irish community pharmacists who participated in this study. Their willingness to share their experiences and perspectives made this research possible.

I am deeply thankful to my family and friends for their unwavering support and encouragement throughout this journey. Your patience and understanding have been my anchor.

ACKNOWLEDGEMENT

This thesis is dedicated to my parents, my husband and my grandparents whose constant love, support, and encouragement have been my foundation. Their belief in me has been my greatest motivation.

To my friends and mentors who have inspired me to pursue my academic goals with passion and dedication.

OPTIMISING MEDICATION ADHERENCE WITH MOBILE APP: PERSPECTIVES OF IRISH COMMUNITY PHARMACISTS AND THEIR ACCEPTABILITY

Abstract

Medication non-adherence remains a significant challenge in healthcare, leading to adverse health outcomes and increased healthcare costs. Despite advancements in technology, including the development of mobile applications (mHealth), medication adherence continues to be suboptimal due to various factors such as forgetfulness, cultural barriers, and therapy-related issues. By integrating technology and digital health solutions into pharmacy practice, pharmacists can revolutionize medication management and patient care. Moreover, global trends in medication adherence applications reflect a growing awareness of the importance of leveraging technology to address healthcare challenges and improve patient adherence.

Community pharmacists play a major role in promoting medication adherence and optimizing patient outcomes. The research objectives include understanding pharmacists' perceptions of mobile applications, identifying current adherence methods, exploring key features of effective mobile apps, examining barriers to implementation, assessing pharmacists' willingness to recommend mobile apps, and determining preferences for app design and usability. Through thematic analysis and interviews with Irish community pharmacists, this study aims to address research questions regarding the effectiveness, key features, recommendations, challenges, and potential benefits of utilizing mobile applications for medication adherence management. However, despite numerous studies on medication adherence, there is currently no universally accepted standard for measuring adherence, and there is a lack of research specifically addressing medication adherence challenges in the Irish context.

In order to achieve the best therapeutic outcomes, adherence to medication is very important. The use of mobile applications can play a crucial role in supporting adherence, thereby contributing to overall health improvement and cost-effectiveness by ensuring patients stick to their prescribed therapies.

Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBRIVIATIONS

Abbreviation	**Meanings**
mHealth	Mobile health
HIV	Human immunodeficiency virus
AIDS	Acquired immunodeficiency syndrome
MES	Modified Enlighted suite
AI	Intelligence Artificial
SCD	Sickle cell disease
WHO	World health organisation
PIL	Participant information leaflet
CF	Consent form
FMC	Fixed medication cycle
PR	Personalized reminders
AT	Awareness of technology
LI	Lack of information
EU	Ease of use
RP	Recommendation of application
DD	Daily dosing
BP	Blister packing
RS	Reminder software
LA	Lack of awareness
OH	Overload in healthcare
UM	Lack of understanding of medication
TU	Technology usage issue

1. INTRODUCTION

1.1 Overview

Medication adherence is about how well a patient sticks to the prescribed medication plan, including when to take it, how much to take, and for how long. When patients don't follow this plan, it's called non-adherence. More than half of the medications prescribed for people with chronic diseases aren't taken as they should be, which leads outcomes such as healthcare overload and sub therapeutic outcome.(Cutler *et al.*, 2018).studies shows that non adherence in long term chronic illnesses causes economic burden by hospitalisation, mortality, low productivity and low quality of life.(van Boven *et al.*, 2014). There are several reasons for non-adherence for example , forgetfulness, cultural barriers, therapy related barriers , socio economic factors, age, Healthcare system related factors, patient related matters, disease related matters, side effects. (Gast and Mathes, 2019).There are two types of non-adherence, intentional and non-intentional non adherence. Intentional non adherence is caused when the patient chooses to not adhere to the medication regimen. Non-Intentional non adherence is caused due to reasons such as forgetfulness, lack of understanding of one's medication. Advances in technology has opened new ways in which medications can be administered correctly, efficiently and also with the help of mobile health applications (mHealth), with features such as scheduling, reminding, alerting by push notifications etc. Several applications are available for the general population. Unfortunately very few applications are known to all age groups and not all applications are customisable or can be used by people who are not very technologically sound(Armitage *et al.*, 2020).The nature of medication adherence is multifaced with different factors such as forgetfulness, doubts about medication effectiveness, fear of side effects, financial barriers, and cultural differences. Recognizing these factors is essential for developing tailored interventions that address the unique needs of individual patients and promote adherence to medication regimens. Recognizing the complexity of medication adherence is important for developing effective interventions tailored to address the unique needs of individual patients. Tailored interventions can help promote adherence to medication regimens and ultimately improve patient outcomes.

The emergence of mobile applications in healthcare has introduced new possibilities for improving medication adherence through innovative solutions. While mobile apps have shown promises in enhancing adherence and behaviours in the short term, their long-term effectiveness and sustainability require further evaluation. Additionally, technological advancements in the pharmaceutical industry, such as automation and digital health solutions,

have transformed healthcare delivery and medication management, offering opportunities to enhance accessibility, safety, and efficiency. Community pharmacists play a crucial role in promoting medication adherence and optimizing patient outcomes. Their integration of technology and digital health solutions into pharmacy practice has the potential to revolutionize medication management and patient care. Moreover, global trends in medication adherence applications reflect a growing awareness of the importance of leveraging technology to address healthcare challenges and improve patient adherence

Mobile applications are proved to be an emerging and efficient tool for medication adherence for patients. Studies have shown that patients using medication adherence tools to help in sticking to their prescribed medications have shown a significant higher percentage of adherence than the group of patients who does not rely on any medication tools.(Armitage *et al.*, 2020).Applications provide features like reminders, in order to take the medications especially for people with complex disease conditions such as cardio vascular diseases etc.(Santo *et al.*, 2016).Mobile applications has also been seen effective among various patient population including adolescent patients with chronic conditions,(Badawy *et al.*, 2017) such as cancer under palliative care,(Gopichandran *et al.*, 2023) and asthma.(Mohan *et al.*, 2018).These applications not only help in medication adherence but also better management of the disease condition by recording and management of chronic illness. Furthermore, studies have shown that the medication adherence application has helped in the management of type 2 diabetes mellitus by helping in increasing the medication adherence (Dayer *et al.*, 2013).These application not only benefits the patients but also the healthcare providers in understanding the medication regimen, providing an opportunity to understand the reasons for medication on adherence and also helps in keeping a better communication with the patient and the provider.(Park *et al.*, 2019). Studies have suggested the advantages of medication adherence application on coronary artery diseases(Li *et al.*, 2023),systemic lupus erythematous, alcohol use disorders(Hui Yuen, 2015) and highlighted their role in increasing awareness in patients with stroke for secondary stroke prevention.(Stoner and Hendershot, 2012)

Pharmacist play a major role in medication adherence. Regular interaction with patients can help the pharmacist understand their patients accordingly to understand the barriers, the challenges faced by the patients in medication adherence, what all measures can be made to ensure the optimum therapeutic outcome etc.(Aremu *et al.*, 2022).

In this study, I aim to conduct a comprehensive assessment of pharmacists' perspectives and acceptance of mobile apps in medication adherence. The module Operation Excellence and science of innovation helped me to know more about the mobile applications in use currently for medication adherence. Building upon my previous experience as a Clinical pharmacist in India, and also as a trainee Pharmacy Technician I intend to enhance my understanding of this emerging field. As part of my post-graduate studies in Pharmaceutical Business and Technology, I am specifically focusing on mobile applications, which will provide valuable insights into evaluating the acceptability of these applications and devising strategies to promote the widespread adoption of apps, particularly in Ireland.

1.2 Research purpose

The purpose of the study is to understand the perspective of pharmacists in the use of mobile application for medication adherence in Ireland. To gain a comprehensive understanding of how pharmacists perceive and accept the use mobile application for medication adherence in their practice. The study aims to explore the attitudes, beliefs, and concerns of community pharmacists on mobile application used for medication adherence with a specific focus on the Irish context.

1.3 Research Aim and Objective

1. To understand the perceptions of Irish community pharmacists regarding the potential of mobile applications in enhancing medication adherence among patients. To explore the barriers and challenges that Irish community pharmacists expects in the integration of mobile applications for medication adherence into their practice.
2. To identify the key features and functionalities that Irish community pharmacists believe would make mobile applications concerning the design, usability, and accessibility features of mobile applications for medication adherence an effective tool for improving medication adherence. To assess the acceptability and willingness of Irish community pharmacists to incorporate mobile applications as part of their patient care strategies for medication adherence. To determine the preferences of Irish community pharmacists.

1.4 Research Questions

- What are the perceptions of Irish community pharmacists regarding the effectiveness of mobile applications in optimizing medication adherence among patients?
- What are the key features and functionalities that Irish community pharmacists believe would enhance the effectiveness of mobile applications for medication adherence?

- To what extent are pharmacists in Ireland willing to recommend medication adherence mobile applications to patients?
- What barriers and challenges do Irish community pharmacists foresee in implementing mobile applications to optimize medication adherence?
- What strategies can be recommended to enhance the acceptability and adoption of mobile applications for medication adherence among Irish community pharmacists?
- What are the potential benefits and limitations of utilizing mobile applications for medication adherence management from the perspective of Irish community pharmacists?

1.5 Hypothesis

The hypothesis I am looking to test to be true are the perspective of Irish community pharmacists towards mobile application to be used for medication adherence are mostly positive. Additionally, the Irish pharmacists recognize the potential benefits of mobile apps in providing medication reminders, educational resources, and tracking mechanisms to improve adherence rates.

1.6 Purpose

The purpose of the study is to understand the perspective of pharmacists in the use of mobile application for medication adherence in Ireland, to gain a comprehensive understanding of how pharmacists perceive and accept the use mobile application for medication adherence in their practice. The study also aims to explore the attitudes, beliefs, and concerns of community pharmacists on mobile application used for medication adherence with a specific focus on the Irish context.

2. LITERATURE REVIEW

2.1 Introduction to medication adherence

2.1.1 Definition and importance of medication adherence in managing chronic diseases and improving health outcomes.

Medication adherence also known as medical compliance refers to the degree to which patients adhere to medical advice, including taking medications, following diets, or making lifestyle changes. They also refer to the extent to which patients follow the instructions provided by healthcare professionals regarding the timing, dosage, and frequency of their prescribed medications. Irregular consumption of medicine can impact health outcomes, potentially extending illness or reducing its effectiveness.(Chaudri, 2004). The act of taking medications as prescribed and sticking to the regimen as recommended is known as medication adherence non-adherence can lead to severe consequences such as heart disease, stroke, and kidney failure. Studies show that in developed countries the non-adherence being reported among the long-term illness patients ais around 50%.(Faisal *et al.*, 2021).One of the main challenges in promoting adherence is obtaining a thorough understanding of adherence rates and the factors contributing to non-adherence. (Lehmann et al., 2014). For many years, failure to comply with drug treatment has persisted as a prevalent and significant healthcare issue. Approximately half of patients either fail to take their medication or do not adhere to the prescribed regimen provided by their doctor. (Choi et al., 2015).

There has been minimal scholarly investigation into the subject of compliance, aside from brief mentions relying on a standard set of evidences. Brian Haynes, an editor of a significant compliance bibliography, humorously suggested that the "first recorded incident of human non-compliance in Judeo-Christian tradition" was Eve eating the apple in the Garden of Eden. In the 18th and 19th centuries, doctors and healers believed strongly in the effectiveness of their treatments, just like doctors do today. For example, in the mid-1800s, a respected doctor named W.R. Gowers talked about how patients sometimes had worse seizures if they didn't stick to their treatment for epilepsy. He noticed that some patients would stop taking their medicine after a few months of feeling better, only to have their seizures come back, and each time it happened, it was harder to stop the seizures.(Chen *et al.*, 2018).

Even though effective medications for epilepsy weren't available until much later, in 1912, Gowers believed strongly in the treatments he was giving and blamed the patients for not following them properly. To understand how people have followed doctors' advice over time,

we need to look at more than just how medicines work. We also have to think about what society believes about getting better and the traditions in medicine.(Montouris and Hohler, 2016) The World Health Organization (WHO) underscores the significance of medication adherence, suggesting that enhancing adherence interventions could have a greater impact on population health than improvements in specific medical treatments alone. Conversely, nonadherence to medication is associated with adverse clinical outcomes, increased morbidity and mortality rates, and unnecessary healthcare expenditures.(Brown and Bussell, 2011). Many studies show that many patients, especially those with long-term illnesses, don't take their prescribed medicines as they should, with about half to sixty percent not following their treatment plans. As a result, not sticking to medication schedules leads to over 30% of hospital admissions related to medicines.(Lam and Fresco, 2015).

Sub-optimal adherence to prescribed medications poses a significant barrier to achieving successful pharmacotherapy in patients receiving care outside of a hospital setting, particularly when healthcare providers fail to recognize it, which happens all too frequently. The studies shows that people with hypertension with non-adherence behaviour have higher chances of getting stroke than people who adhere to their therapy.(Lee *et al.*, 2017) This issue is widespread, affecting a large portion of the population, and is linked to elevated rates of illness and death. Large amounts of money are spent by healthcare systems because they need to provide more medical treatments and use more resources to deal with the problems caused by people not following their treatment plans.

For a long time, healthcare providers didn't pay enough attention to this problem, even though it has a big impact on how well treatments work and how much healthcare costs.(Baryakova *et al.*, 2023). Adherence can be classified into two types primary and secondary. Primary nonadherence happens when patients don't even fill their prescriptions for new medications, affecting the start of treatment. Secondary nonadherence occurs when patients don't take their medications as instructed after getting the prescriptions filled. This not only impacts health outcomes but also affects the costs for the healthcare system. (Fischer et al., 2010). In some cases, people use the term "compliance" instead of "adherence," and they're often used interchangeably in research and healthcare. Compliance means how well patients follow medical advice, including taking their medication. However, some see "compliance" as negative because it can imply that patients are just passively following orders. (Fischer et al., 2010).

2.1.2 The significance of medication adherence in the context of community pharmacy practice.

Even though there are number of researches addressing the importance of medication adherence, there is no golden standard for assessing medication adherence.(Basu *et al.*, 2019). Medication adherence meant taking your meds as prescribed, and it was super important for getting better, saving money on healthcare, and making sure treatments worked. But lots of people struggled to stick to their meds, especially over time or if they faced obstacles. Both patients and healthcare teams needed to work together to improve adherence. Ways to do this included talking directly with patients, sending helpful reminders via text, making medication schedules simpler, using special packaging, reducing side effects, making sure meds were easy to get, and involving everyone on the healthcare team. Better adherence could lead to big benefits for both health and finances.

Non adherence can be a major problem especially in the case of medications such as antibiotics, leading to antibiotic resistance. Antibiotics being the medication used to fight infections non adherence can lead to the medication not being able to help in treating the same. According to studies patients who adhere to their medications showed three times more positive outcomes compared to the rest of them who were non-compliant. Not taking antibiotics right can also lead to bacteria becoming resistant, making infections harder to treat and increasing sickness, death, healthcare costs, and making antibiotics less useful in the future. (DiMatteo *et al.*, 2002).Various studies have shown that the rate of not following antibiotic prescriptions varies widely, ranging from 15% to 93%, with an average of 50% worldwide.(Mohiuddin, 2020).

2.2 Factors Influencing Medication Adherence

To understand in depth about medication adherence we should look into what are the major reasons that can lead to this World Health Organization (WHO) says there are five main reasons why people might not stick to their medication plans. These reasons include things like how much money someone has, how the medication makes them feel, their personal habits, their health condition, and how well the healthcare system works. To help people take their medications better, it's important to figure out why they're not taking them as they should. This helps doctors and other healthcare providers design interventions that fit each person's needs, whether they're not starting their medication at all (primary nonadherence) or they're not taking it as they're supposed to (secondary nonadherence).

2.2.1 Patient-related factors

Many factors influence the non-adherence in medication and patient related factor is one of them, this depends upon their age, their beliefs, their cultural barriers, language barriers, educational qualifications etc. In many places, including Ethiopia, people have trouble sticking to their antibiotic treatment plans. They might forget to take their medicine, feel uncomfortable with side effects, or stop taking it when they start feeling better, Also, antibiotics are sometimes sold without a doctor's prescription, especially in places where it's hard to see a doctor.(Muñoz *et al.*, 2014). Reasons for non-adherence include forgetfulness, doubts about medication effectiveness, fear of side effects, and financial barriers (Dillon et al., 2019). While many doctors attribute nonadherence to issues like limited access or forgetfulness, patients often choose not to adhere to their medication regimens intentionally. Patients may conceal their medication-taking behaviour due to emotional factors involving both the provider and the patient, which can result in serious consequences. (Brown et al., 2016). It's really important for both researchers and doctors to measure how well patients stick to their medication plans. If they don't, it can cause a lot of problems. For example, treatments that actually work might seem like they don't, leading to unnecessary tests or making the treatment even stronger when it's not needed.

Also, in research studies, if patients aren't taking their medication like they should, it can mess up the results and make it hard to tell if the treatment is actually effective. Plus, knowing how well patients stick to their medications helps us understand better what happens when they don't, why some people are better at it than others, and how we can help everyone do better. (Solomon and Majumdar, 2010). It was important for patients and their healthcare providers to trust each other, Sometimes, patients found it hard to talk about why they weren't following their treatment plans, or they didn't fully understand why it was important. Another most common reason for not sticking to the treatment plan were being scared of side effects or things that might make their health worse, not liking to take medications, and thinking the meds wouldn't help them get better. Keeping patients informed and talking regularly with them was key, especially because challenges with treatment could change over time.

Cultural differences can really affect whether people take their medicine properly, Things like not having much money, not having health insurance, not speaking the same language, and different beliefs can make it harder for people to stick to their meds if they're from different cultures.

2.2.2 Medication-related factors.

The other important factor that would likely pave to non-adherence are medication related factors such as polypharmacy and few other comorbidities depending upon the type of medical conditions they had according to a review done by Giulia Rita and Marianna Avola of department of Biomedical and Biotechnological sciences at university of Catania, the most common factors that affected whether people stuck to their osteoporosis medications were getting older, taking lots of different medications, and smoking, being overweight also made it harder for people to stick to their treatment plan. Especially for people with multiple disease conditions for example having both high blood pressure and diabetes made it hard for people to stick to their meds. Managing two chronic illnesses added extra stress and made it tough to remember to take medications. When they had to control both their blood pressure and blood sugar levels, the treatment plans were really complicated and overwhelming. If they didn't stick to their meds, it made their health problems worse. For people with both conditions, not taking medications like they were supposed to led to more heart problems, kidney issues, and damage to small blood vessels. Skipping meds messed up their blood pressure and sugar levels, making their medications less effective and increasing the chances of side effects. This made them feel worse and lowered their quality of life, according to the review by authors targeting studies from Asia, America and the United States.(Kwakye *et al.*, 2024). Overall, deciding to take preventive medications like those for osteoporosis is a complex process that depends on the patient's beliefs, understanding, needs, and expectations, and it's something doctors and patients should discuss together.(Mangano *et al.*, 2022). People are more likely to stick to their treatment plans when they have diseases that they think are really serious, like HIV/AIDS or cancer. But for long-term conditions like asthma, COPD, or diabetes, people tend find it even more challenging on sticking to their treatment plans.(DiMatteo, 2004).

2.2.3 Healthcare system-related

Healthcare related factors that affect medication adherence are many for example in the case of antibiotics which is the most important drug that needs adherence in order to avoid antimicrobial resistance and getting antibiotics is differs from place to place depending on the regulation, economic backgrounds the study done in Spain found that adherence to treatment was 67.2% among groups that received educational interventions, whereas it was 48.4% among groups that did not receive such interventions.(Muñoz *et al.*, 2014).. A comparative study shows that the use of over-the-counter medication dispensed was 32% higher for medication without a prescription in areas with lower economic status. A systematic review and meta-analysis revealed that unregulated access to antibiotics without a prescription constituted 62%

of total antibiotic access worldwide. (Auta *et al.*, 2019).Non adherence is the major cause of antimicrobial resistance which is a major threat to public health worldwide, when it comes to antibiotics, adherence means finishing the prescribed course and not taking them without a doctor's order.

Another barrier related to healthcare system is the long wait for prescriptions, the delays in getting an appointment, undesirable office hours, issues in medication supply shortage of medication.(Santo *et al.*, 2019), Increased healthcare expenses, including additional expenses for physical therapy and rising taxes ,these factors leads to further worsening in medication adherence and utilization of services(Rucinski *et al.*, 2023).

2.3 Methods of Assessing Medication Adherence

2.3.1 Objective measures

Objective methods are a relevant method of measurement of medication adherence in patients to evaluate the patient's adherence practices. In this method of measure of adherence, the qualitative data is collected and are more reliable comparing to the subjective measures. Common objective methods include medication possession ratio, refill adherence, electronic monitoring, unannounced pill counts, and blood assays.(Chkhartishvili *et al.*, 2014).Refill adherence is one if the widely accepted mode due to the easy access of data collection and administrative sources. In this method the refill rates, the possession ratio of medication are evaluated in order to understand the adherence of the regimen. Electronic monitoring provides a detail data on daily adherence over an extended period(Sutton *et al.*, 2014).

2.3.2 Subjective measures

Subjective method of measure of adherence includes self-report questionnaires, interviews etc. The data collected in this method involves the self-disclosure by the patients to the healthcare supporter about their medication taking behaviour and adherence.

Common subjective measures include self-report questionnaires like the "*Medication Adherence Rating Scale (MARS)(Wouters et al., 2019), Adherence Starts with Knowledge 20, Compliance Questionnaire-Rheumatology, General Medication Adherence Scale, Hill-Bone Scale, Immunosuppressant Therapy Barrier Scale, Medication Adherence Reasons Scale (MAR-Scale) revised, 5-item Medication Adherence Rating Scale (MARS-5), 9-item MARS (MARS-9), 4-item Morisky Medication Adherence Scale (MMAS-4), and 8-item MMAS (MMAS-8)"(Kwan et al., 2020)*,Self-reporting questionnaires like Morisky medication adherence scale are most commonly used.(Lee *et al.*, 2017)

2.3.3 Challenges and limitations of different adherence assessment methods

Both Objective and Subjective method of measure of adherence has its own advantages and limitations. Objective methods, like refill adherence and electronic monitoring, may come across issues like expense, technical issues and interference with common adherence improvement strategies, such as pill boxes. An electronic monitoring systems can incur significant costs and might not be a good method in places with limited setting.(Kalichman *et al.*, 2009).However subjective methods like self-reporting and interviews face limitations such as in accuracies occurring due to patients over stating their adherence, cognitive limitations due to patients literacy (Pellowski *et al.*, 2015).

2.4 Interventions to Improve Medication Adherence

2.4.1 Pharmacist-led interventions

Community pharmacists have an important role in public health, Community pharmacies being the first point of contact for patients for both prescription and non-prescription medication and healthcare utilities the amount of people relying on these businesses are very large in number. (Ylä-Rautio et al., 2020). they also play a vital role in helping the people in various aspects such as to reduce cardio vascular risks, weight management, smoking cessation, counselling over the use of OTC medication, use of inhalers for both adults and children interaction checking etc. The role of pharmacist has become crucial now a days as the number of populations growing in need of personalised medication have increased.(Ranchon *et al.*, 2023).It has become important for a pharmacist to address all aspects of the aim to enhance access to health, to cut cost, to maximise healthcare outcome and satisfaction. Randomised controlled trail conducted to understand the impact of medication adherence interventions by pharmacists showed a significant results among the participants in the control group they demonstrated a 3% increase in medication adherence, experienced 1.8% fewer hospital admissions, and had 2.7% fewer emergency room visits compared to those in the control group.(Akinbosoye *et al.*, 2016).

2.4.2 Technological interventions

Smart phones being the most used technological device in this era, having access to them and the number of ways they have help us in our day-to-day life is quite impressive. Originally meant mainly for making calls, modern smartphones are now seen as handheld computers rather than just communication devices. Mobile applications, or apps, have become incredibly popular among smartphone users. These special programs can be downloaded and used on smartphones and tablets. Mobile applications being easy to use, there is practically app for everything from booking a flight ticket to have a workout session at home. High rates of

smartphone and tablet computer ownership among physicians and medical students enable them to utilize these medical apps. Each of the major mobile platforms, Apple iOS and Android OS, hosts over 800,000 apps, with a subset categorized as medical apps—about 2% for Apple iOS and 1% for Android. (Haase et al., 2017)

Health and medical apps are a significant part of the digital market. Thousands of these apps have been created for mobile devices, and new ones are added regularly. By mid-2014, there were over 100,000 health and medical apps available in the main app stores, including the Apple App Store and Google Play. (Lupton, 2014).The number of apps being used in the healthcare sector are increasing and this popularity has led to increase in introduction and use of healthcare applications as well. Applications for weight, diabetes management, smoking cessation, blood pressure tracking. Although there is potential for medication adherence apps to enhance adherence and decrease expenses, their effectiveness has yet to be evaluated. Studies have indicated that electronic mobile devices employing reminder systems, such as Short Message Service (SMS) text messaging, can enhance adherence and behaviour in the short term. However, there is a lack of empirical research analysing patient utilization of smartphones with apps to support adherence.(Dayer *et al.*, 2013; Park *et al.*, 2019). Earlier patients primarily relied on their personal physicians as their main source for information to monitor their health conditions, managing illnesses, and personalized care plans. With the introduction of smartphone and healthcare applications there is immense availability of health-related data from various sources, and they can also monitor and manage their own health conditions and illnesses through mobile devices and software applications. Which in turn has overlooked the need of a expert opinion from a physician or a healthcare provider.(Woodside, 2016).

Like the saying ‘Every coin has two sides’, the mobile applications have its limitations too. Aging being a challenge in global healthcare system, roughly around 75% of the population above the age of 60 are prone to be affected by a chronic illness. Age is one of the main factors that affect the limited usage of mHealth applications or mobile health applications. Yet, even though there are potential advantages and opportunities for elderly individuals to utilize mHealth applications, they exhibit less inclination towards innovation in this regard and encounter numerous challenges and obstacles when engaging with such services. The number of elderly users utilizing mHealth applications to oversee their health is limited, and the current rate of usage remains notably low.(Cao *et al.*, 2020).Few studies also show that the impact of mobile applications had a positive effect on people in helping in medication adherence, but

suggesting larger scale studies must be done for evaluating the sustainability of the application.(Armitage et al., 2020) and also showed interesting insights where people found it easier to use the app including those with limited technological competence. The findings emphasized the importance of personalized functionality, especially in terms of strategies for medication adherence reminders. Overall, the study showed that medication adherence apps are helpful and are not an added burden to people of any age groups under long term illness treatment.(McBride *et al.*, 2020).

2.4.3 Multifaceted interventions

Technology has taken over and has shown a drastic advancement in the last decade in the pharma industry as a whole right from automation of tasks which were once done manually like supply of medication in hospitals using vacuum methods and collection of dispensed medication with the help of robots. This shift has allowed people to focus more on important tasks that directly help patients, like clinical pharmacy services(Baines *et al.*, 2020). The technological advancements have made notable innovation in the pharmaceutical market, making access of drugs easier faster and available, even during the time of the pandemic where lock down was implemented, where it had a major effect on the usual way for buying drugs and other pharmaceutical products.

In different parts of the word there are different methods they follow in order to make it easier for customers to make their medications available for them E.g.: In the Philippines the introduction of its first Drive-Thru Pharmacy, where patient interaction was reduced during the pandemic, ensuring the safety of the staff and spread of illness, Notably, reduced waiting times were highlighted as a substantial benefit,(Jacqueline A. Padilla and Erwin M. Faller, 2022).In Sweden technological support systems such as Electronic Expert Support (EES), has been established which would help in analysing patient prescription drug interactions, during the time of dispensing, The electronic prescriptions are analysed both individually and along with the other medications they prefer to take in case such as OTC in order to ensure safety.(Westerlund *et al.*, 2020).MedCenters are currently operational in the United States, Canada, and Switzerland, these systems have been implemented in various settings, including pharmacies, retail establishments, hospitals, community clinics, university campuses, and medical office buildings. Customers insert their prescriptions into the kiosk for scanning and are linked to a live pharmacist who checks the availability of the prescribed medicines.

A medication is deemed accessible only if it is stocked in the precise quantity requested. (Baloch and Gzara, 2020).Point of sale system or (POS) is generally used to notify the member

of staff about the potential risk the drug might cause and certain points to be noted while taking the drug as they scan the barcode of the medication. This is a support system like CDSS that helps in sensing the decision making while dispensing the drug before the transaction is done.(Rahaman *et al.*, 2019). Virtual pharmacist services is a new innovative practice model that has been shown to improve patient outcomes and minimize costs, where people can contact the pharmacist remotely and get advice for any condition or drug related or disease related issues.(Goode *et al.*, 2019).According to The 'Pharmaceutical Group of the European Union (PGEU) the vision for 2030 are the expansion of pharmacy services to enhance accessibility and improve medication utilization within collaborative primary care teams and also integrating digital health solutions, addressing chronic disease by prevention education, identifying public health threats, and offering innovative and efficient services in healthcare services'.

2.4.4 Current Intervention in technology for medication adherence

An application named "MEDPLAN" which is a medication adherence application was researched to understand the effectiveness, where positive outcomes were observed with decrease in missed doses and pharmacy refills. Asthma management applications were also introduced which also showed a positive efficacy throughout the study but the outcome was not as significant as expected.(Backes *et al.*, 2021).Adherence application such as Smart adherence technology systems and Smart multidose blister packing are also innovations that are used in different parts of the world. Smart adherence technology is a multidose blister package where an online portal designed to remotely monitor the patient's medication intake.(Faisal *et al.*, 2021).Smart multidose blisters contain a plastic cavity with an a foil packing along with a conducting circuit that allows for the tracking of dosage events, Each individual blister package is equipped with a telecommunications device and is prefilled by the pharmacy. When the compartment is opened a push notification is send to the pharmacy notifying that the patient has taken the medication. .(Faisal *et al.*, 2021).

Innovative medication-based technologies, including automated dispensers, electronic dosettes or pill boxes, electronic blister packs, electronic inhaler devices, and electronic injectors, have undergone significant development in recent years. These adherence applications come with wide range of features such as ability to send notifications and reminders to patients and/or caregivers when a dose is scheduled for ingestion. Some of these adherence technologies use the help of pharmacies to set up, pack and dispense depending to the patients' medications and therapeutic regimen.

The study conducted by Poorcheraghi et al. (2023) investigated the effectiveness of an application called "Medication Plan" specifically designed for use by elderly individuals. The findings of the study revealed significant improvements in medication adherence among elderly users compared to those not using an adherence application. This suggests that the "Medication Plan" application could be a valuable tool in supporting medication adherence among older populations, who may face unique challenges in managing their medication regimens.

Furthermore, the "Round Health" application has garnered recognition as one of the top-rated pill reminder applications available on both the Google Play Store and Apple Store. Its popularity is evidenced by its high usage and download rates, making it one of the most widely utilized apps for medication adherence. Similarly, other applications such as "Medisafe," "Pill pack," and "MyTherapy" have also gained traction among users seeking assistance with medication management.

These findings underscore the growing importance of digital solutions in promoting medication adherence, with various mobile applications offering accessible and user-friendly tools to support individuals in adhering to their prescribed medication regimens. The success of these applications highlights the potential for technology to play a significant role in improving medication adherence rates and ultimately enhancing patient health outcomes. A study conducted in 2022 was focused on three major countries categories according to their income levels namely Ireland (high income),South Africa (Middle income),and Malawi (low income) was done to study a quality assessment framework known as MES or Modified Enlighted Suite which could be used to assess an healthcare application by healthcare professionals before recommending to their patients. (Tan *et al.*, 2022)

The survey conducted in 2022 in Ireland, they covered around 10% of Irish community with Sickle Cell Disease (SCD), giving two key information about how well people stick to their medicine and their overall quality of life related to health. The primary objective of the survey was to assess medication adherence rates among individuals with SCD and evaluate their overall quality of life as it pertains to health-related factors. The findings of the survey not only provided valuable insights into medication adherence behaviours among individuals with SCD but also offered important information regarding their overall health-related quality of life. The study helped in understanding the pattern and difficulties in adherence making it easier to understand what people prefer in smart phone apps in building a better technology to help them,

not just useful for SCD but can help in other long-term health problems too.(Fogarty *et al.*, 2022).

2.5 Barriers and Challenges to Medication Adherence in Community Pharmacy Settings: especially in the Irish pharmacy setting

2.5.1 Systemic barriers

Systemic barriers that the patients face in Ireland are difficulties in accessing healthcare services, especially doctor appointments are quit hard to get due to lack of enough workforce and back log due to Covid-19.(Qato *et al.*, 2019).Limited pharmacy assess in rural areas can also be a barrier. Challenges such as time constrains and work load can be one of the reasons that can pose as a barrier in pharmacy lead interventions. (Pathak *et al.*, 2020)

2.5.2 Patient-specific barriers

Namely forgetfulness, financial constraints, polypharmacy, lack of sufficient knowledge on the disease condition the medication on treatment, complex medication routines can be major reasons for patient specific non-adherence.(Bhasu *et al.*, 2021)

2.5 Research Gaps

Medication adherence have been a challenge for a very long time with significant implications for patient health and healthcare systems. Despite advancements in medical science and technology, non-adherence remains prevalent, contributing to adverse clinical outcomes, increased morbidity and mortality rates, and unnecessary healthcare expenditures. Even though there are several studies on medication adherence there is no golden standard for measure of adherence, and not enough studies on Irish context on medication adherence challenges faced and what all innovations can be bought to enhance the healthcare system in Ireland. Moving forward, future research should focus on evaluating the effectiveness and scalability of medication adherence interventions, leveraging innovative technologies, and fostering collaboration between healthcare providers, patients, and technology developers. By adopting a holistic approach that considers historical perspectives, socio-economic factors, cultural influences, and technological advancements, healthcare stakeholders can work together to enhance medication adherence, improve patient outcomes, and advance public health globally. The current methods used for adherence are blister packing and daily dose dispensing but the effectiveness of this method is not known entirely.

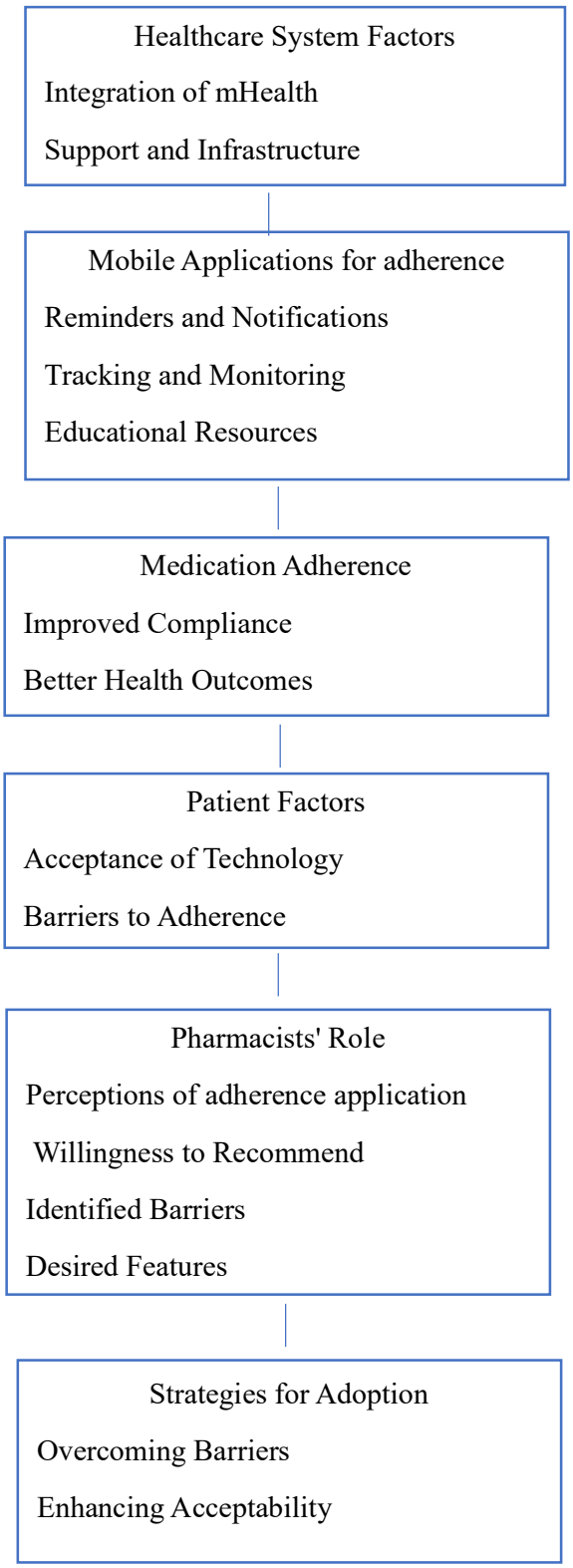
While there are some evidences of technology driven innovations in pharmaceutical industry the need of introduction of application which are AI driven and wearable devises are yet to be studied. A deeper exploration of factors such as socio economic and cultural factors that

influence the acceptability of these applications are not studies much and not enough researches are done in Irish context. There is also a gap in evaluating the feasibility of assigning these interventions in Irish community pharmacy setting.

In my study I intend to address a few of these gaps such as the perspective of the Irish community pharmacists on introduction of an adherence application into their community pharmacy setting their acceptance levels. The qualities and technological features that they prefer would make a medication adherence application more reliable and can be used in a long run. Most common factors of non-adherence among the patients in Ireland, and also gathered insights on what all are the challenges that would be faced by the pharmacist and the staff if an application was to be introduced into the current community setting.

2.6 Conceptual framework

Figure 1:Conceptual framework



3.METHODOLOGY

3.1 Overview

The primary research was interpreted using Interpretivism as research philosophy. Accepting this method helped in understanding the current scenario of Irish community pharmacies and the pharmacist perspective on the understanding and acceptance of mobile apps for medication adherence. Considering the context of the Irish healthcare system, interpretivism thinking facilitated an evaluation of the practical benefits and challenges associated with incorporating mobile applications for medication adherence into pharmacy practice. The data collection was based on interviews with open-ended questions, which helped in understanding their suggestions and practices. An inductive approach to the study helps in allowing the approach to the philosophy in thematic and naturally occurring pattern from the qualitative data collected.

The data collection method used was Zoom interviews and face-to-face interviews. This method helped pharmacists provide detailed responses to the open-ended questions to express their opinions. Options for answers to closed-ended questions were given to the group of pharmacists previously chosen for the study. Zoom interviews were used to streamline data collection depending on the distance. Face-to-face interviews were conducted in reachable locations, mostly depending on the availability of pharmacists.

3.1 Research onion

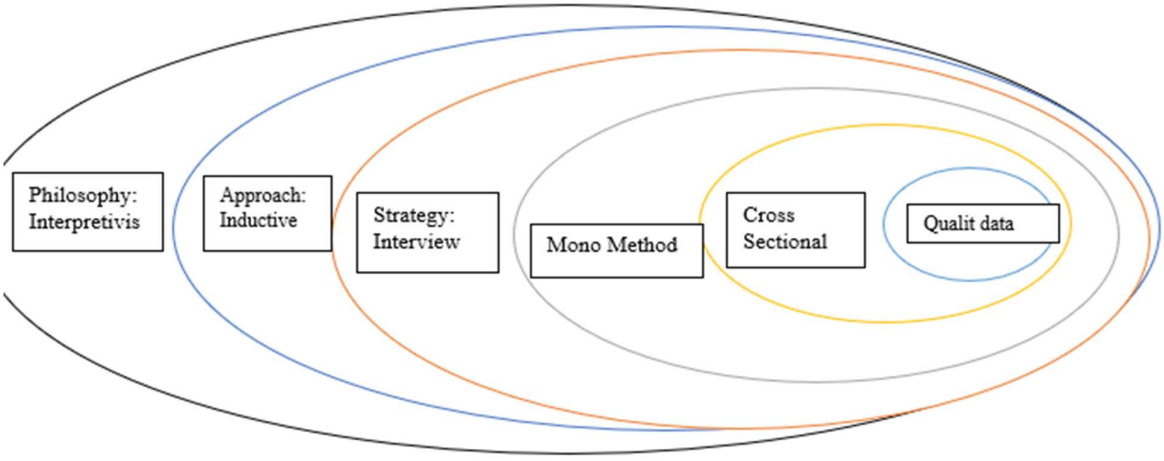


Figure 2:Research onion

3.2 Research philosophy

The primary research was interpreted using Interpretivism as research philosophy. Accepting this method helped in understanding the current scenario of Irish community pharmacies and the pharmacist perspective on the understanding and acceptance of mobile apps for medication adherence. Considering the context of the Irish healthcare system, interpretivism thinking facilitated an evaluation of the practical benefits and challenges associated with incorporating mobile applications for medication adherence into pharmacy practice.

3.3 Primary research strategy

To conduct the primary research with qualitative methods, the data collection was based on interviews with open-ended questions. These questions helped in understanding their suggestions and practices. The data collection methods used were Zoom interviews and face-to-face interviews. This method helped the pharmacists to provide detailed responses to the open-ended questions to express their opinions. Options for answers to closed-ended questions were given for the group of pharmacists who were previously chosen for the study. Zoom interviews were used to streamline data collection depending on the distance. Face-to-face interviews were conducted in reachable locations, mostly depending on the availability of pharmacists.

3.4 Methodology for data collection

3.4.1 Criteria for choosing pharmacists and their location

To gather data for my research, pharmacists across various counties in Ireland were engaged with through online surveys and one-on-one interviews. As it is widely known that Ireland comprises 26 counties, the counties were chosen according to their geographical distribution, including both sides and the central area of South Ireland, encompassing Dublin, Cork, Galway, Louth, and West Meath, with the intention of providing a comprehensive perspective from pharmacists. Snow ball sampling along with social networks such as LinkedIn, WhatsApp, and the websites of each pharmacy were preferred for reaching out to pharmacists, as they provided contact information. Most of the pharmacists were contacted through the websites of their firms.

3.4.2 Criteria for questionnaires and interviews /zoom meetings

To gather the required data from pharmacists, a questionnaire method was adopted. For face-to-face interviews, the availability of pharmacists was taken into consideration. Scheduling the interviews was done based on their availability, and the time and date for Zoom meetings were communicated to them via email at least two days prior to the meeting. The questionnaire used for the interview is attached under appendix. The interview was 15 minutes long and was

recorded the data was transcribed, no notes were taken during the interview as it might hinder the flow of the conversations. The data was transcribed from the audio recordings and coded.

3.4.3 Methodological and ethical issues associated with study

In the study, a qualitative approach was used to gather information from a sample of 6 registered pharmacists in Ireland. It was ensured that the responses did not contain or disclose any personal information about the pharmacists. However, limitations could arise due to time constraints and the clarity of responses, leading to imperfections in the interviewees' responses. Questions were fabricated to keep sensitive information regarding the patient and their medication confidential.

In conclusion, the chosen group of pharmacists engaged to the best of their capacity; however, time constraints may have hindered their ability to offer explanations. These limitations were taken into account when interpreting the study's findings. Before conducting the interview, the participants were presented with a Participant Information Leaflet (PIL) and a Consent Form (CF) to be signed. The consent form included details regarding data storage and encryption, and participants were informed that they could withdraw from the study at any time. The interview questions are attached in the appendix.

Appendix 1- Participant Information Leaflet (PIL)

Appendix 2- Consent Form (CF)

Appendix 3- Questionnaire

3.5 Approach to data analysis

Thematic analysis was used to analyse the collected data, this was because the way pharmacists answered the questions during the interviews could provide a deeper understanding of their viewpoints. The audio recordings were transcribed and the document was coded depending on relevant themes. The most frequent words were found and coded and the frequency response was analysed to find the results. The main focus of the research was on the interactions during the interviews. This was because the way pharmacists answered the questions during the interviews could provide a deeper understanding of their viewpoints. To maintain the study's credibility, every response obtained from each interview was meticulously documented and subjected to statistical analysis. It was important to note that recording the interviewee's answers was conducted with their explicit consent, adhering to principles of privacy and confidentiality. The data was analysed using thematic analysis and a holistic approach, where

the key themes were coded and classified, relating to the research objective. The most frequently occurring codes were identified and discussed to find the results.

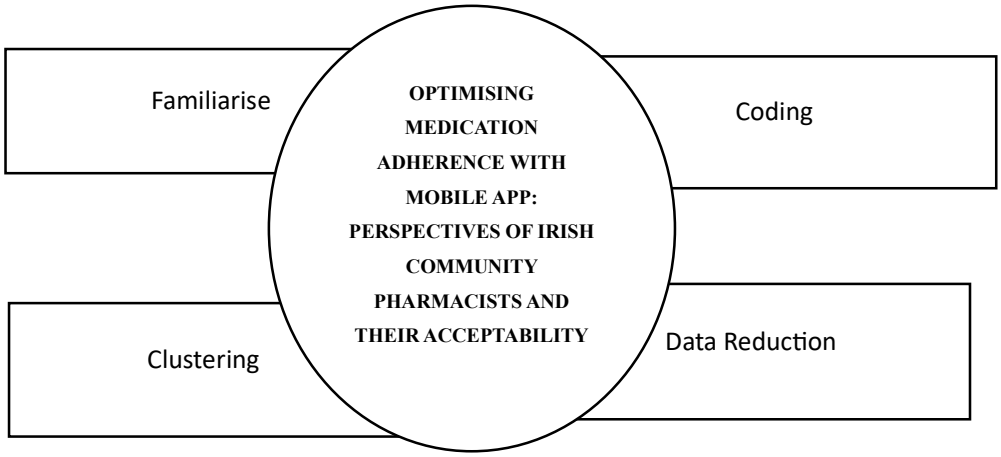


Figure 3: Approach to data analysis

1. The collected data was first familiarized by the researcher.
2. Transcriptions of the interviews from audio recordings to written transcripts were conducted.
3. This process allowed the researcher to gain an understanding of the range of views and arguments presented.
4. The arguments were then tagged based on their respective topics.
5. The data was clustered into the most prevalent topics.
6. Finally, these topics were synthesized and presented in a clustered paragraph format.

4. FINDINGS AND ANALYSIS

Presentation and discussion of findings

4.1 Overview

This section includes the process of gathering data through interviews, followed by a thorough analysis to derive meaningful insights. The method chosen for this analysis is thematic analysis, with holistic approach, a technique that involves identifying and categorizing recurring themes within the data. To accomplish this, a coding technique was utilized.

4.1.1 Respondent background

The respondents interviewed for this study were mainly Community Pharmacists of Ireland. Respondents experience varied to a range within over around a year to over a decade of experience which helped in deeply understand the changes and perspectives from each one of them. Out of 6 participants 3 of them were female and 3 of them were male pharmacists showing the diverse representation of profession. Interview requests were sent out to around 15 pharmacists across 26 counties of Ireland, the response rate was around 9. Total of 6 interviews were conducted, as there were time constrains and other factors such as low responses to emails.

The interview questionnaire is attached in the appendix for further reference, The respondents were interviewed through zoom meetings, all the interviews were audio recorded and transcribed (the transcripts were handed in as raw data along with the dissertation). The original recordings were handed in along with the dissertation as well.

Table 1:Summarizing demographic or participants

Participants Demographics	Interviewee A	Interviewee B	Interviewee C	Interviewee D	Interviewee E	Interviewee F
Years of experience	1	3	10	2	7	1
County of practice	Dublin	Wexford, Clair	Cork, Meath, Waterford	Cork	Limerick	Kildare
Gender	Male	Male	Female	Female	Male	Female

4.1.2 Thematic analysis performed and coding approach and framework used.

- The findings were gathered from the responses obtained from an asynchronous open-ended questionnaire by interviewing Irish community pharmacists.
- Thematic analysis was used to analyze the data to understand the perspective of the Irish community pharmacists. This analysis procedure is based on understanding the common themes addressed in each interview.
- A holistic approach was considered as the study mainly focuses on the perspective of the pharmacists.
- Coding approach to the data was also considered as they helped in thematically aligning the answers of interviewees with that of the themes identifies.
- Six participants were involved, this was crucial as it helped in obtaining significant insights,7 relevant themes were observed from the analysis with linked majorly with the study objectives and related subthemes are elaborated below.
- From the collected interview responses, 7 overarching themes were identified as significant. These themes were further broken down into 15 subthemes, allowing for a more detailed exploration of the data.
- Importantly, the main themes that emerged were found to be closely aligned with the objectives of the research, indicating that the data collected was relevant and meaningful in addressing the research questions and goals.
- This alignment reinforces the validity and significance of the findings obtained through the analysis process.
- The categorization of individual themes within the main themes played a crucial role in helping the researcher ascertain their relevance in achieving the research objectives. This classification process allowed for a deeper understanding of how each theme contributed to the overarching goals of the study.

Table 2:Themes and subthemes

Themes	Subthemes	Interviewee responses
1. Medication adherence challenges	• LA-Lack of awareness, • Lack of Understanding of Medication (UM),	A, B, C, D, E, F

	• (OH) Overload in Healthcare System	
2. Current methods of medication adherence	• BP-Blister • Packing-Daily dose, • RS-Reminder software	A, B, C, E, F
3. Patients' acceptance and pharmacist response to medication application	• Awareness of technology (AT), • Lack of Information (LI) • Ease of Use (EU)	A, C, D, E, F,
4. Pharmacy staff training and implementation challenges	• Time Constraints (TC) • Staff Education (SE)	B, E, F, A
5. Features of Ideal mobile application	• Personalized Reminders (PR), • Fixed Medication Cycle (MC)	A, B, E, F
6. Recommendations and Insights	• Application Recommendations (AR),	A, B, E, F
7. General Comments and Additional Insights	• Recommendation of application (RP)	A, B, C, D, E, F

4.2 Findings

Medication Adherence challenges

The present challenges faced by pharmacists in medication adherence with the patients are discussed under this theme, to understand the perspective of Irish community pharmacists in using an application for medication adherence the knowledge of what the present barriers are

a necessary step, Pharmacists recognize that digital solutions have the potential to mitigate some of these challenges by providing innovative tools and resources to support medication adherence. This theme aligns directly with research objective by focusing on exploring the barriers and challenges that pharmacists expect in the integration of mobile applications for medication adherence into their practice. However, to maximize the effectiveness of such applications, it is crucial to first identify and understand the existing barriers that pharmacists encounter in their practice. Around three themes were recognized.

- Lack of Awareness (Code: LA)
- Overload in Healthcare System (OH)
- Lack of Understanding of Medication (UM)

Lack of Awareness (Code: LA) theme explains the pervasive issue of patients lacking sufficient awareness regarding the importance of medication adherence, which poses barriers to optimal health outcomes. pharmacists observe first-hand the consequences of this lack of awareness on patient behavior and health outcomes was the most frequent code observed, in fact out of six interviewees all six of them responded to this code. Patients may fail to adhere to prescribed medication regimens due to misunderstandings or underestimations of the importance of adherence, resulting in suboptimal treatment outcomes, disease progression, and potential exacerbation of health conditions.

Interviewee **E** states that:

“The lack of awareness of the medication and how to use even the technique of how to use a medication is low in patients in Ireland, by study it says only 80% of the people who are using an inhaler like Ventolin is using it correctly. So, on the other side is lack of understanding of the medication. Many people do know that. Okay let's say. Tablet A is used for this condition, but. There is a good few in the community, especially when it comes to an elderly population who take the medication even without knowing exactly what they're taking for. So, lack of awareness of or lack of knowledge about the medicine or lack of explanation from the healthcare system.

Similarly, Interviewee **D** states that**:**

“*The reason why they taking them and they don't see that any improvement for example you know like for starting like for cholesterol, even if they take, that they, people on. Starting for*

life because I don't see that if they stop taking it for a while, I don't see any change in their health or anything so they just start taking it."

Interviewee **B** states that

"*Just because they're on so many medications. I frequently see patients. Who have no idea whether we're prescribed something. So, they don't take us. And, and I find the patients, kind of you know just neglect to actually follow their doctors' orders.*"

The code **(OH) representing Overload in Healthcare System**, shows the strain placed on healthcare resources and professionals due to non-adherence among patient this code was used by three out of six participants in the study.

Interviewee **E** states that:

"One issue is with the healthcare system because most places have an overload of work so they don't have enough time to actually spend with individual patients to explain to them how to use the medication.".

Interviewee **B** states that:

"*Sometimes they don't tell us this we don't get enough time to talk to them about that either*"

Interviewee **F** states that**:**

"*They are not comfortable in taking about them even if we find time to have a conversation which happens very rarely*"

Lack of Understanding of Medication (UM) poses significant challenges for pharmacists who are tasked with providing medication counseling and education to patients. The UM code was another frequent code used, out of six participants all six of them agreed to this code, showing lack of understanding of medicine is a significant challenge faced by Irish community pharmacists in medication.

Interviewee **F** states that

"*The reason that your, levels are going back to normal is because you're on that medication and some people might be like, okay, I'm back to normal and I don't have to take them anymore or they might not even know that they might be like, okay, I'm feeling well, I'm feeling normal. I'm not feeling like I was before. So, I'm just going to stop the medication*"

Interviewee **A** states that

"*Around 80% of customers in my pharmacy have issues with, medication adherence, most of them are older in age and has lost their ability to understand their medication, tend to lose the tablets and forget to take medications on time*"

Interviewee **C** states that

"*Not understanding what the medication is for or the long-term aim of the medication, I think is quite common as well for*."

By critically analysing these themes we can see that the current challenges faced in medication adherence are mostly due to lack of awareness among patients about their medication regimen, Maily due to factors such as subjective and objective barriers such as age, loss of medication, cognitive difficulties, forgetfulness, lack of enough support from the doctors and healthcare workers.This themes show the importance of patient education on medications and medication adherence and also the challenges that are to be addressed in the current setting to obtain maximum adherence behaviors in patients.

Current methods of medication adherence

In this theme the current methods used by Irish community pharmacies are addressed to understand what changes can be made in the existing system and how technology and mobile application can be used affectively, to manage and enhance the present scenario. This theme directly relates to research objective by focusing on understanding the current methods used by community pharmacies for medication adherence and exploring potential changes through technology and mobile applications. Three themes were observed.

- Blister packing (BP)
- Code (DD)Daily dosing
- Reminder system (RS)

Blister packing (BP) is a method used by pharmacists facilitate medication adherence among patients within the Irish community pharmacy setting Blister packs, also known as unit dose packaging, involve pre-packaging medications into individual compartments or "blisters" organized by dose and administration time. This packaging format provides several benefits for patients, including improved medication organization, ease of dosing, and enhanced medication adherence. By visually separating doses and providing clear instructions, blister packs help patients adhere to their prescribed medication regimens more effectively.

Interviewee **A** states that

"*One of the methods we do is, you know, give out meditation in Blister pack. So, given that medicine in blister pack say for example in a weekly basis or even a monthly basis is far better than giving out medicines you know in a big back to them so they won't get confused, they won't get confused with the timings and how to administer them. And so, I found it. Very, you know, very efficient to give out medicines in a weekly basis in a blister pack*."

Interviewee **B** states that

"*Whether it be the kind of long-term patients that we have on blister packs in our pharmacies already. You run into a lot of the issues with blister packs as well which aren't perfect systems in themselves*"

Similarly, Interviewee **C** states that

"*We have a lot of older patients and sometimes I think there's and memory difficulties or medication is getting lost. So, I think that's 1 part. Like for older patients, we do try to do. We would offer Blister packing services. And weekly collection of Blister packing so that the kind of They don't have an overwhelming number of tablets at home*."

The quotes by Interviewee **E** also supports this theme

"*There is something called. What's that? The actual name is basically let's say simply you can say Blister packing. So, blister packing is something like. You're doing weekly medications for individual patients. And it can be done weekly as well as it can be done daily*"

Interviewee **F** states that**:**

"*Yes, we do blister packing for certain patients. We do blister packing for patients who have been approved for faced dispensing as well and for others on a certain fee*"

Code (DD)Daily dosing is a practical approach Daily dosing regimens involve prescribing medications to be taken once per day, typically at consistent times to establish a routine. This dosing schedule offers several advantages for patients, including simplicity, convenience, and reduced likelihood of missed doses. his dosing schedule offers several advantages for patients, including simplicity, convenience, and a reduced likelihood of missed doses. By taking their medication once daily, patients can integrate it more seamlessly into their daily routines, making it easier to remember and adhere to.

The quotes by Interviewee **E**

"*Some doctors want the pharmacy to do it daily in that case a patient comes to the pharmacy every day to collect the medications*"

Reminder system (RS) serves as a valuable tool for pharmacists to complement traditional adherence support strategies. It's a technological approach where it's designed to prompt patients to take their medications at prescribed times. These software solutions leverage various communication channels, such as text messages, push notifications, or smartphone apps, to deliver timely reminders and reinforce medication adherence behaviors.

Interviewee **A** states that

*"I would say, not, not with medication inheritance, but we have this, app we have this application or website which is connected to a pharmacy dispensing system which we use to give out in information or to send notification to patients. And so that this system was by, people can sign into the application and They fill out their details and we add their medicines into the list of.***"**

Interviewee **E** states that:

"And the other one is, some pharmacies are doing a certain reminder kind of software, but it's not it's not like I've only seen that in one pharmacy in the whole country."

This theme points out the current practices being followed in community pharmacies around Ireland, Blister packing being the most used method of medication adherence practice, seems to be followed by most of the pharmacies in Ireland and from the pharmacists comments its was understood that this method is quite successful and has helped in maintain adherence to an extent. Reminder software's are not quite common although few pharmacies use them, they are not extensively available and not known enough to be used, the responders with experience of using reminder software app comments and expresses the positive outcomes of this innovative approach and also states that they have found a very good promising increase in number of patients utilizing these applications to bring out a positive outcome.

Patients' acceptance and pharmacist response to medication application

In this theme the patient's and pharmacist perspective to medication adherence mobile application and their acceptance is addressed. This theme aligns with research objectives by focusing on assessing the acceptability and willingness of patients and pharmacists to use and consider mobile applications for medication adherence. Three themes were observed which

were coded to understand the response s from patients according to what aspect did their trend depend.

- Awareness of technology (AT)
- Lack of Information (LI)
- Ease of Use (EU)

Awareness of Technology (AT) encompasses patients' understanding and recognition of the role those technological solutions, such as mobile applications or digital platforms, can play in enhancing medication adherence. Patients' awareness of technology is often influenced by various factors, including exposure to digital health information, personal experiences with technology, and recommendations from healthcare providers. As patients become more digitally savvy and accustomed to using smartphones and other devices in their daily lives, they are increasingly receptive to exploring technology-based interventions for managing their health and medications.

Quotes by Interviewee **A**

"One of the main limitations with using the application is that older people are not, you know, quite efficient with technology."

Interviewee **E** states that:

"Lack of information is one challenge. And lack of using the knowledge of using the technology is another one."

Interviewee **D** states a contradicting comment

"I am happy to recommended mobile application to a patient or your friends or someone who has an adherence problem. But not so much for my regular patients mostly because, major issues are their age and most of them are not so aware of how to use technological devices, but there is patient who are on, the sensor, you know, like the Dexcom 7 sensors."

Interviewee **C** states that

"Maybe our description or our talking through if we can't converse in their language or. And then for older people who aren't particularly tech savvy to make it as simple as possible"

Lack of Information (LI) encompasses patients' limited knowledge or misinformation about the availability, functionality, and benefits of technology-based interventions for medication adherence. Within the Irish community pharmacy context, pharmacists frequently encounter

patients who may be unaware of the existence of mobile applications, reminder software, or other digital tools designed to support medication management. The theme of Lack of Information (LI) aligns with broader challenges in healthcare communication and patient education, where gaps in information or understanding can hinder effective self-management and treatment adherence.

Quotes by Interviewee **A**

"They wouldn't have any idea to how to order the prescription or how to keep up with the application. So, when we say download this app into your mobile, they find it difficult. They ask the pharmacy staff first and then the pharmacy staffs will help them to download the app or help them to sign into the app"

Interviewee **E** states that:

"So, at this point I would say people are aware of technologies which can improve their outcomes. So, in that way, they should like if you if you are if you are telling them the right or if you are explaining to them Okay, this is this is a better way and it also saves cost why because people do buy."

Ease of Use (EU) pertains to the simplicity, intuitiveness, and user-friendliness of technology-based interventions designed to support medication management. Patients' willingness to engage with technology-enabled adherence tools is often contingent upon their perception of how easy and convenient these tools are to use. Factors such as intuitive design, clear instructions, and seamless navigation contribute to patients' overall experience and satisfaction with digital applications or software for medication adherence. emphasizing the importance of tailoring technology solutions to meet the needs and preferences of end-users

Comments by Interviewee **F** states that

"They tend to have a difficulty in dealing with technology and some people even if they're capable of, you know, doing everything according to technology, they just don't want to, like especially in Ireland, it's very prevalent like people don't really like technology like they don't really, they don't like using cards instead of cash they prefer you know giving cash instead of cards, I'm not saying that it's bad or anything it's just so I don't know how technology if even if I suggest it to them, it might not be an acceptable approach for them, they might not be amenable to that that solution."

Interviewee **E** states that:

"I would definitely recommend someone an application if I actually have an application which kind of, can keep the standards up and easy to use kind of."

By analysing these themes through the interviews several contradicting views have been observed on the patient's acceptance and pharmacists' response to medication adherence application. Awareness of technology and lack of enough information about mobile applications for adherence seems to be one of the main barriers to which the acceptance rate of these applications and usage is currently low. From the insights of the interviews, the pharmacists express their perspective by expressing positive responses on recommending an application to their patients, if these limitations can be ruled out.

Pharmacy staff training and implementation challenges

This theme highlights the range of obstacles encountered by pharmacists and pharmacy personnel when integrating new technologies and practices into their workflow. This theme directly addresses research objective and by focusing on exploring the barriers and challenges faced by pharmacists and pharmacy personnel in the integration of mobile applications for medication adherence into their practice. Two themes were observed which were coded respectively to understand what all challenges and efforts to be made in introducing a mobile application in pharmacy setting.

- Staff Education (SE)
- Time Constraints (TC)

Code SE, representing **Staff Education**, denotes the importance of providing comprehensive training and educational opportunities for pharmacy staff regarding the use of new technologies, practices, or procedures. Staff education plays a crucial role in promoting adherence to guidelines, protocols, and regulatory requirements. This code was observed quite frequently, even though additional training and staff education could be tedious, all six of the participants showed positive response in introducing new application into their work setting in order to help their patients with medication adherence.

Interviewee **B** states that

"When an application is introduced into pharmacy setting adequate training should be provided to every staff and that would be great"

Supported by the quote by Interviewee **E**

"First of all, for someone to use an application, they should be Well educated on it. For example, if you are bringing bring in new applications into the market or into the system or into a community setting. The education of the staff is. Basic requirement because unpleasant only we are able to explain the same to a patient who understands the same way as we understood it. Especially OTC (Over the counter) staffs as they are the face of the pharmacy."

Comments by Interviewee **F**

"The pharmacist will also need a training on how to do that. So, if there's an app, we can actually train them. Instead of being training."

Code TC represents Time Constraints, which are significant challenges faced by pharmacy staff in implementing new practices or technologies related to medication adherence. Pharmacy staff are often tasked with dispensing medications, providing patient counselling, managing inventory, and handling administrative duties, among other responsibilities.

Quotes by Interviewee **A**

"Yeah, I know there are there are numerous applications to stick on to the medication at, but we don't use it mostly because of time limitations in explaining to patients"

Interviewee **E** states that:

"In most cases the pharmacists wouldn't have like in, in a real-life situation, the pharmacist wouldn't have enough time to actually come down to patient. Most places have an overload of work so they don't have enough time to actually spend with individual patients to explain to them how to use the medication."

Features of Ideal mobile application

This theme addresses the types of features the pharmacists expects in a medication adherence application which can make a significant impact in medication adherence the code was derived from the responses obtained from interviews depending on the experience of the pharmacist in patient care and the trends they have seen so far. This theme directly relates to research objective by focusing on determining the preferences of pharmacists concerning the design, usability, and accessibility features of mobile applications for medication adherence. Two themes were identified

- Fixed medication cycle (MC)

- Personalized Reminders (PR)

Fixed Medication Cycle or code MC represents the theme where The Fixed Medication Cycle helps patients maintain consistency in their medication regimen, which is crucial for improving adherence and health outcomes. By adhering to a fixed schedule, patients are less likely to miss doses or take medications at irregular intervals, thereby enhancing the effectiveness of their treatment plans. Additionally, the Fixed Medication Cycle feature can simplify medication management for patients with complex medication regimens or multiple prescriptions, promoting ease of use and reducing the likelihood of errors.

Quote by Interviewee **E**

"Medication applications having a fixed medication cycle for each patient and that can be customized depending upon the patient regimens, setting in such a way that they can send a notification to their mobile might be a good feature"

Interviewee **F**

"So obviously, the basic features that will help people, you know, take the medication on time, like reminder, it's, And also, maybe tiny, bits of information about the health condition or their medication, yeah. Also, yeah, for medications like methotrexate and folic acid, I, would want that, you know, phone to help the patient choose a day. As the patient shouldn't take the dose of methotrexate on the day of dose of folic acid"

Personalized Reminders (PR) code refer to customizable alerts or notifications within medication adherence applications that remind users to take their medications as prescribed, similar options to set specific times for reminders, choose the frequency of alerts, and select preferred notification methods such as push notifications, text messages, or email reminders.

Quote by Interviewee **E**

"Regular, reminder of let's say. And alarm kind of setting, which can be set from, okay, at this time you have to take these many medications and even the technology like even a text message saying that, okay, you are due for this medication at this particular time. So. In that case, if you if you can allocate a tablet to be taken at the particular period of time with the reminder and what tablet and if possible even the color and the and the shape of that would really help the patient."

Quotes by Interviewee **A**

"So, when we get the medicines ready and we get we send the message back saying it's ready and we'll always tell them how many repeats they have left."

Interviewee **B** states that

"So, I find if you had an app that patients might just get a bit too dependent on the app notification."

Comments by Interviewee **F**

"Yeah, so that they can take it on that particular day and if it if they don't it kind of alerts them to take that medication on that particular day."

From the comments above the pharmacists recommends an application with a customisable feature, depending upon the needs of the patient and their medical condition would be a major factor to look into while considering the designing of a medication adherence application. Personalized reminder applications are the most preferred.

Recommendations and Insights

This theme represents the acceptability of Irish community pharmacists to recommend a mobile application for medication adherence one codes were recognised in this theme this theme reflects the research objective where the chances of pharmacists recommending an application depending upon the patient and the application is observed, along with their willingness to suggest an application.

- Application Recommendations (AR)

Application Recommendations (AR), means to suggestions or advice provided by pharmacists regarding the selection and use of medication adherence applications. Pharmacists may assess the effectiveness, reliability, and user-friendliness of various medication adherence applications to guide patients in making informed decisions. Moreover, pharmacists may offer instructions on how to download, install, and configure the recommended applications, as well as provide ongoing support and guidance to ensure optimal usage.

Interviewee **A** comments that

"We have this, application or website which is connected to a pharmacy dispensing system which we use to give out in information or to send notification to patients. Once this application was introduced, that problem has been solved by quite a lot. So, when they collect their last

supply, the patients get notified that this is their last prescription on file so they should order a new prescription with the doctor so we managed to keep them up to date you know, instead of giving a gap between their second supplies."

Interviewee **B** states that

"It was something I was interested in before. Seeing of bring it in to the Pharmacy and unfortunately the technology is just not there and it does seem a bit outdated that we have Keep it in society now when you have so many apps for different things where you know you can you can literally count."

Quote by Interviewee **E**

"At the moment I haven't come across an application which I would recommend but having said that the policies which I've been they do recommend pharmacist like the patients download their application so that they can make it works both ways because it makes a life of the patient more easier because they can drop in a text and then get the things ready as well as the pharmacy will have enough time for them to like get it done and then, have enough time for them to like get it done"

Comments by Interviewee **F**

"Then maybe I will give them a trial period or something and you know let them test it out and understand how much of it is actually helping them to go back onto the track and if that is helping them okay sure I can install it but, maybe only a fraction of people.'

General Comments and Additional Insights

This theme represents the gaps and additional changes and recommendations that can be bought in the present system to make the present scenario better. Two themes were observed This theme indirectly relates to research objective by focusing on identifying gaps and areas for improvement in the present system related to medication adherence, which can inform the identification of key features and functionalities for mobile applications.

- Willingness to recommend an application (RA)

Willingness to recommend an application (RA) These recommendations may stem from insights gained through experience, knowledge of best practices, or observations of existing challenges within the pharmacy setting. The willingness to recommend an application was collected between the range of 1 to 10 where the average was calculated to 8, showing a positive

response from candidates, their willingness was also limited by the lack of a specific application that has all the features that they feel would make it easier for their patients to follow through.

To the question "As a very well experienced pharmacist from a scale of one to 10, how willing are you to incorporate a mobile application as a part of patient care in your setting?"

The responses were are below:

Interviewee **A**

"Anything which supports the dispensing system or anything with supports patient safety or patient that adherence to the medication would be quite you know quite highly appreciated I would say 9 or 10"

Interviewee **C**

"Yeah, a 10 I should say."

Interviewee **D**

"Probably around 7 to 8"

Interviewee **E**

"Okay, so the willingness to be one to 10 anyway. I mean, it would be a full, 10 on 10."

Interviewee **E**

"I would say 9, because that would be something which would enhance the outcome of the patient

Interviewee **E**

"I would say 9 on 10"

This theme highlights the wiliness of Irish community pharmacists to incorporate a medication adherence application into their work setting, from their perspective. The participants are generally motivated to suggest applications and to incorporate applications into their pharmaceutical setting. Interviewee A and E highlights the advantages of these interventions and also mentions about the lack of a n adequate application in the market at present.

DISCUSSION

Theme 1: Medication adherence challenges

This theme looks into the current challenges that are faced by patients in medication adherence, The four sub themes Lack of Awareness" (LA), "Overload in Healthcare System" (OH), "Lack of Understanding of Medication" (UM), and "Technology Usage Issues" (TU), collectively shows the nature of barriers that hinder medication adherence efforts, emphasizing the need to address these challenges to improve patient outcomes. The existing literature supports these themes the subtheme of "Lack of Awareness" highlights the major issue of patients lacking sufficient understanding regarding the importance of medication adherence, posing a significant barrier, aligns with the study that suggests patients lack of awareness is the most common cause of non-adherence practices.(Odukoya and Chui, 2012) Pharmacists, from firsthand experiences, recognize the consequences of this lack of awareness on patient behaviour. By critically analysing these themes we can see that they resonate with existing literature on medication adherence, which underscores the critical role of patient education and awareness in promoting adherence behaviors (Chaudri, 2004; Brown & Bussell, 2011). Studies have consistently shown that patients with higher levels of health literacy and awareness are more likely to adhere to their medication regimens effectively, highlighting the importance of addressing this gap in knowledge and understanding.(Inanaga *et al.*, 2024). Studies have shown that non-adherence imposes a substantial economic burden on healthcare systems, leading to increased healthcare utilization, hospital admissions, and healthcare expenses (Baryakova et al., 2023).The observed themes were found to be similar to the existing medication adherence studies, which shows that lack of awareness and lack of understanding ones medication and technological usage issues are major medication adherence challenges that need to be addressed in order to attain optimum medication adherence rate in patients under medication treatments, In order to make this happen the over load on healthcare professionals should be reduces in order for them to be able to spent enough time with the patients in helping them understand their medications and making them aware of the importance of adherence.

Theme 2: Current method for medication adherence

Under this theme the current methods utilized by Irish community pharmacies to promote medication adherence are addressed Three prominent subthemes emerged, namely "Blister Packing," "Daily Dosing," and "Reminder System," the strategies commonly employed to support patients in adhering to their medication regimens. Blister packing, also known as unit dose packaging, emerges as a primary method employed by pharmacists to facilitate

medication adherence among patients within the Irish community pharmacy setting by visually separating doses and providing clear instructions, blister packs aid patients in adhering to their prescribed medication regimens more effectively. Daily dosing emerges as a practical approach, The incorporation of daily dosing regimens, often in conjunction with blister packing, contributes to reinforcing adherence behaviours and optimizing patient outcomes, mainly done for controlled drugs such as Methadone, suboxone. The reminder system serves as a valuable technological tool utilized by pharmacists to complement traditional adherence support strategies. This method was found to be used by most pharmacies in Ireland, all six interviewees acknowledged the utility of reminder systems in supporting medication adherence efforts, underscoring its significance in the pharmacy setting. Studies show that BP methods have shown a reduction in the likelihood of missed doses,(Nguyen and Sobieraj, 2017). Blister packing is the most used method for medication adherence although they are widely used, they are not perfect and has its own flaw as mentioned above by one of the participants. According to the study done my Valassi et al in 2019,the medication non adherences was rated and reported for hyperlipidaemic drugs, among several countries Ireland was rated to be ranking 36.87% when compared to countries like Italy and Spain.(Valassi *et al.*, 2019).while examining medication adherences in Ireland we should address the adherence rate in other countries such as Iran, where the author Forozan et al observed a relatively high rate of medication adherence of about 77% while compared to other western countries in patients with inflammatory bowel disease.(Forouzan *et al.*, 2021).Ireland's recent interest in medication adherence application shown in the study by Fogarty et al shows the shift of interest towards technological interventions in medication adherences.(Fogarty *et al.*, 2022).

Theme 3: Patients acceptance and pharmacist response to medication application

Theme four thoroughly examines the viewpoints of pharmacists about the mobile applications and their view points on how the patient's response would be depending on the type of application that they prefer to suggest were observed. Sub themes Awareness of Technology (AT), Lack of Information (LI), and Ease of Use (EU) This theme also emphasises the need of adoption of application with ease of use and providing knowledge to patients about their medication and also about mobile applications that can be used if they are suffering with medication non adherence. Patients' awareness of technology is an important factor in considering the use of medication adherences application, the insights in the study show almost 80%of the patients have issues with medication adherences and most fall under the age group of elderly patients. The existing studies show that the older adults often have a low

understanding of technology and lack of understanding which can pose a s a major challenge in implementing a medication adherences application of adherences. Studies addressing cardiovascular treatment management with medication adherences shows promising results but very few study on elder population. (Khoong *et al.*, 2021 Recent contradicting studies shows the medication application being popular among older patients with the introduction of user friendly interface.(Schorr *et al.*, 2021).The insights in this study aligns with existing researches about the importance of user friendly interfaces to be made essential in order to be able to by assessed by all age groups.

Theme 4: Pharmacy staff training and implementation challenges

This theme underlines the challenges and implication constrains that would be faced while incorporating a medication adherence application into the current pharmacy setting in Irish context. This theme is related to the research objective 4 and 5 Two key themes emerged, namely "Staff Education (SE)" and "Time Constraints (TC)," shedding light on the obstacles faced and efforts required in introducing mobile applications into pharmacy settings. Firstly, "Staff Education" underscores the critical need for comprehensive training and educational opportunities for pharmacy staff regarding the utilization of new technologies. Despite the potential challenges associated with additional training. "Time Constraints" highlights the significant challenge of allocating time for implementing new practices or technologies in pharmacy settings. Most of the participants mentioned the importance of pharmacy staff training as an essential point to be addressed in order to educate patients about adherences applications, one of the interviewees also pointed outed the importance of training OTC assistance as they are the face of the pharmacy. Time constrains are one of the major barriers that would prevent from implementing an application into the current pharmacy setting, The existing literature by Bright et al outlines the workload in pharmacies that has led to the prevention in implementation of medication therapy programmes.(Lounsbery *et al.*, 2009)Workload and time constrains have always been a drawback in rural pharmacies.(Crawford *et al.*, 2022)

Theme 5: Features of Ideal mobile application

In this theme the features the pharmacists have recommended are being addressed in order to successfully incorporate a mobile application for the medication adherence focusing on design, usability, and accessibility. The sub themes observed were "Fixed Medication Cycle (MC)," "Personalized Reminders (PR)," and explains the importance of features that would help in personalizing the medication as one of the interviewees had mentioned about the use of

medication Methotrexate and folic acid where the use of folic acid should be avoided on the day of the methotrexate dose. As this occurs for different medications depending on the patient regimen a patient centric approach to be added as a feature is important to be introduced while considering and application. The theme "Personalized Reminders" also comes under that category. Overall, while each theme addresses different aspects of medication adherence application design, they collectively underscore the importance of features that prioritize consistency, personalization, and usability. Existing studies support these findings as personalised applications has shown a significant impact in medication adherences in several studies.704 applications were studied by the author Rowland et al out of which the applications with customisable features including alerting and text notifications were found to help in increase the rate of adherence in patients. The study by Panakkal and Mohan et al addressed the importance of medication adherences application for patients with conditions of asthma with timely reminders as an added feature.(Mohan *et al.*, 2018)

Theme 6: General Comments and Additional Insights

The code Recommendation of application (RP) what the pharmacist expects in a adherence application and what all changes can be bought in new applications in order to make the current scenario better, These recommendations were obtained from pharmacists' experiences, knowledge of best practices, or observations of existing challenges within the pharmacy setting. The data collected on the willingness to recommend an application, rated on a scale of 1 to 10 with an average of 8, indicates a positive response from participants. However, their willingness is also constrained by the lack of a specific application that encompasses all the features they believe would facilitate better medication adherence for their patients. However, the wiliness of suggesting an application for adherence was tampered as there are no application currently available with all the adequate features that the pharmacist expect. This is a barrier because there is no golden standard for measure of medication adherences.(Basu *et al.*, 2019).Studies shows the importance of emphasizing a golden standard for measuring medication adherence.(Arnet *et al.*, 2016).The study conducted by Mahmood et al, on the context of chronic diseases such as hypertension addressed the need of a golden standard to measure the adherence rate to understand and evaluate the importance of medication non adherences and its outcomes. Initially with in line with above mentioned barriers, the expected response from the pharmacists to still integrate an application into their work setting seemed surprising. Integration of a new application would consist of added burden of training the staff, huge input of resources and other factors. In aligning with all these known facts, the responses

from pharmacist were highly positive and they were ready to put in the work for the benefit of their patients.

5. CONCLUSION

This study explores the perspectives of Irish community pharmacists on medication adherence and the potential role of mobile applications in enhancing adherence practices. Through thematic analysis of interview data, eight overarching themes emerged, providing valuable insights into the challenges, benefits, and preferences surrounding medication adherence within community pharmacy settings. The findings show the benefits of the technology in the current community pharmacy setting for medication adherence. The pharmacist had a positive response on the use of medication adherence application. Furthermore, current challenges in medication adherence, including lack of patient awareness, overload in the healthcare system, and technology usage issues, were identified, emphasizing the need for innovative approaches to address these barriers. Current methods for medication adherence, such as blister packing, daily dosing, and reminder systems, were commonly utilized by Irish community pharmacies. However, there was a notable interest in exploring the integration of mobile applications to augment existing practices and improve patient adherence rates. Pharmacists emphasized the importance of features such as fixed medication cycles, personalized reminders, and user-friendly interfaces in designing effective medication adherence applications. pharmacists demonstrated a willingness to recommend medication adherence applications to patients, highlighting the potential of technology to facilitate pharmacy-patient interactions and improve medication management outcomes. However, challenges such as staff education and time constraints were identified, indicating the need for comprehensive training and support programs to facilitate the adoption of new technologies in pharmacy practice.

Overall, the findings of this study provide valuable insights on the perspective of community pharmacist of Ireland in incorporating medication adherence applications in their challenges that they face in day-to-day work setting regarding medication adherence. This study also shows the importance of pharmacists in understanding patients' preferences and challenges faced by the patients in medication adherence from their perspective and frequent interaction with patients making this study point on the patient perspective to in order to understand the challenges they face in their medication regimen and what do they expect from an application when designed for medication adherence.

5.1 Implication of findings for the research question.

1. What are the perceptions of Irish community pharmacists regarding the effectiveness of mobile applications in optimizing medication adherence among patients?

The research findings show the positive perspective of the Irish community pharmacists regarding the use of mobile applications for medication adherence in their pharmacy setting. They recognise the benefits of mobile application in cost saving and also the patient therapeutic outcome. It was also observed how willing they are to incorporate any technology that can help any for the patient's wellbeing.

2. What are the key features and functionalities that Irish community pharmacists believe would enhance the effectiveness of mobile applications for medication adherence?

In the research, the findings show that pharmacists emphasised the importance of certain features to the medication adherence applications from their experience and interaction with the patients, few recommendations were made by the participants which would make a significant impact in considering the application to be used like features such as fixed medication cycles, personalized reminders, and user-friendly interfaces in designing effective medication adherence applications.

3. To what extent are pharmacists in Ireland willing to recommend medication adherence mobile applications to patients?

   Out of six participants all six of them most willing to recommend a medication adherence application if any, with features that's patient centric easy to use and can be monitored by them for patient safety. They also showed positive response in providing support or any kind of assistance in installing and configuring, and utilizing recommended applications.

4. What barriers and challenges do Irish community pharmacists foresee in implementing mobile applications to optimize medication adherence?

   Few barriers and challenges were brought to understanding during the interview, majorly the ones were that relating to lack of understand of one's medication among patients, lack of patient awareness of medication adherence applications and technology usage issues, age, less technological knowledge, financial constraints, these barriers point out the need of improved applications and the need of steps to be taken to address these matters.

5. What strategies can be recommended to enhance the acceptability and adoption of mobile applications for medication adherence among Irish community pharmacists?

   In the study the strategies recommended by the participants in order to successfully introduce an application to pharmacy setting were training the pharmacy staff to use the medication in order to utilization of new technologies, as well as addressing time constraints associated with implementing new practices or technologies in pharmacy settings

6. What are the potential benefits and limitations of utilizing mobile applications for medication adherence management from the perspective of Irish community pharmacists?

   Benefits include improved patient outcomes, cost savings, and enhanced pharmacy-patient interactions. Limitations include challenges such as staff education and time constraints, which need to be addressed to facilitate the successful integration of mobile applications into pharmacy practices.

5.2 Contributions and Limitations of the Research

The following are the contributions of this research

- This study gives valuable insights on the Irish community pharmacist perspective on mobile applications to be used as medication adherence tool. Understanding pharmacist viewpoints is essential for developing effective interventions and strategies to improve medication management in community pharmacy settings.
- The study points out the barriers and challenges in introducing medication adherence application into Irish community pharmacy setting. This knowledge helps in understanding the potential of technology-driven solutions on patient care as well as the barriers that need to be addressed for successful implementation.
- This research highlights recommendations from Irish community pharmacists on the features and their expectations in a medication adherence app. This serves as a guideline for developers and healthcare professionals involved in designing and implementing medication adherence interventions.
- This research explores pharmacists' willingness to incorporate and also recommend medication adherence application into their work setting and to patients in order to

assist people with medication adherence to improve overall therapeutic outcome, this act as a major sign of promoting adherence application as a medical innovation tool.

- The findings of the research have practical implications for pharmacy practice in Ireland and beyond. s well as the need for comprehensive training and support programs to facilitate the integration of new technologies into pharmacy workflows.

5.3 Limitations of the research

- The duration of the research conduction was the main limitation of this research. A longer time frame may have been used for the research to lend more value to the findings.
- Due to time constraints, the study had a small sample size, which may have prevented the results from being generalizable to a broader population.

5.4 Recommendations for Practice

From the data derived from the interviews a few recommendations can be made to bring in practice

- ✓ Integration of mobile applications for medication adherence can be a great practice to be followed in order to attain optimum therapeutic outcome.
- ✓ In order to incorporate adherence application and to be suggested to the patients before it being distributed, the pharmacy staffs should be trained on the use of medication the features and functionalities, in order to achieve this extensive training is to be provided for the same. The OTC (over the counter) assistant's need to trained more than the pharmacist as they interact the most with patients when compared to the daily interaction with the pharmacist.
- ✓ While developing or improving already existing applications, features to personalize depending upon the patient needs is an important aspect to look into as this is one of the major limitations found in the already existing applications.
- ✓ Collaboration of healthcare professionals with the application developers can help in developing more user friendly and affective application for medication adherence.

5.5 Recommendation for Future research

There is a scope for future researches in this topic. However, certain key elements are to be studied such as Investigating the effectiveness of long-term impact of specific features such as user-friendly design and personalized reminder settings as they could provide valuable insights on how affective they are and also in order to suggest them to different populations globally. Researches exploring the integration of medication applications into present pharmacy settings and also potential challenges regarding the present setting and their constrains can be done to

understand the short comings when introducing an application into the community pharmacy. Studies need to be done in real time to understand the feasibility of introducing an application which would help in understanding the long-term challenges and outcomes and also their effectiveness. Studies on the acceptance a willingness of patients to use a medication adherence application shows a good scope for future study.

5.6 Final conclusion and reflections

The study shows the importance of medication adherence and the positive perspective of the Irish community pharmacists and their willingness to incorporate a medication adherence application into their setting in order to help with the challenges that they frequently face with their patients to bring out the best therapeutic outcome. The barriers found in the study needs to be addressed in order to ensure the application is effective in a long run. Current methods like blister packs, daily dosing and reminder software offer some support for adherence but leave room for improvement. Digital technology when introduced with user friendly interface and personalization features pose a significant impact in medication adherence. Patient response and acceptability to this application play a crucial role in the success of suggesting medication applications. Dressing challenges such as lack of understanding of medication, technology usage issues, and time constraints faced by pharmacy staff needed to be looked into in future studies.

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APPENDIX

1.PARTICIPANT INFORMATION LETTER

OPTIMISING MEDICATION ADHERENCE WITH MOBILE APP: PERSPECTIVES OF IRISH COMMUNITY PHARMACISTS AND THEIR ACCEPTABILITY

I would like to invite you to take part in a research study. Before you decide you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. Ask questions if anything you read is not clear or if you would like more information. Take time to decide whether or not to take part.

WHO I AM AND WHAT THIS STUDY IS ABOUT.

I am Riya Pavithran a student of Griffith college Dublin doing my Masters in Pharmaceutical Business and Technology, I am doing my thesis as a part of my masters. The purpose of the study is to understand the perspective of pharmacists in the use of mobile application for medication adherence in Ireland. To gain a comprehensive understanding of how pharmacists perceive and accept the use mobile application for medication adherence in their practice. The study aims to explore the attitudes, beliefs, and concerns of community pharmacists on mobile application used for medication adherence with a specific focus on the Irish context.

WHAT WOULD TAKING PART INVOLVE?

Taking part in my study would help me explore the attitudes, beliefs, and concerns of community pharmacists on mobile application used for medication adherence with a specific focus on the Irish context. The data collection method that will be used are Zoom interviews, and face-to-face interviews. This method would help the Pharmacists to make a detailed response to the open-ended questions to express their opinions. The responses will be recorded and transcribed for data analysis. I assure you that utmost confidentiality would be maintained throughout the study, and the participants can withdraw at any point of the study if they wish to.

WHY HAVE YOU BEEN INVITED TO TAKE PART?

In my research, the aim is to evaluate the familiarity of pharmacists with Medication adherence applications and their acceptability in Ireland. To accomplish this, conducting interviews with licensed pharmacists, I can gain valuable insights into their perspectives on the topic. Analysing the data gathered through these interviews will help determine the overall stance of pharmacists towards mobile application used to help in medication adherence and their acceptability in Ireland

DO YOU HAVE TO TAKE PART?

Participation to this study is **voluntary**, that consent can be **withdrawn at any time by contacting Riya Pavithran on riya.pavithran@student.griffith.ie**. The responses will be recorded and transcribed for data analysis, with utmost confidentiality maintained throughout the study.

WILL TAKING PART BE CONFIDENTIAL?

The responses will be recorded and transcribed for data analysis, with utmost confidentiality maintained throughout the study.

HOW WILL INFORMATION YOU PROVIDE BE STORED AND PROTECTED

Signed consent forms and original audio recordings will be retained with myself, under security protection until after my degree has been conferred. A transcript of interviews in which all identifying information has been removed will be retained for a further two years after this. Under freedom of information legalisation, you are entitled to access the information you have provided at any time.

WHAT WILL HAPPEN TO THE RESULTS OF THE STUDY?

The dissertation research projects and their content will be made accessible in the college library and could potentially be made available in online e-journals or repository if needed.

WHO SHOULD YOU CONTACT FOR FURTHER INFORMATION?

Riya Pavithran

Email:riya.pavithran@student.griffith.ie

2.CONSENT TO TAKE PART IN RESEARCH

OPTIMISING MEDICATION ADHERENCE WITH MOBILE APP: PERSPECTIVES OF IRISH COMMUNITY PHARMACISTS AND THEIR ACCEPTABILITY

The researcher retains one copy signed by both themselves and the participant. The participant should also receive a copy of consent form as a record of what they have signed up to.

- I [ ] voluntarily agree to participate in this research study
- I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind
- I understand that I can withdraw permission to use data from my interview within two weeks after the interview, in which case the material will be deleted.
- I have had the purpose and nature of the study explained to me in writing and I have had the opportunity to ask questions about the study
- I understand that participation involves are Irish community pharmacists.
- I understand that I will not benefit directly from participating in this research
- I understand that all information I provide for this study will be treated confidentially
- I understand that in any report on the results of this research my identity will remain anonymous. This will be done by changing my name and disguising any details of my interview which may reveal my identity or the identity of people I speak about.
- I understand that disguised extracts from my interview may be quoted in the dissertation.
- I understand that if I inform the researcher that myself or someone else is at risk of harm, they may have to report this to the relevant authorities - they will discuss this with me first but may be required to report with or without my permission
- I understand that signed consent forms and original audio recordings will be retained with the researcher in security for dissertation until exam board confirms the results of their dissertation and for another two years.
- I understand that a transcript of my interview in which all identifying information has been removed will be retained for two years from the date of the exam board.
- I understand that under freedom of information legalisation I am entitled to access the information I have provided at any time while it is in storage as specified above.
- I understand that I am free to contact any of the people involved in the research to seek further clarification and information.

Researcher Details

Name: Riya Pavithran

Degree Programme: Masters in Pharmaceutical business and Technology

College Details: Griffith college Dublin, S Circular Rd, Dublin 8, D08 V04N

Contact mail: riya.pavithran@student.griffith.ie

Signature of participant

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Signature of research participant Date

Signature of researcher

I believe the participant is giving informed consent to participate in this study.

04/04/2024

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3.QUESTIONNAIRE

1. **Demographic Information**

   1.1 Years of experience as a pharmacist

   1.2 County of practice:

2. **Attitude Towards Medication Adherence**

2.1 How frequently do you encounter patients who struggle with medication adherence?

   a. Rarely
   b. Occasionally
   c. Frequently
   d. Very frequently

2.2 In your experience, what are the common reasons for medication non-adherence among patients?

2.3 Do you believe that improving medication adherence can significantly impact patient health outcomes?

a. Yes

b. No

c. Not sure

2.4 What are the current methods used in ensuring medication adherence?

2.5 If yes, what all are the limitations that you have come across?

2.6 In your opinion would digital technology applications be a good choice in order to help with these limitations?

2.7 If yes, on a scale of 1 to 10, how willing are you to incorporate mobile applications as part of your patient care strategies for medication adherence?

(1 being not willing at all, 10 being extremely willing)

2.8 Have you ever recommended mobile apps to patients to help them improve medication adherence?

a. Yes

b. No

2.9 If yes, which mobile apps have you recommended, if any? (Please list)

3 Perceptions and Acceptability of Mobile Apps for Medication Adherence

3.1 How familiar are you with mobile apps designed to improve medication adherence?

a. Very familiar

b. Somewhat familiar

c. Not very familiar

d. Not familiar at all

3.1 What features do you believe are essential for a mobile app aimed at improving medication adherence?

3.2 What concerns, if any, do you have about recommended mobile apps for medication adherence to your patients?

3.3 How do you think patients would respond to the idea of using mobile apps to help them adhere to their medication regimen?

3.4 In your opinion, what barriers might prevent patients from using mobile apps for medication adherence?

Section 4: Integration into Pharmacy Practice

3.3 Would you be willing to integrate a mobile app for medication adherence into your pharmacy practice?

a. Yes
b. No
c. Maybe, with certain conditions (please specify)

3.4 What support or resources would you need to effectively incorporate a mobile app for medication adherence into your pharmacy practice?

3.5 Do you think training on how to use and recommend mobile apps for medication adherence would be beneficial for pharmacists?

a. Yes
b. No
c. Not sure

4 Perceptions of Mobile Applications for Medication Adherence

4.1 Have you previously recommended mobile applications to patients for medication adherence?

a. Yes
b. No
c. Not sure

4.2 What, in your opinion, are the potential benefits of using mobile applications for medication adherence?

4.3 What concerns, if any, do you have about recommended mobile applications for medication adherence to your patients?

5 Features and Functionalities

5.1 What features do you believe would make a mobile application effective in improving medication adherence among patients?

5.2 Are there specific functionalities that you think are essential for a mobile application to effectively support medication adherence?

6 Barriers and Challenges

6.1 What barriers or challenges do you anticipate in integrating mobile applications for medication adherence into your practice?

6.2 How do you think these barriers can be overcome?

7 Acceptability and Willingness

7.1 What factors would influence your decision to recommend a mobile application for medication adherence to your patients?

8 Preferences and Usability

8.1 What design aspects do you believe are important for a medication adherence mobile application?

8.2 How important is ease of use and accessibility in determining the effectiveness of a medication adherence mobile application?

9 Additional Comments

9.1 Do you have any additional comments or insights regarding the use of mobile applications for medication adherence in your practice?

Thank you for your time, I really appreciate it, your valuable inputs would help greatly in deep understanding of how mobile applications can improve medication adherence within the Irish community pharmacy environment.

Table 3:CODING TABLE

CODE	FREQUENCY OF RESPONSE
Theme - 1	
LA-Lack of awareness	**3/6**
OH-Overload in Healthcare	**3/6**
UM-Lack of Understanding of medication	**3/6**
Theme - 2	
Current methods in medication adherence	
BP-Blister Packing	**5/6**
DD-Daily Dosing	**1/6**
RS-Reminder software	**2/6**
Theme -3	
Patient acceptance and response	
AT-Awareness of Technology	**4/6**
LI-Lack of Information	**2/6**
EU-Ease of use	**2/6**
Theme -4	
SE-Staff Education	**3/6**
TC-Time Constrains	**2/6**
Theme-5	
Features of Ideal mobile application	
MC-Fixed medication cycle	**2/6**
PR-Personalized reminders	**4/6**
Theme-6	
Recommendation and insights	

AR-Application Recommendation	**4/6**
Theme -7	
General recommendation	
RP- Recommendation of application	**6/6**