CAPITAL UNIVERSITY OF SCIENCE AND TECHNOLOGY, ISLAMABAD

Empowering Hemodialysis Patients Through Pharmacist-Led mHealth Intervention: A Prospective Randomized Controlled Trial

by

Sadia Parveen

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in the

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Abstract

Chronic kidney disease (CKD), particularly end-stage renal disease (ESRD), poses a substantial global health burden. Hemodialysis patients face complex physical, psychological, and therapeutic challenges, with poor medication adherence being a major contributor to suboptimal clinical outcomes and reduced quality of life. In resource-limited healthcare settings such as Pakistan, the lack of pharmacist involvement in dialysis units further increases these issues. Mobile health (mHealth) based pharmacist-led interventions may offer a feasible strategy to enhance pharmaceutical care in this population. A prospective RCT study was conducted at a public tertiary care hospital in Islamabad. Ambulatory hemodialysis patients were recruited using purposive sampling and allocated to intervention and control groups. The intervention comprised a structured, pharmacist-led mHealth program delivered via WhatsApp-based telehealth. Pharmacists provided individualized education on medication use, adherence, dietary management, and lifestyle modifications relevant to hemodialysis care. Primary outcomes included changes in medication adherence, blood pressure, and weight. Secondary outcomes assessed health-related quality of life, patient satisfaction with telehealth, clinical parameters (hemoglobin, urea, creatinine), and hospitalization rates. A total of 200 patients completed the baseline assessment. At the second follow-up, 62 patients in the control group and 80 patients in the intervention group remained for final analysis. The intervention group demonstrated significant improvements in medication adherence, health-related quality of life, hemodialysis session parameters, and clinical outcomes compared with the control group. Additionally, patients receiving the intervention reported higher satisfaction with telehealth services and a reduction in hospitalization frequency. Pharmacist-led mHealth interventions significantly improved medication adherence, clinical outcomes, and quality of life among ambulatory hemodialysis patients. Integrating digital pharmacist services into routine hemodialysis care represents a feasible and effective approach to strengthening chronic disease management in resource-constrained healthcare systems.

Keywords: Hemodialysis, Pharmacist-led intervention, Medication adherence,

Quality of life, Pharmaceutical care

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Abbreviations

AKD	Acute kidney disease
AKI	Acute kidney injury
CKD	Chronic kidney disease
CVD	Cardiovascular disease
DALYs	Disability- adjusted life years
ESRD	End stage renal disease
GFR	Glomerular filtration rate
GMAS	General Medication Adherence Scale
HD	Hemodialysis
HDL	High Density Lipoprotein
KDIGO	Kidney Disease: Improving Global Outcomes
LDL	Low Density Lipoprotein
mHealth	Mobile Health
RBG	Random blood glucose
RRT	Renal replacement therapy

Chapter 1

Introduction

1.1 Background

Chronic kidney disease (CKD) has emerged as a major global public health concern, with rising prevalence driven mainly by diabetes, hypertension, and other risk factors. Millions of people worldwide are affected, resulting in increasing disability-adjusted life years (DALYs) and premature mortality, placing CKD among the leading causes of years of life lost. CKD is defined as persistent kidney damage for at least three months, identified by reduced glomerular filtration rate (GFR) and albuminuria. The Kidney Disease: Improving Global Outcomes (KDIGO) 2024 guidelines classify CKD using the CGA system (Cause, GFR category G1-G5, and albuminuria A1-A3) to determine disease severity and guide management [1]. CKD is rapidly increasing in low- and middle-income countries due to limited health system capacity, delayed diagnosis, dietary changes, environmental nephrotoxins, infections, and glomerular diseases [1]. Progression to end-stage renal disease (ESRD) necessitates renal replacement therapy (RRT), including hemodialysis, peritoneal dialysis and kidney transplantation. Global registry data show marked disparities in Renal replacement therapy (RRT) access, with significantly lower coverage in resource-limited settings compared to high-income countries [2].

Although hemodialysis is life-saving, it imposes substantial medical, social and economic burdens, including cardiovascular complications, infections, anemia, bone and muscle disorders, polypharmacy, reduced quality of life, and high treatment costs.

Limited infrastructure, trained personnel, and dialysis centers in low-income countries further contribute to higher mortality rates [3]. In Pakistan, inadequate and incomplete registry systems, high infection rates, reliance on temporary catheters, and insufficient dialysis coverage highlight major challenges in RRT delivery, emphasizing the need for improved policies, resources, and data systems [4].

Early diagnosis, effective screening for diabetes, hypertension, and albuminuria, improved dialysis infrastructure, and optimized vascular access are essential to reduce CKD burden. Additionally, enhanced outpatient pharmaceutical care is critical to address polypharmacy and medication-related problems in hemodialysis patients.

Integrating clinical pharmacy services with digital mHealth support can improve adherence, monitoring, patient education, particularly in resource-limited settings, thereby enhancing patient outcomes and quality of life [5].

1.2 Global Burden and Prevalence of Chronic Kidney Disease and Hemodialysis

Chronic Kidney Disease (CKD) has become a significant global public health challenge, affecting approximately 843.6 million individuals worldwide in 2017. Its growing burden reflects not only an increasing prevalence but also a rising impact on healthcare systems, particularly in low- and middle-income countries where access to early diagnosis and treatment remains limited. The prevalence of CKD continues to deteriorate due to the global rise in non-communicable diseases such as diabetes mellitus and hypertension, which are the leading contributors to kidney dysfunction. Additionally, demographic transitions, including population aging,

have further intensified the burden of CKD, as the disease is more prevalent among elderly individuals.

Globally, CKD affects nearly one in ten people and disproportionately impacts susceptible populations, including women and those with underlying chronic conditions. The disease often progresses silently, with many individuals remaining undiagnosed until advanced stages, thereby increasing the risk of complications and mortality. Over time, CKD not only reduces quality of life but also contributes to increased hospitalization rates, cardiovascular morbidity, and premature death.

The mortality associated with CKD has shown a concerning upward trend over recent decades. As illustrated in Figure 1.1, global deaths attributable to CKD increased by more than 41.5% between 1990 and 2017. This significant rise in mortality has resulted in CKD being recognized as the 5th leading cause of death worldwide [6]. The escalating death rates highlight the severity of CKD as a long-term progressive condition that imposes both clinical and economic burdens on healthcare systems.

This silent killer disease progresses and difficult to diagnose earlier and higher disease cure cost [8]. In America, the cost spending for CKD was dominant, while in China the upcoming years causes greater burden of economy for this chronic kidney disease [9]. The hemodialysis is mainly the ailment for end-stage renal disease.

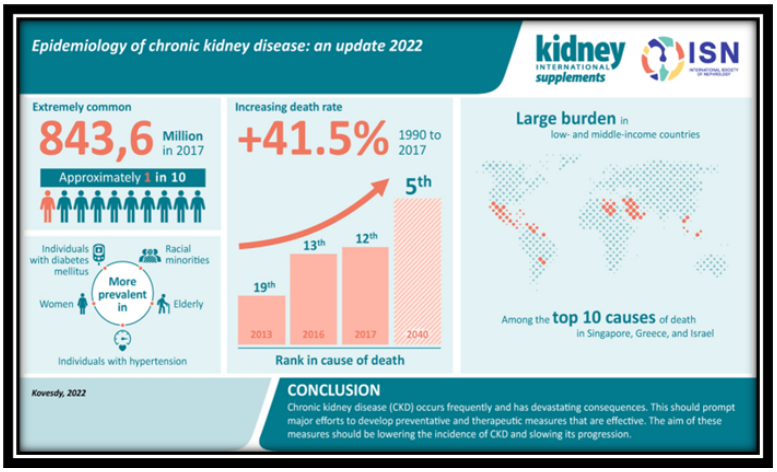

FIGURE 1.1: Epidemiology of Chronic Kidney Disease [7].

1.3 Epidemiology of Chronic Kidney Disease and Hemodialysis in Pakistan

The survey conducted in Pakistan reported that 995 new patients were initiated on maintenance hemodialysis as of December 2023. The majority of these patients were below 40 years of age and predominantly male, highlighting an alarming trend of early onset kidney failure within the younger population. This demographic pattern not only reflects the growing burden of chronic kidney disease in developing countries but also underscores the socio-economic implications associated with long-term dialysis dependence in individuals belonging to the productive age group [11].

1.3.1 Prevalence in Pakistan

The prevalence of ESRD has risen markedly, leading to an increased demand for renal replacement therapies. With an estimated incidence of nearly 100 cases per million population, this translates to approximately 22,000 new patients requiring dialysis annually in a population of around 220 million [52]. Figure 1.2 illustrates the prevalence of CKD by age and gender. In the 40–49 year age group, prevalence remains relatively low, with men showing slightly higher rates (∼6%) than women (∼5%). A notable rise is observed in the 50–59 year category, where prevalence increases to approximately 11% in men and 16% in women. The highest burden is seen in individuals aged above 60 years. This age-related escalation in CKD prevalence aligns with global and regional evidence indicating that advancing age is a major risk factor for kidney dysfunction. Studies conducted in Pakistan and other low- and middle-income countries have similarly demonstrated increasing CKD prevalence in older populations, with a slightly higher disease burden among females [31].

National estimates indicate that approximately 34.3 patients per million population (pmp) are currently receiving maintenance hemodialysis, while the overall prevalence of chronic dialysis is 53.3 pmp, reflecting the growing burden of ESRD

and the rising demand for long-term renal replacement therapy [12]. Hospital-based studies in Pakistan highlight hypertension and diabetes as the leading causes of ESRD. These conditions are often complicated by coexisting hepatitis B and hepatitis C infections, which increase morbidity and pose challenges for patient management. Additionally, a substantial proportion of patients initiate hemodialysis using temporary vascular access such as central venous catheters, indicating late nephrology referral and inadequate pre-dialysis planning. This practice is associated with higher risks of infection, hospitalization, and access-related complications. Therefore, early nephrology referral and timely creation of permanent vascular access are critical to improving clinical outcomes and reducing dialysis-related risks [31, 52].

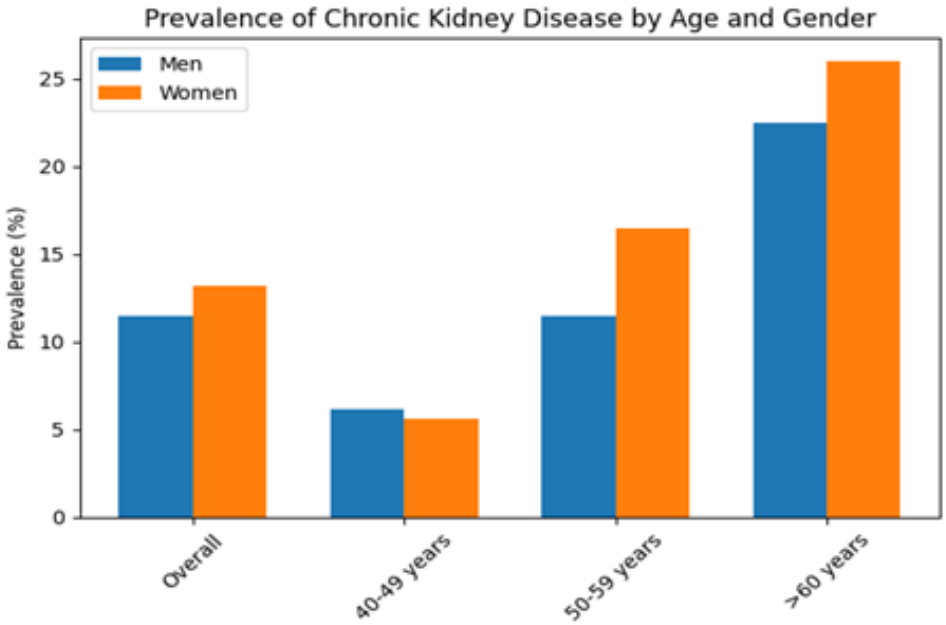

FIGURE 1.2: Age-wise Prevalence of CKD in Pakistan [31].

1.4 Significance of Study in Pakistan

This study highlighted that the use of mobile health (mHealth) interventions, combined with on-site care provided by pharmacists, had a significantly positive impact on patient engagement, improved medication adherence, and enhanced outcomes in hemodialysis patients, who are at higher risk of complications due to complex medication regimens, multiple comorbidities, and poor follow-up [14].

mHealth, as defined by the World Health Organization, refers to the use of mobile devices, such as smartphones and tablets, to deliver health services, monitor patient outcomes, and facilitate communication between patients and healthcare providers [14].

In Pakistan, the clinical role of pharmacists is limited, particularly in nephrology wards, where the adoption of digital health technologies is also minimal. This study introduces a novel approach by integrating digital health applications, specifically using WhatsApp, to support ambulatory hemodialysis patients. It presents a measurable, low-cost model for enhancing pharmaceutical care outside hospital settings. By leveraging this technology, pharmacists can provide ongoing, tailored care, monitor and report medication-related issues, and contribute to the development of a strengthened healthcare system.

Moreover, this approach offers guidance for future policy development, supports the integration of pharmacists into nephrology care, and promotes the use of digital health strategies for managing chronic diseases such as chronic kidney disease and end-stage renal disease in low-income countries [15].

1.5 Problem Statement

Despite the growing use of telehealth there is limited research specifically targeted on hemodialysis, as most studies have focused on kidney transplant patients or individuals with early-stage CKD. Additionally, few prospective cohort studies exist, with the majority of research employing cross-sectional or pre–post study designs, limiting the ability to draw robust conclusions regarding long-term effectiveness [84]. Structured pharmacist-led mHealth interventions are particularly rare in Pakistan, highlighting a significant gap in integrating digital health strategies within nephrology care in low-resource settings [16]. Moreover, existing studies have given limited attention to patient-centered outcomes such as medication adherence, quality of life, and patient satisfaction in the local context, emphasizing the need for interventions that address the full needs of hemodialysis patients [17].

1.6 Aim and Objectives

1.6.1 Aim

This study aimed to evaluate the impact of a pharmacist-led mobile health intervention on medication adherence, quality of life, clinical outcomes, as well as patient usability and satisfaction with telehealth among ambulatory hemodialysis patients.

1.6.2 Objectives of the Study

i. The study evaluated the impact of mHealth on pharmaceutical care for hemodialysis patients in an ambulatory care.

ii. This study assessed the impact of pharmacist-led interventions on clinical parameters in hemodialysis patients.

iii. To evaluated patient adherence and quality of life among ambulatory hemodialysis patients.

iv. This study assessed the pharmacist-led digital interventions based on patient's usability and satisfaction with the care provided by pharmacist.

Chapter 2

Literature Review

2.1 Classification of Chronic Kidney Disease

Kidney damage includes conditions that impair renal filtration, fluid balance, and the waste excretion is classified into acute kidney injury (AKI), acute kidney disease (AKD), and chronic kidney disease (CKD) [18]. AKI is a rapid decline in kidney function diagnosed by Kidney Disease Improving Global Outcomes (KDIGO) criteria based on serum creatinine and urine output [19]. AKD describes kidney abnormalities lasting less than three months that do not meet AKI or CKD criteria. CKD is defined by persistent kidney damage or an eGFR <60 mL/min/1.73 m^2 for more than three months and is associated with increased morbidity and mortality. The KDIGO 2024 guidelines classify CKD using the Cause GFR Albuminuria Classification (CGA) system, incorporating disease cause, eGFR, and albuminuria to guide clinical management [20].

2.2 Factors of Chronic Kidney Disease

2.2.1 Age Related Factor

Age is a key non-modifiable risk factor for CKD. After 40 years, glomerular filtration rate declines by approximately 1 mL/min/1.73 m^2 per year, increasing CKD

risk in older adults [21]. Age-related nephron loss, glomerulosclerosis, and fibrosis reduce renal reserve, while comorbidities such as hypertension and diabetes further accelerate kidney damage [22].

Consequently, CKD prevalence rises sharply with age, affecting nearly 40% of individuals aged ≥60 years and underscoring the need for screening in older populations [23].

2.2.2 Hypertension as a Risk Factor for Chronic Kidney Disease

Hypertension is a major modifiable risk factor for CKD, contributing to nephron loss, glomerulosclerosis, and progressive decline in glomerular filtration rate[24]. It accounts for up to one-third of ESRD cases worldwide and can both cause and result from CKD through mechanisms such as proteinuria and RAAS activation, creating a pathological cycle [25].

Effective blood pressure management reduces CKD progression and cardiovascular risk [26]. In Pakistan, hypertensive individuals are 2-3 times more likely to develop CKD [27]. Early detection, lifestyle modifications, and pharmacological treatment remain essential, with KDIGO 2024 recommending a target blood pressure of ≤130/80 mmHg in CKD patients [6].

2.2.3 Diabetes Mellitus as a Risk Factor for Chronic Kidney Disease

Diabetes mellitus is the leading cause of CKD, responsible for 40–50% of ESRD cases worldwide [23]. Chronic hyperglycemia damages glomeruli, causing albuminuria, reduced GFR, and increased cardiovascular risk [26]. KDIGO 2024 recommends early screening, glycemic control (HbA1c <7%), and Reno protective therapies to prevent CKD progression [22]. In Pakistan, diabetic patients are 2-4 times more likely to develop CKD, often presenting late, making lifestyle modification, monitoring, and optimized pharmacotherapy crucial to reducing CKD burden [28].

2.2.4 Cardiovascular Disease as a Risk Factor for Chronic Kidney Disease

KD and cardiovascular disease (CVD) are closely interconnected and mutually aggravating. CVD promotes CKD progression through reduced renal perfusion, endothelial dysfunction, and inflammation, while CKD increases cardiovascular morbidity and mortality via hypertension, dyslipidemia, and vascular calcification, constituting cardio renal syndrome [29]. Individuals with prior cardiovascular events are 2-3 times more likely to develop CKD, highlighting the importance of early, integrated cardiovascular and renal management as recommended by KDIGO 2024 [22].

2.2.5 Family History of Chronic Kidney Disease

A family history of CKD is a strong, non-modifiable risk factor for renal dysfunction. Genetic variants such as APOL1, UMOD, and PKD1/2 are associated with increased CKD risk and earlier disease progression [25]. Individuals with a first-degree relative affected by CKD have a 2-3 times higher risk of developing the disease [30]. Familial clustering also reflects shared lifestyle, environmental exposures, and comorbidities such as hypertension and diabetes [29]. Low awareness within affected families often leads to delayed diagnosis and poorer outcomes [23]. Evidence from Pakistan confirms family history as an independent CKD risk factor, highlighting the importance of early screening, dietary modification, and regular renal monitoring in high-risk families [6].

2.2.6 History of NSAIDs Usage

Long-term NSAID use increases the risk of CKD by reducing prostaglandin synthesis, causing renal ischemia and tubulointerstitial damage [24]. In Pakistan, widespread unsupervised NSAID use, combined with hypertension, obesity, and dehydration, further elevates CKD risk [25]. Medication counseling and rational NSAID use are essential for CKD prevention [26].

2.2.7 Usage of Herbal Medicines History

Use of traditional and herbal remedies is an emerging risk factor for CKD, particularly in low- and middle-income countries. Herbal products may contain nephrotoxic substances such as heavy metals and aristolochic acid, leading to nephron inflammation and accelerated CKD progression to ESRD [24]. In Pakistan and South Asia, widespread self-medication and poor regulation increase this risk, especially due to drug herb interactions [30]. Public awareness, regulatory control, and routine inquiry by healthcare providers are essential preventive measures [6].

2.2.8 Dyslipidemia as a Risk Factor for Chronic Kidney Disease

Dyslipidemia is an important risk factor for CKD, characterized by elevated triglycerides and low-density lipoprotein (LDL) levels with reduced high-density lipoprotein (HDL). Abnormal lipid profiles contribute to kidney damage through glomerular injury, mesangial expansion, tubulointerstitial fibrosis, oxidative stress, inflammation, and progressive nephron loss [25]. Reduced GFR is also associated with elevated triglyceride levels, further accelerating CKD progression [24]. Population-based studies in Pakistan demonstrate a significant association between high triglyceride levels and increased CKD prevalence [31]. Effective lipid management through statins and lifestyle modification can reduce cardiovascular comorbidity and slow CKD progression, and is recommended by the KDIGO 2024 guidelines as part of comprehensive CKD care [22].

2.2.9 Obesity and High Body Mass Index as a Risk Factor for Chronic Kidney Disease

Obesity is a major, modifiable risk factor for CKD. Excess weight increases intraglomerular pressure and hyper filtration, promotes glomerulosclerosis, nephron loss, oxidative stress, and renal fibrosis, and is often associated with hypertension and dyslipidemia, accelerating CKD progression [25]. Individuals with BMI $\geq$25–30 kg/m^2 have a significantly higher risk of CKD and faster decline in eGFR

[26]. In Pakistan, rising obesity rates in urban populations are linked to increased CKD prevalence [30].

Lifestyle interventions including diet, exercise, and behavioral therapy are key to slowing disease progression, as emphasized by KDIGO 2024 guidelines [22].

2.3 Overview of End-Stage Renal Disease

The annual irreversible stage of kidney failure is known by End-stage renal disease where the function of kidneys drops from 15 % to 10 % and there is the requirement of renal replacement therapy such that the hemodialysis and renal transplantation. Uremia, electrolyte abnormalities, and elevated cardiovascular risk are among the problems that ESRD patients face [11].

According to the Global Burden of Disease research, CKD, including ESRD, is expected to lie as the world's 5th most common cause of death by 2040 [9].

2.3.1 Pathophysiology

Figure 2.1 illustrates the complex pathophysiology of CKD, highlighting the progressive and interrelated mechanisms that lead to gradual loss of kidney function. The process typically begins with initial kidney injury caused by conditions such as diabetes mellitus, hypertension, or glomerular disorders. This injury triggers structural and functional nephron damage, leading to reduced GFR. As CKD progresses, compensatory hyper filtration occurs in the remaining nephrons, which further accelerates glomerular hypertension and sclerosis. Persistent inflammation, oxidative stress, and activation of the renin–angiotensin–aldosterone system (RAAS) contribute to fibrosis and tubular damage. These changes promote worsening proteinuria and progressive nephron loss. Over time, declining renal function results in fluid and electrolyte imbalance, toxin accumulation, metabolic acidosis, anemia, and disturbances in mineral and bone metabolism. Ultimately, these interconnected processes lead to irreversible kidney damage and may progress to ESRD if not effectively managed.

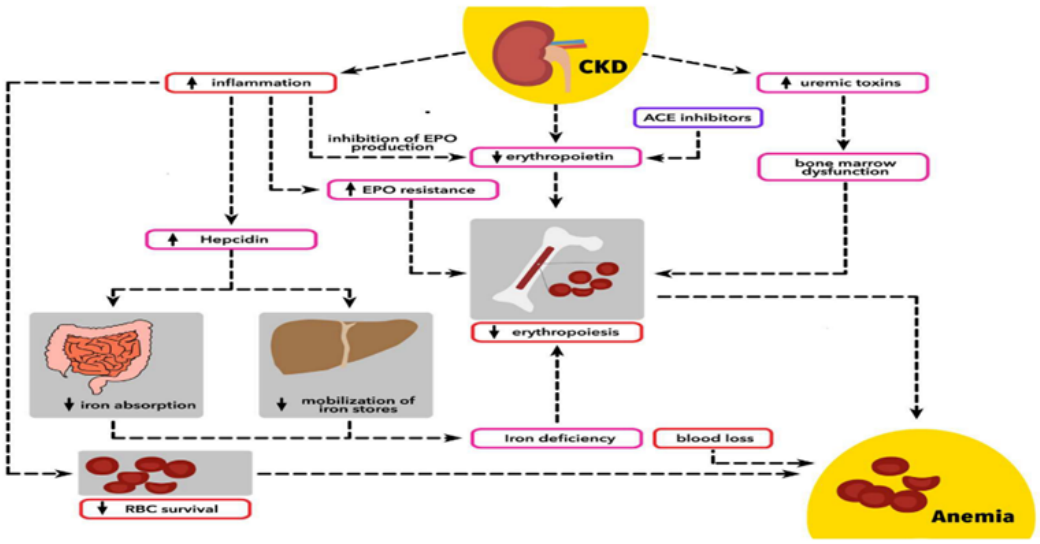

FIGURE 2.1: Pathophysiology of CKD [32].

2.3.2 Treatment of End Stage Renal Disease

Treatment strategies include hemodialysis, peritoneal dialysis, and kidney transplantation. Along with this treatment still there is need of supportive care for managing anemia, mineral and bone disease, hypertension and diabetes. The transplant is best option for enhancing quality of life for patients and considered as gold standard but in Pakistan mostly patients perform hemodialysis due to limited options for transplantation and infrastructure for peritoneal dialysis [33].

2.3.3 Importance of Hemodialysis in End Stage Renal Disease

Hemodialysis removes metabolic waste products, toxins, and excess fluid from the blood; however, it does not restore normal kidney function. Regular and properly conducted hemodialysis sessions, typically performed two to three times per week, are essential for maintaining physiological balance. Timely initiation of dialysis is necessary, and strict adherence to the prescribed treatment regimen is crucial for achieving optimal clinical outcomes [10].

2.4 Medication Burden and the Role of Pharmacists in Improving Adherence

ESRD patients take an average of 10-12 medications daily. This polypharmacy enhances the risk of drug-drug interactions and adverse effects. Studies show non-adherence is linked to poorer clinical outcomes, hospitalization, and mortality. Reasons include complexity, cost, forgetfulness, and lack of understanding of medication benefits. Non-adherence in dialysis settings ranges from 25% to 74% globally [34].

2.5 Challenges in Hemodialysis Management, Opportunities for mHealth Solutions

High therapy burden, logistical problems, restricted vascular access, insufficient dialysis dosage, and psychological stress are just a few of the difficulties hemodialysis patients must deal with. Lack of financing, a shortage of qualified personnel, and inadequate continuity of treatment are obstacles in Low- and Middle-Income Countries (LMICs). Patient and caregiver stress is also increased by frequent hospital visits. Novel solutions like use of digital health tools are required to overcome these issues [6].

2.6 Need of Pharmacist in Hemodialysis Care

Pharmacists perform multiple roles in the management of patients with end-stage renal disease (ESRD), including providing proper counselling, reviewing medications, monitoring drug therapy, and promoting adherence strategies. Pharmacist-led programs have been shown to reduce medication-related problems and enhance patients' awareness of their disease. With the advent of digital health tools that enable virtual care delivery, the role of pharmacists continues to evolve [35].

2.6.1 Need for Pharmaceutical Care in Hemodialysis

Due to the high medication burden, frequent comorbidities, and increased risk of drug-related problems among hemodialysis patients, pharmaceutical care is increasingly recognized as an essential component of their management.

These complications further burden patients, reduce their quality of life, and increase the likelihood of hospitalization. Evidence suggests that pharmacist-led interventions in dialysis settings can enhance patient understanding of treatment plans, optimize medication management, improve adherence, and reduce adverse drug events [36].

2.7 Emergence of Mobile Health

The utilization of mobile applications and other communication platforms facilitates remote monitoring of patients overall health so mHealth is revolutionizing delivery of healthcare. It is especially helpful in addressing long-term conditions like CKD, where ongoing care is crucial.

In both high- and low-resource environments, mHealth is a scalable and affordable option since it enables real-time communication, data tracking, reminders, and teaching [37].

2.7.1 mHealth Intervention in Nephrology

In nephrology departments, mHealth is increasingly used to support patient lifestyle coaching, medication adherence, and dialysis monitoring. Previous research has shown that among patients with CKD and ESRD, mHealth interventions can improve quality of life, reduce hospital visits, and promote patient empowerment. Furthermore, pharmacist-led mHealth interventions have demonstrated improvements in medication safety among renal transplant patients, with potential applicability to dialysis settings [38].

2.7.2 Use of WhatsApp and Mobile Health in Patient Education

By using the WhatsApp application which frequently provide health education in low-resource setting because of its familiarity and accessibility, patients with hypertension and CKD) in Pakistan showed improved adherence and disease understanding because to WhatsApp-based pharmacist intervention. It allows easy delivery of reminders, infographics, and voice messages in the patient's native language, increasing engagement [39].

2.7.3 Combined Approach Pharmacist Led Mobile Health Intervention

Clinical knowledge and digital accessibility are combined when pharmacists are included into mHealth systems. The combine therapy improved therapeutic results, patient engagement, and continuity of care. The proper utilization of these dual strategy pharmacist may make better intervention to track or monitor side effects and customize advice [40].

2.8 Core Principles of Pharmacist - Led Mobile Health

The fundamental core principles of mHealth interventions enhance health outcomes by enabling continuous health monitoring and care. Through readily accessible digital platforms such as smartphone applications or WhatsApp, key concepts including patient-centered care, personalization, interaction, monitoring, and empowerment are effectively implemented [41].

Chapter 3

Research Design and Methodology

3.1 Methodology Overview

This study was conducted as a prospective randomized controlled trial (RCT). In a prospective RCT design, participants are enrolled before the occurrence of outcomes and followed forward in time to assess changes and effects of interventions [42].

Eligible hemodialysis patients were randomly allocated into two parallel groups: an intervention group and a control group. The intervention group received pharmacist-led mobile health (mHealth) support by WhatsApp in addition to routine care, while the control group received standard care alone. Both groups were followed over a defined period, and outcomes related to medication adherence, clinical parameters, and patient satisfaction were measured at baseline and subsequent follow-ups to compare the effect of the intervention. Randomized controlled trials are considered the gold standard for evaluating the effectiveness of healthcare interventions due to their ability to minimize bias and establish causal relationships [43].

3.2 Study Design

The study used a prospective RCT research design to determine how empowered hemodialysis patients through pharmacist-led mobile health in an ambulatory care public hospital.

3.3 Study Setting

This study was conducted in Islamabad, where both hemodialysis services and routine ambulatory care are provided. The study setting includes the dialysis centres of Pakistan Institute of Medical Sciences Hospital and Friends Hospital, Islamabad. In this setting, pharmacists support hemodialysis patients through digital health interventions, continuous monitoring, and personalized therapy adjustments.

3.4 Sample Size Recruitment and Analysis

Initially, 215 patients were approached for participation. After applying the inclusion and exclusion criteria, 200 patients were found eligible and completed baseline data collection, with 100 patients assigned to the control group and 100 patients to the intervention group. The sample size was calculated based on prior studies reporting a Patient Time Ratio (PTR) of 23% in chronic kidney disease patients in the control group. We hypothesized that the pharmacist-led mobile health intervention could approximately double this proportion to 45%. Using a two-sided significance level ($\alpha = 0.05$) and a power of 80% ($\beta = 0.20$), the minimum sample size required was calculated to be 150 patients. To account for an anticipated dropout rate of 25% during follow-up, the total sample size was increased to 200 patients [44].

3.5 Sampling Technique

A non-probability purposive sampling technique was used to select study participants. This method was chosen because the study aimed to evaluate a specific

pharmacist-led intervention in a well-defined population of hemodialysis patients. Purposive sampling was appropriate considering the targeted nature of the study, the availability of participants, and the constraints of time and resources.

3.6 Study Population

The study targeted an ambulatory hemodialysis patients in twin cities of public sector hospital. These patients were recruited based on a predefined set of criteria.

3.6.1 Inclusion Criteria

Adult ambulatory patients aged 18 years and above, who were willing to participate and provide informed consent, and were undergoing hemodialysis at least two to three times per week, were included in the study.

3.6.2 Exclusion Criteria

Patients without access to a mobile phone, those with paralysis or severe communication limitations, patients already enrolled in another study, and inpatients on hemodialysis were excluded from the study.

3.6.3 Randomization

Participants were allocated into control and intervention groups using a shift-based randomization method with a 1:1 ratio.

As patients attended dialysis in fixed shifts, individual randomization was not feasible due to the risk of contamination through interaction within the same clinical environment.

Therefore, dialysis shifts were treated as clusters and randomly assigned to either the intervention (pharmacist-led mobile health support) or control (usual care) group. This cluster randomization approach ensured equal allocation while minimizing cross-group contamination.

3.6.4 Blinding

This study was conducted as an open-label trial therefore, no blinding was implemented. Both the participants and the researcher were aware of group allocation due to the nature of the pharmacist-led mobile health intervention, which required active communication and engagement with patients. Blinding was not feasible as the intervention involved direct interaction through mobile health support.

3.7 Intervention Through mHealth via WhatsApp by Pharmacist

Participants in the intervention group were exposed to a structured pharmacist-led intervention program that was implemented using mHealth on WhatsApp. There was personalized education on medication use, adherence, and diet and lifestyle management to the hemodialysis patients. Educational brochures that contained drug adherence chart, fluid and salt restriction, and dietary instructions were handed over. The pharmacists had to review test results, explain key clinical data, and reinforce treatment plans.

FIGURE 3.1: mHealth intervention on Hemodialysis patients by pharmacists

WhatsApp reminders were also given to the participants and standard checklists were also used in ensuring the delivery of care was consistent. This mHealth model was a pharmacist-led model which integrated the digital health support

with pharmaceutical care in order to enhance medication adherence and general patient management. The figure 3.1 illustrates study flow diagram.

3.8 Follow-up Structure

A total of 200 hemodialysis patients were enrolled, with 100 in each of the control and intervention groups. Both groups were followed prospectively to evaluate the pharmacist-led mobile health intervention over one month with structured follow-ups.

3.9 Data Collection Procedures

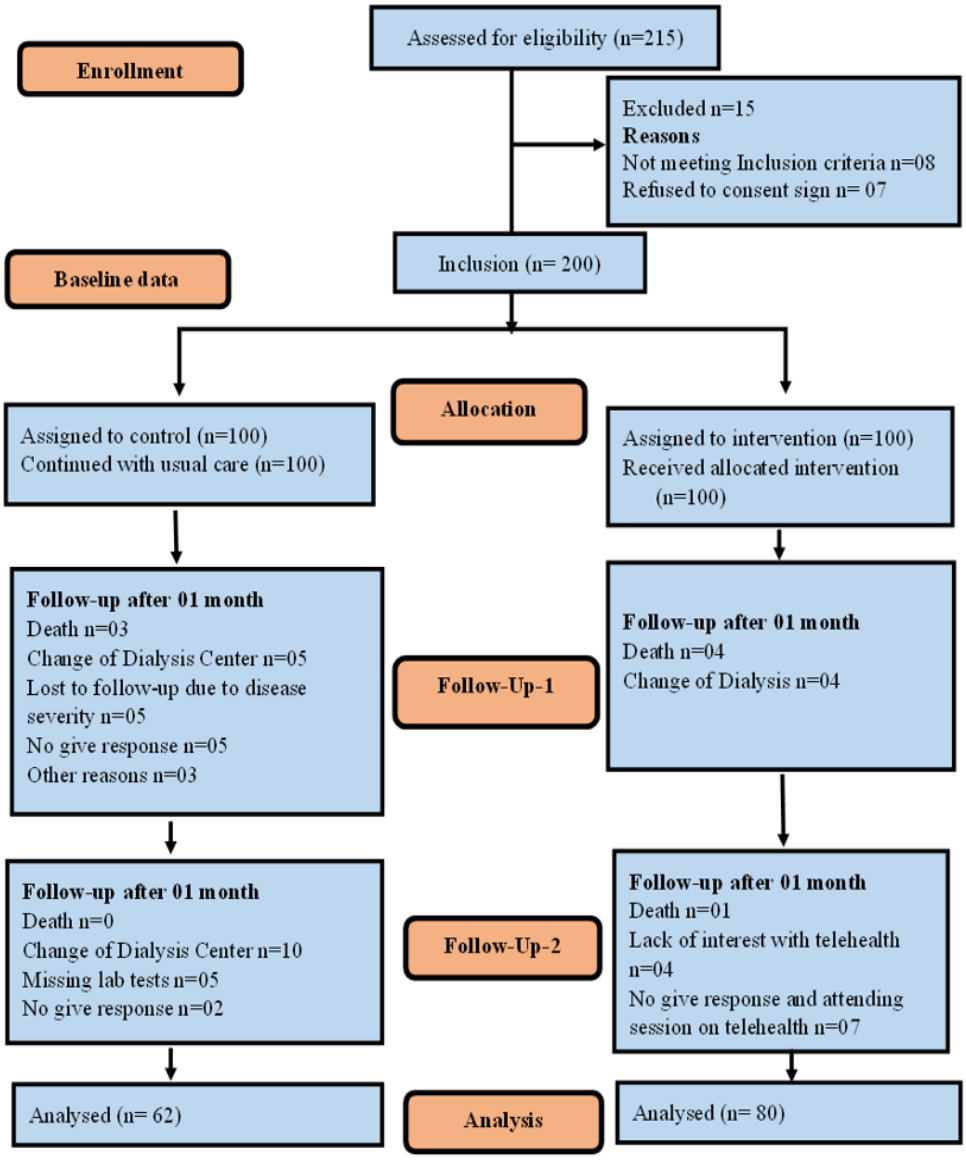

FIGURE 3.2: Methodology Flow Chart

n the control group, 79 participants completed the first follow-up and 62 completed the second, with losses due to death, transfer, hospitalization, or non-response.

In the intervention group, 92 participants completed the first follow-up and 80 the second, with losses mainly from death, transfer, withdrawal, or non-response.

3.9.1 Baseline Data Collection

A total of 200 hemodialysis patients (100 per group) underwent baseline assessments before the pharmacist-led mobile health intervention.

Demographic data, medication adherence (using GMAS), quality of life (using EQ-5D-3L), and laboratory parameters, including hemoglobin, creatinine, electrolytes, and other clinical indicators, were collected.

In the intervention group, patients also completed a pharmacist intervention questionnaire to capture their perceptions of the planned intervention. This comprehensive baseline assessment provided the necessary demographic, behavioral, and clinical data for evaluating pre- and post-intervention outcomes.

3.9.2 First follow-up

Follow-up assessments were scheduled at one-month intervals, conducted in-person or via structured phone interviews. In the control group, 79 participants completed the first follow-up and 62 the second, with losses due to death, transfer, hospitalization, missing lab reports, or non-response.

In the intervention group, 92 participants completed the first follow-up and 80 the second, with losses from death, transfer, withdrawal, or non-response.

At each follow-up, GMAS, quality of life, and laboratory parameters were reassessed. In the intervention group, participants also completed the pharmacist intervention questionnaire to evaluate their perceptions, satisfaction, and engagement with the pharmacist-led mobile health intervention.

3.9.3 Second Follow-up

By the second follow-up in the fifth month, 142 participants remained (62 control, 80 intervention). Between the first and second follow-ups, 17 control participants were lost due to transfer, missing lab results, or non-response, while 12 intervention participants were lost due to death, withdrawal, or non-response.

3.10 Participant Group and Intervention

3.10.1 Experimental Group

Participants will receive pharmacist-led mobile health (mHealth) care through telehealth using WhatsApp.

3.10.2 Intervention Description

The intervention consists of a structured pharmacist-led mHealth program aimed at optimizing medication use and improving patient outcomes. It includes:

i. Monitoring adherence to prescribed medications.

ii. Reviewing clinical parameters such as blood pressure, hemoglobin levels, electrolytes, serum creatinine, urea, and related indicators to guide therapy adjustments.

iii. Educating patients on proper medication use, lifestyle modifications, and self-care strategies.

iv. Assessing patients' QoL by evaluating symptom burden, physical well-being, and treatment satisfaction.

3.11 Data Collection Tools

A six-section questionnaire was used to collect data. The first section included demographic features. The level of medication adherence was measured in terms of the General Medication Adherence Scale (GMAS) a validated 11-item scale offered

in English and Urdu that encompassed the following aspects: patient behavior, comorbidity and pill burden, and out-of-pocket expenditure [45]. The EQ-5D-3L was utilized to determined health related quality of life and measured five health domains and a Visual Analogue Scale (VAS) of 0-100 [46].

A structured questionnaire that was created by the researchers was used to capture clinical and lab parameters, and the target ranges were established according to the KDIGO, KDOQI, and WHO guidelines. The influence of pharmacist-led intervention, such as medication education, dietary advice, reminders, and patient satisfaction, was measured based on the domains that were borrowed in earlier studies [47].

The validated version of a Telehealth Usability Questionnaire (TUQ) was used to determine the usability and satisfaction with the WhatsApp-based intervention [48], [49].

3.12 Outcomes

3.12.1 Primary Outcomes Measures

i. Adherence to therapy: Changes in patient adherence were assessed at baseline (0 month) and during follow-up visits at 2 and 4 months. Variations in adherence were also evaluated after 1 month of intervention.

ii. Random blood pressure during dialysis: Blood pressure changes in hemodialysis patients were measured using a sphygmomanometer on the upper arm while patients were in the supine position during dialysis, from baseline (0 month) up to 4 months.

iii. Pre- and post-dialysis weight: Changes in body weight were measured using a calibrated digital weighing scale immediately before and after each dialysis session to assess fluid removal and weight fluctuations, from baseline (0 month) up to 4 months.

3.12.2 Secondary Outcome Measures

i. Clinical outcomes: Variations in serum hemoglobin, creatinine, urea, sodium, phosphate, potassium, calcium, ALT, ALP, and random blood glucose (RBG) were assessed throughout the study period from 0 to 4 months.

ii. Quality of Life (QoL): Changes in QoL were evaluated from baseline to study completion using the EQ-5D (EuroQol-5 Dimensions) descriptive system during the study period (0–4 months). The assessment covered physical health, social functioning, burden of kidney disease, symptoms and treatment effects, and mental health.

iii. Patient satisfaction and engagement with mHealth: Changes in patient satisfaction and engagement following pharmaceutical care were assessed at baseline (0 month), 2 months, and 4 months.

3.13 Ethical Consideration

Ethical approval was obtained from the Pharmacy Research Ethics Committee at CUST (REC/FoP/S2025/02) and the Ethics Review Committee at PIMS (F-5-2/2024(ERRC)/PIMS). The study was also registered with the Thai Clinical Trials Registry (TCTR ID: TCTR20260214002). Participants received a verbal explanation of the study, provided informed consent, and were assured of confidentiality. Participation was voluntary, and no compensation was provided for completing the survey.

3.14 Statistical Analysis

Data were analyzed using SPSS version 27, with descriptive statistics reported as mean ± SD or median (IQR) for continuous variables and frequencies and percentages for categorical variables; non-parametric tests were applied due to non-normal data distribution, including the Mann-Whitney U test for between-group comparisons and the Wilcoxon signed-rank test for within-group changes, while GMAS and EQ-5D-3L scores were analyzed similarly, pharmacist intervention responses

summarized descriptively, trends illustrated using bar graphs, and a p-value $<$ 0.05 considered statistically significant.

Chapter 4

Results

In total of 200 patients undergoing hemodialysis participated in this study. Among them the 100 patients included in control group and 100 in intervention group. The demographic distribution presented in Table 4.1.

Most participants in both groups were female, married, unemployed, and aged 50 years or older. The majority had no formal education and resided in Islamabad. Most patients had been receiving hemodialysis for 1-5 years and typically underwent dialysis twice per week. Hypertension was the leading cause of chronic kidney disease in both groups, followed by diabetes alone or in combination with hypertension. Overall, the demographic and clinical characteristics were broadly comparable between the control and intervention groups.

TABLE 4.1: Demographic Characteristics of Patients (n=200)

Variable	**Category**	**Control n=100 (%)**	**Intervention n=100 (%)**
Age (groups)	18-29	10 (10)	14(14)
	30-49	21 (21)	39 (39)
	50 Above	69 (69)	47 (47)
Gender	Male	41 (41)	38 (38)
	Female	59 (59)	62 (62)
Marital Status	Single	10 (10)	11 (11)
	Married	90 (90)	89 (89)
Education	No formal education	61 (61)	65 (65)

Table 4.1 continued from previous page

Variable	**Category**	**Control n=100 (%)**	**Intervention n=100 (%)**
	Secondary education	23 (23)	22 (22)
	Higher education	16 (16)	13 (13)
Occupation	Employed	03 (03)	07 (07)
	Unemployed	97 (97)	93 (93)
Residence	Islamabad	71 (71)	70 (70)
	Rawalpindi	24 (24)	26 (26)
	Other	05 (05)	04 (04)
Years on Dialysis	Less than 01 year	23 (23)	27 (27)
	1-5 years	58 (58)	59 (59)
	More than 05 years	19 (19)	14 (14)
Cause	Diabetes	18 (18)	15 (15)
	Hypertension	61 (61)	71 (71)
	Both	21 (21)	14 (14)
Dialysis session per week	2 times	63 (63)	63 (63)
	3 times	24 (24)	26 (26)
	More than 3 times	13 (13)	11 (11)

4.1 Mean and Standard Deviation of Dialysis and Laboratory Parameters from Baseline to Second Follow-Up in control And Intervention Group

The Table 4.2 presents the serum laboratory parameters of the control and intervention group across follow-up visits. From baseline to follow-up 2, mean serum hemoglobin levels increased in both groups, indicating an improvement in hemoglobin status.

Similarly, mean values of serum sodium, calcium, and chloride showed a slight increase over time. In contrast, mean serum creatinine, urea, potassium, phosphorus, alanine aminotransferase (ALT), alkaline phosphatase (ALP), and random blood glucose levels decreased from baseline to second follow-up in both groups, reflecting improved biochemical control. No clinically meaningful changes were observed in the remaining laboratory parameters.

TABLE 4.2: Mean (± SD) and p value of dialysis and laboratory parameters between control and intervention group

Dialysis Parameters	Control (Mean ± SD)	Intervention (Mean ± SD)
Pre-dialysis Blood Pressure		
BPdBP	2.510 ± 0.783	2.250 ± 0.82
F1PdBP	2.590 ± 0.680	2.520 ± 0.72
F2PdBP	2.510 ± 0.710	2.600 ± 0.70
Post - Dialysis Blood Pressure		
BPDB.P	2.080 ± 0.680	2.130 ± 0.560
F1PDB.P	2.110 ± 0.620	1.820 ± 0.610
F2PDB.P	1.910 ± 0.550	1.780 ± 0.490
Pre-dialysis weight		
BPdW	2.220 ± 0.680	2.320 ± 0.560
F1PdW	2.220 ± 0.680	2.300 ± 0.600
F2PdW	2.220 ± 0.710	2.280± 0.570
Post-dialysis weight		
BPDW	2.120 ± 0.730	2.300 ± 0.560
F1PDW	2.170 ± 0.690	2.290 ± 0.640
F2PDW	2.310 ± 0.710	2.250 ± 0.600
Serum Hemoglobin		
BSHb	1.612 ± 0.816	1.375 ± 0.752
F1SHb	1.629 ± 0.773	1.387 ± 0.626
F2SHb	1.790 ± 0.851	1.975 ± 0.745
Serum Creatinine		
BSCr	2.306 ± 0.916	2.762 ± 0.600
F1SCr	2.177 ± 0.820	2.587 ± 0.687
F2SCr	2.129 ± 0.895	2.400 ± 0.704
Serum Urea		
BSU	2.677 ± 0.536	2.625 ± 0.550
F1SU	2.419 ± 0.779	2.200 ± 0.862
F2SU	2.532 ± 0.645	2.270 ± 0.728
Serum Sodium		
BSNa	1.590 ± 0.520	1.760 ± 0.530
F1SNa	1.660 ± 0.510	1.810 ± 0.420
F2SNa	1.640 ± 0.510	1.880 ± 0.400
Serum Potassium		

Table 4.2 continued from previous page

Dialysis Parameters	Control (Mean ± SD)	Intervention (Mean ± SD)
BSK	2.290 ± 0.583	2.587 ± 0.566
F1SK	2.241 ± 0.533	2.175 ± 0.522
F2SK	2.258 ± 0.510	2.91 ± 0.678
Serum Calcium		
BSCa	1.430 ± 0.590	1.360 ±0.620
F1SCa	1.460 ± 0.560	1.380 ± 0.510
F2SCa	1.620 ± 0.510	1.610 ± 0.530
Serum Phosphorus		
BSP	2.800 ± 0.430	2.780 ±0.490
F1SP	2.540 ± 0.610	2.400 ± 0.580
F2SP	2.430 ± 0.560	2.270 ± 0.470
Serum Chloride		
BSCl	1.970 ± 0.550	2.150 ±0.550
F1SCl	1.980 ± 0.480	1.930 ± 0.510
F2SCl	1.900 ± 0.450	2.070 ± 0.610
Serum Alanine Amino Transferase		
BSALT	2.048 ± 0.381	2.050 ± 0.352
F1SALT	2.112 ± 0.366	2.100 ± 0.408
F2SALT	2.112 ± 0.409	2.112 ± 0.366
Serum Alkaline phosphatase		
BSALP	2.450 ± 0.530	2.270± 0.670
F1SALP	2.350 ± 0.510	2.480 ± 0.520
F2SALP	2.400 ± 0.550	2.470 ± 0.550
Serum Random Blood Glucose		
BSRBG	1.460 ± 0.710	1.380 ± 0.700
F1SRBG	1.170 ± 0.550	1.370 ± 0.680
F2SRBG	1.240 ± 0.610	1.420 ± 0.720

B; Baseline, F1; Follow-up 1 and F2; Follow-up 2, BP; Blood Pressure, Pd; Pre-dialysis, PD; Post-Dialysis, W; Weight, S; Serum, Hb; Hemoglobin, Cr; Creatinine, U; Urea; Na; Sodium, K; Potassium, Ca; Calcium, P; Phosphorus, Cl; Chloride, ALT; Alanine Amino Transferase, ALP; Alkaline Phosphatase and RBG; Random Blood Glucose

4.2 Statistical Comparison of Pre - Dialysis Blood Pressure among Control and Intervention Groups

As shown in Table 4.3, there is significant p value in pre-dialysis blood pressure of intervention group by Wilcoxon Signed Rank Test. This demonstrated that from initial value to first follow-up the significant difference with p = 0.02 detected with increase of pre-dialysis blood pressure while from follow-up 1 to 2 the difference was non-significant and from baseline to 2nd follow-up the p = 0.006 suggested statistically significant increase in pre-dialysis blood pressure of intervention group.

TABLE 4.3: Mean differences of Pre-dialysis blood pressure from baseline to second follow-up in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BPdBP- F1PdBP	-0.800 ± 1.040	0.55	- 0.300 ± 1.184	0.02
F1PdBP- F2PdBP	0.800 ± 0.790	0.43	0.700 ± 1.011	0.29
BPdBP- F2PdBP	0.000 ± 0.740	0.96	-0.375 ± 1.194	0.006

B; Baseline, F1; Follow-up 1, F2; Follow-up 2, Pd; Pre-dialysis and BP; Blood Pressure

4.3 Statistical Comparison of Post - Dialysis Blood Pressure Among Control and Intervention Groups

As this table 4.4 gives the statistically significant results in intervention group from starting point to first post intervention evaluation with p = 0.001 and also from initial assessment to follow-up visit 2 indicates p = < 0.001 stated improvement of post dialysis blood pressure as comparison with control group which have only significant value in follow-up 1 to 2 with p = 0.03 illustrated improvements.

TABLE 4.4: Mean differences of Post-dialysis blood pressure from baseline to second follow-up in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BPDBP- F1PDBP	-0.320 ± 0.950	0.64	0.312 ± 0.820	0.001
F1PDBP- F2PDBP	0.190 ± 0.720	0.03	0.050 ± 0.793	0.66
BPDBP- F2PDBP	0.160 ± 0.890	0.19	0.362 ± 0.600	<0.001

B; Baseline, F1; Follow-up 1, F2; Follow-up 2, PD; Post-Dialysis and BP; Blood Pressure

4.4 Statistical Comparison of Pre - Dialysis Weight among Control and Intervention Groups

The pre-dialysis weight of both group had non-significant results as p = < 0.05, but comparison with control group intervention group had much better values than control as it might be due to intervention.

TABLE 4.5: Mean differences of Pre-dialysis Weight from baseline to follow up 02 in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BPdW- F1PdW	0.000 ± 0.180	1	0.025 ± 0.449	0.61
F1PdWBP- F2PdW	0.000 ± 0.180	1	0.125 ± 0.194	0.56
BPdW- F2PdW	0.000 ± 0.250	1	0.037 ± 0.462	0.46

B; Baseline, F1; Follow-up 1, F2; Follow-up 2, Pd; Pre-Dialysis and W; Weight

4.5 Statistical Comparison of Post - Dialysis Weight among Control and Intervention Groups

The post-dialysis weight had non-significant p values in both groups but the intervention suggested no improvements in post dialysis weight of patients in both groups by Wilcoxon signed rank test.

TABLE 4.6: Mean differences of Post-dialysis Weight from baseline to follow up 02 in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BPDW- F1PDW	-0.040 ± 0.210	0.08	0.000 ± 0.506	0.97
F1PDWBP- F2PDW	0.320 ± 0.170	0.15	0.0380 ± 0.250	0.18
BPDW- F2PDW	-0.160 ± 0.120	0.31	0.0500 ± 0.500	0.36

B; Baseline, F1; Follow-up 1, F2; Follow-up 2, Pd; Post-Dialysis and W; Weight

4.6 Statistical Comparison of Serum Hemoglobin among Control and Intervention Groups

As the table 4.7 showed negative mean scores of both groups but with statistically significant p value of < 0.001 in intervention group demonstrated improvements in hemoglobin values.

TABLE 4.7: Mean differences of Serum Hemoglobin from baseline to follow up 02 in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BSHb-F1SHb	-0.016 ± 1.108	0.99	-0.012 ± 0.684	0.88
F1SHb-F2SHb	-0.161 ± 1.089	0.20	-0.100± 0.541	<0.001
BSHb-F2SHb	-0.177 ± 1.221	0.23	-0.112 ± 0.729	<0.001

B; Baseline, F1; Follow-up 1, F2; Follow-up 2, S; Serum and Hb; Hemoglobin

4.7 Statistical Comparison of Serum Creatinine among Control and Intervention Groups

As table 4.8 demonstrated serum creatinine results of both groups from pre-intervention measurement post-intervention assessment to 2, the intervention group had improvements from baseline to follow-up 2 with significant results p =< 0.001 whereas the control group had non -significant results.

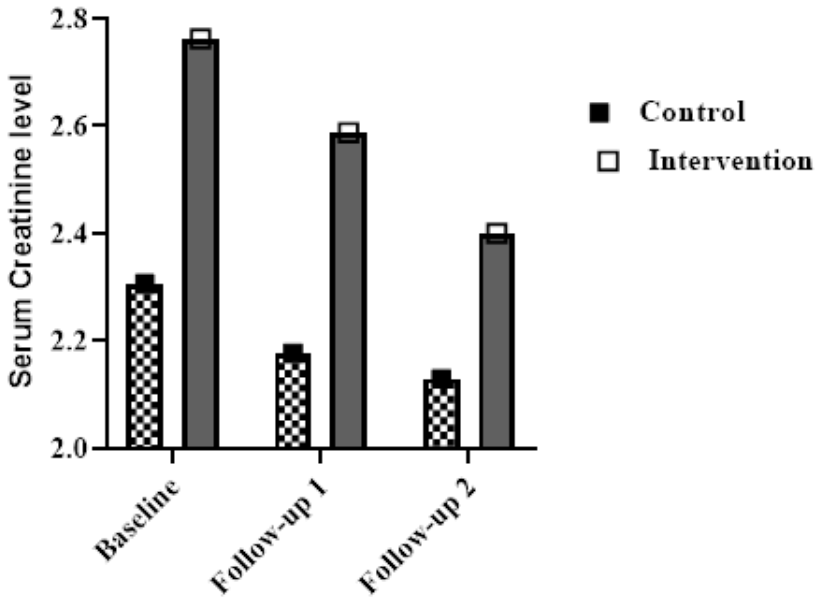

FIGURE 4.1: Comparison of serum creatinine level among groups across follow-ups.

TABLE 4.8: Mean differences of Serum Creatinine from baseline to follow up 02 in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BSCr-F1SCr	0.129 ± 0.983	0.36	0.050 ± 0.447	0.02
F1SCr-F2SCr	0.048 ± 1.015	0.63	0.050 ± 0.447	0.003
BSCr-F2SCr	0.177 ± 1.094	0.23	0.100 ± 0.438	<0.001

B; Baseline, F1; Follow-up 1, F2; Follow-up 2 and S; Serum and Cr; Creatinine

4.8 Statistical Comparison of Serum Urea among Control and Intervention Groups

There is significant p values of serum urea in intervention group given positive improvements while control group had only significant p value in baseline to follow-up 1, but had no improvement in serum urea across all follow-ups.

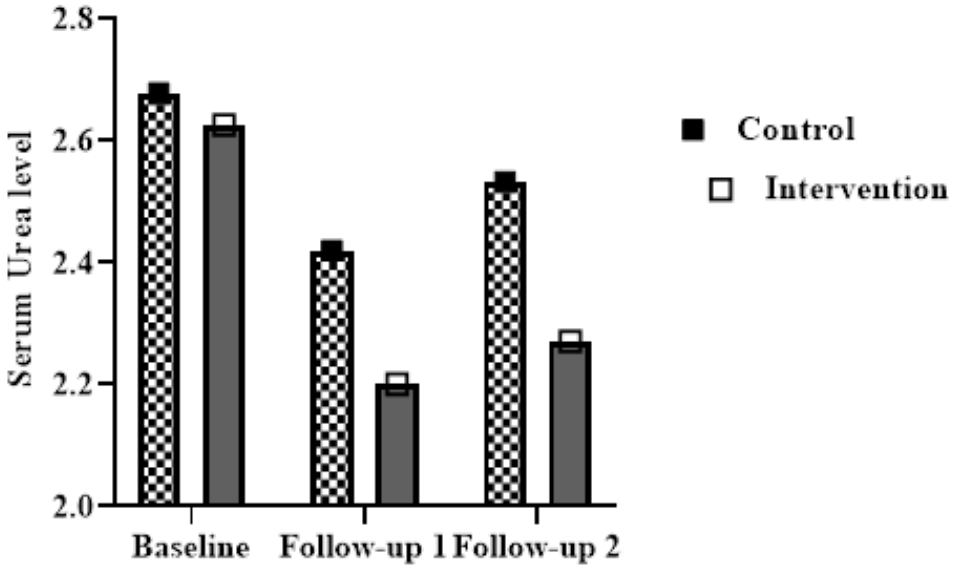

FIGURE 4.2: Comparison of serum urea level among groups across follow-ups

TABLE 4.9: Mean differences of Serum Urea from baseline to follow up 02 in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BSU-F1SU	0.258 ± 0.957	0.03	0.425 ± 1.028	<0.001
F1SU-F2SU	-0.112 ± 0.976	0.30	-0.075 ± 1.166	0.515
BSU-F2SU	0.145 ± 0.673	0.09	0.350 ± 0.828	<0.001

B; Baseline, F1; Follow-up 1, F2; Follow-up 2 and S; Serum and U; Urea

4.9 Statistical Comparison of Serum Sodium among Control and Intervention Groups

The table 4.10 had borderline significant result of p = 0.05 of serum sodium of intervention group in follow-up 2 from baseline suggested improvement while control group does not showed significance results.

TABLE 4.10: Mean differences of Serum Sodium from baseline to follow up 02 in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BSNa-F1SNa	-0.640 ± 0.530	0.34	-0.050 ± 0.709	0.53
F1SNa-F2SNa	0.016 ± 0.610	0.83	-0.750 ± 0.522	0.20
BSNa-F2SNa	-0.040 ± 0.630	0.54	-0.125 ± 0.581	0.05

B; Baseline, F1; Follow-up 1, F2; Follow-up 2 and S; Serum and Na; Sodium

4.10 Statistical Comparison of Serum Potassium among Control and Intervention Groups

The significance result of serum potassium in baseline to follow-up 2 in intervention group while control group had non-significance p value < 0.05.

TABLE 4.11: Mean differences of Serum Potassium from baseline to follow up 02 in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BSK-F1SK	0.048 ± 0.876	0.68	0.412 ± 0.790	<0.001
F1SK-F2SK	-0.016 ± 0.689	0.85	0.262 ± 0.758	0.003
BSK-F2SK	0.032 ± 0.767	0.75	0.675 ± 0.910	<0.001

B; Baseline, F1; Follow-up 1, F2; Follow-up 2 and S; Serum and K; Potassium

4.11 Statistical Comparison of Serum Calcium among Control and Intervention Groups

The Table 4.12 suggested serum calcium mean score and p values with significant results from both groups in follow-up 1 and 2 with significant improvements.

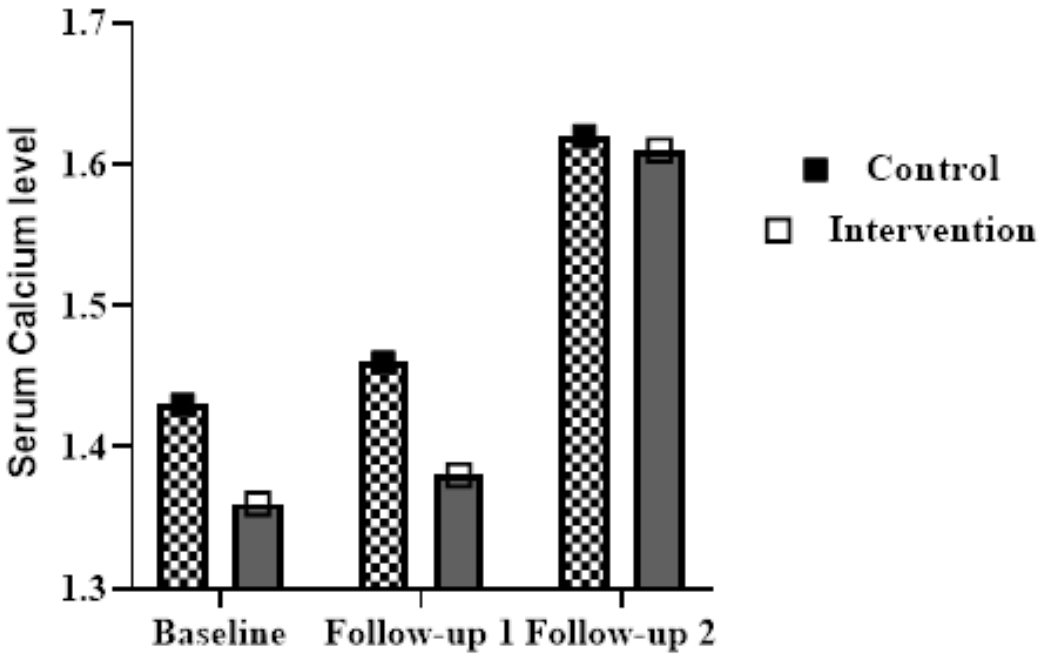

FIGURE 4.3: Comparison of serum calcium level among groups across follow-ups.

TABLE 4.12: Mean differences of Serum Calcium from baseline to follow up 02 in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BSCa-F1SCa	-0.030 ± 0.510	0.61	-0. 025 ± 0.810	0.79
F1SCa-F2SCa	-0.160 ± 0.600	0.04	-0.225± 0.655	0.004
BSCa-F2SCa	-0.190 ± 0.690	0.03	-0.255 ± 0.787	0.007

B; Baseline, F1; Follow-up 1, F2; Follow-up 2 and S; Serum and Ca; Calcium

4.12 Statistical Comparison of Serum Phosphorus among Control and Intervention Groups

As table 4.13 indicated the mean scores of serum phosphorus and significant results of both groups, the control group had improvement from starting point of study to after first phase of intervention with p = 0.02 and from baseline to follow-up 2 p = < 0.001 also the interventional group with similar follow-ups improvements with p = < 0.001.

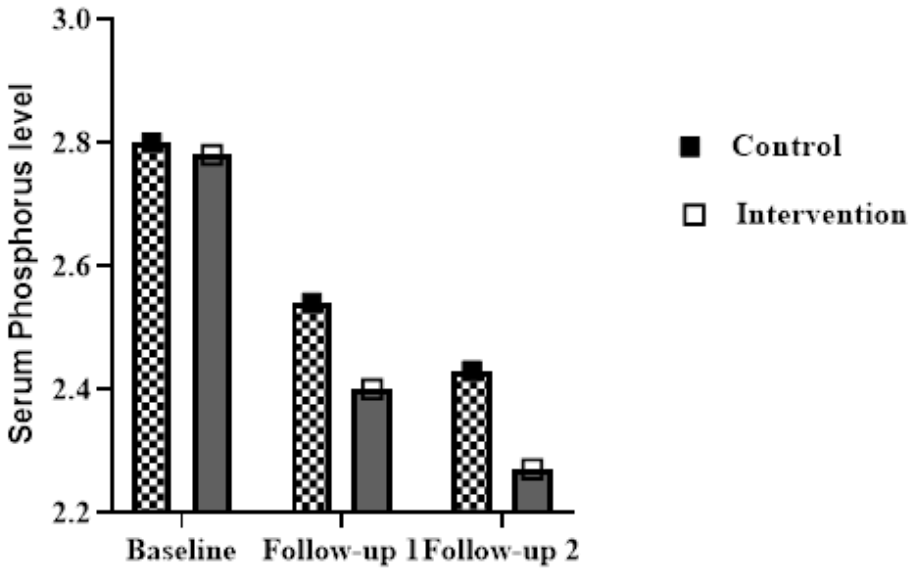

FIGURE 4.4: Comparison of serum phosphorus level among groups across follow-ups.

TABLE 4.13: Mean differences of Serum Phosphorus from baseline to follow up 02 in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BSP-F1SP	0.250 ± 0.580	0.02	0.387 ± 0.584	<0.001
F1SP-F2SP	0.110 ± 0.510	0.09	0.125 ± 0.603	0.07
BSP-F2SP	0.370 ± 0.630	<0.001	0.512 ± 0.616	<0.001

B; Baseline, F1; Follow-up 1, F2; Follow-up 2 and S; Serum and P; Phosphorus

4.13 Statistical Comparison of Serum Chloride among Control and Intervention Groups

The table 4.14 suggested serum chloride levels in both groups and had significant p value of 0.006 in interventional group from initial status to follow-up visit 1 showed significant improvement and in follow-up 1 to 2 the significance was 0.05 states improvement was on borderline and further achieved non-significance results detected.

TABLE 4.14: Mean differences of Serum Chloride from baseline to follow up 02 in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BSCl-F1SCl	-0.030 ± 0.620	0.68	0.212 ± 0.669	0.006
F1SCl-F2SCl	0.640 ± 0.430	0.63	-0.137 ± 0.631	0.05
BSCl-F2SCl	0.030 ± 0.540	0.63	0.750 ± 0.807	0.4

B; Baseline, F1; Follow-up 1, F2; Follow-up 2 and S; Serum and Cl; Chloride

4.14 Statistical Comparison of Serum ALT among Control and Intervention Groups

The below Table 4.15 mentioned the findings of serum ALT of both groups and had significant p value of <0.001 in 2nd post intervention in intervention group even though the control group had non-significance.

TABLE 4.15: Mean differences of Serum ALT from baseline to follow up 02 in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BSALT-F1SALT	-0.064 ± 0.356	0.15	0.012 ± 0.490	0.37
F1SALT-F2SALT	0.000 ± 0.543	1	-0.025 ± 0.388	1.00
BSALT-F2SALT	-0.064 ± 0.539	0.34	-0.012 ± 0.435	<0.001

B; Baseline, F1; Follow-up 1, F2; Follow-up 2 and S; Serum and ALT; Alanine Amino Transferase

4.15 Statistical Comparison of Serum ALP among Control and Intervention Groups

The table 4.16 reported the serum ALP of both groups having significant result in control group of initial without intervention data to 1st follow-up, while interventional group mentioned the significance results p = 0.01 in start of study to post first intervention and from baseline to post second intervention with improvements shown as p = 0.01.

TABLE 4.16: Mean differences of Serum ALP rom baseline to follow up 02 in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BSALP-F1SALP	0.090 ± 0.380	0.03	-0.212 ± 0.740	0.01
F1SALP-F2SALP	-0.080 ± 0.380	0.31	0.010 ± 0.330	0.73
BSALP-F2SALP	0.080 ± 0.380	0.31	-2.000 ± 0.760	0.01

B; Baseline, F1; Follow-up 1, F2; Follow-up 2 and S; Serum and ALP; Alanine Amino Transferase

4.16 Statistical Comparison of Serum Random Blood Glucose among Control and Intervention Groups

As the table 4.17 indicated non-significant p values of both groups in serum RBG levels across follow-ups by Wilcoxon Signed Rank test with p= <0.05.

TABLE 4.17: Mean differences of Serum Random Blood Glucose from baseline to follow up 02 in control and intervention group

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BSRBG-F1SRBG	0.012 ± 1.037	0.93	0.290 ± 0.980	0.06
F1SRBG-F2SRBG	-0.050 ± 1.066	0.69	-0.060 ± 0.300	0.10

Table 4.17 continued from previous page

Parameters	**Control Mean Difference (Mean ± SD)**	**Control P value**	**Intervention Mean Difference (Mean ± SD)**	**Intervention P value**
BSRBG-F2RBG	-0.037 ± 0.892	0.76	0.220 ± 1.040	0.16

B; Baseline, F1; Follow-up 1, F2; Follow-up 2 and S; Serum and RBG; Random Blood Glucose

4.17 Statistical Comparison of Dialysis and Laboratory Parameters between Control and Intervention Group at Second Follow-up

This Table 4.18 presents the results of the Mann-Whitney U test comparing hemodialysis session and laboratory parameters between the intervention and control groups. A Mann-Whitney U test indicated statistically significant differences in session parameters, with higher mean ranks observed in the intervention group for all assessed variables p = < 0.05. In contrast, comparisons of serum hemoglobin, serum urea, serum potassium, serum calcium, serum chloride, serum ALT, and serum ALP between the intervention and control groups did not demonstrate statistically significant differences p > 0.05. Significant between-group differences were found for serum creatinine p = 0.009, serum sodium p = <0.001, serum phosphorus p = 0.003, and random blood glucose p = <0.001, with the intervention group generally showing higher mean ranks for these parameters.

TABLE 4.18: Comparison of Dialysis and Laboratory Parameter between control and intervention group by Mann-Whitney Signed Rank Test

Dialysis Parameters	**Control group Mean Rank**	**Intervention group Mean Rank**	**P value**
Pre dialysis Blood pressure	60.61	79.94	0.03
Post dialysis Blood pressure	44.02	92.8	<0.001
Pre dialysis weight	56.73	82.95	<0.001
Post dialysis weight	59.24	81	<0.001
Laboratory Parameters	**Control group Mean Rank**	**Intervention group Mean Rank**	**P value**

Table 4.18 continued from previous page

Dialysis Parameters	**Control group Mean Rank**	**Intervention group Mean Rank**	**P value**
Serum Hemoglobin	66.24	75.58	0.151
Serum Creatinine	79.24	65.5	0.029
Serum Urea	67.77	74.39	0.301
Serum Sodium	57.9	82.04	<0.001
Serum Potassium	74.31	69.33	0.357
Serum Calcium	65.92	75.83	0.131
Serum Phosphorus	59.18	81.05	<0.001
Serum Chloride	71.5	71.5	1
Serum Alanine Amino Transferase	77.99	66.47	0.08
Serum Alkaline Phosphatase	73.5	69.95	0.57
Serum Random Blood Glucose	58.81	81.81	<0.001

4.18 Statistical Comparison of Hemodialysis Session Parameters and Laboratory Parameters Between Control and Intervention Group at Second Follow-up

Below Table 4.19 showed comparison of hemodialysis session parameters values between control and intervention group, there was statistically significant results seen at second-follow-up in dialysis parameters with higher mean score in intervention group suggested by Wilcoxon signed rank test.

The test also showed the comparison report of laboratory values between control and intervention group stated that there were statistically significant results obtained.

The test also showed the comparison report of laboratory values between control and intervention group stated that there were statistically significant results obtained at second follow-up in serum urea, sodium, calcium, phosphorus, chloride, ALT, ALP and RBG having p = <0.05 and only non-significant results seen in serum HB, serum creatinine and serum potassium with p = >0.05.

TABLE 4.19: Comparison of Dialysis and Laboratory Parameter between control and intervention group by Wilcoxon Signed Rank Test

Dialysis Parameters	**Control group Mean ± Std.**	**Intervention group Mean ± Std.**	**P value**
Pre dialysis Blood pressure	2.516 ± 0.710	2.873 ± 0.890	<0.001
Post dialysis Blood pressure	1.919 ± 0.550	2.169 ± 1.250	<0.001
Pre dialysis weight	2.220 ± 0.711	2.845 ± 1.086	<0.001
Post dialysis weight	2.130 ± 0.718	2.718 ± 1.033	<0.001
Laboratory Parameters	**Control group Mean ± Std.**	**Intervention group Mean ± Std.**	**P value**
Serum Hemoglobin	1.790 ± 0.850	1.915 ± 0.729	0.6
Serum Creatinine	2.500 ± 0.741	2.440 ± 0.719	1
Serum Urea	2.530 ± 0.645	2.253 ± 0.728	0.001
Serum Sodium	1.640 ± 0.510	2.540 ± 1.070	<0.001
Serum Potassium	2.250 ± 0.510	2.230 ± 0.500	1
Serum Calcium	1.620 ± 0.510	2.420 ± 1.200	<0.001
Serum Phosphorus	2.430 ± 0.560	2.940 ± 3.480	<0.001
Serum Chloride	1.880 ± 0.440	2.680 ± 1.010	<0.001
Serum Alanine Amino Transferase	2.110 ± 0.400	3.470 ± 1.120	<0.001
Serum Alkaline Phosphatase	2.400 ± 0.550	2.850 ± 0.870	<0.001
Serum Random Blood Glucose	1.240 ± 0.610	2.240 ± 1.310	<0.001

4.19 Assessment of EQ-5D-3L Utility Scores Between Control and Intervention Groups

The utility assessment technique developed from 1st section of EQ-5D-3L scale, reveals patients observed quality of life rooted in 5 key health aspects. The table 4.20 illustrated from initial assessment to 1st visit after intervention , the mean score of control group decrease from 0.595 ± 0.419 to 0.473 ± 0.387 followed by further increased in follow-up 2 from follow-up 1 that is from 0.473 ± 0.387 to 0.530 ± 0.439. On the other hand the intervention group had a mean score from baseline to follow-up 1 were 0.497 ± 0.470 to 0.596 ±0.424 then further increase of mean score was observed from post first intervention to second post intervention were 0.607 ± 0.460 revealed that overall group mean increased with decreased of standard deviation.

TABLE 4.20: Mean and SD of EQ-5D-3L Utility scores among Control and Intervention groups from Baseline to follow up 02

Follow-ups	Control group (Mean ± SD)	Intervention group (Mean ± SD)
BEQ-5D-3L	0.595 ± 0.419	0.497 ± 0.470
F1EQ-5D-3L	0.473 ± 0.387	0.596 ±0.424
F2EQ-5D-3L	0.530 ± 0.439	0.607 ± 0.460

B-Baseline, F1; Follow-up 1, F2; Follow-up 2, EQ-5D-3L; three-level EuroQol five- dimensional questionnaire

4.19.1 Statistical Comparison of EQ-5D-3L Utility Scores Between Control and Intervention Groups

The statistical comparison of control and intervention group obtained at each follow-up stage by Wilcoxon Signed Rank Test. The table 4.21 suggested mean difference from Baseline to 2nd follow-up, the baseline score detected in usual group were 0.199 ± 0.462 (p= 0.01) while in intervention group the score was -0.165 ± 0.649 with non-significant p value of 0.08. From follow-up 1 to follow-up 2, the mean difference were -0.057 ± 0.504 in control group while in intervention group the score was 0.556 ± 0.561 with non-significant (p=0.99).

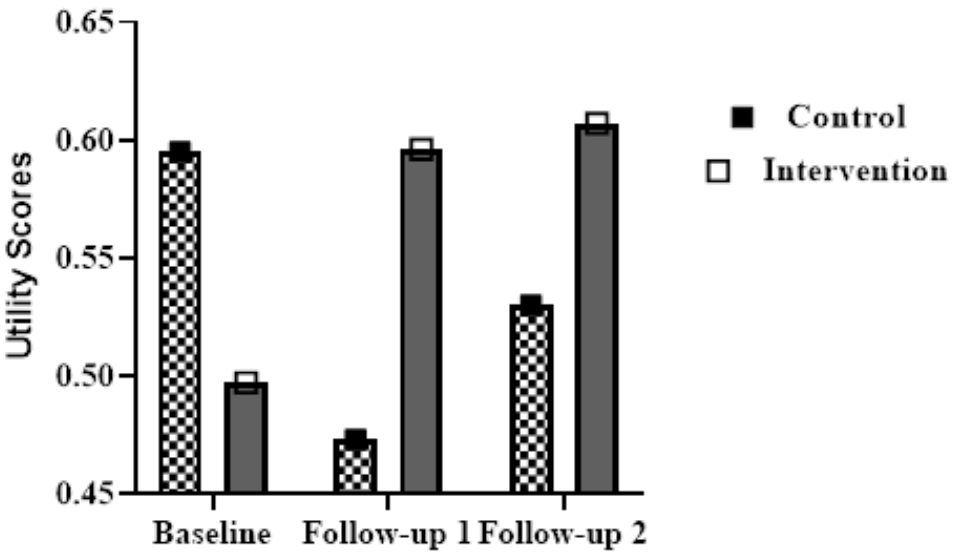

FIGURE 4.5: Comparison of Utility score among groups across follow-ups.

The mean difference from baseline to follow-up 2 suggested in intervention group were -0.109 ± 0.581with statistically significant (p = 0.03) illustrated individually patients quality of life improved compared to control group having p value 0.147 and mean difference was 0.143 ± 0.592. That reflects the positive impact of intervention as compared to control group by quality of life through mHealth platform.

TABLE 4.21: Wilcoxon Test for EQ-5D-3L Utility Scores

Follow-ups	**Control group (Mean ± SD)**	**P value**	**Intervention group (Mean ± SD)**	**P value**
BEQoL- F1EQoL	0.199 ± 0.462	0.01	-0.165 ± 0.649	0.08
F1EQoL- F2EQoL	-0.057 ± 0.504	0.385	0.556 ± 0.561	0.99
BEQoL- F2EQoL	0.143 ± 0.592	0.147	-0.109 ± 0.581	0.03

B; Baseline, F1; Follow-up 1, F2; Follow-up 2, EQoL; Euro Quality of life

4.19.2 Statistical Comparison of Utility Scores between Control and Intervention Group at Follow-up 2

The table 4.22 showed the statistical contrast of utility scores between control and intervention group by Mann- Whitney at follow-up 2. The test showed non-significant value (p= 0.975) with high mean rank of intervention group that is 71.59 as compared to control group which is 71.38, whereas the statistical comparison of VAS in control and intervention group by Mann-Whitney test presented the statistically significance results between groups comparisons of outcomes having p value of <0.001 with higher Mean rank of 79.73 in intervention group.

TABLE 4.22: Mann- Whitney for Utility Scores and EQ-5D-3L VAS between control and intervention group

Variable	**Control group Mean Rank**	**Intervention group Mean Rank**	**P value**
Utility scores	71.38	71.59	0.975
VAS	60.88	79.73	0.005

US; Utility Scores, VAS; Visual Analogue Scale

4.19.3 Statistical Comparison of Utility Scores between Control and Intervention Group at Follow-up 2

The below table 4.23 narrated statistically non-significant result with p = 0.476 of utility score among both groups with higher mean score of intervention group showing 0.607 ± 0.460 even though the statistically significant result obtained by Wilcoxon test with p = 0.003 with higher mean score and lesser standard deviation in EQ-5D-3L VAS score.

TABLE 4.23: Wilcoxon Signed Rank Test for Utility Scores and VAS between control and intervention group

Variable	**Control group Mean Rank**	**Intervention group Mean Rank**	**P value**
Utility scores	0.530 ± 0.439	0.607 ± 0.460	0.476
VAS	55.40 ± 11.09	60.56 ± 10.24	0.003

4.19.4 Descriptive Analysis of Visual Analogue Scale between Control and Intervention Group

The table 4.24 presents the descriptive analysis of mean and standard deviation of control and intervention groups across three follow-ups.

The VAS suggested patients' personal viewpoint of their overall health. From starting point of study to end of study in both groups the mean was differ from 41.45 ± 13.40 to 41.09 ± 13.46 reference initial point to first post intervention point in control group followed by further slightly decreased in follow-up 2 from follow-up 1 that was 40.20 ± 14.05 revealed that according to patients perception the quality of life was not improved in control group, whereas in intervention group.

The mean increased from initial without intervention assessment to 2nd visit after 2nd intervention, initially baseline mean was 43.75 ± 9.84 and further improved in follow-up 1 and two and had a mean of 52.32 ± 11.34 to 60.56 ± 10.24 respectively this confirmed the improved quality of life in intervention group.

TABLE 4.24: Mean and SD of Visual Analogue Scale (VAS) among Control and Intervention groups from Baseline to follow up 02

Follow-ups	**Control group (Mean ± SD)**	**Intervention group (Mean ± SD)**
BVAS	41.45 ± 13.40	43.75 ± 9.840
F1VAS	41.09 ± 13.46	52.32 ± 11.34
F2VAS	40.20 ± 14.05	60.56 ± 10.24

B; Baseline, F1; Follow-up 1, F2; Follow-up 2 and VAS; Visual Analogue Scale

4.19.5 Comparison of Mean VAS Score Changes between Control and Intervention Group

As below mention Table 4.25 demonstrated the statistically significant results of intervention groups by Wilcoxon signed rank test in VAS score, as from initial assessment to first visit of follow-up in control group, the mean difference was -8.112 ± 6.151 with non- significant p value of 0.104.

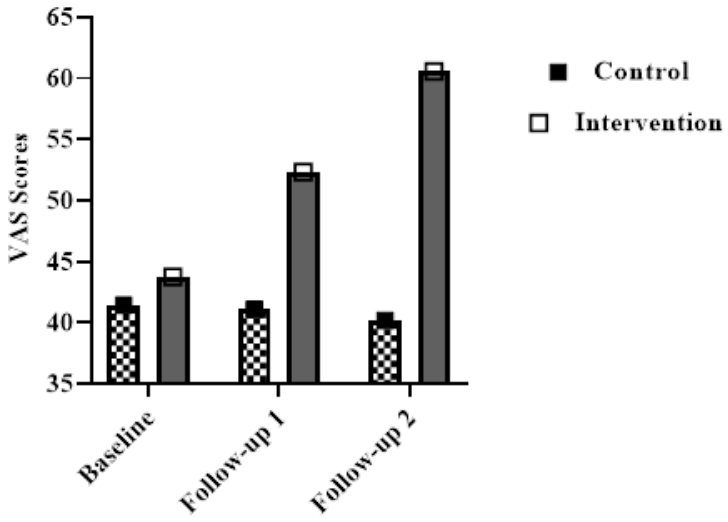

FIGURE 4.6: Comparison of VAS score among groups across follow-ups.

in follow-up 1 to follow-2 the mean score was increased -7.129 ± 6.197 with p = 0.313 then from baseline to follow-up 2 there was also a non- significant results of 0.991 with constant of mean score -7.129 ± 6.197, whereas in intervention group there is also a significant results p = <0.05 that is p = <0.001 from baseline to first follow-up the mean difference was - 8.572 ± 9.81, and from follow-up 1 to

follow-up 2 the mean difference was increased with significant result of <0.001 and then from baseline to follow-up 2 there was significant improvement with <0.001 significant result and mean reduction of -16.81 ± 7.30 as compared to control group there is better improvement in intervention group as their mean score was more reduced.

TABLE 4.25: Wilcoxon Test for VAS Score between control and intervention group

Follow-ups	**Control group (Mean ± SD)**	**P value**	**Intervention group (Mean ± SD)**	**P value**
BQoL6- F1QoL6	-8.112 ± 6.151	0.104	- 8.572 ± 9.810	<0.001
F1QoL6- F2QoL6	-7.129 ± 6.197	0.313	-8.240 ± 8.790	<0.001
BQoL6- F2QoL6	-7.129 ± 6.197	0.991	-16.81 ± 7.300	<0.001

B; Baseline, F1; Follow-up 1, F2; Follow-up 2 and QoL; Quality of life

4.19.6 Assessment of EQ-5D-3L Coding across Follow-ups in Both Groups

This Table 4.26 presents the distribution of EQ-5D-3L five-digit health-state codes across checkpoint of start and after intervention assessments in the control and intervention groups.

At baseline, 27 patients in the control group and 41 patients in the intervention group reported a health condition of 22222, which indicated moderate issues across all five EQ-5D categories. Fourteen control and twenty-six intervention participants had severe health restrictions (33333). In both groups (control: n = 2; intervention: n = 4), reports of optimal health status (11111) were rare. The results of baseline identified as mixed codes of 11122 of n=19 in control group and code 11122 from intervention group with n=9 respondents.

22222 continued to be the most prevalent health state in both groups after the initial follow-up, although the intervention group showed a relative shift toward better health states. In the intervention group, the frequency of 11111 rose from 4 to 21 patients, but it stayed constant in the control group (n = 2).

Severe health states (33333) decreased in the intervention group (n = 7) but stays unchanged in the usual group (n = 14). Only the control group (n = 18) had health statuses involving combined moderate and severe issues (22233), indicating worsening or ongoing impairment in this group.

The intervention group's health-state profiles had significantly improved by the second follow-up. Matched to 14 patients in the control group, the frequency of excellent health status (11111) increased to 19 patients in the intervention group. The code 22222 were common in dual groups, but when identify the frequencies the control group with n=12 and intervention n=35.

The control group showed severe and mixed health states besides codes (e.g., 33322, 33332, and 11211), whereas the intervention group showed no such complex severe profiles, indicating a general improvement and stabilization of health status after the pharmacist-led intervention.

TABLE 4.26: Coding of EQ-5D-3L across follow-ups in both groups

Follow-ups	**Coding of EQ-5D-3L**	**Control group(n)**	**Intervention group (n)**
Baseline	11111	2	4
	22222	27	41
	33333	14	26
	11122	0	9
	22211	19	0
Follow-up 1	11111	2	21
	22222	27	21
	33333	14	7
	11122	1	0
	22233	18	0
	33332	0	15
	33322	0	8
Follow-up 2	11111	14	19
	22222	12	35
	33333	3	21
	33322	17	0
	33332	8	0
	11211	8	0

4.20 Simple Mean and Standard Deviation of GMAS Domains between Control and Intervention Group

As mentioned in table 4.27, the mean score for Domain 1 (non-adherence due to patient behavior) in control group suggested that in baseline the mean score was (1.758 ±1.196) this score was increased in 1ST follow-up (2.129 ± 1.33) and in 2nd follow-up there were also increased of mean score (2.209 ± 1.202) showed an improvement of adherence in control group, whereas in intervention group, the baseline mean score detected was (1.562 ± 1.241) to increase in follow-ups. As presented in table the 1st follow-up showed the mean score was (1.937 ± 1.315) that was further improved to (2.562 ± 1.329) in 2nd follow-up confirmed the adherence.

In Domain 2 (non- adherence due to additional disease and pill burden) the control group showed mean score in baseline was (2.096 ± 1.500) this score improved in 1st follow-up and was (2.29 ± 1.33) revealed that there were improvement of adherence, from follow-up 1 towards two the mean also increased and was (2.516 ± 1.315) in control group, while in intervention group the baseline score was (2.487 ± 1.359) initially after intervention the score of adherence improved in 2nd follow-up by (2.600 ± 1.374).

Domain 3 (non-adherence due to financial constraints) had a baseline mean o (1.693 ± 1.337) in control group this was further improved in1st follow-up and 2nd follow-up by (2.338 ± 1.447) and (2.532 ± 1.314) correspondingly while intervention group mean score of baseline was (2.06 ± 1.315) which after intervention improved the mean score and up to (2.72 ± 1.302) to (2.77 ± 1.211) in follow-up 1 and 2.

TABLE 4.27: B; Baseline, F1; Follow-up 1, F2; Follow-up

Follow-ups	**Control group (Mean ± SD)**	**Intervention group (Mean ± SD)**
Domain 1: Non-Adherence due to patient behavior (un-intentional and intentional)		

Table 4.27 continued from previous page

Follow-ups	**Control group (Mean ± SD)**	**Intervention group (Mean ± SD)**
Baseline	1.758 ±1.196	1.562 ± 1.241
Follow-up 1	2.129 ± 1.330	1.937 ± 1.315
Follow-up 2	2.209 ± 1.202	2.562 ± 1.329
Domain 2: Non-adherence due to additional disease and pill burden		
Baseline	2.096 ± 1.500	2.487 ± 1.359
Follow-up 1	2.516 ± 1.315	2.712 ± 1.274
Follow-up 2	2.612 ± 1.246	2.600 ± 1.374
Domain 3: Non-adherence due to financial constraints		
Baseline	1.693 ± 1.337	2.06 ± 1.315
Follow-up 1	2.338 ± 1.447	2.72 ± 1.302
Follow-up 2	2.532 ± 1.314	2.77 ± 1.211

4.21 Non-Adherence Due to Patient Behavior between control group and intervention Group

The Table 4.28 showed the adherence level in terms of frequency and percent between control and intervention group across follow-ups, initially from baseline both groups showed the less percent of high adherence such as in control group 07 (11.3%) and 07 (8.8%) in intervention group, while the good adherence reported in both groups were 07 (11.3%) and 12 (15.0%) respectively. In contrast, a high portion showed partial adherence in control group that were 22 (35.5%) and 18 (22.5%) in intervention group and remaining were low and poor adherence with a percentage of 16 (25.8%) and 25 (31.3%) with low adherence and 10 (16.1%) and 18 (22.5%) with poor adherence.

By follow-up 1 the marked increase of percentage of all domains in both groups were presented in table as shown that the high adherence that were 12 (19.4%) and 12 (15.0%) in control and intervention group while the good and partial adherence

also increased to 12 (19.4%) and 18 (22.5%) with good adherence and 21 (33.9%) and 15 (18.8%) respectively. The low and poor adherence dropped towards lower percentage from baseline as 06 (9.7%) and 23 (28.7%) with low adherence and 11 (17.7%) and 12 (15.0%) with poor adherence in control and intervention group in similar way. At follow-up 2 the adherence further improved. High adherence reached 11 (17.7%) and 24 (30.0%), good adherence peaked at 13 (21.0%) and 25 (31.3%) in control and intervention group similarly. Meanwhile, the partial, low and poor adherence were decreased to 22 (35.5%), 11 (13.8%), 10 (16.1%) and 12 (15.0%), 06 (9.7%) and 08 (10.0%) respectively in control and intervention groups.

TABLE 4.28: Adherence levels in Domain

Grading 1 Baseline	**Control group n=62 (%)**	**Intervention group n=80 (%)**
High Adherence	07 (11.3)	07 (8.8)
Good Adherence	07 (11.3)	12 (15.0)
Partial Adherence	22 (35.5)	18 (22.5)
Low Adherence	16 (25.8)	25 (31.3)
Poor Adherence	10 (16.1)	18 (22.5)
Grading 1 Follow-up 1	**Control group n=62 (%)**	**Intervention group n=80 (%)**
High Adherence	12(19.4)	12 (15.0)
Good Adherence	12 (19.4)	18 (22.5)
Partial Adherence	21 (33.9)	15 (18.8)
Low Adherence	06 (9.7)	23 (28.7)
Poor Adherence	11 (17.7)	12 (15.0)
Grading 1 Follow-up 2	**Control group n=62(%)**	**Intervention group n=80 (%)**
High Adherence	11 (17.7)	24 (30.0)
Good Adherence	13 (21.0)	25 (31.3)
Partial Adherence	22 (35.5)	11 (13.8)
Low Adherence	10 (16.1)	12 (15.0)
Poor Adherence	06 (9.7)	08 (10.0)

4.21.1 Non-Adherence Due to Disease Burden and Polypharmacy

In the baseline the non-adherence due to polypharmacy and comorbid conditions was significant. Only 13 (21.0%) and 21 (26.3%) showed high adherent, with 18 (29.0%), 27 (33.8%) showing good adherence in both groups. The remaining were

mostly have partial adherence that were 08 (12.9%) and 14 (17.5%) in both groups followed by low and poor adherence that were 08 (12.9%) and 06 (7.5) whereas 15 (24.2%) and 12 (15.0%) in control and intervention groups.

At 1st follow-up the adherence was somehow increased with respect to baseline in both groups that were 16 (25.8%) and 27 (33.8%) in both groups then on good adherence the percentage were 20 (32.3%) and 24 (30.0%) while partial adherence were 15 (24.2%) in usual group and 16 (20.0%) in intervention group. The remaining percent were low and poor responses of adherence in both groups that were 02 (3.2%) and 05 (6.3%) with low adherence whereas the poor adherence were 09 (14.5%) and 08 (10.0%) in both groups.

At 2nd follow-up, the adherence more increased in high and good adherence and showed as 18 (29.0%) and 27 (33.8%) while good adherence was 18 (29.0%) and 22 (27.5%) in both groups. Remaining percentage showed partial, low and poor adherence in both groups percentages of 16 (25.8%), 13 (16.3%), 04 (6.5%), 08 (10.0%) and 06 (11.3%), 10 (12.5%) correspondingly.

Table 4.29: Adherence levels in Domain

Grading 2 Baseline	**Control group n=62 (%)**	**Intervention group n=80 (%)**
High Adherence	13 (21.0)	21 (26.3)
Good Adherence	18 (29.0)	27 (33.8)
Partial Adherence	08 (12.9)	14 (17.5)
Low Adherence	08 (12.9)	06 (7.5)
Poor Adherence	15 (24.2)	12 (15.0)
Grading 2 Follow-up 1	**Control group n=62 (%)**	**Intervention group n=80 (%)**
High Adherence	16 (25.8)	27 (33.8)
Good Adherence	20 (32.3)	24 (30.0)
Partial Adherence	15 (24.2)	16 (20.0)
Low Adherence	02 (3.2)	05 (6.3)
Poor Adherence	09 (14.5)	08 (10.0)
Grading 2 Follow-up 2	**Control group n=62 (%)**	**Intervention group n=80 (%)**
High Adherence	18 (29.0)	27 (33.8)
Good Adherence	18 (29.0)	22 (27.5)
Partial Adherence	16 (25.8)	13 (16.3)
Low Adherence	04 (6.5)	08 (10.0)
Poor Adherence	06 (9.7)	10 (12.5)

4.21.2 Non-Adherence Due to Financial Constraints

At baseline of domain 3, only small responses ranked on high adherence and good in both groups that were 08 (12.9%), 10 (16.1%) and 14 (17.5%), 17 (21.3%).However the partial, low and poor responses were 13 (21.0%), 17 (27.4%), 14 (22.6%), 21 (26.3%), 16 (20.0%) and 12 (15.0%) accordingly.

At 1st follow-up, the high adherence moved towards 19 (30.6%) and 32 (40.0%) in both groups, and good adherence also improved in both groups and up to 11 (17.7%) and 15 (18.8%) in similar way. The partial, low and poor adherence was somehow reduced to 14 (22.6%), 08 (12.9%) and 10 (16.1%) in control group and 18 (22.5%), 09 (11.3%) and 06 (7.5%) in intervention group.

By 2nd follow-up, the adherence further improved and showed in control group were 18 (29.0%) with high and 18 (29.0%) with good in control group same as the percentage for intervention group were 29 (36.3%) with high and 21 (26.3%) with good adherence showed that improvement from baseline. The partial adherence reduced to 11 (17.7%) in control and 18 (22.5%) in interventions group, low adherence were 09 (14.5%) in control and 07 (8.8%) in intervention group and poor adherence to 06 (9.7%) in control and 05 (6.3%) in intervention group.

Table 4.30: Adherence levels in Domain

Grading 3 Baseline	**Control group n=62 (%)**	**Intervention group n=80(%)**
High Adherence	08 (12.9)	14 (17.5)
Good Adherence	10 (16.1)	17 (21.3)
Partial Adherence	13 (21.0)	21 (26.3)
Low Adherence	17 (27.4)	16 (20.0)
Poor Adherence	14 (22.6)	12 (15.0)
Grading 3 Follow-up 1	**Control group n=62 (%)**	**Intervention group n=80 (%)**
High Adherence	19 (30.6)	32 (40.0)
Good Adherence	11 (17.7)	15 (18.8)
Partial Adherence	14 (22.6)	18 (22.5)
Low Adherence	08 (12.9)	09 (11.3)
Poor Adherence	10 (16.1)	06 (7.5)
Grading 3 Follow-up 2	**Control group n=62 (%)**	**Intervention group n=80 (%)**
High Adherence	18 (29.0)	29 (36.3)
Good Adherence	18 (29.0)	21 (26.3)

Table 4.30 continued from previous page

Grading 3 Baseline	Control group n=62 (%)	Intervention group n=80(%)
Partial Adherence	11 (17.7)	18 (22.5)
Low Adherence	09 (14.5)	07 (8.8)
Poor Adherence	06 (9.7)	05 (6.3)

4.21.3 Assessment of Overall GMAS score between control and Intervention Group

The below table 4.31 showed the mean and standard deviation of overall medication adherence scale between control and intervention group, as shown in table from starting results to ending results, the mean score was increased in both control and intervention group the baseline mean was 1.87 ± 0.735 in control group then further increased to 2.24 ± 0.803 and 2.22 ± 0.663 accordingly. In intervention group the baseline mean score was 1.98 ± 0.803 which further increased to 2.35 ± 0.969 and then 2.51 ± 1.006 respectively showing improvement of adherence in both groups.

TABLE 4.31: Mean and SD of GMAS (General Medication Adherence Scale) among Control and Intervention groups from Baseline to follow up 02

Follow-ups	Control group (Mean ± SD)	Intervention group (Mean ± SD)
Baseline	1.870 ± 0.735	1.980 ± 0.803
Follow up 1	2.240 ± 0.803	2.350 ± 0.969
Follow up 2	2.220 ± 0.663	2.510 ± 1.006

B; Baseline, F1; Follow-up 1, F2; Follow-up

4.21.4 Statistical Comparison of Overall GMAS Scale between Control and Intervention Group

This Table 4.32 presented the mean difference and p value of control and intervention group. From baseline to follow-ups the statistically significant difference was recorded in both group as from baseline to 1st follow-up, the mean difference was -0.362 ± 1.082 (p= 0.003) in intervention group while the mean score was -0.37 ± 0.927 (p= 0.003) in control group. From 1st follow-up to 2nd follow-up in

both groups had non-significant results while from baseline to 2nd follow-up there were statistically significant improvement in both groups having p value of 0.001 in intervention group with mean difference of -0.525 ± 1.359 and control group had mean difference of -0.354 ± 1.025 with p=0.008.

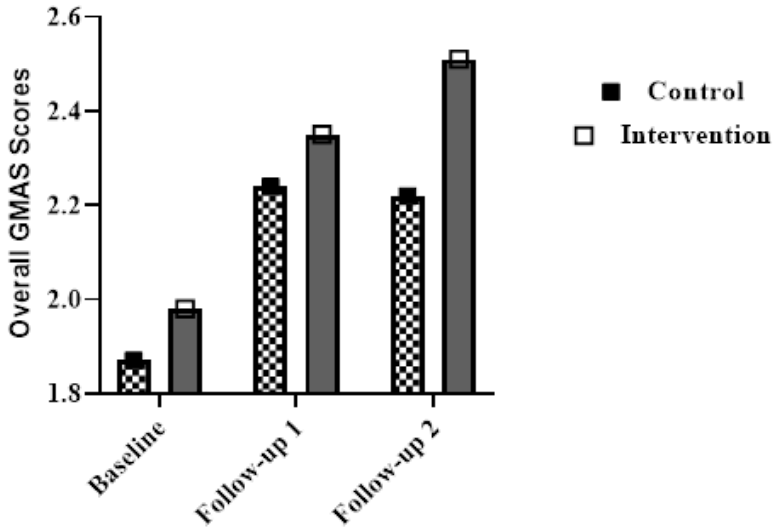

FIGURE 4.7: Comparison of overall GMAS score among groups across follow-ups.

TABLE 4.32: Mean difference and p value of GMAS (General Medication Adherence Scale) among Control and Intervention groups from Baseline to follow up 02

Follow-ups	**Control group (Mean ± SD)**	**P value**	**Intervention group (Mean ± SD)**	**P value**
B-F1	-0.370 ± 0.927	0.003	-0.362 ± 1.082	0.003
F1-F2	0.016 ± 0.983	0.9	-0.162± 1.247	0.228
B-F2	-0.354 ± 1.025	0.008	-0.525 ± 1.359	0.001

B; Baseline, F1; Follow-up 1, F2; Follow-up

4.21.5 Statistical Comparison of Overall GMAS Adherence Scale at Follow-up 2 by Mann-Whitney

The Table 4.33 displayed statistically significant result of overall GMAS adherence scale between control and intervention group at follow-up 2 by Mann-Whitney

having p=0.04 with higher mean rank of 76.66 in intervention group suggested more significant improvement of adherence in intervention group compared with control.

TABLE 4.33: Mean rank of Overall GMAS Score by Mann-Whitney between groups at follow-up 2

Variable	**Control group Mean Rank**	**Intervention group Mean Rank**	**P value**
Overall GMAS Score	64.84	76.66	0.04

GMAS; General Medication Adherence Scale

4.21.6 Statistical Comparison of GMAS Adherence Scale and QoL between Control and Intervention Group at Second Follow-up

The table 4.34 showed the Wilcoxon signed rank test between control and intervention group across GMAS Adherence Scale at follow-up 2. The marginally significance difference detected in GMAS overall domain with (p = 0.05).

TABLE 4.34: Mean SD of Overall GMAS Score by Wilcoxon Test in both groups at follow-up 2

Variable	**Control group Mean Rank**	**Intervention group Mean Rank**	**P value**
Overall GMAS Score	2.220 ± 0.660	2.510 ± 1.000	0.05

4.22 Assessment of Telehealth Usability Questionnaire in Intervention Group at First Baseline

4.22.1 Domain 1

The Table 4.35 demonstrated the frequency and percentages of responses of Telehealth questionnaire in domain 1 usefulness across follow-ups, this domain had several variables the first variable that is telehealth helps to improves health had

initially high neutral score in follow-up 1, 37 (46.3%), disagree 26 (32.5%) minority responses were strongly disagree 04 (5.0%), followed by agree 09 (11.3%) and strongly agree was only 04 (5.0 %). In second variable of same domain, that telehealth saves time of traveling to hospital had majority responses towards neutral and agree in baseline 24 (30.0%) and 28 (35.0%) showing disagree with 12 (15.0%) whereas strongly disagree and strongly agree were 07 (8.8%) and 09 (11.3%) respectively.

In third variable the telehealth provides my healthcare needs had responses of baseline were strongly disagree, disagree, neutral, agree and strongly agree were 06 (7.5%), 09 (11.3%), 20 (25.0%), 28 (35.0%) and 17 (21.3%) correspondingly.

Table 4.35: Responses of TUQ Domain 1 at baseline

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
Telehealth improves my access to healthcare services.	B	04 (5.0)	26 (32.5)	37 (46.3)	09 (11.3)	04 (5.0)
Telehealth saves me time travelling to the hospital/ clinic.	B	07 (8.8)	12 (15.0)	24 (30.0)	28 (35.0)	09 (11.3)
Telehealth provides for my healthcare needs.	B	06 (7.5)	9 (-11.3)	20 (25.0)	28 (-35.0)	17 (21.3)

Domain 1 (Usefulness) B; Baseline SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

4.22.2 Domain 2

At the baseline, responses regarding the ease of use of the telehealth system showed that 7 (8.8%) participants strongly disagreed, 10 (12.8%) disagreed, 30 (37.5%) were neutral, 15 (18.8%) agreed, and 18 (22.5%) strongly agreed that the telehealth system was easy to use. For the item assessing learning to use the telehealth system, most responses were neutral and agree, with 20 (25.0%) selecting neutral and 32 (40.0%) selecting agree, while 9 (11.3%) strongly disagreed, 9 (11.3%) disagreed, and 10 (12.5%) strongly agreed. Regarding the statement "I could become productive quickly using this system," responses were distributed as 13

(16.3%) strongly disagree, 15 (18.8%) disagree, 23 (28.7%) neutral, 10 (12.5%) agree, and 19 (23.8%) strongly agree.

TABLE 4.36: Responses of TUQ Domain 2 at baseline

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
It was simple to use this system.	B	07 (8.8)	10(12.8)	30 (37.5)	15 (18.8)	18 (22.5)
It was easy to learn to use the system.	B	09 (11.3)	09 (11.3)	20 (25.0)	32 (40.0)	10 (12.5)
I believe I could become productive quickly using this system.	B	13(16.3)	15 (18.8)	23 (28.7)	10 (12.5)	19 (23.8)

Domain 2 (Ease of Use and Learnability) B; Baseline SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

4.22.3 Domain 3

In this domain of different variables the majority of responses in baseline of lie in neutral and agree with greater percentages and rest of responses with disagree, strongly disagree and strongly agree.

TABLE 4.37: Responses of TUQ Domain 3 at baseline

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
The way I interact with this system is pleasant.	B	05 (6.3)	14 (17.5)	30 (37.5)	23 (28.7)	08 (10.0)
I like using this system.	B	07 (8.8)	10 (12.5)	18 (22.5)	31 (38.8)	14 (17.5)
The system is simple and easy to understand.	B	07 (8.8)	11 (13.8)	26 (32.5)	24 (30.0)	12 (15.0)
This system can do everything I would want it to be able to do.	B	02 (2.5)	13 (16.3)	30 (37.5)	28 (35.0)	07 (8.8)

Domain 3 (Interface Quality) B; Baseline SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

4.22.4 Domain 4

Overall, patients stated a positive communication practice with the telehealth system. Regarding ease of communication with clinician, a greater responses towards neutral and agree with 33.8% and 30.0% while in terms of auditory responses had highly neutral responses in baseline with 45.0% and in-terms of self-expression majority responses were neutral and agree showing 35.0% and 36.3% whereas the responses by using telehealth as in-person meeting had more on neutral and agree with 30.0 %.

TABLE 4.38: Responses of TUQ Domain 4 at baseline

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
I could easily talk to the clinician using telehealth system.	B	07(8.8)	10 (12.5)	27 (33.8)	24 (30.0)	12 (15.0)
I could hear the healthcare using the telehealth.	B	05 (6.3)	16 (20.0)	36 (45.0)	13 (16.3)	09 (11.3)
I felt I was able to express myself effectively.	B	04 (5.0)	11 (13.8)	28 (35.0)	29 (36.3)	08 (10.0)
Using the telehealth system, I could see the clinician as if we met in person.	B	04 (5.0)	13 (16.3)	24 (30.0)	24 (30.0)	15 (18.8)

Domain 4 (Interaction Quality) B; Baseline SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

4.22.5 Domain 5

The domain 5 suggested in their variable that telehealth system provided same like in-person which reported highly responses were neutral and agree with 37.5% and 28.7% respectively.

In baseline while in other variable that I was easily recover after mistake by using telehealth system demonstrated agree and neutral with 30.0% and 37.5% with minor responses were strongly disagree, disagree and agree.

Most respondents found the system's error messages helpful, with the majority selecting neutral to agree that the messages clearly guided them on how to fix problems with 22.5% and 28.7%.

TABLE 4.39: Responses of TUQ Domain 5 at baseline

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
I think the visits provided over the telehealth system are the same as in-person visits.	B	05(6.3)	12 (15.0)	30 (37.5)	23 (28.7)	10 (12.5)
Whenever I made a mistake using the system, I could quickly recover.	B	07 (8.8)	08 (10.0)	30 (37.5)	24 (30.0)	11 (13.8)
The system gave error messages that told me how to fix problems.	B	09 (11.3)	16 (20.0)	18 (22.5)	23 (28.7)	14(17.5)

Domain 5 (Reliability) B; Baseline SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

4.22.6 Domain 6

Most felt comfortable communicating with clinicians, with the majority responding neutral to agree having 42.5% to 28.7%, while other variable that telehealth was also viewed as an acceptable mode of healthcare delivery rated mostly 33.8% on neutral and agree remaining variable that willingness to use telehealth in the future was similarly high with agree responses 31.3%, with most participants indicating they would use the service again. Another variable of same domain that overall satisfaction with the system was favorable, with the majority selecting neutral to strongly agree, indicating a generally positive user experience with 28.7% to 27.5% responses.

TABLE 4.40: Responses of TUQ Domain 6 at baseline

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
I feel comfortable communicating with the clinicians using the telehealth system.	B	01 (1.3)	13 (16.3)	34 (42.5)	23 (28.7)	09 (11.3)

Table 4.40 continued from previous page

Variable	Follow-ups	SD (n%)	D (n%)	N (n%)	A (n%)	SA (n%)
Telehealth is an acceptable way to receive healthcare services.	B	11(13.8)	06 (7.5)	27 (33.8)	27 (33.8)	09 (11.3)
I would use telehealth services again.	B	08 (10.0)	16 (20.0)	21 (26.3)	25 (31.3)	10 (12.5)
Overall, I am satisfied with this telehealth system.	B	11(13.8)	11 (13.8)	23 (28.7)	22 (27.5)	13 (16.3)

Domain 6 (Satisfaction and Future Use) B; Baseline SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

4.22.7 Assessment of Telehealth Usability Questionnaire in Intervention Group at Follow-up 2

4.22.7.1 Domain 1

Respondents reported generally positive views of telehealth in terms of healthcare access and convenience at 2nd follow-up. Most agreed that telehealth improved their access to healthcare services, with a majority selecting neutral to agree responses with 40.0% and 32.5%. The other area of domain that time-saving advantages were visibly documented, as over 70% agreed and strongly agreed that telehealth reduced travel time to the hospital or clinic.

Table 4.41: Responses of TUQ Domain 1 at follow-up 2

Variable	Follow-ups	SD (n%)	D (n%)	N (n%)	A (n%)	SA (n%)
Telehealth improves my access to healthcare services.	F2	03 (3.8)	04 (5.0)	32 (40.0)	26 (32.5)	15 (18.8)
Telehealth saves me time travelling to the hospital/clinic.	F2	02 (2.5)	08 (10.0)	11 (13.8)	32 (40.0)	27 (33.0)
Telehealth provides for my healthcare needs.	F2	03 (3.8)	08 (10.0)	10 (12.5)	33 (41.3)	26 (32.5)

Domain 1 (Usefulness) F2; Follow-up 2 SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

Similarly, most participants felt that telehealth system effectively gathered their healthcare needs, with the highest proportion responding in agree and strongly agree categories with high percentages.

4.22.8 Domain 2

In this domain of various variables having majority respondents towards agree and strongly agree with high percentages. The area of simply use the telehealth system showed 36.3% and 30.0% responses while the area of learning system had 45.0% and 22.5% whereas the mostly responses from the variable that participants could productive quickly using this system had 42.5% and 20.0% with agree and neutral responses.

TABLE 4.42: Responses of TUQ Domain 2 at follow-up 2

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
It was simple to use this system.	F2	02 (2.5)	05 (6.3)	20 (25.0)	29 (36.3)	24 (30.0)
It was easy to learn to use the system.	F2	02 (2.5)	07(8.8)	17 (21.3)	36 (45.0)	18 (22.5)
I believe I could become productive quickly using this system.	F2	05 (6.3)	10 (12.5)	16 (20.0)	34 (42.5)	15 (18.8)

Domain 2 (Ease of Use and Learnability) F2; Follow-up 2 SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

4.22.9 Domain 3

This domain had various variables having majority responses of patients were agree with greater percentages.

The telehealth system interface was pleasant stated 48.8% responses of agree while regarding system like the patients had mostly towards strongly agree showing 33.8% whereas the variable in which patients told that telehealth system was easy and understandable had 31.3% with strongly agree and remaining variable having this system had all features that patients want to able to do had mostly agree responses with 33.8%.

TABLE 4.43: Responses of TUQ Domain 3 at follow-up 2

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
The way I interact with this system is pleasant.	F2	05 (6.3)	04 (5.0)	15 (18.8)	39 (48.8)	17 (21.3)
I like using this system.	F2	09 (11.3)	06 (7.5)	15 (18.8)	23 (28.7)	27 (33.8)
The system is simple and easy to understand.	F2	07 (8.8)	08 (10.0)	18 (22.5)	22 (27.5)	25 (31.3)
This system can do everything I would want it to be able to do.	F2	03 (3.8)	05 (6.3)	21 (26.3)	27 (33.8)	24 (30.0)

Domain 3 (Interface Quality) F2; Follow-up 2 SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

4.22.10 Domain 4

At second follow-up, patients continued to report strong communication experiences with the telehealth system. Most found it easy to talk to the clinician, with more than 60% agreeing or strongly agreeing. Hearing the healthcare provider was also rated positively, as mostly responses towards agree and strongly agree showing 38.8% and 27.5%. The ability to express themselves effectively, with 75% choosing agree and strongly agree. Visual interaction results also fall in satisfactory level, as the majority felt they could see the clinician clearly, similar to an in-person meeting. Overall, the F2 results indicate consistently positive communication usability of the telehealth platform.

TABLE 4.44: Responses of TUQ Domain 4 at follow-up 2

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
I could easily talk to the clinician using telehealth system.	F2	07 (8.8)	07 (8.8)	16 (20.0)	21 (26.3)	29 (36.3)
I could hear the healthcare using the telehealth.	F2	06 (7.5)	03 (3.8)	18 (22.5)	31 (38.8)	22 (27.5)
I felt I was able to express myself effectively.	F2	02(2.5)	03 (3.8)	15 (18.8)	34 (42.5)	26 (32.5)

Table 4.44 continued from previous page

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
Using the telehealth system, I could see the clinician as if we met in person.	F2	08 (10.0)	06 (7.5)	16 (20.0)	22 (27.5)	28 (35.0)

Domain 4 (Interaction Quality) F2; Follow-up 2 SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

4.22.11 Domain 5

Patients generally seen telehealth visits as similar to in-person consultations, with more respondents were towards agreeing with 32.5% and neutral with 26.3%. Usability remained strong, as the majority reported agreeing with 32.5% that they could quickly recover from mistakes made while using the system.

Additionally, the system's error messages were considered helpful, with over 60% agreed and strongly agreed that the messages clearly guided them in resolving problems.

Overall, the 2nd follow-up findings reflect positive user confidence in both the functionality and reliability of the telehealth platform.

Table 4.45: Responses of TUQ Domain 5 at follow-up 2

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
I think the visits provided over the telehealth system are the same as in-person visits	F2	08(10.0)	06 (7.5)	21 (26.3)	26 (32.5)	19 (23.8)
Whenever I made a mistake using the system, I could quickly recover.	F2	08 (10.0)	06 (7.5)	21 (26.3)	26 (32.5)	19 (23.8)
The system gave error messages that told me how to fix problems.	F2	02 (2.5)	05 (6.3)	22 (27.5)	30 (37.5)	21 (26.3)

Domain 5 (Reliability) F2; Follow-up 2 SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

4.22.12 Domain 6

Respondents reported progressive viewpoints toward the telehealth system. Most sensed comfortable communicating with clinicians, with the majority responding agree and strongly agree having 45.0% to 30.0%, while other variable that telehealth was also noticed as an acceptable mode of healthcare delivery rated mostly 43.8% on agree remaining variable that willingness to use telehealth in the future was

Similarly high with agree responses 33.8%, with most participants indicating they would use the service again. Another variable of same domain that overall satisfaction with the system was favorable, with the majority selecting agree and strongly agree 36.3% and 26.3% indicating a generally positive user experiences.

TABLE 4.46: Responses of TUQ Domain 6 at follow-up 2

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
I feel comfortable communicating with the clinicians using the telehealth system.	F2	01 (1.3)	1 (1.3)	18 (22.5)	36 (45.0)	24 (30.0)
Telehealth is an acceptable way to receive healthcare services.	F2	02 (2.5)	10 (12.5)	12 (15.0)	35 (43.8)	21 (26.3)
I would use telehealth services again.	F2	02 (2.5)	07 (8.8)	19 (23.8)	27 (33.8)	25 (31.3)
Overall, I am satisfied with this telehealth system.	F2	08 (10.0)	12(15.0)	10 (12.5)	29 (36.3)	21 (26.3)

Domain 6 (Satisfaction and Future Use) F2; Follow-up 2 SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

4.22.13 Assessment of Telehealth Usability Questionnaire in Intervention Group across Follow ups

This Table 4.47 suggested the frequencies and percentages of respondents at baseline by using TUQ, initially the majority responses are very low and moderate with percentages of 27.5% and 22.5%, followed by low, very high and high indicating 22.5%, 18.8% and 16.3% accordingly.

TABLE 4.47: Telehealth Usability Questionnaire (TUQ) Scorings of domains across follow

Scoring of Baseline	**Intervention group n (%)**
Very low ($\leq$ 13 points)	22 (27.5)
Low (14-36 points)	15 (18.8)
Moderate (37-59 points)	18 (22.5)
High (60-82 points)	12 (15.0)
Very high (83-105 points)	13 (16.3)

Responses: very low ($\leq$ 13 points), Low (14-36 points), Moderate (37-59 points), High (60-82 points) and Very high (83-105 points)

The table 4.48 stated the follow-up 2 responses of participants confirmed the use of telehealth system in healthcare have positive impact in their needful life showed majority had very high and high percentages of 27.5% and 25.0% followed by low, moderate and very low with 21.3%, 13.8% and 12.5% indicated improvement of responses towards high.

TABLE 4.48: Telehealth Usability Questionnaire (TUQ) Scorings of domains across follow

Scoring of Follow-up 2	**Intervention group n (%)**
Very low ($\leq$ 13 points)	10 (12.5)
Low (14-36 points)	17 (21.3)
Moderate (37-59 points)	11 (13.8)
High (60-82 points)	20 (25.0)
Very high (83-105 points)	22 (27.5)

Responses: very low ($\leq$ 13 points), Low (14-36 points), Moderate (37-59 points), High (60-82 points) and Very high (83-105 points)

4.22.14 Mean and Standard Deviation of Telehealth Usability Questionnaire across Follow-ups

The Table 4.49 showed the mean and standard deviation of telehealth usability questionnaire across follow-ups with initially at baseline 2.737 $\pm$ 1.429 mean score and this would be increased in follow-up 2 with mean score of 3.333 $\pm$ 1.404 established that TUQ helped patients in their healthcare needs to communicate with healthcare provider.

TABLE 4.49: Mean and standard deviation of TUQ across follow-ups

Follow-ups	**Mean ±SD**
Baseline	2.737 ± 1.429
Follow-up 2	3.333 ± 1.404

B; Baseline and F2; Follow-up 2

4.22.15 Statistical Comparison of Telehealth Usability Questionnaire across Follow-ups

The Wilcoxon Signed Rank Test had demonstrated statistically significant result having p = 0.01 with mean score of -0.596 ± 2.108 to 0.596 ± 2.108 in follow-ups of TUQ, elaborated that by using this telehealth system patients get benefited their needs by communicating with healthcare.

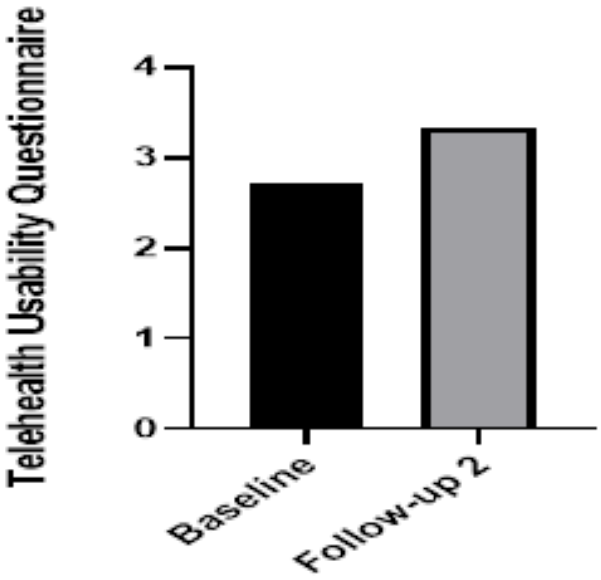

FIGURE 4.8: Comparison of Telehealth Usability Questionnaire in intervention group across follow-ups.

TABLE 4.50: Mean difference and p value of TUQ across follow-ups by Wilcoxon Signed Rank Test

Follow-ups	**Mean Difference ± SD**	**P value**
B_TUQ- F2_TUQ	-0.600 ± 2.108	0.01
F2_TUQ- B_TUQ	0.600 ± 2.108	

B; Baseline, F2; Follow-up 2 and TUQ; Telehealth Usability Questionnaire

4.23 Assessment of Pharmacist Intervention Questionnaire in Baseline

Table 4.51 presents patients' responses regarding pharmacist-led interventions at baseline. For medication education, the highest proportion of participants selected strongly disagree (42.5%), followed by neutral (17.5%), while lower responses were observed for disagree (15.0%), agree (12.5%), and strongly agree (12.5%). In the dietary advice domain, most responses were negative, with 31.3% strongly disagree and 30.0% disagree, whereas 38.9% of participants reported neutral to positive responses. Similarly, in the medication reminder domain, 43.8% of respondents selected strongly disagree or disagree, while the remaining 56.3% reported neutral, agree, or strongly agree responses.

TABLE 4.51: Responses of patients across follow-ups in Pharmacist Intervention Questionnaire

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
The pharmacist educated me about each of my prescribed medicines.	B	34 (42.5)	12 (15.0)	14 (17.5)	10 (12.5)	10 (12.5)
I received personalized dietary advice from the pharmacist during dialysis care.	B	25 (31.3)	24 (30.0)	05 (6.3)	13 (16.3)	13 (16.3)
The pharmacist reminded me regularly to take my medications as prescribed.	B	13 (16.3)	22 (27.5)	14 (17.5)	15 (18.8)	16 (20.0)

B; Baseline Responses coded on a 5-point Likert scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

4.23.1 Assessment of Pharmacist Intervention Questionnaire in Follow-up 1

This table 4.52 indicated the follow-up 1 responses of various measures having counselling of patients regarding their medications had higher responses of neutral and agree with 22.5% and 30.0%, the dietary advise domain had most of responses

with strongly agree 36.3% and concerning to medication reminders there were also higher responses of strongly agree with 33.8% while others in all fields of this domain had other responses were towards disagree and strongly disagree as compared to baseline.

TABLE 4.52: Responses of patients across follow-ups in Pharmacist Intervention Questionnaire

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
The pharmacist educated me about each of my prescribed medicines.	F1	08 (10.0)	14 (17.5)	18 (22.5)	24 (30.0)	16 (20.0)
I received personalized dietary advice from the pharmacist during dialysis care.	F1	09 (11.3)	13 (16.3)	11 (13.8)	18 (22.5)	29 (36.3)
The pharmacist reminded me regularly to take my medications as prescribed.	F1	11 (13.8)	09 (11.3)	15 (18.8)	18 (22.5)	27 (33.8)

Follow-up 1 Responses coded on a 5-point Likert scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

4.23.2 Assessment of Pharmacist Intervention Questionnaire in Follow-up 2

This table 4.53 indicated the follow-up 2 responses of numerous items, counselling of medications and medication reminders had higher responses of agree with percentages of 37.5% and 28.7% whereas the dietary advise to patients had higher responses of strongly agree with 45.0% while rest of respondents with lower responses in neutral, disagree and strongly disagree.

TABLE 4.53: Responses of patients across follow-ups in Pharmacist Intervention Questionnaire

Variable	**Follow-ups**	**SD (n%)**	**D (n%)**	**N (n%)**	**A (n%)**	**SA (n%)**
The pharmacist educated me about each of my prescribed medicines.	F2	08 (10.0)	09 (11.3)	09 (11.3)	30 (37.5)	24 (30.0)

Table 4.53 continued from previous page

Variable	Follow-ups	SD (n%)	D (n%)	N (n%)	A (n%)	SA (n%)
I received personalized dietary advice from the pharmacist during dialysis care.	F2	07 (8.8)	06 (7.5)	09 (11.3)	22 (27.5)	36 (45.0)
The pharmacist reminded me regularly to take my medications as prescribed.	F2	11 (13.8)	10 (12.5)	19 (23.8)	23 (28.7)	17 (21.3)

F1; Follow-up 2 Responses coded on a 5-point Likert scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

4.23.3 Evaluation of Pharmacist Intervention in Patients

The table 4.54 noted the median and IQR of various characteristics of patients with pharmacist-led tele health, at baseline this table indicated that mostly responses were disagree with median IQR of 2(2.75) and 2(3) in medication counselling and dietary counselling and neutral response in medication reminder area with median IQR of 3(2).

TABLE 4.54: Median and IQR of Pharmacist Intervention Questions across follow-ups

Baseline	M (IQR)
The pharmacist educated me about each of my prescribed medicines.	2 (2.75)
I received personalized dietary advice from the pharmacist during dialysis care.	2 (3)
The pharmacist reminded me regularly to take my medications as prescribed.	3 (2)

At follow-up 1, the majority responses towards agree as compared to baseline in all areas of this pharmacist-led intervention for patients with median IQR of 3.5(2), 4(3) and 4(2.75) respectively in all features of this domain.

TABLE 4.55: Median and IQR of Pharmacist Intervention Questions across follow-ups

Baseline	M (IQR)
The pharmacist educated me about each of my prescribed medicines.	3.5 (2)
I received personalized dietary advice from the pharmacist during dialysis care.	4 (3)
The pharmacist reminded me regularly to take my medications as prescribed.	4 (2.75)

This table 4.56 indicated the follow-up 2 responses of patients and improvement of responses from baseline were detected in overall domain of this with median IQR of 4(2), 4(2) and 3.5(2) accordingly recommended the positive impact of pharmacist intervention on patients overall health status.

TABLE 4.56: Median and IQR of Pharmacist Intervention Questions across follow-ups

Baseline	**M (IQR)**
The pharmacist educated me about each of my prescribed medicines.	4 (2)
I received personalized dietary advice from the pharmacist during dialysis care.	4 (2)
The pharmacist reminded me regularly to take my medications as prescribed.	3.5 (2)

Chapter 5

Discussion of Studies

The present study showed that a WhatsApp based mHealth intervention significantly improved hemodialysis patients' health, enhancing quality of life, medication adherence, and clinical outcomes. These results support evidence that mHealth can effectively complement conventional care, promoting long term management and patient engagement (systematic reviews have reported that mHealth interventions improve treatment adherence and quality of life outcomes in chronic disease populations, including dialysis patients) [50]. The demographic profile of our cohort reflects patterns reported in the Pakistani CKD and hemodialysis literature. Older adults ($\geq$50years) constituted the largest proportion in both groups, consistent with evidence that CKD prevalence increases with age in Pakistan and South Asia. In national CKD data, the highest prevalence was observed among individuals $>$ 50 years, highlighting age related renal decline as a key risk factor [51]. Females in our study were slightly predominant, aligning with some reports that CKD prevalence can be comparable or greater among women in local populations [51]. A high proportion of participants had no formal education, reflecting poor health literacy frequently documented in Pakistani dialysis cohorts. For instance, surveys of maintenance hemodialysis patients in tertiary care settings found that a majority had education below the tenth grade [52]. Most patients had been on dialysis for 1-5 years, a duration associated with increased morbidity and diminished quality of life in chronic dialysis populations. Although comprehensive

national data on dialysis vintage are limited, available reports indicate that many patients initiate dialysis comparatively late and remain on maintenance therapy for extended periods [4]. Additionally, twice weekly dialysis was the most common regimen, which is typical in Pakistani clinical practice due to resource and cost constraints [52].

Overall, baseline demographic and clinical characteristics were comparable between groups and aligned with existing literature from Pakistan and similar settings.

Hypertension remained the leading cause of CKD, followed by diabetes, consistent with national data [53] The pre-dialysis blood pressure showed minimal, non-significant change in the control group ($p > 0.05$). In contrast, the intervention group improved significantly, with mean values rising from 2.250 ± 0.820 at baseline to 2.600 ± 0.700 at the second follow-up ($p = 0.02$ and $p = 0.006$), demonstrating the positive effect of pharmacist-led intervention on blood pressure control. These results are supported by prior evidence from both CKD and hemodialysis populations. A cluster randomized trial in patients with CKD reported that a collaborative physician pharmacist intervention significantly reduced mean systolic blood pressure by 8.64 mmHg (95% CI -12.8 to -4.49; $p < 0.001$) and improved blood pressure control rates (adjusted OR 1.97-2.16; $p < 0.05$) compared with usual care [54]. Similarly, a randomized study in hemodialysis patients found that pharmacist-led interventions increased the proportion of patients achieving target blood pressure ($\leq$135/85 mmHg) to 46% versus 14.3% in controls ($p = 0.02$), with a mean weekly systolic blood pressure reduction of 10.9 mmHg ($p = 0.004$) [55]. Moreover, meta-analytic evidence indicates that pharmacist interventions, especially when combined with home blood pressure tele monitoring, significantly improve blood pressure control (OR = 2.03; 95% CI 1.49-2.77; $p < 0.01$) [56]. The post-dialysis blood pressure decreased in both groups; however, improvements were more consistent in the intervention group across follow-ups ($p = 0.001$ to <0.001), indicating the effectiveness of structured pharmacist support in blood pressure control. These findings align with evidence that blood pressure instability during and after dialysis is common and clinically important.

The greater intradialytic BP variability is linked with higher all-cause and cardiovascular mortality (HR 1.26-1.32; $p < 0.05$) [57]. Pharmacist-involved care improves outcomes, collaborative interventions in CKD patients reduced mean systolic BP by 8.64 mmHg ($p < 0.001$) and increased BP control (OR 1.97-2.16; $p < 0.05$) [57], while in hemodialysis patients, 46% achieved target BP vs. 14.3% in controls ($p = 0.02$), with a mean systolic reduction of 10.9 ± 17.7 mmHg ($p = 0.004$) [54]. Moreover, the meta-analysis confirms pharmacist-led telemonitoring improves BP control (OR = 2.03; $p < 0.01$) [56]. These findings align with the present study, where significant improvement in post-dialysis blood pressure following the pharmacist-led mobile health intervention underscores the importance of continuous pharmaceutical involvement, patient education, and ongoing monitoring in optimizing hemodynamic stability among hemodialysis patients.

The interdialytic weight gain is an important indicator of fluid management in hemodialysis patients, and poor control of body weight has been linked to adverse cardiovascular outcomes and reduced survival [58]. The pre dialysis weight remained largely unchanged in the control group, showing no significant variation during follow up. In the intervention group, a slight reduction was observed over time; although the change was not statistically significant in both groups. The challenge of fluid adherence in dialysis patients is well documented in the literature, with many patients exhibiting weight gains greater than recommended targets due to behavioral and physiological factors [59]. While the post-dialysis weight showed a slight increase in the control group, whereas a modest reduction was observed in the intervention group. Although these changes were not statistically significant ($p > 0.05$). Similar trends have been reported in the literature, where short term post dialysis weight often remains largely stable or only minimally changes due to physiological fluid redistribution and variability in ultrafiltration. Studies of large hemodialysis cohorts report that post dialysis weight generally fluctuates around target post dialysis dry weight with mean differences on the order of a few tenths of a kilogram (e.g., mean post dialysis target weight difference $\approx 0.3 \pm 1.2$ kg over time) without major short term reductions, emphasizing the challenge of modifying these measures with brief interventions [60]. Additionally, systematic reviews of patient level behavioral and educational interventions have

demonstrated small reductions in interdialytic weight gain (-0.15 kg; 95% CI -0.26 to -0.05; p = 0.004), although the absolute magnitude of weight change tends to be limited despite improved adherence and fluid related behaviors [61].

These findings align with the present study, where only modest changes in post dialysis weight were observed, highlighting that while pharmacist led interventions may support better fluid control and help prevent excessive weight gain, short term reductions in post dialysis weight are often constrained by physiological and treatment related factors.

Anemia is a prevalent and clinically significant complication in hemodialysis patients, primarily caused by reduced erythropoietin production, iron deficiency, and chronic inflammation. It contributes to fatigue, diminished quality of life, increased hospitalization, and higher mortality. Effective assessment and management of anemia are therefore critical for optimizing hemodialysis care and patient outcomes [62]. The study showed a clear difference in anemia outcomes between groups. The control groups hemoglobin remained unchanged (baseline 1.610 ± 0.810; mean difference -0.010 ± 1.100; p = 0.99), indicating routine care had little effect. In contrast, the intervention group receiving pharmacist-led mHealth support showed progressive, significant increases in hemoglobin at both follow-ups ($p < 0.001$), demonstrating improved anemia management over time. These findings are consistent with prior evidence showing improved anemia control with pharmacist-led care. A randomized controlled trial reported that 65-75% of patients in pharmacist-managed groups achieved target hemoglobin levels compared with 40-50% under usual care, alongside significant improvements in iron indices ($p < 0.05$) [63]. Similar studies have demonstrated mean hemoglobin increases of 0.8-1.2 g/dL with structured pharmacy-led anemia monitoring. Meta-analytic evidence further supports these results, reporting pooled hemoglobin improvements of 0.6-1.0 g/dL in intervention groups ($p < 0.05$) [64]. Collectively, these findings reinforce the role of pharmacist-led interventions in optimizing anemia management and improving hematological outcomes in hemodialysis patients.

Serum creatinine and blood urea are key biochemical markers used to assess renal function and dialysis adequacy in patients undergoing hemodialysis. Elevated

levels of these parameters reflect impaired renal clearance and accumulation of nitrogenous waste products, which are associated with uremic symptoms and poor clinical outcomes. Monitoring changes in serum creatinine and urea is therefore essential for evaluating treatment effectiveness and patient response to hemodialysis therapy [65]. In the control group, both parameters demonstrated minimal and non-significant fluctuations, reflecting the limited impact of routine dialysis care without structured pharmaceutical involvement. Similar patterns have been reported in previous studies, where patients receiving standard dialysis care showed no significant improvement in creatinine or urea levels over short follow-up periods ($p > 0.05$), with observed variations primarily attributed to interdialytic accumulation, hydration status, and dietary inconsistency rather than true metabolic improvement [66, 67]. In contrast, evidence from pharmacist-involved care models demonstrates meaningful biochemical improvement. [68, 69]; reported significant reductions in serum creatinine ranging from 10-18% following pharmacist-led medication review and dietary counseling ($p < 0.01$), while [68, 69]; observed a significant decrease in serum urea levels by approximately 12-20% after structured pharmaceutical intervention ($p < 0.001$). Similarly, documented improved dialysis adequacy markers, including reductions in both urea and creatinine, attributed to optimized medication timing, enhanced dietary adherence, and close session monitoring. These findings align with the present study, where the intervention group showed significant reductions in serum creatinine ($2.760 \pm 0.600 \rightarrow 2.400 \pm 0.700$) and urea ($2.620 \pm 0.550 \rightarrow 2.270 \pm 0.720$; $p < 0.001$). This consistency reinforces the role of pharmacist-led interventions in improving biochemical control through medication optimization, personalized dietary counseling, and enhanced adherence, contributing to better dialysis adequacy and metabolic outcomes.

Serum sodium and chloride are essential electrolytes involved in maintaining fluid balance and acid-base homeostasis in hemodialysis patients. Abnormal levels of these electrolytes have been associated with intradialytic complications, cardiovascular events, and increased mortality, highlighting the importance of regular monitoring [70]. The serum sodium remained largely stable in both groups, with only modest and non-significant improvement in the intervention group, reflecting the dominant role of dialysate composition in sodium regulation. Similar findings

have been reported previously, where pharmacist-led dietary counseling produced minimal short-term changes in serum sodium ($p > 0.05$) [71].

Likewise, individualized education combined with dialysis optimization showed non-significant sodium variation over short follow-up periods, with levels primarily maintained by dialysate prescriptions [72]. Although the serum chloride showed minor fluctuations in the control group, while the intervention group demonstrated modest stabilization over follow-up. These findings align with prior studies reporting minimal short-term changes in chloride levels after hemodialysis [73]. However, evidence indicates that lower serum chloride is associated with increased all-cause and cardiovascular mortality, emphasizing the clinical importance of maintaining stable levels [74]. Overall, pharmacist-led dietary and fluid counseling may help support electrolyte homeostasis and reduce chloride variability in hemodialysis patients [75].

Serum potassium is a critical electrolyte in hemodialysis patients, as both hyperkalemia and hypokalemia can lead to serious cardiac arrhythmias and increased mortality. Maintaining optimal potassium levels through regular monitoring and appropriate management is therefore essential for patient safety [76]. The serum potassium control is vital to prevent arrhythmias in hemodialysis patients. In this study, the control group remained stable (2.290 ± 0.580), while the intervention group improved significantly after pharmacist-led counseling (2.580 ± 0.560 â†' 2.170 ± 0.520; $p < 0.001$). Minor increases at the second follow-up reflect normal interdialytic accumulation and do not reduce the interventions overall effectiveness. These findings are supported by prior studies. Study [71] reported a mean reduction in serum potassium of 0.35 ± 0.12 mmol/L after structured dietary counseling and medication review ($p < 0.01$), while study [68] observed similar reductions of 0.3-0.4 mmol/L in patients receiving pharmacist-led interventions.

In addition, studies [77, 78] demonstrated that adherence reinforcement, individualized dietary advice, and optimized potassium binder use collectively contributed to statistically significant decreases in serum potassium ($p < 0.05$). The present results are consistent with these studies, indicating that structured pharmacist-led mobile health interventions effectively improve potassium control through dietary

management, patient education, and medication optimization, thereby enhancing overall dialysis safety and reducing cardiovascular risk.

Serum calcium and phosphorus play a vital role in bone metabolism and mineral balance in hemodialysis patients. Imbalance of these minerals contributes to chronic kidney disease-mineral and bone disorder (CKD-MBD), which is associated with bone complications and increased cardiovascular risk [79].

The control group showed stable calcium and variable phosphorus, the intervention group achieved significant improvements in both calcium ($p = 0.007$) and phosphorus ($p < 0.001$), demonstrating the effectiveness of pharmacist-led counseling, phosphate binder optimization, and continuous monitoring. These results are supported by prior studies.

Moreover this study [78] stated an average phosphorus reduction of 0.45-0.60 mmol/L in patients receiving structured dietary counseling and phosphate binder education ($p < 0.01$). Similarly, study observed a mean calcium increase of 0.20-0.25 mmol/L following pharmacist-led intervention ($p = 0.02$), while studies [80–82] documented consistent improvements in mineral metabolism markers, including reductions in serum phosphorus by 15-20% and stabilization of calcium, largely attributed to optimized binder therapy, individualized counseling, and regular monitoring. The present findings align with this evidence, suggesting that structured pharmacist-led interventions can significantly improve mineral balance in hemodialysis patients, reducing cardiovascular and bone-related complications through a combination of education, medication optimization, and ongoing supervision.

Alanine aminotransferase (ALT) and alkaline phosphatase (ALP) are important biochemical markers used to assess liver function and bone metabolism in patients undergoing hemodialysis. Abnormal levels of these enzymes may indicate hepatic dysfunction or mineral bone disorders commonly observed in chronic kidney disease [83].

The ALT, a marker of hepatocellular integrity, fluctuated minimally in both control (baseline 2.040 ± 0.380) and intervention groups (baseline 2.050 ± 0.350),

with changes largely reflecting hemodilution and fluid shifts rather than true hepatic injury. These findings are consistent with prior studies, which reported only minor ALT variations (0.02-0.05 IU/L) in hemodialysis patients receiving standard care or pharmacist-led interventions, with no clinical or statistical significance ($p > 0.05$) [71]. Even though the serum ALP, a marker of bone turnover, showed stabilization and improvement in the intervention group (baseline 2.270 ± 0.670 â†' 2.470 ± 0.550; $p = 0.01$), highlighting the positive effect of pharmacist-guided interventions on bone-mineral management. Supporting literature reports similar outcomes, this study [84] demonstrated an ALP increase of 0.15-0.20 IU/L after structured pharmacist-led counseling on phosphate binder use and vitamin D supplementation ($p < 0.05$), while another study [85] observed comparable stabilization in ALP levels over 12 weeks, attributing improvements to optimized bone-mineral therapy and patient adherence. These results suggest that pharmacist-led interventions can effectively support bone-mineral health in hemodialysis patients, as reflected by improved ALP, while liver enzymes such as ALT remain largely unaffected, indicating safety of the intervention regarding hepatocellular integrity.

Random blood sugar is an important parameter for assessing glycemic control in hemodialysis patients, particularly those with diabetes mellitus. Poor glycemic control is associated with increased risk of cardiovascular complications, infection, and mortality in this population [86]. The Random blood sugar showed minimal, non-significant changes in the control group, while the intervention group demonstrated a modest initial reduction followed by a slight increase at second follow-up ($p = 0.16$). This trend reflects the transient effect of pharmacist-led counseling amid dialysis-related stress and complex glycemic regulation in hemodialysis patients. These observations align with prior studies. Despite this study [87] reported a mean reduction in RBS of only 0.15-0.20 mmol/L after pharmacist-led dietary and medication counseling, which was not statistically significant ($p > 0.05$), attributing limited effect to dialysis-induced metabolic stress. Similarly, studies [71, 88] demonstrated modest reductions in blood glucose (0.1-0.3 mmol/L) following structured pharmacist interventions, highlighting that while education and adherence support improve short-term glycemic trends, sustained control typically requires multifactorial management including insulin optimization, dietary

adherence, and hormonal regulation. Overall, the present findings suggest that pharmacist-led interventions may contribute to transient improvements in RBS but are insufficient alone to achieve statistically significant or long-term glycemic control in patients undergoing maintenance hemodialysis [89].

Health-related quality of life (HRQoL) is markedly compromised in patients undergoing hemodialysis due to physical limitations, psychological stress, and the continuous burden of long-term treatment. In clinical research, HRQoL is commonly assessed using both descriptive health state scores such as EQ-5D index scores and subjective self-rated measures the EQ-5D visual analogue scale, as poor HRQoL has been strongly associated with increased hospitalization, reduced treatment adherence, and higher mortality [90].

In the present study, HRQoL outcomes differed notably between the control and intervention groups. In the control group, EQ-5D-3L scores showed minimal variation over time, with a slight decline at the first follow-up and only modest improvement thereafter. These changes were not statistically significant, indicating that routine dialysis care alone was insufficient to produce meaningful improvement in patients quality of life. This finding is consistent with previous studies reporting non-significant HRQoL changes in patients receiving standard care without structured pharmacist involvement, with mean differences ranging from 0.02 to 0.08 ($p > 0.05$) [91, 92].

In contrast, patients receiving the pharmacist-led mHealth intervention demonstrated significant and sustained improvements in HRQoL. EQ-5D scores increased from 0.497 ± 0.470 at baseline to 0.607 ± 0.460 at follow-up ($p < 0.05$), reflecting better overall health status. These findings align with earlier studies that reported improvements of 0.08-0.12 in EQ-5D scores and increases of 5-10 points in KDQOL following pharmacist-led interventions ($p < 0.05$) [93, 94]. Such improvements are likely attributable to enhanced medication adherence, improved self-care behaviors, and increased patient satisfaction resulting from continuous counseling and digital follow-up. Collectively, this evidence emphasizes the effectiveness of pharmacist-led interventions in strengthening holistic hemodialysis care. The assessment of perceived health status using the visual analogue scale

(VAS) revealed a similar trend. In the control group, VAS scores showed little change, declining slightly from 41.45 ± 13.41 to 40.21 ± 14.06, further indicating the limited impact of routine care. Conversely, the intervention group demonstrated a significant improvement, with VAS scores increasing from 43.75 ± 9.84 at baseline to 60.56 ± 10.24 at follow-up 2 ($p = 0.005$-0.003). This improvement reflects enhanced patient perception of health following pharmacist-led counseling and continuous engagement. These findings are supported by previous studies reporting VAS score increases of 8-15 points among chronic disease and hemodialysis patients receiving structured pharmacist interventions and mHealth support ($p < 0.05$-0.01) [95, 96].

The observed divergence between EQ-5D-3L and VAS outcomes highlights their conceptual differences, as EQ-5D-3L evaluates domain-specific health states, where as VAS captures overall subjective health perception, which may improve earlier with patient-centered support. Overall, the results suggest that pharmacist-led mHealth interventions not only enhance objective HRQoL outcomes but also significantly improve patients perceived health and psychosocial well-being, reinforcing the value of integrating telehealth and pharmacist involvement into routine hemodialysis care [97]. Further health states provide a detailed understanding of patients functional status across mobility, self-care, usual activities, pain/discomfort, and anxiety/depression domains. Evaluating these dimensions helps identify specific areas of impairment and the impact of targeted interventions on overall health-related quality of life. The analysis of EQ-5D-3L health states revealed marked improvements in the intervention group over the study period. The proportion of patients reporting the optimal health state (11111) increased steadily, while severe profiles, such as 33322 and 33332, were reduced or entirely absent by the second follow-up. In contrast, the control group continued to exhibit moderate and severe limitations across multiple dimensions, indicating that routine care alone was insufficient to mitigate persistent health burdens. Furthermore, the present results are supported by existing literature demonstrating the benefits of structured mHealth-supported care. Previous studies have reported a 15-20% improvement in optimal EQ-5D health profiles [98], significant reductions in severe health states over 12 weeks ($p < 0.05$) [99], and notable improvements

in functional well-being and self-reported health outcomes [100]. Collectively, this evidence emphasizes the effectiveness of pharmacist-led interventions in strengthening holistic hemodialysis care.

Medication adherence is a critical determinant of clinical outcomes in patients undergoing hemodialysis, as poor adherence is associated with increased morbidity, frequent hospitalizations, and suboptimal treatment effectiveness. In the present study, medication adherence was evaluated across behavioral, disease- and pill-burden related, and financial domains to provide a comprehensive understanding of adherence patterns. At baseline, behavioral adherence was notably low in both study groups. Only 11.3% of patients in the control group and 8.8% in the intervention group demonstrated high adherence, while the majority exhibited partial or poor adherence. These findings are consistent with previous studies reporting high behavioral adherence in only 10-20% of hemodialysis patients prior to pharmacist-led interventions [45].

This highlights behavioral non-adherence as a persistent and widespread challenge in dialysis populations, often influenced by limited disease understanding, treatment fatigue, and inadequate patient engagement. Following the pharmacist-led intervention, behavioral adherence improved progressively over time. At the first follow-up, increases in high and good adherence were observed in both groups; however, more pronounced improvements were evident in the intervention group by the second follow-up. High adherence in the intervention group increased to 30.0%, while good adherence reached 31.3%. These improvements align with earlier studies demonstrating that structured pharmacist counseling and continuous follow-up can raise high adherence levels from approximately 15-20% at baseline to 35-45% within three to six months ($p < 0.05$) [101, 102].

These findings emphasize the importance of repeated education, motivation, and reinforcement of self-management behaviors in sustaining long-term adherence. Adherence related to disease complexity and pill burden showed a similar improving trend. At baseline, high adherence was observed in 21.0% of control patients and 26.3% of intervention patients, reflecting the challenges posed by polypharmacy and complex dosing regimens commonly seen in hemodialysis care.

By the second follow-up, high adherence increased to 29.0% in the control group and 33.8% in the intervention group. These findings are consistent with previous literature reporting 10-25% improvements in pill-burden adherence following pharmacist-led medication reconciliation, dose optimization, and regimen simplification ($p < 0.05$) [103, 104].

This supports the role of pharmacists in addressing unintentional non-adherence arising from treatment complexity. Financial adherence also demonstrated meaningful improvement throughout the study period. At baseline, high financial adherence was reported by only 12.9% of control participants and 17.5% of intervention participants. By the second follow-up, these proportions increased to 29.0% and 36.3%, respectively, while poor adherence declined substantially. These findings are in line with earlier studies showing that pharmacist-led financial counseling can reduce cost-related non-adherence from 30-40% at baseline to below 15-20% following intervention [105, 106].

This suggests that guidance regarding affordable alternatives, generic substitution, and awareness of available healthcare resources can significantly reduce financial barriers to medication use in chronic dialysis patients. The overall medication adherence scores improved significantly in both groups, with greater and more sustained gains observed in the intervention group. A statistically significant improvement was noted from baseline to the second follow-up ($p < 0.05$). These results are consistent with previous studies reporting 15-20% improvements in adherence scores following structured pharmacist-led interventions, along with associated improvements in clinical outcomes such as reduced missed doses and better biochemical control [45, 107, 108].

Collectively, these findings demonstrate that pharmacist-led interventions are effective in addressing both intentional and unintentional non-adherence among hemodialysis patients. By targeting behavioral factors, treatment complexity, and financial constraints simultaneously, such interventions offer a comprehensive and sustainable approach to improving medication adherence and optimizing long-term dialysis care.

The usability of mHealth interventions is a key determinant of their effectiveness and patient engagement. In this study, the TUQ was used to assess patients experiences across multiple domains, including ease of use, interface quality, reliability, satisfaction, usefulness, and impact on self-management. Evaluating these domains provides a comprehensive understanding of how patients interact with the digital platform, their comfort in using it, and the perceived value of the intervention in supporting treatment adherence and self-care behaviors. High usability scores are critical to ensure sustained engagement and maximize clinical benefits in hemodialysis care. The TUQ was neutral to moderately positive at first baseline, particularly regarding reduced travel and meeting healthcare needs. By the second follow-up, over 70% of patients agreed telehealth reduced travel and met their healthcare needs. These results align with a 2023 U.S. study reporting 68% improved access and 72% reduced travel among chronic illness patients [109], supporting telehealths value in long-term disease management. At the first baseline, many patients were neutral or only somewhat positive about ease of use and learnability, reflecting an early learning curve. By the second follow-up, 36.3% agreed and 30% strongly agreed the system was easy to use, while 45% agreed and 22.5% strongly agreed learning it was simple. These results indicate growing user confidence, consistent with a Saudi survey where 76% found telehealth easy to use and 71% easy to learn [110], and align with studies showing that perceived ease of use strongly predicts continued telehealth utilization [111].

At the first baseline, interface quality responses were mostly neutral to agree, with 38.8% neutral and 31.3% agreeing the system was easy to use. By the second follow-up, satisfaction improved, with 48.8% agreeing they enjoyed using the system, 31.3% strongly agreeing it was easy to understand, and 33.8% agreeing it performed all desired functions. These results align with prior studies reporting 65-80% user satisfaction with telehealth interface design [112], highlighting the importance of a user-friendly system for engagement and continued use. At the first baseline, interaction quality showed moderate acceptance, with 35% agreeing and 27.5% neutral about comfort speaking with clinicians. By the second follow-up, over 60% agreed or strongly agreed that communication was easy, 38.8% agreed and 27.5% strongly agreed they could hear providers clearly, and nearly 75% felt

able to express themselves effectively. These findings align with prior studies reporting 70-85% patient satisfaction with telehealth communication [113], indicating that telehealth can support clinician-patient interaction comparable to in-person care. At the first baseline, reliability and error-handling perceptions were moderate, with 32.5% neutral and 26.3% agreeing that telehealth visits were comparable to in-person care. By the second follow-up, 32.5% agreed they could recover from errors quickly, and over 60% found error messages clear. These findings align with prior studies reporting 65-78% of users viewed telehealth as reliable and comparable to face-to-face consultations [114], highlighting the importance of technical stability and effective error management in building patient confidence. Patient satisfaction and willingness to use telehealth improved over time. At the second follow-up, 45% agreed and 30% strongly agreed they were comfortable communicating, while 43.8% found telehealth acceptable and 33.8% were willing to use it again. These results align with previous studies reporting 70-85% satisfaction and continued telehealth use among chronic illness patients [114], suggesting that positive experiences and improved usability promote long-term acceptance. The overall usability improved, with mean TUQ scores increasing from 2.737 ± 1.429 to 3.333 ± 1.404 ($p = 0.01$) and mean differences rising from -0.660 ± 2.108 to 0.596 ± 2.108, reflecting greater confidence, comfort, and engagement. These results align with prior studies showing repeated telehealth exposure enhances usability and satisfaction ($p < 0.05$) [110], supporting pharmacist-led telehealth in promoting long-term engagement and acceptance in chronic disease management.

Pharmacist-led interventions in hemodialysis patients provide structured medication counseling, adherence support, and dialysis-specific dietary guidance. By helping patients manage complex regimens and prevent treatment-related complications, these interventions promote self-management and are associated with improved clinical outcomes and quality of life [7]. At baseline, patient perceptions of pharmacist-led interventions were low. In medication education, 42.5% strongly disagreed they received adequate counseling, while 30-31% disagreed or strongly disagreed about dietary guidance, and 43.8% reported insufficient medication reminders. These findings indicate minimal adherence support and limited prior exposure to pharmacist-led services, consistent with studies showing 40-55%

of chronic disease patients experienced inadequate counseling before pharmacist involvement [115]. Following the pharmacist-led intervention, patient perceptions improved over time. At the first follow-up, 30% agreed they received adequate medication counseling, while 36.3% and 33.8% strongly agreed that dietary guidance and medication reminders were provided. By the second follow-up, 37.5% reported improved medication understanding, 28.7% rated reminders positively, and 45% strongly agreed nutrition advice was beneficial. These trends align with prior studies showing increases in understanding, adherence (70-85%), and patient satisfaction (>80%) after pharmacist-led interventions [116], highlighting the value of early and sustained pharmacist involvement in promoting awareness, trust, and long-term behavioral change. The median and IQR analyses showed improved patient engagement over time, with counseling and dietary guidance rising from 2 to 4, and medication reminders from 3 to 3.5 by the second follow-up. These improvements align with previous pharmacist-led studies [117, 118], highlighting the effectiveness of structured interventions in enhancing education, adherence, and dietary compliance in hemodialysis care.

5.1 Limitations of Study

When interpreting the results of this study, several limitations should be acknowledged. Due to the short study duration, it was not possible to include a larger patient population, which may limit the generalizability of the findings. Medication adherence was assessed using self-reported measures, which are inherently subject to recall bias and may affect the accuracy of the reported outcomes. Additionally, the short follow-up period restricted the ability to evaluate the long-term sustainability and continued impact of pharmacist-led interventions on patient outcomes.

Chapter 6

Conclusion and Future Recommendation

6.1 Conclusion

According to the study's findings, patients receiving hemodialysis benefit from pharmacist-led interventions that are strengthened by mHealth techniques in terms of medication adherence, health-related quality of life, and overall clinical results. The results confirmed that the clinical pharmacist both in-person and remote care play critical role in promoting medication adherence, identifying medication origin issues, enhanced patients quality of life and boost telehealth satisfaction. Using mHealth tools and integrating pharmacists into multidisciplinary hemodialysis teams may enhance patient-centered outcomes, boost telehealth service satisfaction, and optimize dialysis management.

6.2 Future Recommendations

To improve the applicability of results and strengthen causal inference, future research should concentrate on carrying out multicenter randomized controlled investigations with bigger sample sizes. Extensive follow-up periods are recommended in order to assess the sustainability of pharmacist-led, mHealth-supported

therapies on medication adherence, clinical outcomes, quality of life, and telehealth satisfaction. More study should look into the integration of state-of-the-art mHealth solutions, including as mobile applications and remote monitoring systems, to enhance patient participation and personalized care. In order to encourage policy-level adoption of pharmacist-integrated telehealth services in hemodialysis treatment, it will also be crucial to assess cost-effectiveness and healthcare resource use.

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Appendix A - Patient Consent Form

Title of the Study

Empowering Hemodialysis Patients Through a Pharmacist-Led Mobile Health Intervention: A Prospective Randomized Controlled Trial

Subject

Acceptance of Verbal and Written Consent for Participation in a Pharmacist-Led Mobile Health Intervention Among Hemodialysis Patients

Principal Researcher

Sadia Parveen Faculty of Pharmacy, Capital University of Science and Technology email: MPH241003@cust.pk

Invitation to Participate

You are invited to participate in this study to evaluate the impact of pharmacist-supervised care on the management of hemodialysis patients. The study includes random blood pressure monitoring, assessment of interdialytic weight gain, medication adherence, patient satisfaction, and improvement in quality of life.

Purpose of the Study

If you agree to participate, you will be involved in monthly interviews and data collection during two follow-up visits. You will also receive personalized medication reviews and lifestyle-related counseling. There are no known risks associated

with this study. Your personal information will be kept strictly confidential, and your identity will not be disclosed in any reports or publications. Your participation is entirely voluntary. You may withdraw from the study at any time without any effect on your ongoing treatment or care.

Consent Statement

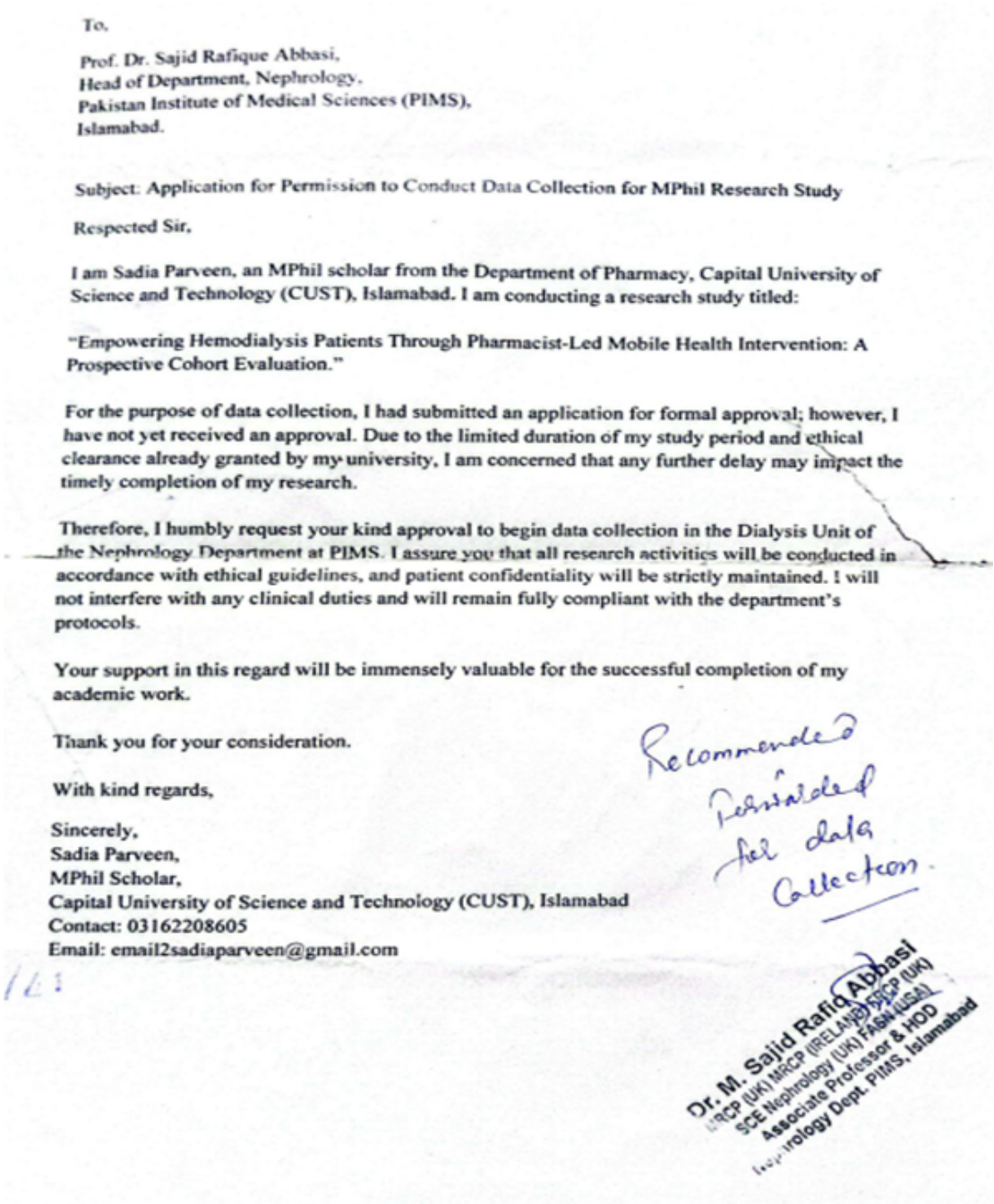
I have read and understood the purpose, procedures, potential risks, and benefits of this study. I voluntarily agree to participate and understand that I may withdraw from the study at any time. Both verbal and written forms of consent are accepted for this study to facilitate participant convenience.

Participant: Signature / Thumb Impression:

Date:

Researcher Signature:

Appendix B - Ethical Approval Letter from Hospital



To,

Prof. Dr. Sajid Rafique Abbasi,
Head of Department, Nephrology,
Pakistan Institute of Medical Sciences (PIMS),
Islamabad.

Subject: Application for Permission to Conduct Data Collection for MPhil Research Study

Respected Sir,

I am Sadia Parveen, an MPhil scholar from the Department of Pharmacy, Capital University of Science and Technology (CUST), Islamabad. I am conducting a research study titled:

"Empowering Hemodialysis Patients Through Pharmacist-Led Mobile Health Intervention: A Prospective Cohort Evaluation."

For the purpose of data collection, I had submitted an application for formal approval; however, I have not yet received an approval. Due to the limited duration of my study period and ethical clearance already granted by my university, I am concerned that any further delay may impact the timely completion of my research.

Therefore, I humbly request your kind approval to begin data collection in the Dialysis Unit of the Nephrology Department at PIMS. I assure you that all research activities will be conducted in accordance with ethical guidelines, and patient confidentiality will be strictly maintained. I will not interfere with any clinical duties and will remain fully compliant with the department's protocols.

Your support in this regard will be immensely valuable for the successful completion of my academic work.

Thank you for your consideration.

With kind regards,

Sincerely,
Sadia Parveen,
MPhil Scholar,
Capital University of Science and Technology (CUST), Islamabad
Contact: 03162208605
Email: email2sadiaparveen@gmail.com

Recommended / Forwarded for data Collection

Dr. M. Sajid Rafiq Abbasi
FRCP (UK) MRCP (IRELAND) FCCP (UK)
SCE Nephrology (UK) FASN (USA)
Associate Professor & HOD
Nephrology Dept. PIMS, Islamabad

بسم اللہ الرحمن الرحیم

ISLAMABAD HOSPITAL
PAKISTAN INSTITUTE OF MEDICAL SCIENCES
G-8/3, ISLAMABAD

Your Ref. No. _____

Our Ref. No. F-5-2/2024(ERRC)/PIMS *Date:* 17/6/2025

Subject: - APPROVAL LETTER ETHICAL RESEARCH REVIEW COMMITTEE

1. MISS SADIA PARVEEN
2. DR. FARMAN ULLAH KHAN
3. DR.M.SAJID RAFIQ ABBASI
4. DR. BILAL HAIDER

Reference your application submitted for study titled. "EMPOWERING HEMODIALYSIS PATIENTS THROUGH PHARMACIST-LED MOBILE HEALTH INTERVENTION: A PROSPECTIVE COHORT EVALUATION. "After close review of the proposal, the study is approved on behalf of ethical and research review board. In case of any change in topic, authors or research methodology new ERRC certificate will be required.

The Board Reserves Right to stop the research project if report is received regarding any violation of ethics/ deviation from the proposed study plan.

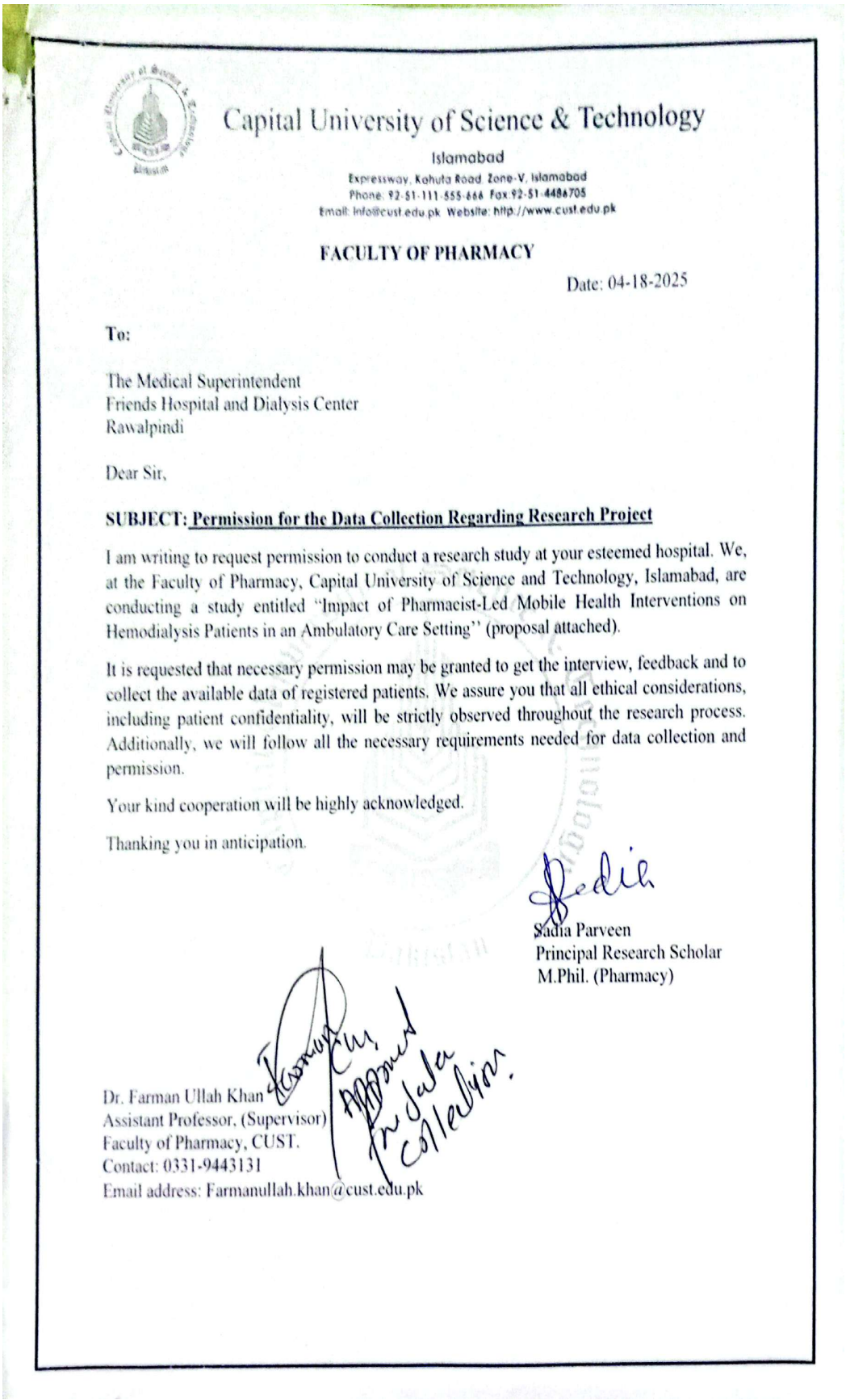
Prof.Mumtaz Ahmad Khan Niazi
Chairman
Ethics Research Review Committee (ERRC)
Professor of General Surgery

PROF. MUMTAZ
Professor of Gen
Chairman
Ethical Review

MISS. SADIA PARVEEN
Student of M.Phil. (Pharmacy Practice)
CUST University, Islamabad
03162208605

Copy to:

- PS to Dean, PIMS, Islamabad
- Relevant File



Capital University of Science & Technology
Islamabad
Expressway, Kahuta Road Zone-V, Islamabad
Phone: 92-51-111-555-666 Fax:92-51-4486705
Email: info@cust.edu.pk Website: http://www.cust.edu.pk

FACULTY OF PHARMACY

Date: 04-18-2025

To:

The Medical Superintendent
Friends Hospital and Dialysis Center
Rawalpindi

Dear Sir,

SUBJECT: Permission for the Data Collection Regarding Research Project

I am writing to request permission to conduct a research study at your esteemed hospital. We, at the Faculty of Pharmacy, Capital University of Science and Technology, Islamabad, are conducting a study entitled "Impact of Pharmacist-Led Mobile Health Interventions on Hemodialysis Patients in an Ambulatory Care Setting" (proposal attached).

It is requested that necessary permission may be granted to get the interview, feedback and to collect the available data of registered patients. We assure you that all ethical considerations, including patient confidentiality, will be strictly observed throughout the research process. Additionally, we will follow all the necessary requirements needed for data collection and permission.

Your kind cooperation will be highly acknowledged.

Thanking you in anticipation.

Sadia Parveen
Principal Research Scholar
M.Phil. (Pharmacy)

Approved for data collection.

Dr. Farman Ullah Khan
Assistant Professor, (Supervisor)
Faculty of Pharmacy, CUST.
Contact: 0331-9443131
Email address: Farmanullah.khan@cust.edu.pk

CamScanner

Appendix C - Data Collection Tools

1. What is your age?

(a) 18-29 years **(b)** 30-49 years **(c)** 50 years and above

2. What is your gender?

(a) Male **(b)** Female

3. What is your marital status?

(a) Single **(b)** Married

4. What is your highest level of education?

(a) No formal education **(b)** Secondary education **(c)** Higher education

5. What is your occupation?

(a) Employed **(b)** Unemployed

6. What type of residence do you live in?

(a) Islamabad **(b)** Rawalpindi **(c)** Other

7. How many years have you been on dialysis?

(a) Less than 1 year **(b)** 1-5 years **(c)** More than 5 years

8. What is the cause of your kidney disease?

(a) Diabetes **(b)** Hypertension **(c)** Both

9. How many dialysis session do you undergo per week?

(a) 2 times **(b)** 3 times **(c)** More than 3 times

Appendix D - Laboratory Profiles of Participants

Patient name: **Contact number:**

Patient ID: ----------

Pre-dialysis blood pressure			

a) Low (< 120/70 mmHg)
b) Target (120–139/70-89 mmHg)
c) High (≥ 140/ ≥90 mmHg)

Post-dialysis blood pressure			

a) Low (< 110/<65 mmHg)
b) Normal (110–139/65-89 mmHg)
c) High (≥ 140/ ≥90 mmHg)

Pre-dialysis weight			

a) Low weight (<50 kg)
b) Normal weight (50-70 kg)
c) High (>70kg)

Post-dialysis weight			

a) Low weight (<48kg)
b) Target (48-68kg)
c) High (>68kg)

Serum Hb level			

a) Low (< 10.0 g/dL)
b) Target range (10.0–11.5g/dL)
c) High (> 11.5 g/dL)

Serum creatinine			

a) Mild (0.6-2 mg/dL)
b) Moderate (2.1–5 mg/dL)
c) Severe (> 5 mg/dL)

Serum Urea			

a) Mild(26- 50 mg/dL)
b) Moderate (51–100 mg/dL)
c) Severe (> 100 mg/dL)

Serum Sodium			

a) Low (< 135 mmol/L)

b) Normal (135–145 mmol/L)
c) High (> 145 mmol/L)

Serum Potassium			

a) Low (< 3.5 mmol/L)
b) Normal (3.5–5.5 mmol/L)
c) High (> 5.5 mmol/L)

Serum Calcium			

a) Low (< 8.5 mg/dL)
b) Normal (8.5–10.5 mg/dL)
c) High (> 10.5 mg/dL)

Serum Phosphate			

a) Low (< 2.5 mg/dL)
b) Normal (2.5–4.5 mg/dL)
c) High (> 4.5 mg/dL)

Serum Chloride			

a) Low (< 96 mmol/L)
b) Normal (96–106 mmol/L)
c) High (> 106 mmol/L)

Serum ALT			

a) Low (< 7 U/L)
b) Normal (7–56 U/L)
c) High (> 56 U/L)

Serum ALP			

a) Low (< 40 U/L)
b) Normal (40–129 U/L)
c) High (> 129 U/L)

Serum Random blood glucose			

a) Normal (< 140 mg/dL)
b) Impaired pre-diabetes (140-199 mg/dL)
c) High/diabetes (≥ 200 mg/dL)

Appendix E

Health Questionnaire

English version for the UK

Sample

UK (English) © 2009 EuroQol Group EQ-5D™ is a trade mark of the EuroQol Group

Under each heading, please tick the ONE box that best describes your health TODAY.

MOBILITY

I have no problems in walking about ❑
I have slight problems in walking about ❑
I have moderate problems in walking about ❑
I have severe problems in walking about ❑
I am unable to walk about ❑

SELF-CARE

I have no problems washing or dressing myself ❑
I have slight problems washing or dressing myself ❑
I have moderate problems washing or dressing myself ❑
I have severe problems washing or dressing myself ❑
I am unable to wash or dress myself ❑

USUAL ACTIVITIES *(e.g. work, study, housework, family or leisure activities)*

I have no problems doing my usual activities ❑
I have slight problems doing my usual activities ❑
I have moderate problems doing my usual activities ❑
I have severe problems doing my usual activities ❑
I am unable to do my usual activities ❑

PAIN / DISCOMFORT

I have no pain or discomfort ❑
I have slight pain or discomfort ❑
I have moderate pain or discomfort ❑
I have severe pain or discomfort ❑
I have extreme pain or discomfort ❑

ANXIETY / DEPRESSION

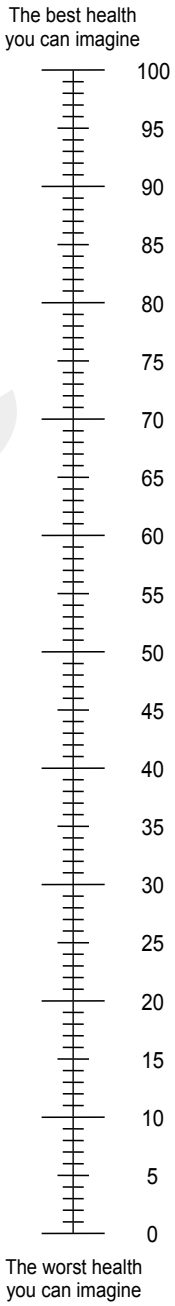
I am not anxious or depressed ❑
I am slightly anxious or depressed ❑
I am moderately anxious or depressed ❑
I am severely anxious or depressed ❑
I am extremely anxious or depressed ❑

UK (English) © 2009 EuroQol Group EQ-5D™ is a trade mark of the EuroQol Group

Sample

- We would like to know how good or bad your health is TODAY.
- This scale is numbered from 0 to 100.
- 100 means the best health you can imagine.
  0 means the worst health you can imagine.
- Mark an X on the scale to indicate how your health is TODAY.
- Now, please write the number you marked on the scale in the box below.

YOUR HEALTH TODAY = ☐



Sample

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Appendix F - General Medication Adherence Scale

Copyright©Naqvi_Hassali_GMAS_coding_version_0.03_2020

The General Medication Adherence Scale (GMAS)

CODING

No	Question	Categories	Grading	Grading within domain
Non-adherence due to patient behavior (un-intentional and intentional)				
1.	Do you have difficulty in remembering to take your medications?	Always Mostly Sometimes Never	0 1 2 3	• High adherence = 13 – 15 • Good adherence = 11 – 12 • Partial adherence = 8 – 10 • Low adherence = 5 – 7 • Poor adherence = 0 – 4
2.	Do you forget to take your medication due to your busy schedule, travelling, meeting, events at home, party, marriage, religious celebrations, etc.?	Always Mostly Sometimes Never	0 1 2 3	
3.	Do you discontinue your medication when you feel well?	Always Mostly Sometimes Never	0 1 2 3	
4.	Do you stop taking medications when you feel adverse effects such as gastric discomfort, etc.?	Always Mostly Sometimes Never	0 1 2 3	
5.	Do you stop taking medications without informing the doctor?	Always Mostly Sometimes Never	0 1 2 3	
Non-adherence due to additional disease and pill burden				
6.	Do you discontinue your medicines due to other medicines that you have to take for your additional disease?	Always Mostly Sometimes Never	0 1 2 3	• High adherence = 11 – 12 • Good adherence = 9 – 10 • Partial adherence = 6 – 8 • Low adherence = 4 – 5 • Poor adherence = 0 – 3
7.	Do you find it is a hassle to remember your medications due to medication regime complexity?	Always Mostly Sometimes Never	0 1 2 3	
8.	During the last month, had there been any occasion when you missed your medicines due to progression of disease and addition of new medicines?	Always Mostly Sometimes Never	0 1 2 3	
9.	Do you alter medication regimen, dose and frequency by yourself?	Always Mostly Sometimes Never	0 1 2 3	
Non-adherence due to financial constraints				
10.	Do you discontinue these medications because they are not worth of the money you spent on them?	Always Mostly Sometimes Never	0 1 2 3	• High adherence = 6 • Good adherence = 5 • Partial adherence = 3 – 4 • Low adherence = 2 • Poor adherence = 0 – 1
11.	Do you find it difficult to buy your medicines because they are expensive?	Always Mostly Sometimes Never	0 1 2 3	
Grading for overall medication adherence (cumulative) High Adherence = 30 – 33 Good adherence = 27 - 29 Partial Adherence = 17 – 26 Low Adherence = 11 – 16 Poor Adherence = 0 – 10				

Appendix H - Pharmacist Intervention Questionnaire

5: Pharmacist Intervention Questionnaire

S.No	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	The pharmacist educated me about each of my prescribed medicines.					
2.	I received personalized dietary advice from the pharmacist during dialysis care.					
3.	The pharmacist reminded me regularly to take my medicines as prescribed.					

Appendix H - Telehealth Usability Questionnaire (TUQ)

1

6- Telehealth Usability Questionnaire (TUQ)

Response Options (Likert Scale)
1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

S.No	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	Telehealth improves my access to healthcare services.					
2.	Telehealth saves me time traveling to a hospital or clinic.					
3.	Telehealth provides for my healthcare needs.					
4.	It was simple to use this system.					
5.	It was easy to learn use the system.					
6.	I believe I could become productive quickly using this system.					
7.	The way I interact with this system is pleasant.					
8.	I like using this system.					
9.	The system is simple and easy to understand.					
10.	This system can do everything I would want it to be able to do.					
11.	I could easily talk to the clinician using telehealth system.					
12.	I could hear the healthcare using the telehealth.					
13.	I felt I was able to express myself effectively.					
14.	Using the telehealth system, I could see the clinician as if we met in person.					
15.	I think the visits provided over the telehealth system are the same as in-person visits.					

2

16.	Whenever I made mistake using the system, I could quickly recover.					
17.	The system gave error messages that told me how to fix problems.					
18.	I feel comfortable communicating with the clinicians using the telehealth system.					
19.	Telehealth is an acceptable way to receive healthcare services.					
20.	I would use telehealth services again.					
21.	Overall, I am satisfied with this telehealth system.					

Appendix I

YOUR KIDNEY HEALTH CARE PLAN FOR HEMODIALYSIS PATIENTS

(Following WHO and FIP Standards)

آپ کی گردوں کی صحت

ہیماڈائیلاسز مریضوں کے لیے دیکھ بھال کا منصوبہ

(WHO اور FIP معیار کے مطابق)

HOW ARE YOU FEELING? آپ کیسا محسوس کر رہے ہیں؟ ***(SUBJECTIVE FINDINGS)*** (ذاتی مشاہدات)

YOUR VOICE MATTERS! آپ کی آواز اہم ہے

- How do you feel today? **آج آپ کیسا محسوس کر رہے ہیں؟**
- Any Pain, cramps, fatigue during dialysis? **ڈائیلاسز کے دوران کوئی درد، اکڑن یا تھکن؟**
- Are you taking your medicine easily? **کیا آپ آسانی سے اپنی دوائیاں لے رہے ہیں؟**
- Any problems (itching, dizziness or poor sleep)? **کسی قسم کی خارش، چکر یا نیند کی کمی کا مسئلہ؟**

(WHAT WE MONITOR)? ہم کیا مانیٹر کرتے ہیں؟ ***(OBJECTIVE FINDINGS)*** (معروضی مشاہدات)

Blood pressure----mmHg, **بلڈ پریشر** : —— mmHg, Weight before/after Dialysis, ----kg **وزن (ڈائیلاسز سے پہلے/بعد): —— کلوگرام**

Blood tests (Potassium, creatinine, phosphorus, Hemoglobin) ---, etc. **خون کے ٹیسٹ: پوٹاشیم، کریٹینین، فاسفورس، ہیموگلوبن وغیرہ**

YOUR MEDICINES- STAY ON TRACK! اپنی دوائیوں کے ساتھ پابندی رکھیں ***(Care Plan)*** دیکھ بھال کا

MEDICINE دوا کا نا م	**WHY YOU TAKE IT?** کیو ں لیتے ہیے؟	**WHEN TO TAKE?** کب لینا ہے؟
Phosphate binders فا سفنٹ با ئنڈ ر	Lowers phosphorus۔ فا سفو ر س کوکم کرتے ہے	With meals as prescribed کھانے کے سا تہ جیسا تجویزکیا گیا ہو۔
Blood pressure بلڈ پر نشر کئ دوا	Control BP بلڈ پر نشرکو قا بو میں رکھتئ ہے	Measures BP at home۔ گھرپر بلڈ پر نشر چیک کریں
Erythropoietin shot ایری تھرو پا نئین انجکشن	Keeps you energized۔ آپ کو توا نا رکھتا ہے	Keep you energized۔ توا نا ئئ کوبر قرا رکھنے کے لیے
Vitamin D(Calcitriol) وٹا من ڈ ئ(کیلسیٹر یو ل)	Keep-bone strong۔ ہڈ یو ں کو مضبو ط رکھتا ہے	Watch calcium levels۔ کیلشم کئ سطح کو ما نیٹیر کر یں

EASY DIET TIPS کھانے میں محدود کریں

LIMIT (کم استعما ل کریں)	**EAT (کھا یں)**
Salt and salty foods (نمک اور نمک سے بنئ اشیا)	Chicken, eggs, fish (چکن، انڈ ے، مچھلئ)
Potassium (Banana, Oranges, Potatoes) (پوٹا شیم (کیلا، ما لٹا، آ لو)	Small fruits ***(Apple, Grapes)*** (سیب، انگور)
Phosphorus Cheese, cola, nuts (فا سفورس(پنیر، کولا، بادام)	Iron-rich foods (فولاد سے بھر پور غزا)
Fluids Ice, Soups, Water (پا نی، سوپ، برف)	

Smart Tip: سمارٹ ٹپ : ***Freeze grapes as cool treat!*** انگور کو فریز کر کے ٹھنڈی ٹریٹ کے طور پر استعمال کریں

Medication Adherence Chart: ادویات کی پابندی کا چارٹ

Week ہفتہ	Mon پیر Morning,صبح Afternoon,دوپہر Nightرات	Tue منگل Morning,صبح Afternoon, دوپہر Nightرات	Wed بدھ Morning,صبح Afternoon, دوپہر Nightرات	Thu جمعرات Morning,صبح Afternoon, دوپہر Nightرات	Fri جمعہ Morning,صبح Afternoon, دوپہر Nightرات	Sat ہفتہ Morning,صبح Afternoon, دوپہر Nightرات	Sun اتوار Morning, صبح Afternoon, دوپہر Nightرات
1	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐
2	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐
3	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐
4	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐
5	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐

Fill this everyday (ہر دن صبح، دوپہر، رات نوٹ کریں)

IMPORTANT SIGNS TO WATCH: اہم علامات جو فوری توجہ چاہتی ہیں

Shortness of breath, سانس میں دشواری ***Severe Itching,*** شدید خارش ***High blood pressure*** بلند فشار خون ***and Unusual Swelling.*** غیر معمولی سوجن

What to join us? Contact Us! Phone 03162208605
WhatsApp 03162208605/ 03125248881
University: Capital University of Science and Technology