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Innovation of the M-Nursing Application to Improve Compliance with Haemodialysis Therapy and Urea-Creatinine Levels in Patients with Chronic Kidney Disease

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ABSTRACT

Background: Chronic Kidney Disease (CKD) represents a prominent health concern due to soaring propensity and occurrence rate, alongside the growing demand for kidney replacement therapies among affected individuals. **Objective:** This research focused on improving compliance, decreasing urea and creatinine with haemodialysis therapy among chronic renal failure patients by utilising the innovative M-Nursing Application model and assessing the impact of this novel approach. **Methods:** This research is experimental research with one group Pretest-Posttest design. The M-Nursing Application is an alternative therapy that can be given to patients by providing a Supportive Educative System in digital form. The procedure for this study was a pre-test to measure haemodialysis compliance, urea and creatinine; then the provision of M-Nursing Application intervention for 3 months; and then a post-test to measure haemodialysis compliance, urea and creatinine again. The measurement of the effectiveness of providing the M-Nursing Application intervention was carried out with 110 kidney failure patients at the Tangerang Regency General Hospital. **Results:** The results showed that in the pre-test, 31 respondents (56.4%) were compliant, while the post-test showed that number raised to 100.0% (55 compliant respondents). There was a significant decrease in mean urea level from pre-test to post-test (179.709 to 79.709), while the creatinine level dropped from pre-test (5.880) to 2.572 (post-test). The average knowledge score increased from 13.854 (pre-test) to 14.945 (post-test). The average attitude improved from 50.909 (pre-test) to 55.800 (post-test). Analysis that was done statistically confirmed a notable advancement in adherence (*p*-value 0.000). **Conclusion:** The M-Nursing Application as Innovation model was a strategy for decreasing urea values and creatinine values and increasing compliance in chronic kidney failure patients. This study provides nursing care promotive and preventive aspects, namely providing health education regarding patient compliance with haemodialysis so that optimal patient health status was achieved through the M-Nursing Application.

Keywords: Chronic Kidney Failure; Haemodialysis Therapy Adherence; Innovation of M-Nursing Application; Urea Creatinine

INTRODUCTION

One of the critical challenges of wellbeing worldwide is Chronic Kidney Disease (CKD). Setting the prevalence as well as the incidence rate aside, the kidney replacement treatment that sufferers must undergo is also increasing. Kidney failure is an expensive treatment that requires time and patience, which must be borne by kidney failure sufferers and their families (Thummak *et al.*, 2023). In 2018, the Ministry of Health Republic Indonesia reported a significant increase in the prevalence of chronic renal failure cases, which rose from 2.0‰ in 2013 to 3.8‰. Additionally, the number of new CKD cases in the country more than doubled, from 30,831 in 2017 to 66,433 in 2018. While the chronic renal failure cases have surged in countries with low and middle incomes (LMICs), particularly in Asia, the mean prevalence (95% CI) of CKD stages 3–5 across 14 LMICs in Asia was reported at 11.2% (9.3–13.2%). In the Southeast Asia region, the prevalence stands at 12.0% (7.7–17.0%). Furthermore, the prevalence rate for CKD is 9.8% (8.3–11.5%) in upper-middle-income countries and 13.8% (9.9–18.3%) in lower-middle-income countries (Suriyong *et al*., 2022).

Haemodialysis is a kidney replacement procedure for patients with Chronic Kidney Disease (CKD) that aims to extend life. It is a lifelong treatment that often has adverse effects on patients, especially on mental health.

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According to the Ministry of Health of the Republic of Indonesia (2018), the proportion of patients undergoing haemodialysis in Indonesia was 19.3%. The impact of haemodialysis can lead to long-term complications, reduced productivity, and negative mood changes. The perception that their quality of life is deteriorating can worsen the patient's condition. The quality of life among patients undergoing haemodialysis treatment is of great interest to health professionals because quality of life issues are crucial in ensuring that patients can undergo haemodialysis and survive even with the aid of a dialysis machine (Andriati, Pratiwi & Indah, 2024).

Haemodialysis patients will experience various problems, including physical, psychological, financial, spiritual, boredom-related, and social issues; they may even contemplate suicide due to the psychological impact of losing their sense of purpose in life. This situation results in non-adherence to haemodialysis therapy and elevates the risk of mortality. Out of 150 patients undergoing haemodialysis, 70 (46.6%) experienced depression, and 43 (28.6%) had suicidal thoughts. CKD causes a loss of physical and cognitive abilities, ultimately leading patients not to undergo HD therapy and potentially resulting in suicide. Failure to cope with the stress of dialysis triggers suicide (Chen *et al*., 2025).

Therefore, adequate management efforts are needed to achieve optimal patient health status. Nursing science includes the management of kidney failure, both acute and chronic. In caring for patients with chronic kidney failure, nurses can act as caregivers, educators, and facilitators in dealing with their problems. The M-Nursing Application innovation is an alternative therapy that can be given to patients by providing a Supportive Educative System in digital form. The M-Nursing application contains material to improve knowledge and compliance and also contains information about nursing care. This educational, supportive therapy is implemented through the M-Nursing Application so that it is hoped that the digital educational model can be utilised by nurses and other health practitioners effectively to enhance adherence to haemodialysis therapy among patients with chronic kidney disease, improving urea creatinine levels in CKD patients, and increasing life expectancy through motivation in expectation of decreasing the death rate. The Tangerang Regency General Health House is a type B hospital and a haemodialysis referral centre in Banten province. The number of visits per day is 44 individuals diagnosed with chronic renal failure assigned for therapy using haemodialysis, using 35 specific devices available for haemodialysis treatment. The shifts in the HD room consist of two periods: morning and afternoon, each equipped with machines for haemodialysis (Andriati, Pratiwi & Indah, 2024).

This study was done to pinpoint necessary nursing care for patients with chronic kidney failure to provide nursing care by paying attention to promotive and preventive aspects. Provide health education or counselling to patients and their families regarding risks or complications that can worsen the disease's condition. This study seeks to strengthen the compliance of individuals with chronic renal failures to therapy using the haemodialysis process by means of M-Nursing Application innovation models and assess the potency of these models in promoting adherence to the haemodialysis therapy process. The aim of the study focused on improving discipline in haemodialysis therapy among patients with chronic renal failure by utilising the innovative M-Nursing Application model and assessing the impact of this novel approach in improving compliance with haemodialysis treatment.

METHODOLOGY

Study Design

This study employed a quasi-experimental design using a one-group pretest-posttest approach, which is commonly used to evaluate the effectiveness of interventions within a single sample without a control group (Polit & Beck, 2021). This design allows researchers to observe and compare changes in participants before and after an intervention is applied, and in this case, the use of the M-Nursing Application to improve haemodialysis therapy compliance and reduce biochemical markers such as urea and creatinine in patients with Chronic Kidney Disease (CKD).

Intervention Description

The M-Nursing Application served as a digital Supportive Educative System, offering structured educational content for CKD patients. The application included modules covering key aspects of chronic kidney failure, such as aetiology, stages, signs and symptoms, laboratory tests, pathophysiology, diet and fluid management, and detailed information about haemodialysis procedures. It also featured psychoeducational tools, including motivational posters, short videos, and rhymes, designed to enhance patient engagement and self-management.

Digital health interventions such as this application have demonstrated effectiveness in improving chronic disease management through patient education, self-care promotion, and real-time support (Ramesh & Yadav, 2023; Zhang *et al*., 2024b).

Participants and Setting

A total of 110 patients with End-Stage Renal Disease (ESRD) undergoing regular haemodialysis at the Tangerang Regency General Hospital were recruited through purposive sampling. Inclusion criteria consisted of adults aged 18 and above, diagnosed with CKD, undergoing routine haemodialysis, and willing to participate in the study for three months.

Data Collection Procedure

The data collection was conducted in three phases: (1) Pre-test Phase: Patients completed a haemodialysis compliance questionnaire, and their urea and creatinine levels were measured in the hospital laboratory. (2) Intervention Phase: Patients were given access to the M-Nursing Application for three months. (3) Post-test Phase: The same questionnaire and laboratory tests were administered to evaluate changes.

Instruments

Hemodialysis Compliance Questionnaire: This self-administered instrument contained 15 Likert-scale questions (Always = 4, Often = 3, Sometimes = 2, Never = 1), covering key compliance domains: attendance, diet, medication, and fluid restrictions. A total score of 31–60 indicated compliance, while scores ≤30 indicated non-compliance. The instrument had been previously validated in a sample of 30 patients at South Tangerang Hospital, yielding $r > 0.361$ for all items and Cronbach's alpha = 0.862, indicating strong internal consistency (Pallant, 2020). Biochemical Markers: Blood samples were tested to determine urea and creatinine levels before and after the intervention. Laboratory testing adhered to standardised clinical procedures.

Data Analysis

Data were analysed using IBM SPSS Statistics version 22. Prior to inferential testing, Kolmogorov–Smirnov tests were conducted to assess data normality. As the data were not normally distributed, non-parametric tests were used. To assess differences in compliance, urea, and creatinine levels between pre- and post-intervention phases, the Wilcoxon Signed-Rank Test was applied (Pallant, 2020). This test is suitable for comparing two related samples, particularly when assumptions of normality are violated. Effect size and post-hoc power analysis were also calculated to estimate the practical significance of the intervention outcomes.

Ethical Consideration

The researchers obtained ethical clearance from the Ethics Committee of Tangerang Regency General Hospital, Indonesia with reference number 613/RSUTangerang/2024 on 5th February 2024.

RESULTS

Table 1: Data on Characteristics Respondents' Implementation of M-Nursing Application

Characteristics Respondents	Frequency (n)	Percentage (%)
Gender		
Male	30	54.5
Female	25	45.5
Age		
1-30 years	2	3.6
31-50 years	15	27.3
51 and above (> 60 years)	38	69.1
Education		
Junior High School or equivalent	7	12.7
Senior High School/ Vocational High School or equivalent	29	52.7
D1-D3 or equivalent	4	7.3
Total	55	100

Source: Primary Data, 2024

According to Table 1, the majority of respondents are male, comprising 30 individuals (54.5%). Additionally, 69.1% of the respondents (38 individuals) are aged between 51 and over 60 years. The largest group by education level includes 29 respondents (52.7%) who have completed senior high school or vocational high school.

Figure 1: M-Nursing Application in Indonesian Version

The application provides educational content related to chronic kidney failure, including causative factors, grades, signs and symptoms, laboratory tests, pathophysiology, dietary and fluid intake guidelines, haemodialysis therapy, and caregiving functions. It also includes support and motivational components for CKD patients, such as psychoeducation through posters, rhymes, or engaging videos, as shown in Figure 1. It is expected that CKD patients will be able to improve their compliance in undergoing haemodialysis therapy so that urea creatinine levels improve.

Table 2: Pre-test and Post-test Compliance Implementation of M-Nursing Application

Compliance		Frequency (n)	Percentage (%)	Total (n)	Total (%)
Pre Test	Obedient	31	43.6	55	100
	Disobedient	24	56.4		
Post-Test	Obedient	55	100.0	55	100
	Disobedient	0	0.00		

Source: Primary Data, 2024

The pretest results indicate that the majority of respondents demonstrated compliance, with 31 individuals (56.4%). Following the post-test, all 55 respondents (100.0%) were found to be compliant in Table 2.

The Wilcoxon Signed-Rank Test results suggest that the implementation of the M-Nursing Application as a management strategy for Chronic Kidney Disease (CKD) resulted in statistically significant improvements in patient outcomes, as evidenced by a *p*-value of 0.000. This implies that there is a difference in compliance between the pre-test and post-test results.

Table 3: Urea Levels and Creatinine Levels Implementation M-Nursing Application (n=55)

Variable	Time	Mean ± SD	95% CI Mean	Min-Max	*P*-value	Effect Size	Power (1–β)
Urea Levels	Pre Test	179.71 ± 26.93	172.43 – 186.99	82.00-240.00	0. 000	r = 0.87*	1.00
	Post Test	79.71 ± 9.75	77.07 – 82.34	40.00-92.00			
Creatinine Levels	Pre Test	5.88 ± 1.34	5.52 – 6.24	3.20-9.20	0. 000	r = 0.87*	1.00
	Post Test	2.57 ± 0.63	2.40 – 2.74	1.90-4.20			

**Effect size (r) is calculated using Wilcoxon Z-statistic. Power calculated via G*Power with alpha = 0.05, two-tailed.*
Source: Primary Data, 2024

The urea level is known to have an average (mean) pre-test value of 179.709. After the post-test, the average (mean) value decreased to 79.709. The creatinine levels can be seen from the average (mean) pre-test value of 5.880; after the post-test, there was a decrease to an average (mean) value of 2.572. Based on the bivariate results, differences in urea levels and creatinine levels were observed, with a corresponding p-value in Table 3. For urea levels, the pre-test mean value was within the 95% Confidence Interval (CI) of 172.43 to 186.99 mg/dL, which decreased markedly in the post-test to a CI of 77.07 to 82.34 mg/dL. The effect size, calculated as $r = 0.87$, indicates a very large effect, reflecting the strong impact of the intervention. The statistical power of the analysis was 1.00, suggesting that the sample size was sufficient to detect a true effect with high certainty.

Using Wilcoxon Signed-Rank Test results as the base, an implementation of the M-Nursing Application to reduce urea levels in Chronic Kidney Disease patients with a p-value of 0.000 showed that there is a difference in urea levels between the pre-test and post-test. Using the same test results as part of an implementation of the M-Nursing Application to reduce creatinine levels in patients with a p-value of 0.000 again showed that there is a difference in creatinine levels between the pre-test and post-test. For creatinine levels, the pre-test 95% CI ranged from 5.52 to 6.24 mg/dL, which decreased significantly post-intervention to 2.40 to 2.74 mg/dL. The effect size was again large ($r = 0.87$), and the post-hoc power analysis yielded a value of 1.00, indicating excellent statistical reliability.

These results support the conclusion that the M-Nursing Application contributed significantly to improving patient compliance and reducing key biochemical markers associated with kidney dysfunction. The combination of large effect sizes and narrow confidence intervals reflects both the effectiveness and precision of the intervention.

DISCUSSION

Implementation of M-Nursing Application as a Management Strategy for Chronic Kidney Disease (CKD) to Increase Compliance with Haemodialysis Therapy in Chronic Kidney Failure Patients

This study demonstrates a significant improvement in patient compliance with haemodialysis therapy following the implementation of the M-Nursing Application. Pre-test findings showed that 56.4% of patients adhered to their treatment regimen, while post-test results indicated full compliance (100%) among all participants. The Wilcoxon Signed-Rank Test revealed a statistically significant difference ($p = 0.000$), suggesting that the intervention was effective in enhancing treatment adherence.

Compliance in chronic disease management, particularly in haemodialysis, is a critical determinant of patient outcomes. It encompasses a range of behaviours, including adherence to medication, dietary restrictions, scheduled therapies, and lifestyle modifications (Thummak, Uppor, & Wannarit, 2023). In this context, nursing care plays a central role. Nurses not only provide clinical care but also act as educators, motivators, and facilitators in fostering patient engagement. As highlighted by Wang *et al*. (2024), the nursing role in managing chronic kidney disease (CKD) spans promotive, preventive, curative, and rehabilitative dimensions, each of which is essential to improving long-term health outcomes. In caring for patients with chronic kidney failure, nurses can act as caregivers to patients, as educators, and as facilitators in dealing with problems faced by patients. The role of nursing as a provider of nursing care to patients with chronic kidney failure includes four aspects, which include the promotive aspect, namely providing health education or counselling to patients and families regarding risks or complications that can worsen the condition of the disease, the preventive aspect, namely preventing or controlling so that the incidence of chronic kidney failure does not get worse, then the curative aspect, namely providing nursing care according to the problem and nursing diagnosis to achieve an optimal level of patient health, and the rehabilitative aspect, namely by motivating patients to avoid risk factors or causes that worsen the condition of the disease. Nurses must properly understand the appropriate care and treatment for individuals with end-stage renal disease. Patient care is delivered through the application of the nursing process, encompassing assessment, formulation of nursing diagnoses, nursing planning, nursing implementation, and nursing evaluation (Menezes *et al*., 2023; Silva, 2024).

The findings of this study are consistent with previous research by Sitanggang, Anggraini and Utami (2021), which reported high compliance (75%) in patients undergoing haemodialysis. Given that

haemodialysis replaces essential renal functions, noncompliance may result in the accumulation of toxic metabolic waste, contributing to systemic complications and increased mortality risk. Therefore, improving patient adherence is not merely a behavioural goal but a life-saving necessity. Haemodialysis is a treatment that can replace kidney function by removing metabolic waste, excess water, and substances that the body does not need (Wahyuni *et al*., 2025).

The integration of mobile health (m-health) technologies has emerged as an innovative solution to support chronic disease management. M-health interventions, such as the M-Nursing Application, provide patients with real-time health information, facilitate decision-making, and enhance access to services (Varshney, 2014; Indah *et al.*, 2022). These digital tools support individualised care by incorporating lifestyle advice, treatment reminders, and self-monitoring features, aligning with findings of Özdemir and Şendir (2025), who reported improved self-care behaviours and disease knowledge in patients using mobile applications compared to traditional educational methods. Technological advancement in haemodialysis care extends beyond patient education. Digital platforms now support clinical monitoring and data analytics, enabling more personalised treatment strategies. As noted by Zhang *et al*. (2024a), multidisciplinary interventions supported by m-health can significantly improve patient outcomes in long-term therapy. Moreover, innovations such as artificial intelligence, big data, and telemedicine hold promise for predictive care and early intervention strategies (Nazira *et al*., 2025).

International applications of similar interventions further validate the effectiveness of digital integration in CKD management. Fei *et al*. (2025) demonstrated that structured web-based nursing care led to improved adherence and quality of life, while Shi *et al*. (2024) developed the SuYi app to support outpatient management through modules for self-monitoring, medication tracking, and lifestyle guidance. These technologies not only enhance patient autonomy but also bridge gaps in traditional healthcare delivery systems by fostering continuous communication and care coordination.

So, the M-Nursing Application exemplifies a successful, evidence-based approach to increasing haemodialysis compliance among CKD patients. By integrating nursing principles with mobile health technologies, the intervention addresses both behavioural and systemic challenges in chronic disease management. Future studies should explore long-term outcomes and scalability in diverse healthcare settings to maximise the impact of such innovations.

Implementation of an M-Nursing Application as a Management Strategy for Chronic Kidney Failure (CKD) to Reduce Urea and Creatinine Levels in Chronic Kidney Failure Patients

The implementation of the M-Nursing Application demonstrated a statistically significant impact on kidney function markers in patients with Chronic Kidney Disease (CKD). Specifically, the mean urea levels decreased from 179.709 mg/dL pre-intervention to 79.709 mg/dL post-intervention, while mean creatinine levels declined from 5.880 mg/dL to 2.572 mg/dL. The Wilcoxon Signed Rank Test confirmed the significance of these reductions (p = 0.000 for both parameters), indicating the effectiveness of the intervention in improving clinical indicators associated with CKD progression.

Elevated levels of urea and creatinine are hallmark indicators of impaired renal function and are frequently used to monitor disease severity and treatment efficacy. Urea, a nitrogenous waste product resulting from protein metabolism, and creatinine, a by-product of muscle metabolism, both accumulate in the bloodstream as kidney function declines (Lin, 2023; Casciola *et al*., 2023). These markers not only reflect the physiological burden of the disease but also correlate with increased morbidity and risk of complications if left unaddressed. This study also aligns with the research conducted by Sudarso *et al.* in 2023. The analysis reveals a significant difference, with a *p*-value of 0.003. The study compares urea levels in patients with end-stage renal disease before receiving haemodialysis treatment and after. This research is also in accordance with Sudrajat and Fetriyana, (2023) who that the values of serum creatinine levels before and after haemodialysis have significant differences in results. These results show haemodialysis treatment affected creatinine levels, where the value is lower after receiving treatment.

The observed reductions in urea and creatinine levels suggest that the M-Nursing Application played a role in promoting better adherence to haemodialysis regimens and fluid management practices. This is

consistent with the integrated nursing process model, which includes assessment, diagnosis, planning, intervention, and evaluation as essential components of patient care (De Oliveira *et al*., 2021). By facilitating continuous health education, treatment reminders, and personalised monitoring, digital tools such as M-Nursing can enhance patients' self-management capabilities and support behavioural changes necessary for optimal therapy outcomes.

These findings are supported by previous studies. For instance, Chen *et al*. (2025) reported that interventions based on the Integrated Theory of Health Behaviour Change (ITHBC) improved fluid control and reduced hospital readmissions among dialysis patients. Similarly, Sayed *et al*. (2025) emphasised the role of nurse-led education in maintaining vascular access and minimising haemodialysis-related complications. Furthermore, application like "Sahabat Dialysis" demonstrated effectiveness in helping patients monitor fluid intake and output, thus preventing overload and its associated risks (Faridah *et al*., 2024).

Additional evidence from the studies of Qin, Mingxia and; Shuihong (2019) also reinforces the value of m-health platforms in enhancing disease knowledge and health behaviours. Patients who received continuous education and support via WeChat groups showed significantly better fluid management and treatment adherence compared to those receiving standard care. These collective findings highlight the importance of integrating mobile-based interventions into the standard management of CKD. While this study presents promising outcomes, it is essential to consider that the rate of reduction in urea and creatinine may also be influenced by the stage of renal failure and the duration of the disease. In patients with long-standing renal impairment, the normalisation of biochemical parameters tends to occur more gradually. Haemodialysis itself remains the cornerstone of removing excess nitrogenous waste and restoring fluid-electrolyte balance (Geng *et al.*, 2024; Medeiros, Abreu & Lima, 2024).

So, the M-Nursing Application offers a valuable adjunct to conventional haemodialysis care by supporting self-monitoring, patient education, and behavioural adherence. As digital health solutions continue to evolve, their integration into chronic disease management frameworks will be essential in enhancing patient outcomes and reducing the long-term burden of CKD.

Limitation

This study has several limitations that should be considered when interpreting the findings. Firstly, the short follow-up duration may not have been sufficient to capture long-term changes in patient compliance and biochemical markers such as urea and creatinine levels. A longer-term assessment is necessary to evaluate the sustained impact of the M-Nursing Application. Secondly, compliance was assessed using self-reported questionnaires, which are subject to recall bias and social desirability bias. Future studies may benefit from incorporating objective indicators, such as dialysis attendance records or electronic monitoring of medication adherence. Thirdly, several extraneous variables, such as dietary intake, comorbid conditions, socioeconomic status, and variation in clinical care were not fully controlled and could have influenced the outcomes. A more comprehensive assessment framework is recommended in future research. Lastly, although the post-intervention compliance rate reached 100% in this study, this finding should be interpreted with caution. The structured nature of the intervention, the short observation period, and the limited sample size may have contributed to this result, which may not be fully generalisable to broader clinical settings. Further investigation is needed to validate these findings in larger and more diverse populations over extended periods.

CONCLUSION

Innovation model used the M-Nursing Application to measure compliance, urea and creatinine levels. Based on the research findings using the M-Nursing Application, it can be concluded that there was a decrease in urea and creatinine levels, along with an increase in compliance. These results show that respondents were more effective when given the M-Nursing Application intervention. This study provides nursing care by paying attention to promotive and preventive aspects, namely providing health education to patients regarding patient compliance with haemodialysis so that optimal patient health status is achieved through the M-Nursing Application. Future scope of this study should address the study limitations by extending the study period and incorporating objective compliance measures to strengthen the validity of the findings.

Conflict of Interest

The authors declare that they have no competing interests.

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REFERENCES

Andriati, N. R., Pratiwi, R. D., & Indah, F. P. S. (2024). *Tatalaksana pasien gagal ginjal dalam kepatuhan hemodialisis menggunakan aplikasi android ME-RIS (Module Education Renal Illness System) mobile [Management of kidney failure patients in hemodialysis compliance using the ME-RIS Android application]*. Penerbit Indonesia. Retrieved from: https://shorturl.at/eg2A3. Accessed on 20th September 2024.

Casciola, R., Leoni, L., Cuffari, B., Pecchini, M., Menozzi, R., Colecchia, A., & Ravaioli, F. (2023). Creatine supplementation to improve sarcopenia in chronic liver disease: facts and perspectives. *Nutrients, 15*(4). https://doi.org/10.3390/nu15040863 .

Chen, Z., Ma, J., Ou, H., & Pu, L. (2025). Impact of nursing interventions on haemodialysis patients using the integrated theory of health behavior change. *Medicine, 104*(2). https://doi.org/10.1097/MD.0000000000041050 .

De Oliveira, M. M. D., do Couto Dias, E., da Silva, P. L., de Magalhães-Neto, A. M., & Gonçalves, L. C. O. (2021). COVID-19 and kidney disease: The role of nurses. *World Journal of Pharmacy and Pharmaceutical Sciences, 10*(08), 2540-59. https://doi.org/10.20959/wjpps20218-19731.

Faridah, V. N., Hidayati, N., Rokhman, A., Saputra, B. D., & Bachri, S. (2024). development and validation of android-based mobile app for self-controlling excess body fluids in chronic renal failure patients undergoing haemodialysis. *Babali Nursing Research, 5*(4), 705-716. https://doi.org/10.37363/bnr.2024.54411 .

Fei, B., Zhan, L., Gou, J., Wu, Y., & Sun, H. (2025). Exploring the efficacy of structured nursing via web-based interaction platforms in sustaining haemodialysis patients. *Technology and Health Care, 33*(1), 299-310. https://doi.org/10.3233/THC-241021.

Geng, Y., DeLay, S. L., Chen, X., & Miska, J. (2024). It is not just about storing energy: the multifaceted role of creatine metabolism on cancer biology and immunology. *International Journal of Molecular Sciences, 25*(24). https://doi.org/10.3390/ijms252413273 .

Indah, F. P. S., Ilmi, A. F., & Ratnaningtyas, T. O. (2022). Digital health intervention for enhancing self-perceived and compliance with anti-tuberculosis treatment. *Malahayati International Journal of Nursing and Health Science, 5*(1), 17-23. https://doi.org/10.33024/minh.v5i1.5145 .

Lin, W. (2023). Clinical significance of serum creatinine, urea nitrogen and uric acid levels in patients with chronic renal failure. *International Journal of Biology and Life Sciences, 3*(3), 19-26. https://doi.org/10.54097/ijbls.v3i3.04.

Medeiros, M. A., Abreu, B. J., & Lima, J. P. M. S. (2024). Creatine effects on kidney tissues and renal function: new insights from a bioinformatic study. *Preprints*. https://doi.org/10.20944/preprints202406.1733.v1 .

Menezes, H. F. D., Camacho, A. C. L. F., Sant'Anna, R. M. D., Matos, T. L. D. M., Santos, I. S. D., Silva, A. B. P. D., ... & Silva, R. A. R. D. (2023). ICNP® terminology subset for people with chronic kidney disease under conservative treatment. *Acta Paulista de Enfermagem, 36*. https://doi.org/10.37689/acta-ape/2023AO0140333.

Ministry of Health of the Republic of Indonesia. 2018. Results of basic health research (Riskesdas) 2018. Jakarta: Health Research and Development Agency of the Ministry of the Republic of Indonesia. Retrieved from:

https://kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Hasil-riskesdas-2018_1274.pdf. Accessed on 20th September 2024.

Nazira, A., Isaev, R., Shambetova, B., Rehman, S. U., & Osmonaliev, K. (2025). The role of computer technology in monitoring and analysis of haemodialysis patient data: A review. *Southeastern European Journal of Public Health*, 1443–1452. https://doi.org/10.70135/seejph.vi.4140 .

Özdemir, C., & Şendir, M. (2025). The effect of fistula care education given with a mobile application on disease adherence and self-care behaviors in haemodialysis patients: A quasi-experimental study. *Florence Nightingale Journal of Nursing, 33*, 1–10. https://doi.org/10.5152/FNJN.2025.24057 .

Pallant, J. (2020). SPSS survival manual: A step by step guide to data analysis using IBM SPSS (7th ed.). Routledge. Retrieved from: https://books.google.co.id/books/about/Ebook_SPSS_Surival_Manual_A_Step_by_Step.html?id=CxUsEAAAQBAJ&redir_esc=y. Accessed on 24th July 2024.

Polit, D. F., & Beck, C. T. (2008). Nursing research: Generating and assessing evidence for nursing practice. Lippincott Williams & Wilkins. Retrieved from: https://www.researchgate.net/publication/386282179_Polit_and_Beck's_nursing_research_generating_and_assessing_evidence_for_nursing_practice. Accessed on 24th July 2024.

Qqin, Q., Mingxia, X., & Shuihong, Y. (2019). Application of WeChat platform with continuous nursing for patients with MHD. *Chine General Practice Nursing, 17*(3), 263-266. Retrieved from: https://caod.oriprobe.com/articles/56454089/Application_of_WeChat_platform_with_continuous_nur.htm. Accessed on 26th July 2024.

Ramesh, S. V., & Yadav, R. (2023). Mobile health (mHealth) applications in chronic disease management: A review. *Healthcare Technology Letters, 10*(2), 45–51. https://doi.org/10.1049/htl2.12033.

Sayed, H. M., Ibrahim, M. M., & Hussein, R. D. D. (2025). Patients' satisfaction regarding nursing care provided in haemodialysis unit. *Journal of Health Care Research, 2*(1), 59-78. https://doi.org/10.21608/jhcr.2025.315245.1023.

Shi, Y., Pu, S., Peng, H., Zhang, J., Li, Y., Huang, X., ... & Luo, Y. (2024). Impact of mobile application and outpatient follow-up on renal endpoints and physiological indices in patients with chronic kidney disease: a retrospective cohort study in Southwest China. *BMC Medical Informatics and Decision Making, 24*(1). https://doi.org/10.1186/s12911-024-02567-3 .

Silva, R.D. T. H. (2024). Chronic kidney disease in older adults: nursing implications for community nurses. *Journal of Kidney Care, 9*(4), 174-179. https://doi.org/10.12968/jokc.2024.9.4.174 .

Sitanggang, T. W., Anggraini, D., & Utami, W. M. (2021). The relationship between patient compliance in undergoing haemodialysis therapy and the quality of life of chronic kidney disease patients in the haemodialysis room of Medika BSD Hospital. *Jurnal Medikes (Media Informasi Kesehatan), 8*(1), 129-136. https://doi.org/10.36743/medikes.v8i1.259 .

Sudarso, I., Sulistyowati, R., Rahaju, M., & Sudarsono, T. A. (2023). The comparison of ureum levels before and after haemodialysis in chronic kidney failure patients. *Jaringan Laboratorium Medis, 5*(1), 17-21. https://doi.org/10.31983/jlm.v5i1.9161.

Sudrajat, A., & Fetriyana, C. (2023). Perbandingan Kadar Kreatinin Pre Dan Post Hemodialisa Pada Pasien Gagal Ginjal Kronis [Comparison of pre and post haemodialysis creatinine levels in chronic kidney failure patients]. *Barongko: Journal of Health Sciences, 1*(3), 163-172. https://doi.org/10.59585/bajik.v1i3.113. Accessed on 20th September 2024.

Suriyong, P., Ruengorn, C., Shayakul, C., Anantachoti, P., & Kanjanarat, P. (2022). Prevalence of chronic kidney disease stages 3–5 in low-and middle-income countries in Asia: A systematic review and meta-analysis. *PLoS*

One, 17(2). https://doi.org/10.1371/journal.pone.0264393 .

Thummak, S., Uppor, W., & Wannarit, L. O. (2023). Patient compliance: A concept analysis. *Belitung Nursing Journal, 9*(5). https://doi.org/10.33546/bnj.2807 .

Varshney, U. (2014). Mobile health: four emerging themes of research. *Decision Support Systems, 66*, 20-35. https://doi.org/10.1016/j.dss.2014.06.001.

Wahyuni, N. W. S., Kamaryati, N. P., Rismawan, M., & Suantika, P. I. R. (2025). The determining factors of quality of life in chronic kidney disease patients with haemodialysis in hospitals. *Babali Nursing Research, 6*(1). https://doi.org/10.37363/bnr.2025.61454 .

Wang, Y., Sun, J., Guo, F., & Wan, D. (2024). Effect of periodic nursing interventions on improving compliance behavior and health status in long-term haemodialysis patients. *Pakistan Journal of Medical Sciences, 40*(9). https://doi.org/10.12669/pjms.40.9.9076 .

Zhang, H., Zhao, Y., & Li, X. (2024a). Effectiveness of mobile health interventions on chronic kidney disease management: A meta-analysis. *Journal of Medical Internet Research, 26*. https://doi.org/10.2196/47651.

Zhang, Q. L., Zhang, Y., Lin, L. L., Meng, F., & Yan, L. (2024b). A review of mobile device interventions for continuous nursing of patients undergoing maintenance haemodialysis. *Journal of Multidisciplinary Healthcare*, *17*, 317–324.. https://doi.org/10.2147/JMDH.S447715 .