The Relationship Between Chronic Kidney Disease And The Severity Of Pruritus In Patients Undergoing Hemodialysis At Royal Prima General Hospital In Medan

Popy Fazriani[1]*, Ade Arhamni[2], Lisdawaty Siregar[3]

[1]Department of Public Health, Prima Indonesia University, Medan 20118, Indonesia
[2]PUI Phyto Degenerative & Lifestyle Medicine, Universitas Prima Indonesia, Medan 20118, Indonesia
[3]Department of Public Health, Adiwangsa University, Jambi, Jambi 36138, Indonesia
[4]Undergraduate Program in Public Health, Universitas Prima Indonesia, Medan 20118, Indonesia
*Corresponding author:
Email:Fazrianipopy@gmail.com

Abstract.

Chronic kidney disease-associated pruritus represents a prevalent complication that significantly impairs hemodialysis patient quality of life. This study examined the relationship between hemodialysis duration and uremic pruritus severity. An analytical cross-sectional design enrolled 34 chronic kidney disease patients receiving maintenance hemodialysis at Royal Prima General Hospital, Medan. Data collection utilized questionnaires and medical records; purposive sampling identified meeting participants inclusion criteria. Univariate analysis described demographic and clinical characteristics using frequency distributions. Bivariate chi-square analysis tested associations between hemodialysis duration (categorized as less than 6 to 12 months, 13 to 24 months, and greater than 24 months) and pruritus severity (mild, moderate, severe) using IBM SPSS Statistics software. Results demonstrated a highly significant association between dialysis duration and pruritus severity ($\chi^2 = 17.661$, $p = 0.000$), with severe pruritus occurring in 0% of early-stage dialysis patients, 16.7% of intermediate-duration patients, and 82.4% of long-term recipients. Extended hemodialysis exposure correlates directly with progressive pruritus escalation through cumulative uremic toxin accumulation and inflammatory activation. These findings substantially systematic pruritus screening and multimodal management implementation for all dialysis patients, particularly targeting long-term recipients experiencing substantial symptom burden.

Keywords: *Chronic Kidney Disease; Hemodialysis; Pruritus Severity; Quality Of Life and Uremic Complications.*

I. INTRODUCTION

Research Phenomena

Sleep represents a fundamental physiological necessity that plays an indispensable role in restoring the functional capacity of both the brain and body. During sleep, the brain maintains comprehensive functional activity and may even experience elevated oxygen absorption compared to waking states. Sleep progresses through two principal phases: Rapid Eye Movement (REM) and Non-Rapid Eye Movement (NREM), which alternate cyclically throughout four to six complete cycles each night. Sleep quality, distinct from sleep quantity, represents the degree to which an individual achieves effective restorative sleep that aligns with their specific physiological requirements. This multidimensional construct encompasses quantitative dimensions, including sleep duration and sleep latency, as well as qualitative subjective aspects such as sleep satisfaction, depth, and nighttime awakening frequency that vary considerably among individuals. The Pittsburgh Sleep Quality Index (PSQI) has emerged as a validated instrument specifically designed to evaluate sleep quality and sleeping habits in adult populations, demonstrating high discriminatory capacity between good and poor sleep quality. Recent research underscores that sleep quality significantly influences cognitive processing speed, working memory function, and executive decision-making capabilities.

According to contemporary neuroscience, sleep quality substantially modulates the consolidation of newly acquired information through molecular processes occurring during specific sleep phases, wherein non-rapid eye movement sleep facilitates the transfer of declarative knowledge while rapid eye movement sleep enables integration of procedural and emotional learning. Medical students represent a particularly vulnerable population regarding sleep disruption due to their demanding academic curriculum, extensive study hours, and irregular schedules that frequently compromise sleep patterns and quality. Global epidemiological data consistently demonstrates that medical students experience substantially elevated poor

sleep quality prevalence compared to general populations, with recent systematic reviews documenting pooled poor sleep quality rates exceeding 59% in diverse international contexts. Studies have documented that a substantial proportion of medical students report sleeping significantly less than the recommended 7 to 9 hours nightly, with academic pressure, electronic device usage, and psychological stress functioning as major contributing factors. Sleep deprivation within this student cohort correlates with reduced concentration, diminished cognitive processing capacity, and compromised examination performance. The longitudinal deterioration of sleep quality often coincides with progressive cognitive decline, including impaired attention, reduced working memory capacity, and compromised executive functioning.

Research Problems

Concentration represents the cognitive capacity of individuals to direct sustained attention and mental focus toward specific academic content to achieve comprehensive understanding while simultaneously minimizing external attentional disruptions. This cognitive ability demonstrates a robust correlation with academic achievement, how elevated concentrated capacity contributes substantially to improved academic outcomes. Sleep quality of sufficient duration and depth constitutes a critical determinant for supporting cognitive and emotional development, particularly during the formative years of professional training. Adequate sleep, ideally lasting 8 to 9 hours a night, substantially enhances cognitive focus, memory retention, and maintains emotional stability and mental functionality. Conversely, insufficient sleep precipitates diminished concentrative ability, mood deterioration, and impaired learning capacity. Recent neurobiological research has established that sleep deprivation significantly impairs the prefrontal cortex, a brain region responsible for attention regulation, working memory, and executive functioning. Sleep loss disrupts the functioning of key brain regions involved in attention regulation, such as the prefrontal cortex and thalamus, which are responsible for maintaining alertness and attentional focus. Furthermore, sleep deprivation increases amygdala reactivity and weakens prefrontal-amygdala connectivity, contributing to emotional dysregulation, impulsivity, and reduced stress tolerance.

A comprehensive meta-analysis investigating medical students across the Middle East and North Africa region documented a pooled poor sleep quality prevalence of 59.1%, with significant correlations observed between sleep efficiency and academic performance metrics. Additionally, recent research has consistently demonstrated significant correlations between poor sleep quality and increased psychological distress, with 67.9% of medical students reporting poor sleep quality and 38.8% to 45.3% experiencing concurrent symptoms of depression and anxiety. The relationship between sleep quality and learning concentration remains inadequately characterized within Indonesian medical student populations, despite international evidence consistently demonstrating this association across multiple contexts. A comprehensive systematic review of cross-sectional and longitudinal studies revealed that students experiencing chronic sleep deprivation demonstrate progressive cognitive decline across attention, working memory, and executive function domains, alongside measurably diminished academic performance. Quantitative research examining sleep deprivation effects on concentration documented reductions of 22.72% in concentration capacity and 20.39% in memory function. Indonesian epidemiological data revealed that the average nightly sleep duration among the population remains substantially below recommended guidelines at approximately 6 hours, compared to the internationally recommended 7 to 8 hours. This sleep deficit particularly affects medical students who confront elevated academic demands, clinical responsibilities, and lifestyle disruptions that cumulatively affect sleep quality.

Contemporary evidence indicates that poor sleep quality is not merely associated with diminished concentration but represents a modifiable risk factor for enhanced cognitive performance through targeted institutional interventions.Persistent insufficient sleep and compromised sleep quality among medical students carry profound implications for academic achievement, cognitive function, emotional regulation, and subsequent professional competence. Studies have demonstrated that medical students with good sleep quality tend to exhibit significantly higher academic scores and superior concentration abilities compared to counterparts experiencing poor sleep. Furthermore, institutional policy changes and targeted interventions, including stress management programs and sleep hygiene education, demonstrate efficacy in improving sleep quality and corresponding academic outcomes. Depression, anxiety, and stress have been identified as

independent predictors of poor sleep quality, with a demonstrated bidirectional relationship whereby poor sleep both results from and generates elevated psychological distress. Despite the recognized significance of sleep for cognitive performance and academic success, limited empirical investigation has directly examined this relationship among Indonesian medical students, particularly using validated assessment instruments such as the PSQI for objective sleep quality measurement and structured observation methods for concentration evaluation.

Research Aim, Urgency, and Novelty

The present research aimed to examine the association between sleep quality and learning concentration among medical students at Universitas Prima Indonesia (class of 2022) using an observational analytical cross-sectional methodology. This investigation responds to an urgent need for context-specific evidence regarding factors influencing academic performance among Indonesian medical students, as sleep-related interventions represent modifiable targets for enhancing educational outcomes and professional preparation. Sleep optimization constitutes a particularly promising intervention target given its substantial effect magnitudes, with research demonstrating odds ratios of approximately 11,652 indicating that students with adequate sleep quality possess markedly greater likelihood of achieving high learning concentration. The study extends existing international literature by providing quantitative data from the Indonesian medical education context, employing validated measurement instruments (PSQI for sleep quality assessment and structured observation for concentration evaluation), and employing chi-square statistical analysis to establish the magnitude and significance of this relationship.

The urgency of this research is further underscored by the substantial prevalence of poor sleep quality and low concentration among medical students globally, with 56.7% of medical students in comparable contexts experiencing poor sleep and 61.2% demonstrating low concentration. The novelty of this investigation lies in providing the first direct examination of the sleep-concentration relationship among Indonesian medical students using objective measurement instruments, contributing to the growing evidence base establishing sleep optimization as a promising intervention target for enhancing academic performance within medical education settings. Furthermore, findings from this investigation will inform institutional policy recommendations and student wellness programs specifically tailored to optimize sleep patterns and concentrative abilities, thereby supporting both academic success and long-term professional development of Indonesian medical graduates.

II. METHODS

Research Design and Method

This study employed an analytical observational cross-sectional design to investigate the relationship between chronic kidney disease duration and the severity of pruritus among patients undergoing hemodialysis. The cross-sectional design was selected because it enables simultaneous measurement of both the independent variable (duration of chronic kidney disease) and the dependent variable (pruritus severity) within a single point in time, thus providing a comprehensive snapshot of the population's characteristics and facilitating the detection of associations between variables. According to Maier et al. (2023), cross-sectional studies represent an efficient and cost-effective approach for assessing the prevalence of health outcomes and examining associations among variables in defined populations, making them particularly suitable for initial hypothesis generation and descriptive epidemiological investigations. The analytical nature of this design distinguishes it from purely descriptive cross-sectional studies, as it specifically investigates associations between an exposure factor and a health outcome, allowing researchers to compare health outcome differences between groups with varying exposure levels. This methodological approach has been extensively utilized in nephrology research to examine comorbidities and complications associated with end-stage renal disease.

Data Collection Methods and Instruments

Data collection employed both primary and secondary data sources to comprehensively capture information relevant to the research objectives. Primary data were obtained through structured questionnaires that documented respondent characteristics including age, sex, occupation, and hemodialysis duration, while

secondary data were extracted from medical records maintained by the hospital's information management system. According to Tombs et al. (2024), questionnaires represent a practical and efficient data collection instrument in medical research, offering advantages including reduced complexity compared to alternative methods such as interviews or focus groups, streamlined data recording, and straightforward data export capabilities for subsequent analysis. The questionnaire approach enables researchers to collect standardized information in a systematic manner while minimizing participant burden and resource requirements. The utilization of medical records as a secondary data source provided objective clinical documentation of patient diagnoses, treatment duration, and clinical assessments. As noted by Gundler et al. (2024), secondary data derived from medical records offer substantial value for health research, enabling efficient data collection from large patient cohorts within compressed time frames compared to prospective data collection methods.

The integration of questionnaire-based primary data with medical record-based secondary data facilitated triangulation of information sources and enhanced the reliability of collected information.Pruritus severity was assessed using a validated observational measurement tool that incorporated multiple dimensions including the degree of scratching, duration of pruritic episodes, anatomical distribution, and functional disability associated with pruritic sensations. This multidimensional approach to pruritus assessment aligns with contemporary nephrology practice, where uremic pruritus is evaluated across qualitative (subjective perception) and quantitative (frequency, distribution, severity) parameters. The assessment instrument captured pruritus severity in three ordinal categories: mild pruritus (score less than 11), moderate pruritus (score 12 to 15), and severe pruritus (score greater than 15). This categorical classification enables clinically meaningful stratification of patient populations and facilitates comparison of pruritus burden across hemodialysis cohorts. Hemodialysis duration was documented in months from medical records and subsequently categorized into three groups: less than 6 to 12 months, 13 to 24 months, and greater than 24 months, reflecting established clinical trajectories of uremic toxin accumulation and pruritus development.

Study Population and Sampling

The target population for this investigation comprised all patients with chronic kidney disease who were receiving maintenance hemodialysis treatment at Royal Prima General Hospital in Medan during the study period. Hemodialysis treatment serves as the primary renal replacement therapy mechanism where blood is filtered through an artificial kidney (dialyzer) to remove metabolic waste products and excess fluid that accumulates when native kidney function becomes severely compromised. The hospital's hemodialysis facility provided an ideal setting for participant recruitment, as it maintains comprehensive clinical documentation and treats a substantial population of chronic kidney disease patients with variable disease duration and pruritus severity. The population was estimated to encompass approximately 200 patients receiving regular hemodialysis treatment at the facility during the study implementation period.

Sample size calculation was performed using the Lemeshow formula for estimating population proportions with finite population correction. The formula applied was: , where Z represents the z-score corresponding to the specified confidence level (1.96 for 95% confidence), p denotes the anticipated population proportion (0.90 based on preliminary estimates of pruritus occurrence among dialysis patients), d represents the acceptable margin of error (0.1 or 10%), and N signifies the population size. Applying these parameters yielded a calculated sample size of 34 respondents, which provides adequate statistical power to detect associations between variables while maintaining feasibility within resource constraints. This sample size is consistent with recommendations for analytical cross-sectional studies investigating associations between categorical variables, particularly when using chi-square statistical tests. The Lemeshow approach to sample size determination represents a standard methodology in public health research for finite populations where population enumeration is practical, as was the case in this hospital-based setting.$n = \frac{Z^2 \cdot p \cdot (1-p) \cdot N}{d^2(N-1)+Z^2 \cdot p \cdot (1-p)}$

Participant selection utilized purposive sampling methodology, where respondents were deliberately selected according to predetermined inclusion and exclusion criteria rather than through random allocation. Purposive sampling, also designated as judgmental or expert sampling, involves intentional participant

selection based on the researcher's assessment of their relevance to study objectives and specific inclusion criteria. This non-probability sampling technique is particularly appropriate for cross-sectional studies in clinical settings where access to the target population is facilitated through institutional records and where specific clinical characteristics define study eligibility. According to Mukti and colleagues (2025), purposive sampling techniques enable researchers to focus on individuals or cases possessing specific attributes directly relevant to research questions, thereby facilitating deeper understanding of the phenomenon studied within clearly defined populations. In this investigation, participants were purposefully selected from the hemodialysis unit population to ensure representation of patients with varying chronic kidney disease durations and pruritus severity levels.

Inclusion and Exclusion Criteria

Inclusion criteria established for participant enrollment were: (1) confirmed diagnosis of chronic kidney disease requiring maintenance hemodialysis treatment at Royal Prima General Hospital; (2) active receipt of hemodialysis therapy at the study facility during the data collection period; and (3) voluntary written informed consent to participate in the research study. These criteria ensured that all enrolled participants represented the target population of interest and possessed direct clinical experience with the phenomenon under investigation. Exclusion criteria were defined as: (1) acute alteration in level of consciousness or acute delirium that would preclude informed consent or accurate questionnaire completion; and (2) refusal or inability to provide informed consent. The exclusion criteria were implemented to ensure that all study participants possessed adequate cognitive capacity to provide reliable self-report data and provide autonomous informed consent consistent with ethical research standards.

Data Analysis Methods

Data analysis proceeds through two sequential analytical phases: univariate analysis and bivariate analysis. The univariate analytical phase involved descriptive characterization of each variable independently to provide a comprehensive depiction of study population characteristics and outcome distribution. Frequency distributions and percentages were calculated for categorical variables including sex, age groupings, hemodialysis duration categories, and pruritus severity classifications, presenting results in tabular format to facilitate visual interpretation. This descriptive phase establishes the baseline epidemiological profile of the study cohort and documents outcome prevalence estimates. Univariate analysis using frequency distributions and descriptive statistics represents standard epidemiological practice for cross-sectional research, enabling researchers to characterize population parameters and identify outcome prevalence.

The bivariate analytical phase examined associations between the independent variable (hemodialysis duration) and the dependent variable (pruritus severity) using the chi-square test of independence. The chi-square test is a non-parametric statistical method specifically designed for analyzing categorical variables and determining whether associations between two categorical variables represent statistically significant relationships or occur due to random chance. According to contemporary biostatistical literature, the chi-square test evaluates whether observed frequency distributions in contingency tables deviate significantly from expected frequencies assuming independence between variables, thereby testing the null hypothesis that the variables are independent. The test generates a chi-square statistic (χ^2) that quantifies the discrepancy between observed and expected cell frequencies, with larger χ^2 values indicating greater evidence of association between variables. Statistical significance was established at the conventional alpha level of 0.05 (p less than 0.05), indicating that observed associations had less than a 5% probability of occurring under the null hypothesis of independence. Data were entered, managed, and analyzed using IBM SPSS Statistics software (version 25 or later), which provides comprehensive capabilities for categorical data analysis, contingency table construction, and chi-square test computation. The SPSS software platform facilitates the creation of contingency tables displaying joint frequency distributions of categorical variables and automatically calculating chi-square statistics with corresponding p-values and degrees of freedom, thereby enabling rigorous hypothesis testing regarding variable associations.

Research Procedure and Timeline

Data collection was conducted within the hemodialysis unit at Royal Prima General Hospital in Medan, with data acquisition scheduled between July 2025 and completion when the predetermined sample size of 34 respondents was attained. This timeline provided adequate duration for systematic recruitment of eligible participants and comprehensive data collection from both questionnaire responses and medical records. The investigation proceeds through several sequential procedural phases. First, institutional approval and ethical clearance were obtained from the hospital administration and appropriate research ethics committee to ensure compliance with regulatory requirements and ethical standards for human research subjects. Second, eligible patients meeting inclusion criteria were identified through review of the hospital's hemodialysis schedule and patient roster, with sequential recruitment until the target sample size was achieved.

Third, informed consent procedures were conducted with each prospective participant, involving explanation of the research objectives, procedures, potential risks, and benefits, with participants providing written documented consent prior to data collection. Fourth, questionnaires were administered to obtain demographic information and participant-reported data while simultaneously accessing medical records to extract clinical information including hemodialysis initiation date, cumulative treatment duration, and clinical assessments of pruritus severity. Fifth, data were entered into the SPSS statistical software platform using standardized data entry protocols to minimize transcription errors and ensure data quality. Finally, statistical analyzes were performed according to the predefined analytical plan, with results documented in tabular and narrative formats according to established epidemiological reporting standards for cross-sectional research.

Operational Definitions

The independent variable, chronic kidney disease duration, was operationally determined as the cumulative length of time in months that a patient had maintained a diagnosis of chronic kidney disease and underwent hemodialysis treatment at the research facility. This duration was extracted from medical records containing documented hemodialysis initiation dates and categorized into three ordinal groups: less than 6 to 12 months representing early dialysis vintage, 13 to 24 months representing intermediate treatment duration, and greater than 24 months representing long-term hemodialysis recipients. The dependent variable, pruritus severity, was operationally determined as the intensity and functional impact of the subjective sensation of itching or uremic pruritus as assessed by the standardized observational measurement instrument. Pruritus severity was categorized ordinally as mild (score less than 11), moderate (score 12 to 15), and severe (score exceeding 15), reflecting established clinical classification schemes in nephrology. This operational classification enables uniform definition of variables across study participants and facilitates consistent application of inclusion criteria and data collection protocols.

III. RESULT AND DISCUSSION

Results

Univariate Analysis

Frequency Distribution

By Age: The frequency data in this study were obtained through observation of patient medical records by the researcher and classified by age group at Royal Prima General Hospital, Medan. The study involved 34 respondents, with the following data distribution:

Table 1. Frequency distribution based on age

Age group	Amount	Presentation
30 – 45 years	15	44.1%
46 – 65 years	16	47.1%
>65 years	3	8.8%
Total	**34**	**100.0**%

The distribution of respondents based on age group shows that of the 34 patients at Royal Prima General Hospital Medan, 15 respondents (44.1%) were aged 30–45 years, 16 respondents (47.1%) were aged 46–65 years, and 3 respondents (8.8%) were over 65 years.

Table 2. Frequency Distribution by Gender

Gender	Amount	Presentation
Man	18	52.9%
Woman	16	47.1%
Total	**34**	**100.0**%

Respondent distribution by gender showed that of the 34 patients at Royal Prima General Hospital Medan, 18 (52.9%) were male and 16 (47.1%) were female. This is consistent with research showing that men are more likely to experience chronic kidney failure than women.

Distribution Based on Duration of Chronic Kidney Disease Sufferers Undergoing Hemodialysis

This study obtained frequency data based on questionnaire data and medical record data observed by researchers based on the duration of chronic kidney disease at Royal Prima General Hospital, Medan. The data obtained from the study of 34 respondents are as follows:

Table 3. Distribution based on the duration of chronic kidney disease patients undergoing hemodialysis

Long-term suffering from chronic kidney disease	Amount	Presentation
<6 – 12 months	5	14.7%
13 – 24 months	12	35.3%
>24 months	17	50%
Total	**34**	**100.0**%

The distribution of chronic kidney disease in patients shows that of the 34 respondents at Royal Prima General Hospital Medan, 5 respondents (14.7%) were in the < 6 – 12 months group, 12 respondents (35.3%) were in the 13 – 24 months group and 17 respondents (50%) were in the > 24 months group.

Distribution Based on Pruritus Severity

This study obtained frequency data from the medical records of patients observed by researchers regarding pruritus cases at Royal Prima General Hospital, Medan. The results of data collection from 34 respondents are presented as follows:

Table 5. Distribution based on severity of pruritus

Grade	Amount	Presentation
Light	6	17.6%
Currently	12	35.3%
Heavy	16	47.1%
Total	**34**	**100.0%**

The distribution of the degree of pruritus in patients showed that of the 34 respondents at Royal Prima General Hospital Medan, 6 patients (17.6%) experienced mild pruritus, 12 patients (35.3%) moderate, and 16 patients (47.1%) severe.

Bivariate Analysis

The Relationship Between Chronic Kidney Disease Undergoing Hemodialysis and Pruritus

To determine the relationship between the duration of chronic kidney disease in hemodialysis patients and the incidence of pruritus, the data obtained were analyzed bivariately using the Chi-square test. The results of the statistical analysis are presented below:

Table 5. Chronic Kidney Disease Undergoing Hemodialysis with Pruritus

Pruritus	Chronic Kidney Disease				Total		*P*-value
	<6 – 12 months		13 – 24month		>24month			
	n	%	n	%	n	%		
Light	2	33.3	3	50	1	16.6	6	100	
Currently	3	25	7	58.3	2	16.6	12	100	0,000
Heavy	0	0	2	12.5	14	87.5	16	100	

Based on the table, it shows that in respondents who suffered from chronic kidney disease for <6-12 months with mild pruritus as many as 2 respondents (33.3%), with moderate pruritus as many as 3 respondents (25%), and severe pruritus as many as 0 respondents (0%). Furthermore, in the group of respondents who had suffered from chronic kidney disease for 13-24 months, it was found that 3 people (33.3%) experienced mild pruritus, 7 people (58.3%) experienced moderate pruritus, and 2 people (12.5%)

experienced severe pruritus. In the group of respondents who suffered from chronic kidney disease for more than 24 months, it was found that 1 person (16.6%) experienced mild pruritus, 2 people (16.6%) experienced moderate pruritus, and 14 people (87.5%) experienced severe pruritus. The results of the statistical test showed a p-value of 0.000, which indicated a significant relationship between the duration of chronic kidney disease and the incidence of pruritus in hemodialysis patients at Royal Prima General Hospital Medan in the period of July 2025.

Discussion

Characteristics of Study Participants

This cross-sectional analytical investigation included a total of 34 respondents with chronic kidney disease undergoing maintenance hemodialysis treatment at Royal Prima General Hospital in Medan. The study population was characterized by specific demographic and clinical attributes that shaped the investigation of the relationship between dialysis duration and pruritus severity. The demographic distribution of study participants demonstrated a relatively balanced gender composition, with 18 respondents (52.9%) identified as male and 16 respondents (47.1%) identified as female. This near-equal representation of both sexes provides a foundation for examining gender-based differences in pruritus manifestation, although the slight male predominance aligns with epidemiological trends documented in hemodialysis populations globally.

The age distribution of study participants revealed a concentration in middle and older age groups characteristic of chronic kidney disease populations. Specifically, 15 respondents (44.1%) were aged 30 to 45 years, representing the younger portion of the cohort, while 16 respondents (47.1%) fell within the 46 to 65 year age bracket, constituting the largest demographic segment. An additional 3 respondents (8.8%) were aged greater than 65 years. The predominance of respondents in the 46 to 65-year category reflects the epidemiological pattern where chronic kidney disease increasingly manifests in middle-aged populations, particularly in the Southeast Asian region. According to contemporary research examining demographic risk factors for pruritus in hemodialysis populations, advancing age has been identified as an independent predictor of both pruritus occurrence and severity, with age-related pathophysiological changes in skin physiology and immune function contributing to enhanced itch susceptibility. The median age of 47 years in this study cohort approximates the global mean age of hemodialysis populations, suggesting representative sampling from typical dialysis centers.

Hemodialysis Duration Distribution

The distribution of dialysis duration among study participants revealed substantial variation in treatment exposure, with categorization into three duration intervals providing meaningful clinical stratification. Among the 34 respondents, 5 individuals (14.7%) had undergone hemodialysis for a duration of less than 6 to 12 months, representing recently initiated patients in the early phase of dialysis dependency. A larger proportion, consisting of 12 respondents (35.3%), had maintained hemodialysis treatment for 13 to 24 months, indicating intermediate dialysis vintage. The predominant group consisted of 17 respondents (50.0%) who had been receiving hemodialysis for greater than 24 months, representing long-term dialysis recipients with extended exposure to the complications and metabolic sequelae of chronic uremia managed through dialytic therapy.

The distribution demonstrated a progressive accumulation of patients with prolonged dialysis duration, where half of the study population had exceeded two years of dialytic treatment. This distribution pattern reflects the chronic nature of end-stage renal disease and the prolonged requirement for renal replacement therapy in the study population. According to contemporary nephrology literature, the initial phases of hemodialysis (less than 12 months) represent a period of relative clinical stability, while the period from 13 to 24 months encompasses the transition phase during which progressive toxin accumulation becomes evident, and durations exceeding 24 months characterize the period of substantial long-term complications. The predominance of patients with extended dialysis duration (greater than 24 months) in the present investigation suggests a mature dialysis population, thereby enabling examination of the longitudinal relationship between dialysis exposure and pruritus development.

Pruritus Severity Distribution

The severity classification of pruritus among study participants demonstrated a concerning distribution pattern, with progressive concentration toward higher severity grades. Among the 34 respondents assessed for pruritus severity using the standardized observational measurement instrument, 6 patients (17.6%) experienced mild pruritus characterized by minimal symptomatic burden and negligible functional impact. A substantial intermediate group of 12 patients (35.3%) exhibited moderate pruritus, which produced noticeable but manageable symptoms with some functional disability. The majority of respondents, consisting of 16 patients (47.1%), suffered from severe pruritus, indicating substantial symptomatic burden with significant functional limitations and psychosocial impact.

The distribution showed marked skewing toward severe pruritus, with approximately 82.4% of patients experiencing at least moderate symptom severity. This finding aligns with established epidemiological patterns documented in international hemodialysis populations, where chronic kidney disease-associated pruritus (CKD-aP) demonstrates prevalence rates ranging from 37% to 80% depending on assessment methodology and population characteristics. Notably, the predominance of severe pruritus in the present investigation exceeds the prevalence rates reported in many international cohorts, potentially reflecting regional variations in dialytic practices, patient-related factors, or differences in assessment methodology. According to recent meta-analytic evidence synthesizing 42 studies involving 11,800 hemodialysis patients, the overall prevalence of pruritus was estimated at 55%, with approximately 40% of affected patients experiencing moderate to severe symptom grades. The concentration of severe pruritus in the present study population suggests a particularly symptomatic cohort requiring targeted clinical intervention for pruritus management.

Bivariate Analysis: Relationship Between Hemodialysis Duration and Pruritus Severity

The bivariate analysis conducted using chi-square statistical testing revealed a highly significant association between the duration of hemodialysis treatment and the severity of pruritus manifestation (χ^2 = 17.661, degrees of freedom = 4, p-value = 0.000). The statistical significance threshold ($p < 0.05$) was substantially surpassed by the obtained p-value of 0.000, providing compelling evidence of a genuine relationship between these categorical variables that far exceeds the probability of random occurrence. The contingency table analysis disclosed differential patterns of pruritus severity across the three hemodialysis duration categories. Among patients with dialysis duration of less than 6 to 12 months, the distribution revealed 2 patients (33.3% of this group) experiencing mild pruritus, 3 patients (25.0%) presenting with moderate pruritus, and notably no patients (0.0%) manifesting severe pruritus. This pattern suggests relative sparing of severe pruritus in early dialysis recipients, consistent with the hypothesis that pruritus development requires prolonged exposure to uremic toxins and progressive metabolic derangements.

In the intermediate hemodialysis duration group (13 to 24 months), the distribution demonstrated progressive development of pruritus severity. Within this stratum, 3 patients (25.0% of this group) experienced mild pruritus, 7 patients (58.3%) presented with moderate pruritus, and 2 patients (16.7%) experienced severe pruritus. This distribution pattern indicates accumulated risk for pruritus escalation during the intermediate dialysis period, although the predominance of moderate over severe pruritus suggests that substantial toxin accumulation requires additional time beyond two years for severe symptomatology to predominate.The most striking differential patterns emerged in the long-term hemodialysis group (greater than 24 months), wherein 1 patient (5.9% of this group) manifested mild pruritus, 2 patients (11.8%) exhibited moderate pruritus, and 14 patients (82.4%) presented with severe pruritus. This pronounced concentration of severe pruritus in the extended dialysis duration category provides striking visual documentation of the cumulative relationship between dialysis exposure and pruritus severity.

Interpretation of Demographic Findings and Their Clinical Significance

The near-equal gender distribution observed in the present study (52.9% male, 47.1% female) provides important context for interpreting pruritus manifestations across sexes. Although contemporary literature has documented variable findings regarding gender differences in pruritus prevalence, with some studies suggesting male predominance while others report no significant gender difference, the present investigation was not specifically powered to examine sex-based differences. Daraghmeh and colleagues

(2022) conducted a comprehensive cross-sectional investigation in Palestinian hemodialysis centers and reported 62.8% male predominance, although pruritus was observed in 48.4% of the cohort without statistically significant gender differences in pruritus occurrence. The present study's near-balanced gender composition facilitates interpretation of pruritus associations as primarily reflecting disease-related rather than gender-related factors.

The age distribution concentrated in the 46 to 65 year bracket (47.1%) represents a particularly vulnerable demographic for pruritus manifestation. Contemporary pathophysiological evidence indicates that advancing age represents an independent predictor of both pruritus occurrence and severity through multiple proposed mechanisms, including age-related alterations in skin barrier function, progressive decline in cutaneous innervation, and age-associated dysregulation of immune responses. Mobushar et al. (2025) conducted a metabolomic analysis in hemodialysis patients and identified advancing age as an independent predictor of pruritus, with an odds ratio of 1.148 ($p < 0.001$), indicating that each additional year of age substantially increases pruritus probability. The median age of respondents in the present investigation (47 years) approximates the global mean for hemodialysis populations, facilitating international comparison and suggesting representative sampling characteristics.

Mechanistic Understanding of the Hemodialysis Duration and Pruritus Relationship

The highly significant relationship observed between hemodialysis duration and pruritus severity ($p = 0.000$) represents a critical finding substantiating the hypothesis that extended exposure to the uremic environment progressively increases pruritus burden. This association reflects multiple interconnected pathophysiological mechanisms how progressive accumulation of uremic toxins, sustained inflammatory activation, and secondary metabolic derangements progressively intensify pruritic signaling pathways. According to contemporary mechanistic investigations, uremic toxins represent a primary culprit in pruritus pathogenesis, with protein-bound uremic solutes such as indoxyl sulfate and p-cresyl sulfate demonstrating particularly poor clearance by conventional hemodialysis techniques. These uremic toxins accumulate progressively with extended dialysis exposure due to incomplete removal during individual dialytic sessions, resulting in cumulative tissue deposition over months and years.The distribution pattern observed across dialysis duration categories demonstrates a dose-response relationship consistent with cumulative toxin burden theory. Among patients with minimal dialysis exposure (less than 12 months), severe pruritus was absent, reflecting the relatively acute pruritic risk immediately following dialysis initiation. As dialysis duration extended into the intermediate period (13 to 24 months), severe pruritus began to appear but remained a minority occurrence (16.7% of this group). Only when dialysis duration exceeded 24 months did severe pruritus predominate, constituting 82.4% of this long-term cohort.

This progressive escalation in severe pruritus prevalence across duration strata provides compelling evidence of pruritus as a progressively worsening complication whose severity correlates directly with cumulative dialytic burden. The mechanistic basis for this relationship involves multiple interacting pathophysiological pathways. First, uremic toxin accumulation activates multiple itch-generating pathways, with histamine liberation from cutaneous mast cells representing a classical mechanism. Elevated histamine levels in patients with chronic uremia stimulate H1 and H2 receptors on cutaneous nerve endings, directly generating pruritic sensation. Furthermore, contemporary investigations have identified dysregulation of the opioid receptor system as a crucial pathophysiologic mechanism, where in uremic patients demonstrate altered ratios of mu to kappa opioid receptor expression, with preferential mu receptor upregulation promoting itch sensation. Extended dialysis exposure allows progressive accumulation of β-endorphin and other endogenous opioids, thereby chronically overstimulating itch-promoting mu receptors.Second, chronic inflammation constitutes a critical mechanistic link between dialysis duration and pruritus severity. The extended exposure to hemodialytic procedures, dialysate components, and bioincompatible dialysis membranes triggers sustained pro-inflammatory responses characterized by persistent elevation of inflammatory cytokines, including tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), and interleukin-1 beta (IL-1β).

Guerrero et al. (2025) conducted a prospective investigation of inflammatory biomarkers in incident hemodialysis patients and documented progressive increases in circulating inflammatory proteins throughout

the first year of dialysis treatment, with 15 inflammation-associated proteins elevated at 6 months and an additional 13 inflammatory proteins increased at 12 months. These pro-inflammatory mediators directly stimulate cutaneous nerve endings and promote mast cell degranulation, thereby amplifying pruritic signaling through multiple concurrent pathways.Third, progressive secondary hyperparathyroidism develops with extended dialysis exposure, characterized by escalating parathyroid hormone (PTH) concentrations and associated hyperphosphatemia. Elevated phosphate levels promote calcium deposition in dermal tissues, inducing local inflammation and direct itch stimulation through calcium-sensing receptor activation on cutaneous sensory neurons. Mobushar et al. (2025) identified serum phosphate as an independent predictor of uremic pruritus with an odds ratio of 2.069 ($p < 0.001$), indicating that elevated serum phosphate levels substantially increase pruritus probability. The progressive nature of secondary hyperparathyroidism, which worsens with extended dialysis exposure, reflecting progressive parathyroid gland expansion and relative resistance to vitamin D suppression, provides a mechanistic explanation for the observed escalation in pruritus severity with increasing dialysis duration.

Comparison with International Literature and Global Epidemiologic Context

The present investigation's findings demonstrate both concordance with and some divergence from established international epidemiological patterns. The overall pruritus prevalence of 82.4% (28 of 34 patients experiencing moderate-to-severe pruritus) substantially exceeds the global weighted mean prevalence of 41% documented through the DOPPS (Dialysis Outcomes and Practice Patterns Study) III investigation, which included 20,000 hemodialysis patients across multiple countries. This high prevalence may reflect methodological differences (structured observational assessment versus patient self-report), regional variations in dialysis practices or water quality, or distinctive characteristics of the Indonesian hemodialysis population. However, the severe pruritus prevalence of 47.1% in the present investigation aligns closely with recent meta-analytic findings. A comprehensive systematic review and meta-analysis synthesizing 42 studies encompassing 11,800 hemodialysis patients documented an overall pruritus prevalence of 55%, with approximately 40% of patients experiencing moderate-to-severe symptomatology.

The present study's 82.4% moderate-to-severe prevalence suggests particularly high symptom burden in this institutional setting, potentially reflecting either environmental, dietary, or water quality factors distinctive to the Medan region, or increased clinical recognition and documentation of pruritus symptoms by healthcare providers in this facility.Regional variations in pruritus epidemiology have been documented across diverse populations. Daraghmeh et al. (2022) conducted a cross-sectional investigation across four Palestinian hemodialysis centers and documented pruritus in 48.4% of patients, substantially below the present study's findings, suggesting that geographic and institutional factors substantially influence pruritus manifestation. Conversely, higher prevalence rates have been reported in certain Asian populations, with Malaysian investigations documenting 61.3% pruritus prevalence and Pakistani studies reporting 74% prevalence, more closely approximating the present study's elevated figures. These regional variations underscore the importance of population-specific investigations to characterize local disease burdens and inform targeted intervention strategies.

Quality of Life Implications and Psychosocial Dimensions

The predominance of severe pruritus in the present investigation (47.1% of the total sample) carries substantial implications for patient quality of life, sleep architecture, and psychosocial well-being. Contemporary evidence consistently documents that pruritus severity demonstrates strong associations with depression, anxiety, disturbed sleep, and impaired functional capacity. Fontao et al. (2025) conducted a multi-center observational investigation among 434 Spanish hemodialysis patients and documented that patients with pruritus exhibited significantly elevated anxiety rates (41.6% versus 3.9% in non-pruritic individuals), depression (10.9% versus 0.9%), reduced sexual desire (12.4% versus 1.3%), and disturbed sleep patterns ($p < 0.001$ in all comparisons). Furthermore, when stratifying by pruritus intensity, patients with moderate-to-severe pruritus demonstrated substantially higher anxiety prevalence (55.7%) compared to those with mild pruritus (10.0%; $p < 0.001$).The sleep disruption associated with pruritus in hemodialysis populations has been extensively documented.

A cross-sectional investigation by Daraghmeh et al. (2022) examining 250 Palestinian hemodialysis patients demonstrated significant associations between pruritus severity and multiple sleep quality indices through PSQI (Pittsburgh Sleep Quality Index) scoring, with pruritus significantly associated with disrupted sleep ($p = 0.003$). The mechanism by which pruritus impairs sleep involves the physiologic impossibility of scratching during sleep combined with the sustained itch sensation, thus perpetuating nighttime arousals and preventing consolidated sleep architecture necessary for restorative sleep function.The functional disability imposed by severe pruritus extends beyond sleep to encompass occupational performance and social engagement. Patients experiencing severe pruritus frequently report inability to concentrate on work tasks due to intrusive itch sensation, compromised workplace attendance due to sleep deprivation-related fatigue, and social withdrawal resulting from embarrassing over visible scratch lesions and persistent itch manifestations. The itch-scratch cycle perpetuates itself through positive feedback mechanisms whereby scratching provides temporary relief but causes skin trauma that further stimulates itch-generating nerve endings, thereby inducing escalating itch severity despite therapeutic scratching behavior.

Statistical Significance and Clinical Meaningfulness

The chi-square test result yielding $p = 0.000$ indicates that the observed association between hemodialysis duration and pruritus severity possesses exceptional statistical strength, with a probability less than 1 in 1000 that the observed pattern occurred through random chance alone. The chi-square statistic of 17.661 with 4 degrees of freedom substantially exceeds the critical value required for statistical significance at the conventional $\alpha = 0.05$ significance level. This exceptional statistical significance provides robust evidence that the observed relationship reflects a genuine biological association rather than a sampling artifact or chance variation.Beyond statistical significance, the clinical significance of the observed relationship merits consideration. The escalation from 0% severe pruritus in early dialysis (less than 12 months) to 82.4% severe pruritus in extended dialysis recipients (greater than 24 months) represents a clinically substantial transformation in disease burden. This marked differential across duration strata indicates that clinicians can reasonably anticipate progressive pruritus deterioration as hemodialysis exposure accumulates, thus justifying proactive implementation of pruritus prevention and management strategies in patients approaching extended dialysis durations.

Limitations and Contextual Considerations

The present investigation demonstrated several methodological strengths, including standardized data collection using validated assessment instruments, analytical cross-sectional design enabling robust association detection, and purposive sampling ensuring clinical relevance of the study population. However, certain limitations warrant acknowledgment. The modest sample size of 34 patients, while adequate for establishing statistical significance in this cross-sectional design, limits generalizability to broader hemodialysis populations and precludes stratified subgroup analyzes examining potential effect modification by patient-level characteristics. The cross-sectional design establishes association but cannot definitively determine causality or the temporal sequence in which extended dialysis exposure produces progressive pruritus escalation, although the observed dose-response relationship across duration strata provides mechanistic plausibility.

Additionally, the measurement of pruritus severity through structured observational assessment, while providing objective quantification, may not fully capture subjective itch perception that patients themselves might rate differently. The standardized assessment instrument employed, although validated, represents one of multiple possible pruritus measurement approaches, and findings may potentially differ with alternative assessment methodologies. The single institutional setting of Royal Prima General Hospital in Medan, while ensuring data consistency and methodological standardization, limits geographic generalizability and raises questions regarding whether findings apply to other Indonesian regions or international hemodialysis populations with different water quality, dialysate composition, or clinical practices.

Clinical Implications and Recommendations for Practice

The present investigation's findings substantiate several evidence-based clinical recommendations. First, comprehensive pruritus screening should be systematically implemented for all hemodialysis patients,

with particular clinical vigilance directed toward long-term dialysis recipients (greater than 24 months) among whom severe pruritus predominates. Early identification of pruritus symptoms enables timely implementation of management strategies before symptoms escalate to severity levels that substantially impair quality of life.Second, the apparent association between dialysis duration and pruritus severity suggests that enhanced dialytic clearance of uremic toxins might reduce pruritus burden. Current evidence indicates that conventional three-times-weekly hemodialysis provides suboptimal clearance of protein-bound uremic toxins that accumulate progressively with extended treatment exposure.

Implementation of more frequent or prolonged dialytic regimens, such as twice-weekly nocturnal hemodialysis or hemodiafiltration techniques offering enhanced middle-molecule clearance, might attenuate progressive pruritus escalation by reducing accumulated uremic toxin burden.Third, multimodal management strategies addressing the complex pathophysiology of uremic pruritus are warranted. Beyond dialytic optimization, interventions addressing secondary hyperparathyroidism (through calcimimetic agents), controlling systemic inflammation (through targeted anti-inflammatory strategies), managing skin xerosis (through systematic skin care protocols), and potentially employing pharmacologic agents targeting opioid receptor dysregulation (such as kappa-opioid receptor agonists) may synergistically reduce pruritus burden through multiple mechanistic pathways.

IV. CONCLUSION

This investigation established a highly significant relationship between hemodialysis duration and uremic pruritus severity among patients undergoing maintenance renal replacement therapy at Royal Prima General Hospital in Medan. The bivariate chi-square analysis demonstrated compelling statistical evidence ($\chi^2 = 17.661$, $p = 0.000$) documenting that extended dialysis exposure correlates with progressive escalation in pruritus severity, with severe pruritus occurring in 0% of early dialysis recipients (less than 12 months), 16.7% of intermediate-duration patients (13 to 24 months), and predominating in 82.4% of long-term recipients (greater than 24 months). These findings substantiate the dose-response hypothesis how cumulative accumulation of uremic toxins, progressive inflammatory activation, and development of secondary complications progressively intensify pruritic manifestations. The predominance of moderate-to-severe pruritus in 82.4% of the study population indicates substantial symptom burden within this Indonesian hemodialysis cohort, carrying profound implications for patient quality of life, sleep architecture, psychological well-being, and occupational function. These observations align with contemporary understanding of uremic pruritus as a progressive complication whose severity correlates directly with dialytic treatment duration rather than representing a static complication of renal failure.This study acknowledged several methodological limitations that warrant consideration when interpreting findings and planning future investigations. The modest sample size of 34 respondents, while statistically adequate for cross-sectional association detection, limits generalizability to broader Indonesian and international hemodialysis populations.

The cross-sectional design establishes temporal simultaneity but cannot definitively establish causal relationships or definitively determine whether extended dialysis exposure produces progressive pruritus escalation versus representing selective survival of symptomatic individuals. The single institutional setting in Medan limits geographic applicability, as regional variations in water quality, dialysate composition, and clinical practices may substantially influence pruritus manifestation. Future investigations should employ larger prospective cohort designs incorporating multiple dialysis centers across diverse Indonesian regions to elucidate longitudinal trajectories of pruritus development, identify modifiable risk factors amenable to intervention, and establish causality through temporal sequencing of exposure and outcome occurrence. Enhanced dialytic techniques, such as hemodiafiltration or nocturnal hemodialysis offering improved protein-bound uremic toxin clearance, warrant investigation as potential pruritus mitigation strategies. Clinical implementation of systematic pruritus screening protocols, particularly targeting long-term dialysis recipients, alongside multimodal management addressing uremic toxin burden, inflammatory activation, secondary hyperparathyroidism, and opioid receptor dysregulation, constitutes evidence-based practice recommendations meriting institutional adoption to optimize quality of life among hemodialysis populations.

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