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Original Article

Global prevalence and potential factors influencing willingness for renal transplantation in end-stage renal disease patients: A systematic review and meta-analysis

Fredo Tamara[1*], Jonny K. Fajar[2*], Agung Susanto[1], Yesica T. Enggriani[3], Maria IS. Beluan[3], Reychell Mirino[3], Lia D. Farida[4], Diana V. Hastutya[5], Dewi A. Puspitasari[5], Yama S. Putri[5], Jefri P. Susanto[6] and Volodymyr Dzhyvak[7]

[1]Division of Nephrology and Hypertension, Department of Internal Medicine, Faculty of Medicine, Universitas Negeri Sebelas Maret, Surakarta, Indonesia; [2]Brawijaya Internal Medicine Research Center, Department of Internal Medicine, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia; [3]Faculty of Nursing, Universitas Indonesia, Depok, Indonesia; [4]Department of Biomedical Sciences, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia; [5]Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta, Indonesia; [6]Department of Internal Medicine, Dr. Ben Mboi General Hospital, Kupang, Indonesia; [7]Department of Children's Diseases and Pediatric Surgery, I. Horbachevsky Ternopil National Medical University, Ternopil, Ukraine

*Corresponding author: gembyok@gmail.com (FT) and fredotamara@gmail.com (JKF)

Abstract

The prevalence of willingness to undergo renal transplantation and its potentially associated factors have been documented in multiple prior studies across different regions, yet certain findings are conflicting. The aim of this study was to determine the global prevalence of willingness for renal transplantation and identify its associated factors through meta-analysis methods. Databases such as Scopus, PubMed, and Embase were utilized for the search strategy, covering the period from April to May 2024. Data collection focused on gathering information regarding the prevalence and potential contributing factors of renal transplantation. Statistical analysis involved examining the cumulative prevalence of willingness for renal transplantation using single-arm meta-analysis. Factors associated with willingness for renal transplantation were analyzed using the Mantel–Haenszel test for categorical variables and the inverse variance method for numerical variables. A total of nine articles, covering 3935 patients with end-stage renal disease (ESRD) were included. The pooled estimates revealed that the overall prevalence of willingness to undergo renal transplantation among ESRD patients was 57% (95%CI: 0.46–0.67). Furthermore, we observed a higher likelihood of willingness among men and those of younger age, attainment of at least a bachelor's degree or higher in education, employment status, higher income levels, and a shorter duration of hemodialysis (<5 years). Our study has documented the global prevalence and potential associated factors of willingness to undergo renal transplantation, providing valuable insights for policymakers aiming to enhance the acceptance of renal transplantation.

Keywords: Renal transplantation, end-stage renal disease, willingness, prevalence, predictors

Introduction

End-stage renal disease (ESRD) continues to pose a significant global health challenge. The prevalence of ESRD is projected to rise to between 2700 and 3500 per million by 2030, marking

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a 29% to 68% increase over the 2015 prevalence of 2087 per million [1]. The mortality rate of ESRD varies depending on factors such as age, gender, race, cause of ESRD, treatment modality, and its complications. The overall mortality rate for ESRD patients is approximately 8.07 deaths per year [2]. Additionally, another study found the annual mortality rate to be 7.44% [3]. Managing ESRD is highly complex and poses its own challenges, including increased mortality and cardiovascular morbidity, higher rates of infections, fluid overload, dialysis-related complications, psychosocial and quality of life issues, and high costs [4-6]. Cost is an important factor to consider, as managing ESRD is an ongoing process [7]. Therefore, alternative efforts in ESRD management, such as renal transplantation, are needed.

Renal transplantation was first successfully performed by Dr. Erich Ullmann in 1902 [8]. Today, renal transplantation has been proven to yield good efficacy and outcomes with minimal complications through strict management [9]. However, renal transplantation faces challenges, including organ availability, immunosuppression, patient compliance, complications, financial incentivization, graft loss, cost, and willingness to undergo the procedure [10]. Willingness to undergo renal transplantation is crucial for the success of transplantation programs among ESRD patients. Even with effective management, transplantation cannot yield positive outcomes if patients are unwilling to undergo the procedure [11]. Hence, there is a necessity for studies to assess the global prevalence of willingness to undergo renal transplantation and identify factors influencing ESRD patients in determining their readiness for the procedure. Several previous studies have examined the prevalence of willingness for renal transplantation and its potential associated factors in diverse regions [12-20]. However, some of these studies have yielded inconclusive results [12-20]. A meta-analysis study assessing this willingness to undergo renal transplantation among hemodialysis patients had never been conducted before. Therefore, the aim of this study was to determine the global prevalence of willingness to undergo renal transplantation and identify factors associated with this willingness using meta-analysis. Through this method, the aim was to summarize data on the findings of previous studies that remained inconclusive. The findings of the study could serve as a guide for policymakers in educating ESRD patients about renal transplantation.

Methods

Study design and search strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist was employed to ensure the methodological rigor throughout the process [21]. The PRISMA checklist for this study is included in the supplementary file [22]. The primary objective was to extract information from relevant studies and calculate the cumulative size effect, including event rates for prevalence data, odds ratios for categorical potential risk factors data, and mean differences for numerical potential risk factors data. The protocol of this study was registered on PROSPERO with a reference number of CRD42024543720 (16 May 2024).

The study was performed between April and May 2024, where the records screening was carried out on Scopus, Embase, and PubMed databases on 8 May 2024. A combination of keywords 'willingness' AND 'renal transplant' AND 'end-stage renal disease' OR 'chronic kidney disease' were used to identify the relevant records in the database. The keywords were adapted from the Medical Subject Heading (MeSH). In addition to database searches, supplementary methods were employed, including the examination of reference lists from related articles.

Eligibility criteria

Inclusion criteria were observational studies that assessed the willingness of hemodialysis patients to undergo renal transplantation and provided complete data for calculating cumulative effect estimates (such as the number of patients willing to receive a renal transplant and the total number of patients). To be included, the study should exclusively evaluate the willingness for renal transplantation among patients diagnosed with ESRD. ESRD is defined as a glomerular filtration rate of less than 15 mL/min [23]. Studies that fell into categories such as case-control studies, reviews or commentaries were excluded. Those reported in languages other than English were also excluded.

Quality assessment

The Newcastle Ottawa Scale (NOS) was utilized as the primary tool to evaluate the quality of articles included in the study. This assessment tool evaluates articles based on three main components: patient selection, comparability, and outcome assessment. Each component is rated on a scale from 0–9, with a maximum score of 9 indicating high quality. Articles scoring 7–9 are considered high quality, 4–6 moderate quality, and 0–3 low quality [24]. To ensure consistency and reliability, assessments were conducted by eight individuals (YTE, MISB, RM, LDF, DVH, DAP, YSP, and JPS). In cases where assessments diverged, resolution resulted from an open discussion with a senior researcher (JKF).

Data extraction

From each article, data extraction was carried out for details such as the first author's name, publication year, country of study, study design, participant ages, gender distribution, sample sizes of both cases and controls, and population source. The data extraction process was conducted by a team of eight individuals (YTE, MISB, RM, LDF, DVH, DAP, YSP, and JPS) to ensure accuracy and reliability. In instances where discrepancies arose, resolution was achieved through collaborative discussion with a senior researcher (JKF).

Covariates

In this study, the prevalence of willingness among ESRD patients to undergo renal transplantation served as the primary outcome covariate. Data on patients' willingness was collected through questionnaires that were asked whether they were willing to undergo renal transplantation. The prevalence of willingness was calculated by dividing the number of patients willing to undergo renal transplantation by the total sample size and multiplying by 100%. Additionally, various predictor covariates were examined to elucidate factors potentially influencing this willingness. These predictors included age, gender, marital status, educational attainment, employment status, socioeconomic standing, duration of hemodialysis, possession of health insurance, as well as the presence of comorbidities such as diabetes mellitus and hypertension.

Statistical analysis

The data presentation in this study adhered to established conventions, with numerical data presented as mean ± standard deviation (SD) and categorical data as n (%). To assess the potential of publication bias, both Egger's regression test and funnel plot asymmetry were utilized. Publication bias was inferred if the *p*-value from Egger's test was less than 0.05 or if the funnel plot was asymmetry. If publication bias was detected, it was addressed using either the Trim and Fill method or a weight function model [25]. Heterogeneity was evaluated using *I*-squared (I^2) and the *p*-value for heterogeneity (*p*-Het). A random effects model was employed if I^2 exceeded 50% or if the *p*-value for heterogeneity was less than 0.10; otherwise, a fixed-effects model was utilized [26-28]. Main findings were assessed using statistical tests such as the *Z*-test, the Mantel–Haenszel test for dichotomous data, or the inverse variance method for continuous data. For prevalence data, a single-arm meta-analysis was conducted. Effect estimates were calculated using event rates for prevalence data, odds ratios for risk data, and mean differences for numerical data [29]. The analyses were performed using the R package within RStudio version 4.1.1 (RStudio, Inc., MA, USA).

Results

Article selection

The initial selection process involved screening articles from Scopus, PubMed, and Embase, resulting in a total of 92 articles. Additionally, 12 articles were identified from the reference lists of related articles. Through two rounds of exclusions, duplicates (n=6) and irrelevant studies (n=79) were removed during the first exclusion phase. In the second exclusion phase, articles lacking sufficient data (n=7) [30-36] and review articles (n=3) were excluded. Consequently, a final sample of nine articles was deemed eligible for inclusion in the study [12-20]. A flowchart

depicting the sample selection process according to the PRISMA guidelines is presented in **Figure 1**.

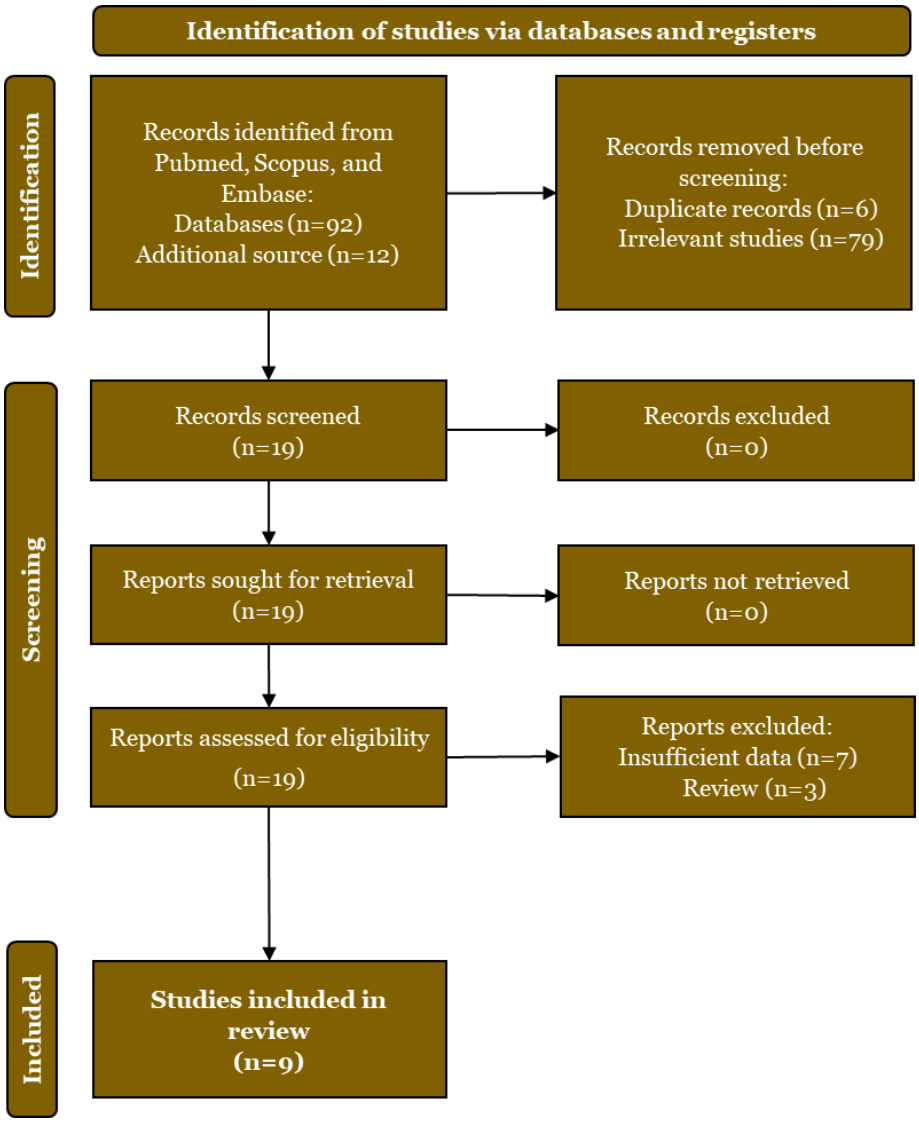

Figure 1. A flowchart depicting the selection process for studies reporting the prevalence of willingness to undergo renal transplantation among hemodialysis patients.

Characteristics and quality of the included studies

Characteristics of the included articles are presented in **Table 1**. There were nine articles included in our study: one study conducted in Saudi Arabia [12], one study conducted in Ghana [13], one study conducted in Pennsylvania [14], one study conducted in Morocco [16], one study conducted in Taiwan [17], two studies conducted in the US [15,20], and two studies conducted in China [18, 19]. Regarding the quality of the articles based on the NOS assessment, five articles were categorized as high quality [12,14,15,19,20] and four articles were moderate quality [13,16-18]. All of these articles were cross-sectional studies. All ESRD patients recruited in the selected studies received hemodialysis therapy. The complete detail of the quality assessment is presented in the supplementary file [22].

Table 1. Characteristics of the included articles

First author, year	Region	Total	Age (years) [a]	M/F	Study period	NOS
Alansari, 2017 [12]	Saudi Arabia	252	55.27±15.21	59/41	Nov 2016-Jan 2017	8
Boima, 2021 [13]	Ghana	342	50.24±17.08	57/43	Not reported	6
Gillespie, 2014 [14]	Pennsylvania	101	57 (28–82) [b]	48/52	Jul 2008-Jan 2009	8
Ilori, 2015 [15]	United States	211	18–60 [c]	52/58	Apr-Jun 2013	8

First author, year	Region	Total	Age (years) [a]	M/F	Study period	NOS
Kabbali, 2014 [16]	Morocco	2066	50±15.3	57/43	Not reported	6
Lee, 2022 [17]	Taiwan	108	Not reported	59/41	Not reported	6
Qiao, 2016 [18]	China	307	49.47±12.52	64/36	Jun-Jul 2015	6
Tan, 2017 [19]	China	239	42.4±10.6	60/40	Dec 2014-Jan 2015	8
Vilme, 2018 [20]	United States	309	53 (44–60)[b]	58/42	Feb 2009-May 2011	8

ESRD: end-stage renal disease; HD: hemodialysis; M/F: male/female; NOS: Newcastle-Ottawa Scale
[a] Presented as mean±SD
[b] Presented as median (min-max)
[c] Presented as overall range

Table 2. The potential factors associated with the willingness to undergo renal transplantation among hemodialysis patients

Covariates	Willingness/total, (%)	NS	MD*/OR	95%CI	*p*-Egger	*p*-Het	*p*-value
Age (years), mean±SD	-	4	-7.43	-14.36–-0.50	0.494	<0.001	0.036
Age group							
<60 years	421/1215 (34.65)	5	1.45	0.48–4.41	0.387	<0.001	0.512
≥60 years	245/1215 (20.16)	5	0.69	0.23–2.09	0.387	<0.001	0.512
Sex							
Male	1457/3872 (37.63)	9	1.43	1.03–2.00	0.698	<0.001	0.034
Female	1062/3872 (27.43)	9	0.70	0.50–0.97	0.698	<0.001	0.034
Marital status							
Married	516/1485 (34.75)	7	1.24	0.98–1.58	0.756	0.524	0.070
Single	379/1485 (25.52)	7	0.80	0.64–1.02	0.756	0.524	0.070
Educational attainment							
<Higher education	1654/3134 (52.78)	6	0.49	0.25–0.93	0.866	<0.001	0.029
≥Higher education	370/3134 (11.81)	6	2.06	1.08–3.95	0.866	<0.001	0.029
Employment							
Not working	474/1337 (35.45)	6	0.63	0.49–0.81	0.919	0.194	<0.001
Working	325/1337 (24.31)	6	1.58	1.24–2.03	0.919	0.194	<0.001
Socioeconomic status							
Low income	290/1076 (26.95)	5	0.50	0.25–0.90	0.167	<0.001	0.040
High income	271/1076 (25.19)	5	1.99	1.10–3.95	0.167	<0.001	0.040
HD duration							
<5 years	229/559 (40.97)	2	1.87	1.13–3.10	NA	0.807	0.015
≥5 years	53/559 (9.48)	2	0.53	0.32–0.88	NA	0.807	0.015
Having health insurance	1072/3029 (35.39)	5	1.78	0.95–3.34	0.159	<0.001	0.071
Diabetes mellitus	257/2305 (11.15)	2	0.54	0.28–1.03	NA	0.069	0.063
Hypertension	856/2305 (37.14)	2	1.13	0.94–1.37	NA	0.618	0.190

CI: confidence interval; MD: mean difference; NS: number of studies; OR: odds ratio; *p*-Het: *p*-Heterogeneity

The prevalence of willingness to undergo renal transplantation among ESRD patients

A total of nine articles were evaluated to determine the global prevalence of willingness to undergo renal transplantation among ESRD patients [12-20]. Our calculation, which employed single-arm meta-analysis, revealed that the overall prevalence of willingness to undergo renal transplantation among ESRD patients was 57% (**Figure 2A**) (Event rate: 0.57; 95%CI: 0.46–0.67; *p*-Het<0.001; *p*-Egger: 0.062; *p*=0.230).

The factors associated with the willingness to undergo renal transplantation among ESRD patients

From the array of potential variables we evaluated, including age, gender, marital status, educational attainment, employment, socioeconomic status, hemodialysis duration, possession of health insurance, diabetes mellitus, and hypertension, our findings revealed an increased likelihood of willingness to undergo renal transplantation among ESRD patients within specific demographics. We observed that a higher risk of willingness was associated with younger age groups (**Figure 2B**) (MD: -7.43; 95%CI: -14.36–-0.50; *p*-Egger: 0.494; *p*-Het<0.001; *p*=0.036),

male gender (**Figure 2C**) (OR: 1.43; 95%CI: 1.03–2.00; *p*-Egger: 0.698; *p*-Het<0.001; *p*=0.034), attainment of at least a Bachelor's degree or higher in education (**Figure 2D**) (OR: 2.06; 95%CI: 1.08–3.95; *p*-Egger: 0.866; *p*-Het<0.001; *p*=0.029), employment status (**Figure 3A**) (OR: 1.58; 95%CI: 1.24–2.03; *p*-Egger: 0.919; *p*-Het: 0.194; *p*<0.001), higher income levels (**Figure 3B**) (OR: 1.99; 95%CI: 1.10–3.95; *p*-Egger: 0.1673; *p*-Het<0.001; *p*=0.040), and a shorter duration of hemodialysis (<5 years) (**Figure 3C**) (OR: 1.87; 95%CI: 1.13–3.10; *p*-Egger: NA; *p*-Het: 0.807; *p*=0.015). Detailed results of the analysis of the contributing factors in willingness to undergo renal transplantation among ESRD patients are presented in **Table 2**.

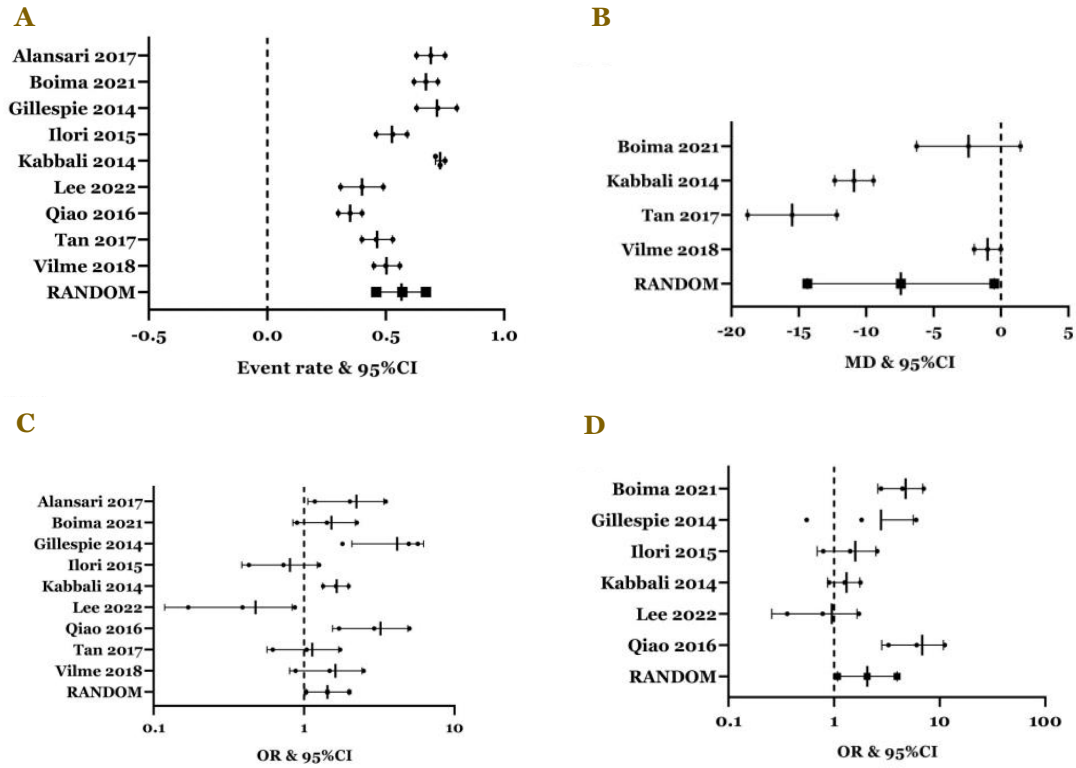

Figure 2. Forest plot of the global prevalence of willingness to undergo renal transplantation (Event rate: 0.57; 95%CI: 0.46–0.67; *p*-Het<0.001; *p*-Egger: 0.062; *p*=0.230) (A). The association between age and the willingness to undergo renal transplantation (MD: -7.43; 95%CI: -14.36–-0.50; *p*-Egger: 0.494; *p*-Het<0.001; *p*=0.036) (B). The association between male gender and the willingness to undergo renal transplantation (OR: 1.43; 95%CI: 1.03–2.00; *p*-Egger: 0.698; *p*-Het<0.001; *p*=0.034) (C). The association between educational attainment (having a higher education certificate) and the willingness to undergo renal transplantation (OR: 2.06; 95%CI: 1.08–3.95; *p*-Egger: 0.866; *p*-Het<0.001; *p*=0.029) (D).

Heterogeneity among studies & potential publication bias

The results of the Q test indicated that the variables of marital status, employment status, HD duration, and hypertension exhibited *p*-Het>0.10. Consequently, these variables were analyzed using a fixed-effect model. The variables such as age, gender, educational attainment, socioeconomic status, health insurance, and diabetes mellitus displayed *p*-Het<0.10, leading to their analysis using a random-effects model. Subsequently, in the assessment of potential publication bias, none of the variables showed significant indications (*p*-Egger>0.05). However, three variables (hemodialysis duration, diabetes mellitus, and hypertension) were not able to undergo potential publication bias calculations due to sample limitations. A summary of the calculations for heterogeneity tests and potential publication bias is presented in **Table 2**.

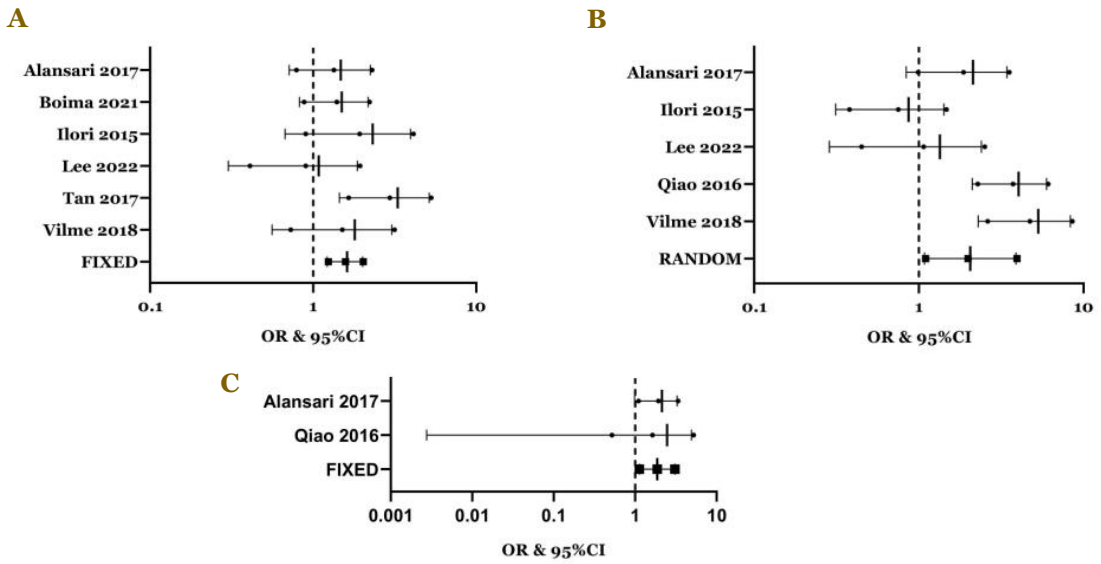

Figure 3. Forest plot of the association between employment and the willingness to undergo renal transplantation (OR: 1.58; 95%CI: 1.24–2.03; *p*-Egger: 0.9186; *p*-Het: 0.1940; *p*<0.0001) (A). The association between high income and the willingness to undergo renal transplantation (OR: 1.99; 95%CI: 1.10–3.95; *p*-Egger: 0.1673; *p*-Het<0.0001; *p*=0.0400) (B). The association between hemodialysis duration <5 years and the willingness to undergo renal transplantation (OR: 1.87; 95%CI: 1.13–3.10; *p*-Egger: not available; *p*-Het: 0.8070; *p*=0.0150) (C).

Discussion

Findings from the present study indicated that the global prevalence of willingness to undergo renal transplantation among ESRD patients was 57% (95%CI: 0.46–0.67). A meta-analysis study assessing this willingness among ESRD patients had never been conducted before. Therefore, we were unable to compare our study's results with previous studies. However, our study's report on the global prevalence of willingness to undergo renal transplantation could serve as an additional knowledge resource regarding renal transplantation preparedness. This could significantly contribute to improving the understanding and support for patients considering or undergoing renal transplantation procedures.

Although, in the present study, grouping age with a cut-off of 60 years did not reveal differences in willingness to undergo renal transplantation, numerical age analysis found that younger age was associated with an increased willingness to undergo the procedure. Our study also found that males exhibited a higher willingness to undergo renal transplantation compared to females. Furthermore, ESRD patients with employment status showed a greater willingness to undergo renal transplantation compared to non-working individuals. Moreover, individuals with educational attainment of ≥higher education demonstrated an increased willingness to undergo renal transplantation compared to those with educational attainment <higher education. Nevertheless, it remains difficult to elucidate the reasons why an individual is willing to undergo renal transplantation. In a previous study, willingness was found to be associated with the level of knowledge about ESRD and renal transplantation among younger individuals and those with higher educational attainment [37]. Males and employed individuals were also likely to have better social interaction and literacy, potentially resulting in a higher level of knowledge about renal disease and renal transplantation within these populations [38,39].

The difficulty in elucidating the factors affecting the willingness to undergo renal transplantation is further challenged by the absence of studies evaluating the role of knowledge about kidney disease. Comprehending the nature and progression of kidney disease has been widely recognized to influence patients' decisions regarding treatment options, including transplantation [40]. A previous study also revealed that patients who were better informed about their condition and the available treatments might be more likely to consider transplantation as a viable option [41]. Unfortunately, mainstream studies primarily focus on kidney transplantation outcomes, the impact of donor relationships, and types of kidney transplants [42,43].

The findings of the present study also revealed that a hemodialysis duration of less than five years was associated with an increased willingness to undergo renal transplantation compared to a duration of five years or more. The underlying reasons for these results were difficult to ascertain. However, it may be related to an individual's level of adaptation. Individuals with longer hemodialysis durations likely had adapted well and felt comfortable with the dialysis process. In contrast, a previous study reported that those with durations of less than five years may have still been adjusting to the dialysis process [44]. This notion was supported by a study indicating that individuals with hemodialysis durations of five years or more had a better quality of life compared to those with less than five years [45-47].

The present study indicated that individuals with high income and employed status exhibited an increased willingness to undergo renal transplantation compared to individuals with low income and unemployed status. The detailed reasons behind our study's findings remained a question. However, this might have been related to socioeconomic status factors. In a previous study, individuals with high income and employment were likely to have better socioeconomic status compared to those with low income and unemployed status [48]. Renal transplantation incurs significant costs, with approximately USD 100,000 [49]. Therefore, individuals with low income and unemployed status might have felt unable to afford the costs of renal transplantation, leading this population to be unwilling to undergo the procedure. Conversely, individuals with high income and employed status likely had sufficient financial means for the renal transplantation process, resulting in an increased willingness to undergo renal transplantation.

This study is the first meta-analysis to report the global prevalence of willingness to undergo renal transplantation and its potential contributing factors. By providing data on this global prevalence, we can understand the extent of ESRD patients' willingness towards this renal transplantation procedure. Consequently, we can gauge the target population for this procedure in the coming years. Additionally, this knowledge could provide insights into healthcare policy and resource allocation to better support ESRD patients considering transplantation [13]. Identifying the factors contributing to willingness to undergo renal transplantation could have enabled us to develop investigative studies to understand why certain populations of ESRD patients had low willingness towards the procedure. Furthermore, these factors could have been targeted through patient education and counseling programs to increase the likelihood of patients accepting transplantation [19]. The study's findings, which revealed the significant contribution of socioeconomic factors to willingness to undergo renal transplantation, emphasize the importance of considering local socioeconomic contexts when developing strategies to promote transplantation [19].

Our meta-analysis study had several limitations. First, some factors contributing to willingness to undergo renal transplantation, such as knowledge of renal transplantation, religion, and social support, were not evaluated due to data limitations. Second, the limitation of sample size posed a concern, especially since some variables could not undergo potential publication bias analysis due to data constraints. Therefore, the results of this study must be interpreted with caution. Third, the uneven and unbalanced distribution of study regions in our meta-analysis also requires attention when interpreting our findings. Fourth, our study population exhibited a diverse range of ages, which requires consideration when interpreting the potential factors contributing to willingness to undergo renal transplantation.

Conclusion

Our study revealed that the global prevalence of willingness to undergo renal transplantation among ESRD patients is 57% (95%CI: 0.46–0.67). Factors associated with an increased willingness to undergo renal transplantation are younger age, male gender, employment, educational attainment of at least a bachelor’s degree, high income, and hemodialysis duration of less than five years. This information may be useful in formulating policies aimed at increasing willingness to undergo renal transplantation. Recommendations for future studies included conducting a study that considered confounding factors like knowledge of renal transplantation, religion, and social support, with larger sample sizes and a balanced distribution across study regions.

Ethics approval

Not required.

Acknowledgments

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Competing interests

All the authors declare that there are no conflicts of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

How to cite

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