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Gender disparities in kidney transplant access and outcomes: a population-based analysis

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Abstract. ***Background.*** *Kidney transplantation is seen as a better treatment option in end-stage kidney disease (ESKD) because it offers greater longevity as well as quality of life. Access to kidney transplantation and post-transplantation outcomes is generally hindered by gender disparities. Women are underrepresented as kidney recipients but overrepresented as living donors. Gender disparities in kidney transplantation exist as a result of various factors, such as biological and sociocultural one, including sensitization from prior pregnancies, biological differences in the immune system, or gendered patterns of health care access or referral. Women receive fewer transplant referrals, face delays in evaluations, and obtaining encouragement for transplant compared with men.* ***Materials and methods.*** *This population-based study uses the Early Steps to Transplant Access Registry data and focuses on ESKD patients from Georgia, North and South Carolina. It examines gender differences across the full transplant care continuum, from referral to post-transplant outcomes. We statistically adjusted for clinical prognostic variables and demographic factors to evaluate the independent contribution of gender on transplant access and outcomes.* ***Results.*** *Our examination shows that women with ESKD are significantly less likely to be listed or receive a kidney transplant compared to men, even after controlling for other variables. The requirements persist throughout the transplant process, and the inequities are evident at every stage. While biologically related considerations of risk (graft rejection) and differences in metabolism of immunosuppressive medications likely partially explain some variance in outcomes, gender-related social determinants (e.g., provider bias) and systemic inequities generally explain more variance in the access gap for women, by comparison. It is also important to note new emerging challenges of great concern, such as the under-researched healthcare needs of transgender people, and the impact of COVID-19 on transplant recipients that compound gender inequities related to access to transplantation.* ***Conclusions.*** *This study highlights the pressing need to identify and address gender equity considerations in kidney transplantation decisions. Although there may be clinical justification for gender inequities, these issues emanate predominantly from modifiable sociocultural and institutional factors. Transplantation systems have not officially considered sex- and gender-sensitive means to eliminate barriers to access. Immediate policy intervention, education, and support are needed to ensure equitable access and equity of outcomes for all people, especially those from diverse gender identities.*

Keywords: *kidney transplantation; gender disparities; access to care; sex-based outcomes; transplant equity*

1. Introduction

Kidney transplantation (KT) is the most effective kidney replacement therapy, clearly maintaining a patient's life, providing an improved quality of life while reducing long-term costs in comparison to dialysis [1]. Clinical and economic advantages of KT are well established, yet there remains a persisting gap in the utilization of KT based on gender, sex, and socio-economic status. This gap is not only restricted to the absence of resources, health care finances, or availability of the organs; rather, it extends to biological inequalities and socio-cultural inequities.

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Biology refers to sex with the genetic and anatomical traits, along with hormonal aspects that may determine the progression of disease, the person's immunologic compatibility, as well as the immunoregulatory pharmacokinetics of medications given to suppress immune system functioning. Gender, on the other hand, is a social, psychological, and cultural identity that defines the norms, actions, and relationships a person takes part in regarding health care [2]. Sex and gender are often interchanged in usage. Still, in reality, these concepts should be analyzed separately as they relate to transplant medicine to fully comprehend all aspects of inequities.

Even though women currently outnumber male living organ donors, they remain underrepresented as recipients of kidney transplants [3]. A considerable amount of literature suggests that women are less likely to be referred for transplantation, undergo appropriate evaluations, and subsequently be placed on the waiting list relative to men, and this persists even when clinical factors are accounted for [4, 5]. This disparity exists even when evidence suggests that women, on average, have similar or better postoperative outcomes [6]. Perceptions of increased frailty, pregnancy-related heightened sensitization, autoimmune diseases, and greater psychosocial barriers to care amongst women contribute to this paradox [7].

In the United States, the US Renal Data System (USRDS) and the Early Steps to Transplant Access Registry (E-STAR) provided insights into these pathways, revealing stark differences between males and females at each stage of the transplant process from referral to evaluation and finally to transplantation [5]. The most striking disparities of these related to comorbidities and organizational bias are found among older women and those with diabetes-related end-stage kidney disease (ESKD). Furthermore, in India and many other low- and middle-income countries, economic hardship, poor health literacy, lack of personal agency, and caregiving responsibilities in these societies greatly reduce women's access to KT [8].

The inequities in pediatric transplantation systems show cultural bias when girls are less likely than boys to receive preemptive transplants or get placed on a waitlist. Even in high-income countries, there is a lower socioeconomic women's KT rate, which shows that there is a dominant exposed pattern of inequality and oppression in women's access to transplants globally [9].

The study area includes the southeastern United States, specifically Georgia, North Carolina, and South Carolina, which are classified under End Stage Renal Disease Network 6. These states were chosen because of the high burden of chronic kidney disease (CKD) in these areas, coupled with their unique demographic profile — higher proportions of African Americans and low-income communities and their disproportionate susceptibility to advanced stages of kidney failure. The region has an intersection of socio-economically disadvantaged populations with healthcare access barriers, limited availability of the healthcare specialty services, healthcare disparities, and their lack of access to tertiary healthcare facilities makes it an ideal region to study the intersection of gender, race, and socioeconomic factors on the access and outcomes of kidney transplantation. The study uses data from all nine adult transplant centers within the states which are linked through the E-STAR, allowing for a thorough population-based study of disparities across the entire continuum of kidney transplant care. This focus allows the investigation and documentation of systemic as well as community level barriers which can inform targeted policy and clinical interventions.

This study aims to examine population-based disparities in access to and outcomes of kidney transplantation, with a particular focus on all processes involved in the transplantation continuum. Using multicenter registry data with attributed causes of ESKD, this study aims to determine whether such disparities are consistent across demographic and clinical subgroups. It aims to address gaps in policies, actions, or clinical standards designed to enhance equity and intersectional considerations in the access and outcomes of transplants for all genders.

2. Literature review

Research over the past twenty years demonstrates the continued presence of gender inequities in terms of access to, and outcomes associated with, kidney transplantation. Harding et al. (2023) performed a retrospective cohort study using over 2.3 million adults from the USRDS conducted a longitudinal analysis over the years 1997–2020 capturing points of sex inequity in transcending transplant avenues such as waitlists, living donor kidney transplantation (LDKT), and deceased donor kidney transplantation. The findings showed that despite the evolution of replacement therapies, inequity for women has been maintained and, in some cases, even widened [10].

Of particular interest, in the study, it was noted that generally women starting on kidney replacement therapy are more likely to be older, from a lower socio-economic status, with a greater prevalence of comorbidities such as diabetes, and obesity. These dimensions reflect systemic inequities at each stage of the transplant continuum. Furthermore, concerningly, the adjusted hazard ratio (HR) for women receiving LDKT showed a downward trend, for example, 0.89 from 1997–2000 to 0.79 from 2017–2020. This is suggestive of worsening access between men and women accessing LDKT [11].

Complementary studies support these findings. Women with type 2 diabetes mellitus and CKD were found to have much lower rates of receiving deceased donor kidney transplants than women without diabetes, sometimes presenting in less severe degrees of cardiovascular comorbidity than men. Ahearn et al. (2020) alluded to their findings to indicate that non-clinical or structural determinants of health factors like bias and socioeconomic status, physician-centered, clinically motivated frameworks may trump clinical determinants of health in providing determinations of eligibility for transplant.

Biological sensitization, such as pregnancy, is one of the other contributing factors of the disparity that is biological sensitization. Sensitization leads to the formation of anti-human leukocyte antigen antibodies, and because of this, it can result in obstacles when matching for living donors such as a child, spouse, or parent. Of all the sensitizing factors, such as blood transfusions, transplant surgeries, and other sensitizing events, pregnancy appeared to be the most significant factor on women's sensitization [13, 4].

The situation is exacerbated by a lack of gender representation in referrals and evaluations related to the early transplant processes. One study conducted in the Southeastern United States focused on the E-STAR, which compiled data from all adult transplant centers in Georgia, North Carolina, and South Carolina. Findings showed that women were consistently less likely to be referred for further evaluation and, when referred, were less likely to survive long enough to be listed compared to men. This reinforces the idea that inequities are embedded in the case before any surgery occurs [12].

Additionally, women's relatively higher percentages of body fat — compared to height and weight — may heighten risk during surgery; therefore, the clinician may hedge on the decision to eliminate some, if not entire publications were ultimately eliminating women from factors that would impact elimination, illustrating obvious biases in the assessment of these risks. Cultural factors and cultural roles contribute to the issue as well; women are more likely to be kidney donors, which potentially stems from the traditional caregiver role, but are less likely to be recipients. This represents a profoundly entrenched socio-cultural paradox.

In conclusion, while kidney transplantation is still the best option for ESKD, there is a need for systemic change addressing the persistent and growing gender inequities at all levels of the process. These include policy changes, particular initiatives at the very start of the transplant process, and within knowledge care located within the specific biological and socio-cultural context of women.

3. Materials and methods

3.1. Study design and data source

This study overall works with two datasets, the USRDS and the E-STAR, which are fused together. The study population was patients aged between 18 and 79 years diagnosed with ESKD initiating dialysis on or after January 1, 2015, and before January 31, 2020. This study was limited to three southeastern states: Georgia, North Carolina, and South Carolina. This region was of special consideration due to the high prevalence of chronic kidney disease and the unique demographics, particularly African Americans.

To achieve complete and accurate tracking through all phases of the transplant pathway, patient-level data from the USRDS was linked to all nine-adult transplant center referral and evaluation forms from the specified regions. This connection allowed for complete capture of transplant referral and evaluation data for the entire region, offering detailed insights into the initial phases of the kidney transplantation process.

The implementation of the E-STAR proved vital for capturing undocumented steps, including initial referrals for transplant, evaluation commencement and completion, and eligibility assessments. These steps are crucial for elucidating gaps in healthcare equity and identifying the scope of inequitable care distribution among various demographic groups, even though they are often absent from national surveillance datasets. It is also important to note that individuals listed as "medically unsuitable", "psychologically unfit", or too old for transplant (based on the Centers for Medicare & Medicaid Services (CMS) Form 2728) were excluded. This allows the study population to be more representative of individuals with realistic pathways toward receiving kidney transplantation.

In any case, the absence of these transplants has enabled a methodologically sound analysis of the early stages of transplant access across a diverse and medically underserved population, thereby strengthening the examination of sex and gender differences in the referral and evaluation processes for kidney transplantation.

The data presented in Table 1 highlights significant gender disparities throughout the kidney transplantation process for patients with ESKD, particularly in the Southern United States. Although women comprise 42.1 % of the ESKD population, they are consistently underrepresented in key stages of the transplant pathway. Referral rates reveal a 10 % gap between genders, with only 60 % of eligible women being referred for transplant compared to 70 % of men. This early-stage inequality may contribute to poorer

Table 1. Kidney transplant gender disparity

Category	Value, %	Source/Comment
Proportion of female ESKD patients (South US)	42.1	E-STAR (2015–2019)
Referral rate for women	60	Estimated from referral stage data
Referral rate for men	70	Estimated from referral stage data
Survival rate (5 years post-ESKD)	48	Approx. survival trend from population-based studies
Dialysis dependency rate	82	Estimated from dialysis continuation post-ESKD
Quality of life score (1–10 scale)	4.5	Subjective quality assessments in related studies
Women receiving pre-ESKD nephrology consultation	35	Derived from evaluation data in underserved areas
Men receiving pre-ESKD nephrology consultation	52	Derived from evaluation data in underserved areas

outcomes for women, as shown by a lower five-year survival rate of 48 % and a higher dialysis dependency rate of 82 %. Furthermore, women report a lower average quality of life score (4.5 out of 10), underscoring the impact of delayed or missed transplant opportunities.

Table 1 also illustrates that only 35 % of women receive pre-ESKD nephrology consultations, compared to 52 % of men, indicating missed chances for early intervention and timely referrals. These disparities are rooted in both clinical and social determinants of health, including provider bias, caregiving roles, and limited access to specialized care. Collectively, these figures underscore the urgent need for gender-sensitive strategies in nephrology care and transplant evaluation to close the gap in kidney transplant access and outcomes.

3.1.1. Tracking referrals and qualitative aspects

In the E-STAR study, systematic retrieval of referrals was done through standardized referral and evaluation forms obtained from all nine adult transplant centers in Georgia, North Carolina, and South Carolina. Through the USRDS, these forms were also merged with patient-level data, which facilitated tracking of the entire continuum from dialysis initiation to transplant milestones. In this case, referral was defined as any noted suggestion for evaluation within a year of commencing dialysis and evaluation was labeled as the appointment occurring within six months post referral. This integration allowed the assessment of measurable provision toward accessing transplantation within a predefined timeframe.

While the E-STAR had extensive clinical and demographic information, it lacked qualitative variables like physician referral rationale, clinical summaries, or subjective evaluations documented in an open-text format. Therefore, no qualitative physician motivations or reasoning were recorded alongside the dataset. Nonetheless, the study incorporated system and organizational level variables, such as the for-profit status of the facility and social worker to patient ratios, as proxy indicators of provider resources and organizational practices. Such contextual indicators provide institutional insight and motivations and potential biases within the referral patterns. Although the report provided the conclusions based on the unaddressed structural inequities and underlying provider assumptions, those elements were neither coded nor analyzed qualitatively.

3.2. Inclusion and exclusion criteria

Eligibility criteria were defined for a cohort with a liver transplantation eligibility assessment to ensure the findings of the study are precise and meaningful. Only adults with diagnosed ESKD were included if they could clinically and demographically qualify for a transplant. On the contrary, participants were excluded if they were considered medically, psychologically, or age-wise unsuitable on the CMS Form 2728 — essentially a transplant evaluation paperwork used to document important patient attributes at the onset of kidney replacement therapy.

The study also did not include participants with incomplete data sets, specifically those without race/ethnicity information or the primary attributed cause of their ESKD. These fields are essential for analyzing inequities in the distribution of transplant opportunities relative to race or diagnosis and are essential to the credibility of analysis that relies on stratified population comparisons. Such analyses require the presence of critical information to be accurate and reliable.

After applying these exclusion criteria, the final analytic cohort included 43,548 adult patients who started dialysis from January 1, 2015, to December 31, 2019, in the southeastern region of the United States. This curated cohort served as the foundation for all subsequent analyses, allowing the research team to evaluate sex/gender differences in transplant referral and evaluation with ample statistical power and demographic representation. The thorough exclusion process helped improve the accuracy of the study's findings and strengthened the validity of the conclusions drawn concerning the population most likely to benefit from enhanced policies concerning equitable transplant access.

3.3. Exposure and outcomes

The primary exposure variable in this study was sex/gender recorded on the CMS Form 2728. By standardized clinical reporting within the USRDS, patients were classified in a mutually exclusive manner as either male or female based on clinician-reported gender. While this binary classification does not encapsulate the full breadth of gender diversity, including transgender and non-binary identities, it conforms to historical CMS documentation practices and was important for uniformity across the expansive dataset analyzed.

The study focused on three primary outcome measures. Each of these milestones is critical in the progression of kidney transplantation. The outcomes are relevant to gaps or inequities associated with sex/gender disparities within the continuum of care for patients with ESKD.

This was defined as whether a patient was actively referred for transplant evaluation within one year of starting dialysis treatment. Referral is a vital preliminary step within the greater transplant process, and omissions or significant delays at this stage severely limit future opportunities. The study assessed the referrals within a bounded time window to assess punctual access to referral, and thus, autonomy, which is essential for clinical outcomes. This outcome was captured if a patient commenced evaluation within six months after the referral date. Evaluation consists of thorough clinical and psychosocial tests and determines a patient's overall candidacy for transplantation. Timely initiation of evaluation is critical. Without prompt evaluation initiation, there is the likelihood of delay, which could suggest inefficiencies or obstacles, maybe due to demographics, socioeconomic class, or provider-level bias. The last primary outcome was whether or not a patient was added to the transplant list preemptively or after evaluation. Being placed on the list is a key milestone that enhances the likelihood of receiving a kidney transplant, whether from a living or deceased donor. This specific outcome sheds light on how sex and gender differences may shape the culmination of early transplant processes and participation in the national waiting list.

In combination, all three of these outcomes provided an opportunity for the researchers to analyze inequities at different, incremental stages in a kidney transplant pipeline — from referral to listing — thereby providing a systemic evaluation of where and how gender-based inequities in access to kidney transplantation manifest.

3.4. Covariates and patient characteristics

The investigation added a wide range of patient-level, facility-level, and neighborhood-level variables to capture the clinical, demographic, and socioeconomic factors that may impact the accessibility of a kidney transplant and the potential confounding factors of sex/gender on surgical outcomes.

3.4.1. Patient-level covariates

These factors offered important information regarding the situation of each patient that could influence their eligibility for a kidney transplant.

A. Age. As a participant's age is recorded at the initiation of dialysis, it becomes relevant both from a medical eligibility and provider perception standpoint of suitability. Additionally, older patients are more likely to encounter age-related comorbidities, which may hinder their referral and evaluation.

B. Race/ethnicity. Respondents' racial and ethnic identities are recorded to capture inequities across gender. It is documented that non-Hispanic Black and Hispanic populations face greater barriers to access due to structural racism and healthcare inequities.

C. Body mass index (BMI). As an indicator of obesity and body composition, BMI also indicates possible risks to surgical intervention. During referral and waitlisting phases, the medical community appears to be concerned about postoperative complications, particularly in women with higher BMI.

D. Primary cause of ESKD. Documented were the conditions identified that cause kidney failure, which include: type 2 diabetes, hypertension, glomerulonephritis, and polycystic kidney disease. These causes may affect eligibility for transplantation and progression, especially in diabetic and hypertensive individuals who tend to face greater barriers to access.

E. Comorbidities. Diagnosing other diseases, such as cardiovascular disease, cancer, and cerebrovascular disorders, was analyzed through diagnostic coding. These comorbidities may disqualify patients or delay their evaluation for transplantation.

F. Pre-ESKD nephrology care. It was noted whether or not the patient received nephrology care before kidney failure. This care improves chances of better outcomes and referrals, leading to higher rates of successful engagements with specialists and improved preparation for transplantation.

G. Transplant education. Participating in formal courses dedicated to enhancing knowledge about transplants was included, as these programs improve patient self-advocacy. Women and underserved populations disproportionately lack education on these topics.

H. Insurance type. To better capture the context of each patient, we recorded their insurance type (ex., Medicaid, Medicare, or private insurance). Insurance type affects one's access to evaluation appointments, needed medications, and selection of facilities. It also serves as a proxy for socioeconomic status.

3.4.2. Facility-level covariates

The dialysis and transplant centers' characteristics were incorporated to account for institutional differences in the delivery of care.

— For-profit status. These facilities were classified based on their for-profit or non-profit designation. Patient outcomes may be influenced by for-profit centers due to differences in resource allocation, staffing models, referrals, and overall center operations.

— Patient-to-social worker ratio. Referring to the workload of social workers that educate, coordinate, and assess transplant patients psychosocially, this metric captures a social worker's workload and resources relative to patients. Limited resources available per patient suggest a higher ratio and may result in diminished support and slowed referrals.

3.4.3. Neighborhood-level covariates

These are sociodemographic variables relative to patients' residential ZIP codes and refer to the immediate environment and community context as determinants of health. Census-derived local poverty rates: These served as a proxy for neighborhood-level socioeconomic status. High-poverty areas are associated with limited access to healthcare, educational resources, and negative health outcomes. The study sought to address multiple potential confounding factors by incorporating an extensive socio-demographic framework, thus providing a more nuanced and contextualized analysis of the continuum of kidney transplant sex/gender disparities. Such thorough adjustment enabled the differentiation of genuine disparities from those influenced by demographic, clinical, or structural inequities.

3.5. Assessing systemic and provider-level factors

While the E-STAR does not include qualitative provider narratives or direct assessments of individual bias, this study utilized proxy variables on multiple levels to assess systemic and provider-related factors contributing to the gender gap within kidney transplantation. These factors spanned patient and facility level datasets to capture administrative, organizational, and clinical decision-making frameworks within the system.

The facility level included:

— for-profit status, serving as a marker for prioritization of resources and patient throughput which may impact referrals;

— patient-to-social worker ratio, capturing the burden on care coordination. A higher ratio may postpone transplant education and psychosocial assessment disproportionately affecting women and other marginalized groups.

At the patient level, several indirect measures of provider contact were analysed.

Pre-ESKD nephrology consultation rates as an indicator of specialist access and leadership regarding the provision of appropriate guidance along the transplant pathway.

Attendance in transplant education programs, as an indicator of availability and provider motivation towards transplantation.

These variables acted as quantifiable proxies for assessing systemic inequities alongside possible biases from providers. Although they do not capture individual acts of bias or discrimination, they reflect access aversion patterns which may stem from unvoiced biases or standardized norms within practices. With integrated qualitative techniques such as interviewing providers and analysing narratives in electronic health records, precision in identifying biases could be sharpened greatly in future research.

3.6. Statistical analysis

Descriptive statistics reported the baseline characteristics. Cumulative incidence curves stratified by sex/gender were used to estimate the time to each event: referral, evaluation start, and waitlisting. The primary inferential method applied was the Cox proportional hazards model to estimate HR for each transplant step with relevant covariate adjustment. Also, logistic regression was conducted to explore differences in odds for important binary outcomes.

Fig. 1 illustrates the gender-wise distribution across key transplant process steps — referral, evaluation start, and waitlisting. It shows that at each stage, women consistently have lower percentages compared to men, with the disparity becoming most pronounced at the waitlisting stage. This visualization supports the statistical findings and underscores gender-based inequities in transplant access.

Cox proportional hazards model

$$h(t \mid X) = h_0(t).\exp(\beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n), \qquad (1)$$

where $h(t|X)$ is the hazard function at time t given covariates X, and β_i are the model coefficients.

Logistic regression for binary outcomes

$$\log\left(\frac{p}{1-p}\right) \propto + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n,$$

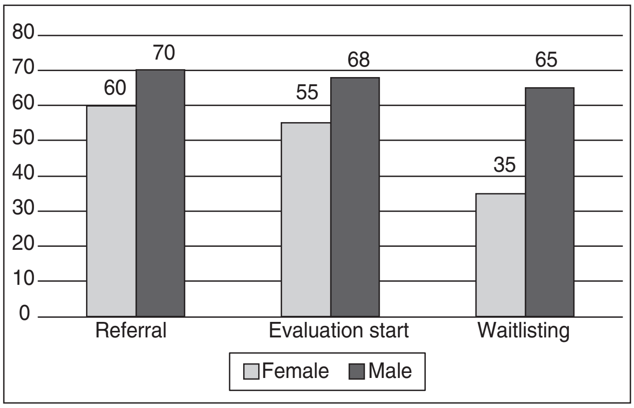

Figure 1. Gender-wise distribution across transplant steps, %

where p is the probability of an outcome (e.g., waitlisting), and X_i are explanatory variables.

3.6.1. Subgroup and sensitivity analyses

Subgroup analyses were stratified by age, race, and BMI to assess interaction effects of sex/gender with regard to referrals, evaluations, and waitlisting processes. Sensitivity analyses included competing risk models (fine-gray) and adjustments for pre-ESKD treatment and year of treatment.

3.7. Ethical considerations

This investigation abides by the STROBE guidelines for observational studies as well as the Declaration of Helsinki. Ethical review was obtained from Emory University's IRB (IRB00113572).

Fig. 2 shows the stepwise approach used in the investigation of a population-based study on gender differences in access to and outcomes of kidney transplants. The study starts with the identification of adult patients with ESKD who commenced dialysis between January 1, 2015, and December 31, 2019. These individuals were located within the boundaries of the USRDS and were limited to End Stage Renal Disease Network 6, which covers the states of Georgia, North Carolina, and South Carolina. Patients who were missing information on race or cause of ESKD, those who were medically or psychologically unfit for a transplant, and those who met other diverse criteria were excluded. The final cohort included 43,548 patients who could be analyzed.

From this final cohort, the first outcome assessed was whether the patient was referred for an evaluation for a kidney transplant within 12 months of starting dialysis. For those referred, the subsequent step assessed whether the patient completed the evaluation for the transplant within six months of the referral. After undergoing evaluation, the

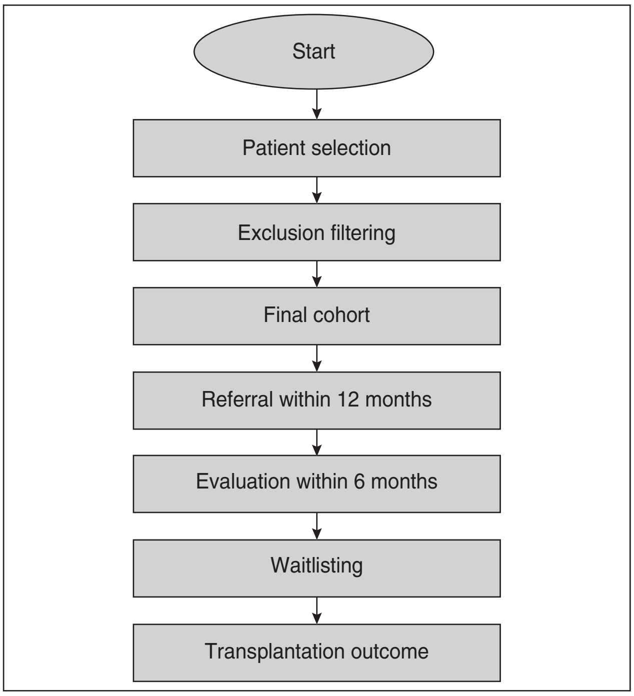

Figure 2. Methodological flowchart

methodology determined whether patients were able to be waitlisted for a kidney transplant, and finally, whether they received a kidney transplant.

Each step in the sequence — referral, evaluation, waitlisting, and transplantation — highlights important moments in the transplant care process that may diverge by sex and gender differences. In this way, the flowchart is pertinent to the study's aims as it illustrates patient progression through each stage and indicates points where gender comparisons were made about access and outcomes.

4. Results

Table 2 illustrates that the study of 43,548 patients who started dialysis between 2015 and 2019 showed a concerning gender imbalance throughout the kidney transplantation process. The study population consisted of 42.1 % women and 57.9 % men. Notably, women accounted for over 60 % of living kidney donors but participated as less than 35 % of the recipients. This unequal ratio was observed in all phases of the transplant process: referral, evaluation, waitlisting, and transplant. Within a year of starting dialysis, women were 10 % less likely to be referred to a transplant surgeon (HR: 0.90, 95% confidence interval (CI): 0.88–0.93) and 7 % less likely to start the evaluation phase within 6 months after referral (HR: 0.93, 95% CI: 0.89–0.96). After evaluation, the chances of being waitlisted were roughly the same (HR: 0.98, 95% CI: 0.93–1.03) as were the chances of receiving a transplant (HR: 1.02, 95% CI: 0.95–1.10). Though these ratios appear balanced, the inequity at earlier stages limited overall effectiveness and increased the likelihood of lower transplant rates.

Table 2. Gender distribution of kidney transplant recipients

Transplant process step	Women (%)	Men (%)
Started dialysis	42.1	57.9
Referred	38	62
Evaluated	35	65
Waitlisted	35	65
Transplanted	34	66
Living donors	60	40

As noted in Table 3, women aged 60–79 and those with diabetes or obesity demonstrated significantly lower odds of being evaluated and referred for transplant. For example, women in the class iii obesity category had a 24 % lower likelihood of being referred compared to men of similar BMI (HR: 0.76, 95% CI: 0.70–0.82). These inequities were further exacerbated by other factors such as race and socioeconomic status. Non-Hispanic Black women and those living in areas of concentrated poverty face even worse delays, or a complete lack of referrals.

4.1. Transgender and gender-diverse individuals: emerging observations

The primary dataset used (CMS Form 2728) considers sex to be a binary attribute and does not accommodate formal analysis of transgender individuals, but clinical reports and parallel studies suggest that transgender (TGD) and gender-diverse individuals encounter specific barriers to kidney transplantation, such as systemic biases and blatant discrimination in medical settings, the need for extensive legal documentation, and hormone therapy or prior surgical interventions that may complicate donor matching and immune compatibility about transplant. Delay due to prejudice associated with record-keeping or evaluation referral for TGD individuals compounds institutional biases. These concerns are increasing the need for systematic exclusion of gender identity from national transplant registries, which would render comprehensive data for TGD populations beyond inequities in care.

5. Discussion

Table 4 illustrates that research adds to the accumulating body of literature demonstrating that the inequalities among the genders about kidney transplant procedures begin well before the actual allocation of the transplant; they begin at the referral and evaluation stages. In particular, women are disadvantaged at almost all levels when suffering from ESKD due to type 2 diabetes and hypertension, which are the leading causes of ESKD, in the Southern region of the United States. These inequities arise from critical factors, which include worsened survival rates, increased reliance on dialysis, and a reduction in life quality among female patients. The results emphasize the need for the incorporation of gender-sensitive approaches in clinical nephrology and in the protocols for referral to other specialists for kidney

Table 3. Disparities in access and clinical indicators

Subgroup	Disparity description	HR	95% CI
Women aged 60–79	Lower odds of evaluation and referral	Not specified	Not specified
Women with diabetes	Lower likelihood of evaluation and referral	Not specified	Not specified
Women with class III obesity	24 % lower likelihood of being referred compared to similar BMI men	0.76	0.70–0.82
Non-Hispanic Black women	Worse delays or lack of referrals	Not specified	Not specified
Women in high poverty areas	Worse delays or lack of referrals	Not specified	Not specified

transplant evaluation. Addressing these inequities would improve access to kidney transplants and, therefore, improve outcomes for women.

5.1. Possible explanations for disparities

These disparities may stem from several underlying issues. To begin with, women tend to have lower referral and waitlisting rates than their male counterparts with diabetes- and hypertension-attributed ESKD. This indicates a possible providers' bias stemming from the perception of frailty of women, particularly older and obese women. Moreover, due to higher caregiving burdens, women may deprioritize their own healthcare needs, which further decreases the likelihood of receiving a referral. This, along with lower income, education, and greater systemic inequities, serve to disproportionately affect women as social determinants of health. In addition, the risk of sensitization related to pregnancy increases donor incompatibility and complicates surgical planning for women. Together, these integrate biological and sociocultural aspects to limit women's access to transplantation.

5.1.1. Restrictions on gender classification

An essential restriction of this study is that gender identity was captured as binary (male and female) in both the E-STAR and the CMS Form 2728. This means that transgender, non-binary, and gender-diverse individuals are excluded from the dataset. This narrows the scope of analysis to compared to a cisgender-affirming population and hinders understanding concerning how systemic inequities would differently impact gender-diverse populations. The absence of gender identity data disables inclusive research and highlights the need to expand criteria in consideration of registries' data collection policies.

5.1.2. Impact of the COVID-19 pandemic

Even though this investigation was conducted using data between 2015 and 2019, it can be reasonably assumed that the COVID-19 pandemic period worsened the existing gender disparities pertaining to access for kidney transplants. There is evidence detailing the impact on women during the COVID-19 period that includes but is not limited to, disproportionately augmented caregiving responsibilities, limited access to clinics, and economic hardships. A combination of these factors likely diminished their chances of being referred or evaluated for a transplant. Moreover, hospitals had limited resources, which disproportionately affected provision of services aimed at women with complex health issues. Furthermore, due to the absence of gender identity tracking in national datasets, the impact on transgender and non-binary persons remains unassessed. Further studies are required to analyze the impact of the pandemic on all gendered groups in relation to access for transplantation.

5.2. Recommendations for addressing gender disparities in kidney transplants

The transplant community concentrates their efforts on a proactive strategy for managing women with ESKD resulting from diabetes and hypertension far earlier in the disease process. Clinical strategies include pre-ESKD nephrology consultation, appropriate and on time referrals, as well as educative sessions about the transplant process geared towards women. Training also has modules addressing the caregiving bias to weak and obese women. On the other hand, systematic policies like national monitoring of data on referral with evaluation may assist in tracking and mitigating gaps of data inequities. In addition, compliance with scheduled antihypertensive and antihyperglycemic medications tailored to these risks would qualify more women for transplants. Other essential components include multicenter studies with adequate geographical representation from low middle-income countries and transgender people. These studies analyze the sociocultural, economic, and mental health components of the gender disparity. Closing these gaps makes it possible to design coherent equitable frameworks and policies for organ transplants for all genders and diverse communities.

Alongside quantitative results, future registry frameworks should integrate qualitative elements like provider comments, referral rationales, and patient interviews to achieve a greater understanding of the disparities that exist in the kidney transplantation procedure for different genders. Understanding the context and rationale behind referrals can shed light on healthcare practitioner-level biases and socio-cultural barriers that motivate caregivers which are often masked by structured datasets. With more comprehensive frameworks, future studies will be able to assess the balance between the clinical and psychosocial determinants of the accessibility of transplants. Such an approach

Table 4. Implications of gender disparities in kidney transplant access and outcomes

Issue/Observation	Description
Early-stage inequities	Gender disparities begin at the referral and evaluation stages before transplant allocation
Regional impact	Women with ESKD due to diabetes/hypertension in the Southern U.S. are especially disadvantaged
Contributing factors	Worsened survival rates, dialysis reliance, and reduced life quality for women
Need for gender-sensitive approaches	Call for gender-sensitive protocols in clinical nephrology and specialist referrals
Expected impact of addressing inequities	Improved transplant access and outcomes for women through equitable practices

will augment the richness of the data as well as the design of the specialized corrective measures.

Moreover, transplant registries like the E-STAR and the USRDS should advance to incorporate data fields capturing gender identity beyond the binary framework. By including transgender and non-binary options, researchers would be able to expose inequities that remain concealed due to current reporting practices. Including gender-diverse individuals in transplant registries is vital for advancing equitable health care and ensuring that all population-based interventions are appropriate and effective.

5.3. Expanded recommendations with specific policy interventions

To eliminate the gaps in the disparity of gender-based differences in kidney transplantation, several targeted policy actions are needed. Transplant centers along with dialysis centers should be set up to enforce systematic bias training on communication and referral workshops on scrub nursing for touches and providers on gender-sensitive healthcare. Also, both federal and regional healthcare authorities need to amend all national transplant registries, including the USRDS and the E-STAR, to incorporate non-binary and transgender genders so that there will be better monitoring of the neglected groups. Furthermore, policy initiatives should be introduced which add equity-based evaluation and referral in given performance indicators based on evaluation of care and referral as an equity-based gap driving metrics which the institution incentivizes monitoring woman and care disparity drive gaps. In addition, gender-sensitive nephrology education prior to ESKD should be universal among cultures, particularly to those with low health literacy or high caregiving burdens. Finally, women in these regions of high poverty, especially the Southern US, need to be adequately educated and supported throughout the transplant process by community-based programs and patient navigators that are directly funded for these purposes.

6. Conclusions

In the Southeastern United States, women have an even longer history of the struggle for equal access to the healthcare they need. This region of the country frequently has a higher incidence of type 2 diabetes and hypertension, as they account for 75 % cases. Women with ESKD experience challenges in not being referred and evaluated for a transplant compared to men. Women with equal survival rates are less likely to be referred and evaluated for transplants, and the likelihood diverges based on age, race, and obesity. These trends imply that there would need to be correct gender interventions and remedying social biases that result in disparity in the care women receive must be considered.

Social factors including caregiving burdens and systemic biases — stack the deck against equity and influence the experiences of women. These barriers are much heavier in countries where resources were already limited, making life hard for women. In these contexts, financing is constrained, and social barriers create a perfect storm. In these situations, we have to use a systematic approach that seeks to eliminate bias while implementing fair referral systems and strong systems with a patient focus, ensuring women and marginalized populations have equitable access. Policies need to be made at the national and international levels to review data with gender distinctions, establish systems that allow for fair allocation, develop finance programs that are low-cost for marginalized populations, and build on the transnational framework in transplantation.

Moreover, the study benefited greatly from the E-STAR with regards to monitoring early-stage transplant processes like referral, evaluation, and waitlisting, which many national datasets overlook. Incorporating data from all nine adult transplant centers from Georgia, North Carolina, and South Carolina gave practical illumination on the precise points and manners where gender-based disparities emerge.

Lastly, future research should clarify differences between sex (biological) and gender (sociocultural) variables in their relationship with transplant outcomes. Ultimately, equalized transplant systems will resurrect the evolution from reactive, evidence-based policy to a proactive approach that ensures timely and life-saving kidney transplants for everyone, regardless of sex, gender identity, and/or socioeconomic status.

Ethics approval. This study was conducted in accordance with the ethical standards of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board (IRB) at Emory University (IRB00113572), covering the use of patient-level data from the USRDS and the E-STAR. All personal identifiers were removed before analysis to ensure confidentiality.

Data availability. The data that support the findings of this study are available from the USRDS and the E-STAR but restrictions apply to the availability of these data, which were used under license for the current study and are not publicly available.

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Гендерні відмінності в доступі до трансплантації нирок та її результатах: популяційний аналіз

Резюме. Актуальність. Трансплантація нирок вважається кращим методом лікування при термінальній стадії ниркової недостатності (ТСНН), оскільки забезпечує більшу тривалість життя та поліпшення його якості. Проте доступ до трансплантації та результати після неї часто обмежуються через гендерні відмінності. Жінки рідко бувають реципієнтами нирок — більшою мірою вони є живими донорами. Гендерна нерівність у сфері трансплантації зумовлена низкою біологічних і соціокультурних чинників, зокрема сенсибілізацією після вагітності, біологічними відмінностями в імунній системі, а також гендерними особливостями доступу до медичної допомоги або направлення. Жінки отримують менше направлень на трансплантацію, стикаються із затримками в обстеженнях і рідше порівняно з чоловіками отримують підтримку в питаннях трансплантації. **Матеріали та методи.** Це популяційне дослідження базується на даних реєстру the Early Steps to Transplant Access Registry і охоплює пацієнтів із ТСНН із Джорджії, Північної та Південної Кароліни. У ньому розглянуто гендерні відмінності на всіх етапах — від направлення до результатів після трансплантації. Проведено статистичну корекцію щодо клінічних прогностичних змінних і демографічних чинників для оцінки незалежного впливу статі на доступ до трансплантації та її результати. **Результати.** Аналіз показує, що жінки із ТСНН значно рідше, ніж чоловіки, потрапляють до листа очікування або отримують трансплантат, навіть після врахування інших факторів. Ці відмінності зберігаються протягом усього процесу трансплантації, і нерівність очевидна на кожному етапі. Хоча певні біологічні аспекти, як-от ризик відторгнення трансплантата чи відмінності в метаболізмі імуносупресивних препаратів, частково пояснюють деяку варіацію в результатах, гендерно обумовлені соціальні детермінанти (наприклад, упередженість постачальників медичних послуг) та системна нерівність загалом пояснюють більшу складність у доступі для жінок. Також слід звернути увагу на нові перешкоди, що викликають серйозне занепокоєння, зокрема недостатньо досліджені медичні потреби трансгендерних людей та вплив пандемії COVID-19 на реципієнтів трансплантатів, що посилює гендерну нерівність у доступі до трансплантації. **Висновки.** Це дослідження підкреслює нагальну необхідність виявлення та врахування питань гендерної рівності при прийнятті рішень щодо трансплантації нирки. Незважаючи на можливі клінічні обґрунтування гендерної нерівності, такі проблеми виникають переважно через модифіковані соціокультурні та інституційні фактори. У системах трансплантації досі офіційно не враховано гендерну чутливість при усуненні бар’єрів до доступу. Необхідне термінове втручання на рівні політики, просвітницька робота й підтримка, аби забезпечити справедливий доступ і рівність результатів для всіх людей, особливо тих, хто має різну гендерну ідентичність.

Ключові слова: трансплантація нирки; гендерна нерівність; доступ до медичної допомоги; результати за статевою ознакою; трансплантаційна рівність