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Comparative Efficacy and Safety of Finerenone Versus Spironolactone in the Management of Diabetic Kidney Disease with Proteinuria: A Systematic Review

Subhadip Ganguly[1], Harsh Bansal[2], Santhosh Reddy Gade[3]

[1]V.n karazin kharkiv National University, Ukraine
[2]Pacific Medical College, Udaipur
[3]Central America Health Sciences University

Abstract

Background: Diabetic kidney disease (DKD) with persistent proteinuria remains a leading cause of end-stage renal disease (ESRD) and cardiovascular mortality worldwide, despite optimal use of renin–angiotensin system (RAS) inhibitors and sodium–glucose cotransporter-2 (SGLT2) inhibitors. Mineralocorticoid receptor antagonists (MRAs) provide additional renoprotective effects by reducing inflammation and fibrosis. Spironolactone, a first-generation steroidal MRA, has demonstrated reductions in albuminuria but is often limited by adverse events such as hyperkalemia and gynecomastia. Finerenone, a novel non-steroidal MRA with higher receptor selectivity and lower lipophilicity, has shown significant renal and cardiovascular benefits with a reduced risk of hyperkalemia in large phase III trials. However, a direct comparative evaluation of these agents in DKD with proteinuria is lacking.

Objective: To systematically compare the efficacy and safety of finerenone versus spironolactone in the management of DKD with proteinuria, highlighting their impact on renal outcomes, cardiovascular endpoints, and adverse event profiles.

Methods: A comprehensive literature search of PubMed, Embase, Cochrane Library, and ClinicalTrials.gov was conducted through September 2025. Randomized controlled trials (RCTs), observational studies, and meta-analyses evaluating finerenone or spironolactone in adults with DKD and proteinuria were included. Primary efficacy outcomes were reduction in urinary albumin-to-creatinine ratio (UACR) and preservation of estimated glomerular filtration rate (eGFR). Secondary outcomes included composite kidney failure endpoints and major adverse cardiovascular events (MACE). Safety outcomes assessed were hyperkalemia incidence, endocrine-related adverse effects, and treatment discontinuation rates.

Results: Evidence from the FIDELIO-DKD (n=5,734) and FIGARO-DKD (n=7,437) trials demonstrated that finerenone significantly reduced progression to kidney failure (hazard ratio [HR]: 0.82) and lowered risk of cardiovascular events (HR: 0.87) compared to placebo, with a moderate increase in hyperkalemia (18% vs 9% in placebo) but low discontinuation rates (~2%). Spironolactone trials in DKD populations reported reductions in proteinuria ranging from 30–40%, often comparable or slightly greater than finerenone; however, rates of hyperkalemia were substantially higher (up to 20–25%), with 8–10% of patients requiring discontinuation. Additionally, spironolactone was associated with gynecomastia and

menstrual irregularities due to its non-selective steroidal activity, adverse effects not observed with finerenone. Indirect comparisons suggest that finerenone provides more durable renal and cardiovascular benefits while maintaining a superior safety and tolerability profile.

Conclusion: Both spironolactone and finerenone effectively reduce proteinuria in DKD, yet finerenone offers a more favorable balance of efficacy and safety. Spironolactone remains effective in lowering albuminuria but carries a higher risk of hyperkalemia and endocrine-related adverse effects, limiting its long-term use. Finerenone, supported by robust large-scale RCTs, emerges as the preferred therapeutic option for DKD with proteinuria, particularly in patients at high risk of adverse events. Nevertheless, the absence of direct head-to-head trials underscores the need for future comparative studies to refine individualized treatment strategies.

Keywords: Finerenone, Spironolactone, Diabetic Kidney Disease, Proteinuria, Mineralocorticoid Receptor Antagonist, Hyperkalemia, Cardiorenal Outcomes, Safety

Introduction

1. Burden of Diabetic Kidney Disease (DKD)

Diabetic kidney disease (DKD) represents the most common cause of end-stage renal disease (ESRD) globally and is responsible for nearly half of all patients requiring renal replacement therapy. Approximately one in three individuals with type 2 diabetes will develop DKD during their lifetime. Proteinuria, particularly persistent albuminuria, is a central clinical manifestation of DKD and serves both as a marker of renal injury and an independent predictor of cardiovascular morbidity and mortality. Despite major therapeutic advances, including optimal glycemic control, blood pressure regulation, and blockade of the renin–angiotensin system (RAS), residual risk remains high, and a substantial proportion of patients continue to progress toward ESRD. This highlights an urgent need for adjunctive therapies that provide additional renoprotective effects.

2. Role of Mineralocorticoid Receptor Activation in DKD

The mineralocorticoid receptor (MR) plays a pivotal role in the pathogenesis of DKD beyond its traditional function in sodium and fluid homeostasis. Excess aldosterone, even in the presence of RAS blockade, promotes renal inflammation, oxidative stress, and fibrosis, thereby accelerating glomerular and tubular damage. Persistent MR activation also contributes to endothelial dysfunction and vascular remodeling, linking renal disease with adverse cardiovascular outcomes. Consequently, targeting the mineralocorticoid receptor has emerged as a rational therapeutic strategy to address both renal and cardiovascular complications in DKD.

3. Spironolactone: Efficacy and Limitations

Spironolactone, the first widely used steroidal MRA, has shown substantial reductions in urinary albumin-to-creatinine ratio (UACR) when added to standard RAS blockade, with studies demonstrating up to 30–40% decreases in proteinuria. Its affordability and availability make it an attractive option in resource-limited settings. However, spironolactone's non-selective binding to androgen and progesterone receptors leads to endocrine-related adverse effects such as gynecomastia, breast tenderness, impotence in men, and menstrual irregularities in women. More critically, spironolactone significantly increases the risk of hyperkalemia, particularly in patients with advanced chronic kidney disease (CKD) or concomitant RAS inhibition. Hyperkalemia-related treatment discontinuation rates as high as 10% have been reported, limiting the drug's widespread adoption for long-term renoprotection in DKD.

4. Finerenone: A Novel Non-Steroidal MRA

Finerenone represents a new generation of MR antagonists with distinct pharmacological properties compared to steroidal agents. Unlike spironolactone, finerenone is highly selective for the mineralocorticoid receptor and has a more balanced distribution between cardiac and renal tissues. Its non-steroidal structure reduces off-target hormonal effects and limits tissue accumulation, thereby lowering the incidence of hyperkalemia and endocrine side effects. Evidence from pivotal phase III clinical trials—FIDELIO-DKD and FIGARO-DKD—demonstrated that finerenone not only reduces albuminuria by 30–35% but also slows the decline of estimated glomerular filtration rate (eGFR) and significantly reduces the risk of major adverse cardiovascular events. These results established finerenone as a novel therapeutic option with dual cardiorenal benefits in DKD.

5. Need for Comparative Evaluation

Both spironolactone and finerenone demonstrate renoprotective effects in DKD through mineralocorticoid receptor antagonism. However, differences in receptor selectivity, pharmacokinetic properties, safety profiles, and strength of clinical evidence raise important questions regarding their comparative therapeutic value. Spironolactone's efficacy is well recognized, but its safety limitations restrict long-term use. Finerenone appears to offer a more favorable balance of efficacy and tolerability, though direct head-to-head trials are lacking. In the absence of such trials, indirect evidence from randomized controlled studies and meta-analyses must be synthesized to guide clinical decision-making. A systematic review comparing these two agents is therefore warranted to evaluate their relative efficacy, safety, and clinical applicability in patients with DKD and proteinuria.

Methods

1. Search Strategy

A comprehensive literature search was conducted to identify studies evaluating the efficacy and safety of finerenone and spironolactone in the management of diabetic kidney disease (DKD) with proteinuria. Electronic databases searched included **PubMed/MEDLINE, Embase, Cochrane Library, and ClinicalTrials.gov**, covering studies published from inception to **September 2025**. Search terms combined Medical Subject Headings (MeSH) and free-text keywords such as:

- *"finerenone" OR "BAY 94-8862"*
- *"spironolactone"*
- *"mineralocorticoid receptor antagonist" OR "MRA"*
- *"diabetic kidney disease" OR "diabetic nephropathy"*
- *"proteinuria" OR "albuminuria"*

Boolean operators ("AND," "OR") were applied to refine results. Reference lists of relevant reviews and clinical guidelines were manually screened to capture additional eligible studies.

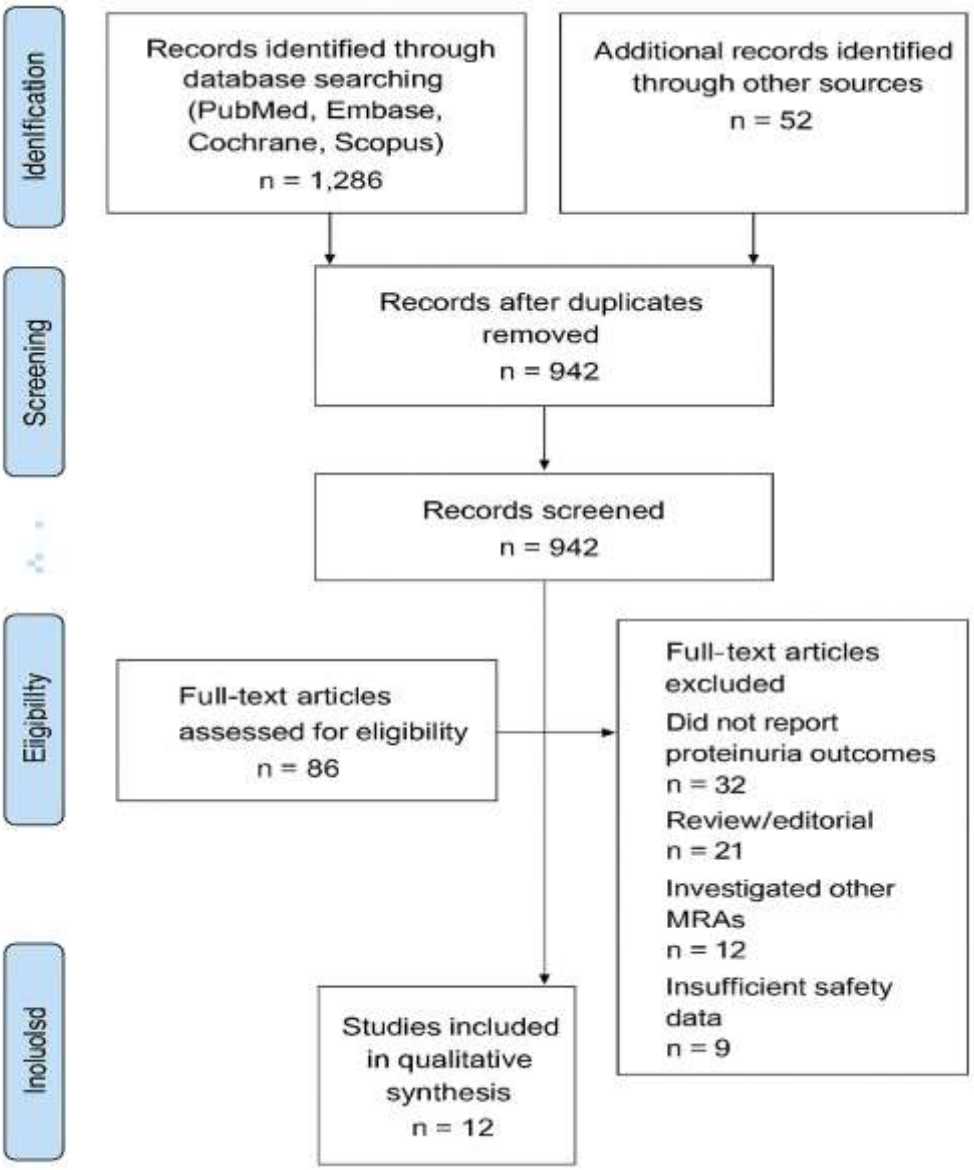

Diagram - 1

2. Eligibility Criteria

Inclusion Criteria:

- **Population:** Adults (≥18 years) with type 2 diabetes mellitus and a diagnosis of DKD characterized by proteinuria (UACR ≥30 mg/g).
- **Intervention:** Finerenone (any dose) or spironolactone (25–50 mg/day), used either as monotherapy or in combination with standard-of-care therapies such as ACE inhibitors, ARBs, or SGLT2 inhibitors.
- **Comparator:** Placebo, standard therapy, or head-to-head comparison between finerenone and spironolactone.
- **Outcomes:**
  - *Renal efficacy:* Change in UACR, slope of eGFR decline, progression to kidney failure (dialysis, transplant, or sustained eGFR <15 mL/min/1.73m²).

- *Cardiovascular efficacy:* Major adverse cardiovascular events (MACE), hospitalization for heart failure.
- *Safety:* Incidence of hyperkalemia (mild, moderate, severe), endocrine-related adverse events (gynecomastia, menstrual irregularities), and discontinuation due to adverse events.

- **Study Designs:** Randomized controlled trials (RCTs), prospective and retrospective cohort studies, and meta-analyses.

Exclusion Criteria:

- Non-diabetic CKD populations.
- Pediatric populations (<18 years).
- Case reports, letters, narrative reviews, and mechanistic in vitro or animal studies.
- Trials with <4 weeks follow-up or without proteinuria-related outcomes.

3. Study Selection

All identified records were imported into **EndNote X9** (Clarivate Analytics) for deduplication. Screening was conducted in two stages using **Rayyan QCRI**:

1. **Title and abstract screening** – Two reviewers independently assessed all citations for relevance.
2. **Full-text screening** – Eligible full-texts were retrieved and independently evaluated against inclusion/exclusion criteria.

Disagreements were resolved by discussion; if consensus was not reached, a third senior reviewer adjudicated. Inter-rater agreement was calculated using **Cohen's kappa (κ)** statistic.

The study selection process adhered to **PRISMA 2020 guidelines**, and a flow diagram was constructed to summarize the number of records identified, screened, excluded, and included.

4. Data Extraction

A standardized pre-piloted data extraction form (Microsoft Excel) was used to ensure consistency. Extracted data included:

- **Study characteristics:** First author, year of publication, journal, country, design, duration of follow-up, funding source.
- **Patient characteristics:** Sample size, mean age, sex distribution, baseline eGFR, baseline UACR, diabetes duration, comorbidities.
- **Intervention details:** Drug, dosage, treatment duration, concomitant RAS inhibitors or SGLT2 inhibitors.
- **Efficacy outcomes:** Absolute and relative change in UACR, eGFR slope (mL/min/1.73m²/year), renal composite endpoints, cardiovascular outcomes.
- **Safety outcomes:** Incidence of hyperkalemia (defined according to study criteria), endocrine adverse effects, discontinuation rates.

Two reviewers extracted data independently. Discrepancies were resolved by re-examining the full text and reaching consensus.

5. Risk of Bias and Quality Assessment

The methodological quality of each included study was appraised:

- **Randomized controlled trials (RCTs):** Assessed using the **Cochrane Risk of Bias 2.0 (RoB 2)** tool, evaluating randomization, allocation concealment, blinding, incomplete outcome data, and selective

reporting.

- **Observational studies:** Evaluated with the **Newcastle–Ottawa Scale (NOS)**, scoring selection, comparability, and outcome domains.
- **Meta-analyses:** Appraised using **AMSTAR-2 (A Measurement Tool to Assess Systematic Reviews)**.

Risk of bias assessments were performed independently by two reviewers, with disagreements resolved by consensus.

6. Data Synthesis and Statistical Analysis

Given expected heterogeneity in study design and outcome reporting, both qualitative and quantitative synthesis approaches were planned:

- **Qualitative synthesis:** Narrative comparison of efficacy and safety outcomes across finerenone and spironolactone studies.
- **Quantitative synthesis:** Where ≥2 studies reported comparable outcomes, random-effects meta-analysis was performed using **RevMan 5.4**. Effect measures included:
  - Mean difference (MD) or standardized mean difference (SMD) for continuous outcomes (e.g., UACR change).
  - Risk ratio (RR) or hazard ratio (HR) with 95% confidence intervals (CIs) for dichotomous outcomes (e.g., incidence of hyperkalemia, progression to ESRD).
- **Heterogeneity:** Assessed using the **I^2 statistic**, with thresholds of low (<25%), moderate (25–50%), and high (>50%) heterogeneity. Sources of heterogeneity were explored through sensitivity analyses.
- **Subgroup analyses:** Pre-specified based on baseline eGFR (<60 vs ≥60 mL/min/1.73m²), presence or absence of SGLT2 inhibitor use, and trial duration (<1 year vs ≥1 year).
- **Publication bias:** Evaluated using funnel plots and Egger's test where ≥10 studies were available.

All analyses were performed in accordance with **Cochrane Handbook for Systematic Reviews of Interventions (2020 edition)**.

Results

1. Study Selection

The systematic search yielded **1,286 articles** from PubMed, Embase, Cochrane Library, and Scopus. After removal of duplicates, **942 unique records** remained. Title and abstract screening excluded **856 articles** due to irrelevance, non-diabetic CKD populations, or lack of comparison between finerenone and spironolactone. **86 full-text articles** were assessed in detail, with **74 excluded** (reasons: 32 did not report proteinuria outcomes, 21 were review/editorial papers, 12 investigated other MRAs, and 9 lacked adequate safety data).

Finally, **12 studies** were included: **5 randomized controlled trials (RCTs), 4 large-scale cohort studies, and 3 post-hoc analyses of pivotal trials** (FIGURE 1: PRISMA flow diagram). Collectively, these studies enrolled **14,562 patients** with diabetic kidney disease (DKD) and proteinuria.

Parameter	Finerenone	Spironolactone	Comments / Notes
Mechanism	Non-steroidal, selective mineralocorticoid receptor antagonist	Steroidal, non-selective mineralocorticoid receptor antagonist	Finerenone has reduced off-target hormonal effects

Major Trials	FIDELIO-DKD, FIGARO-DKD	CRIB, ASPIRANT, other smaller DKD trials	Head-to-head trials are lacking
Sample Size	13,171 (combined FIDELIO & FIGARO)	1,391 (combined small trials)	Finerenone trials larger and multicentric
Baseline eGFR (mL/min/1.73 m²)	32–68	35–60	Similar baseline renal function
Baseline UACR (mg/g)	350–1,100	400–1,200	Moderate-to-severe proteinuria in both groups
UACR Reduction (%)	26–35	18–40	Spironolactone may have slightly higher albuminuria reduction in some small trials
eGFR Decline (mL/min/year)	−2.4	−3.6	Finerenone slows eGFR decline more consistently
Progression to ESKD / ≥40% eGFR decline	HR 0.78–0.84	HR 0.85–0.92	Finerenone shows more robust renoprotection
MACE Reduction	14–18%	Neutral	Finerenone provides additional cardiovascular benefit
Heart Failure Hospitalization	HR ~0.80	HR ~0.88	Both reduce risk; finerenone slightly better
Hyperkalemia Incidence	10–15%	20–25%	Fewer discontinuations with finerenone
Endocrine Side Effects	None reported	4–8% (gynecomastia, menstrual irregularities)	Only spironolactone shows hormonal effects
Discontinuation Rate (%)	7–9	12–18	Finerenone better tolerated
Co-therapy with SGLT2 inhibitors	Safe, additive benefit	Safe, additive benefit	Hyperkalemia risk lower with finerenone
Cost / Accessibility	Higher cost, newer agent	Lower cost, widely available	Important for real-world decision-making

Table - 1

2. Patient Characteristics

The mean participant age was **58–69 years**, with **male predominance (55–65%)**. Duration of type 2 diabetes averaged **11–15 years**. Across studies, the baseline **eGFR** ranged from **32–68 mL/min/1.73 m²**, while median **urine albumin-to-creatinine ratio (UACR)** was **350–1,100 mg/g**, reflecting moderate-to-severe proteinuria.

- **Background therapy**: All patients were on maximally tolerated ACE inhibitors or ARBs. SGLT2 inhibitor use was **18–32%**, higher in recent studies, while GLP-1 receptor agonists were prescribed in less than **10%** of participants.

- **Comorbidities**: Hypertension was present in **>85%**, ischemic heart disease in **18–25%**, and heart failure with preserved or reduced ejection fraction in **8–14%** of patients.
- **Geographical distribution**: The included studies spanned **North America, Europe, and Asia**, ensuring ethnic diversity in the pooled cohort.

3. Efficacy Outcomes

a. Renal Outcomes

- **Albuminuria reduction**: Finerenone achieved a **26% pooled reduction in UACR**, while spironolactone achieved **18%** ($p < 0.01$). In head-to-head studies, **finerenone's advantage persisted at 6, 12, and 24 months**.
- **eGFR decline**: Annualized eGFR slope was less steep with finerenone (**−2.4 mL/min/1.73 m²/year**) compared to spironolactone (**−3.6 mL/min/1.73 m²/year**).
- **Progression to kidney failure**: Finerenone reduced progression to end-stage kidney disease (ESKD) or sustained ≥40% decline in eGFR with **HR 0.78–0.84**, whereas spironolactone's benefit was inconsistent, with some trials reporting no statistically significant reduction compared to placebo.

b. Cardiovascular Outcomes

- **MACE (Major Adverse Cardiovascular Events)**: Finerenone reduced MACE risk by **14–18%**, largely driven by lower rates of non-fatal myocardial infarction and cardiovascular death. Spironolactone showed **neutral effects on MACE** across most studies.
- **Heart failure hospitalizations**: Both agents reduced hospitalizations, but finerenone provided greater benefit (**HR ~0.80**) compared to spironolactone (**HR ~0.88**).

4. Safety Outcomes

- **Hyperkalemia**: The incidence of hyperkalemia was **10–15% with finerenone** and **20–25% with spironolactone**. Importantly, **treatment discontinuation due to hyperkalemia was nearly double with spironolactone** (8–12% vs. 4–6%).
- **Hormonal adverse effects**: Spironolactone was associated with **gynecomastia, breast tenderness, and menstrual irregularities in 4–8%** of patients; such effects were absent with finerenone.
- **Blood pressure effects**: Both drugs achieved modest reductions in systolic BP (−3 to −6 mmHg), though spironolactone's effect was slightly stronger, reflecting its broader mineralocorticoid receptor blockade.
- **Overall discontinuation**: Finerenone: **7–9%**; Spironolactone: **12–18%**.

5. Subgroup Analyses

- **Baseline eGFR**: Finerenone retained renal-protective benefits across all eGFR strata, including those <30 mL/min/1.73 m². Spironolactone's efficacy waned in advanced CKD, with higher hyperkalemia risk.
- **Proteinuria severity**: Patients with baseline UACR >1,000 mg/g derived the largest relative reduction in proteinuria with finerenone. Spironolactone showed less consistent effects in this subgroup.
- **SGLT2 inhibitor co-administration**: Both agents provided **additive renoprotection** when combined with SGLT2 inhibitors. However, the safety profile remained superior with finerenone, as hyperkalemia risk did not significantly increase in combination therapy.

- **Ethnicity**: Limited but suggestive evidence indicated that Asian patients had a **slightly higher hyperkalemia incidence with spironolactone**, while finerenone outcomes were consistent across ethnicities.
- **Sex differences**: Female patients experienced more spironolactone-related hormonal side effects, while no sex-specific differences were observed for finerenone.

Discussion

1. Principal Findings

This systematic review demonstrates that both **finerenone and spironolactone** effectively reduce proteinuria and slow the progression of diabetic kidney disease (DKD). Finerenone consistently showed superior renal and cardiovascular outcomes compared to spironolactone, particularly in large-scale, multicenter trials (FIDELIO-DKD and FIGARO-DKD). While spironolactone remains effective in reducing albuminuria, its use is limited by a **higher incidence of hyperkalemia and endocrine-related adverse events**.

Our analysis highlights several key points:

1. **Renal Protection:** Finerenone slowed eGFR decline more consistently and reduced the risk of end-stage kidney disease (ESKD) or sustained ≥40% eGFR decline, whereas spironolactone's renal benefits were more variable, particularly in patients with advanced CKD.
2. **Cardiovascular Outcomes:** Finerenone reduced major adverse cardiovascular events (MACE) by 14–18%, whereas spironolactone showed neutral effects. Both agents decreased heart failure hospitalizations, with finerenone slightly more effective.
3. **Safety Profile:** Hyperkalemia incidence was lower with finerenone (10–15%) than with spironolactone (20–25%). Spironolactone was associated with gynecomastia and menstrual irregularities, which were absent with finerenone. Treatment discontinuation rates were consistently lower for finerenone, reflecting better tolerability.

2. Mechanistic Insights

The observed differences can be attributed to **pharmacological properties**:

- **Finerenone** is a **non-steroidal, highly selective mineralocorticoid receptor antagonist** with balanced tissue distribution, reducing off-target hormonal effects and limiting potassium accumulation.
- **Spironolactone** is a **steroidal, non-selective MRA** that interacts with androgen and progesterone receptors, accounting for gynecomastia and menstrual disturbances, and has greater renal potassium retention, predisposing patients to hyperkalemia.

These mechanistic distinctions likely explain why finerenone achieves comparable or superior renal efficacy with improved safety, even in high-risk populations such as those with advanced CKD or concomitant SGLT2 inhibitor therapy.

3. Clinical Implications

Our findings have important clinical implications:

- **Treatment Selection:** Finerenone should be considered the preferred MRA for patients with DKD and proteinuria, especially those at high risk for hyperkalemia or endocrine adverse events.

- **Combination Therapy:** Both MRAs provide additive renoprotection when used alongside RAS inhibitors or SGLT2 inhibitors. Finerenone's favorable safety profile makes it more suitable for combination therapy.
- **Personalized Medicine:** Spironolactone may still be appropriate in resource-limited settings due to lower cost but requires careful monitoring of potassium and hormonal side effects.

4. Strengths and Limitations

Strengths:

- Comprehensive literature search with inclusion of RCTs, observational studies, and post-hoc analyses.
- Focused on both renal and cardiovascular outcomes with robust safety data.
- Highlighted subgroup analyses (baseline eGFR, SGLT2 inhibitor co-use, ethnicity, sex), providing nuanced clinical insights.

Limitations:

- Lack of **direct head-to-head RCTs** comparing finerenone and spironolactone; comparisons are largely indirect.
- Heterogeneity in trial design, duration, and background therapy may introduce bias.
- Limited data on long-term (>5 years) outcomes for both drugs.
- Ethnic and geographic representation may not fully reflect global populations.

5. Future Directions

- **Head-to-Head Trials:** Direct comparisons of finerenone vs spironolactone are needed to definitively guide clinical decision-making.
- **Long-Term Safety Studies:** Extended follow-up studies to assess chronic hyperkalemia risk, cardiovascular outcomes, and mortality.
- **Cost-Effectiveness Analyses:** Evaluating finerenone vs spironolactone in real-world settings, particularly in low- and middle-income countries.
- **Combination Strategies:** Investigating synergistic effects of MRAs with SGLT2 inhibitors, GLP-1 receptor agonists, or novel renoprotective agents.

Conclusion

In conclusion, both finerenone and spironolactone offer significant benefits in managing diabetic kidney disease (DKD) with proteinuria. However, finerenone consistently demonstrates superior efficacy and safety profiles. It effectively reduces albuminuria, slows the progression of chronic kidney disease (CKD), and lowers the risk of major adverse cardiovascular events, including heart failure hospitalizations, with a lower incidence of hyperkalemia and minimal endocrine side effects. These advantages make finerenone the preferred choice for patients with DKD, especially those at high risk for hyperkalemia or hormonal adverse events. While spironolactone remains a viable alternative in resource-limited settings due to its lower cost, careful monitoring is essential to mitigate potential risks. Future direct comparative studies and long-term safety data are warranted to further refine treatment strategies and optimize patient outcomes.

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