RESEARCH PAPER

The Overlap of Cardiac, Renal and Metabolic Conditions in Adults: Prevalence and Implications

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Abstract

Background:

The presence of cardiac, renal and metabolic disorders among adults is often predetermined by a common risk factor and the presence of a common pathophysiology, as well as the ability to enhance each other. This three-fold, commonly known as cardiorenal-metabolic multimorbidity, causes a significant amount of hospitalization, polypharmacy and mortality. Although increased awareness is present, evidence on true overlap and its clinical consequences has not been well-estimated on a population level.

Objective:

To evaluate the commonness of comorbid cardiac, renal, and metabolic disorders among adults and determine their predictive healthcare use and poor clinical outcomes.

Method:

The study design was a cross-sectional study with the use of electronic health records of adult patients 18 years old in a large health system. Diagnostic codes, laboratory thresholds and medication profiles were used to find cardiac disease, chronic kidney disease and metabolic disorders (diabetes or obesity). Outcome measures were hospitalization rates, emergency visits and all-cause mortality.

Results:

Out of 182,000 adults, 27% of them had a disease at least; 11% of them had complete cardiorenal-metabolic overlap. Patients who were multimorbid incurred much higher rates of hospitalization, extended medication burden and mortality rates one year post-discharge relative to those who had single conditions. The number of overlap disorders was proportional to risk.

Conclusion:

There is a high rate of cardiorenal-metabolic multimorbidity, which is closely linked to poor outcomes. Long-term health and reduction of the risk should be based on early detection and combined methods of management.

Keywords: Cardiorenal metabolic multimorbidty, chronic kidney disease, heart failure, multisystem disease, population health

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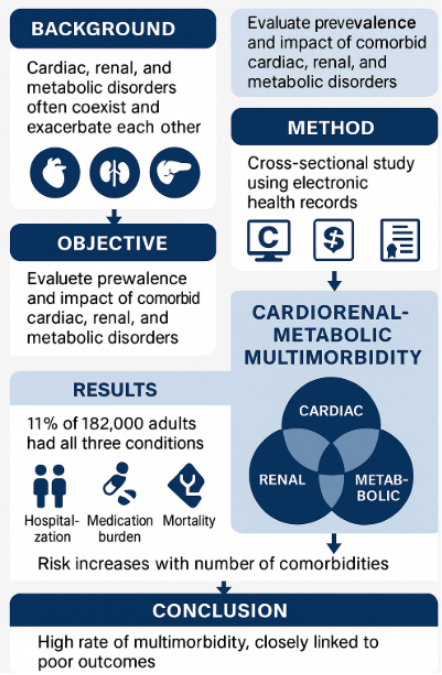
Graphical abstract



1 Introduction

Cardiac, renal and metabolic conditions form three major contributors to morbidity and mortality in the world and growing evidence reveals that the mentioned conditions often co-exist instead of being independent. This comorbidity of cardiorenal-metabolic multimorbidity is challenging to prevent, diagnose, and treat over the long term. These risk factors include hypertension, obesity, insulin resistance, dyslipidemia and chronic inflammation, which establish a biological background in which the failure of one organ system predisposes worsening development in the other [1]. With the growing recognition of these interdependencies in the clinical guidelines on heart failure, chronic kidney disease (CKD) and diabetes, the actual prevalence and implications of this multimorbidity are now of paramount significance.

The relation between these conditions is two way. The cardiac underperformance can reduce the renal oxygeniation leading to progressive nephropathy and CKD stimulates structural and electrical cardiac re-structuring by maintaining a fluid, uremic toxins, neurohormonal stimulations [2]. The metabolic pathology such as type 2 diabetes and obesity that exacerbates oxidative stress, endothelial malfunction and systemic inflammation further exacerbates this cycle to both cause heart failure and the development of CKD [3]. This disease clustering is not simply additive: it yields an exaggerated risk of being hospitalized, polypharmacy, poor quality of life and a premature death [4].

Detailed epidemiologic analyses indicate that there is increasing prevalence of combined cardiac, renal, and metabolic diseases in adults due to changes in lifestyles and increase in age [5]. Nevertheless, the available records and data indicate that the reported incidences are highly varied because of inconsistent definitions, distinctions in the diagnostic criteria, a disparity in the approach of health system coding. Furthermore, the prevalence of kidney or metabolic disease in adults at the beginning of the disease has not been fully determined as a significant portion of them are undiagnosed, implying that the real burden can be underestimated [6]. Knowledge about prevalence will be better assisted in forming predictions about the very high-risk individuals and in terms of facilitating the implementation of targeted intervention, and in minimizing preventablemorbidity.

Studies also point to a high level of inequalities in multimorbidity trends. Unequal clustering of diseases and poor clinical courses of some groups of people are caused by socioeconomic factors, race and ethnicity, and access to preventive care [7]. These differences make management challenging since the overlapping disorders would need multidisciplinary care, which should be provided by cardiology, endocrinology, and nephrology services. Conventional disease-specific strategies can overlook the opportunity to look at common mechanisms which exacerbates the risk and makes treatment more complicated.

There is a growing promotion of clinical approaches to cardiorenal-metabolic health combining guideline-based

therapy, using SGLT-2 inhibitors, GLP-1 receptor agonists, RAAS blocking, and lifestyle modification [8]. But there exist gaps in practice of implementation still, which is partly due to the disjointed models of care, and the uncertainty concerning the precedence of the deliverance of treatment in case of multiple conditions [9]. A more effective way to build the intervention: appropriate characterization of the rates of multimorbidities and their outcomes would help to develop more effective population-wide intervention and thus build up the integrated care pathways.

The investigation presented in the context of the current study centers on the frequency and prevalence of overlapping cardiac, renal, and metabolic conditions in a group of large adults and how the two are connected to healthcare use and clinical outcomes. This study will help in the current attempt to explain the relationship between diseases and enhance their management system because it will come to highlight the level of multimorbidity and its practical implications. Some students adopt external writing assistance because of the large volume of work they have on the same topic--some even use EssayWriters.com to do much of the writing--but I can do the entire work with you, one a bit at a time.

2 Literature Review

The comorbidity of cardiac, renal and metabolic complications, also known as cardiorenal-metabolic multimorbidity has emerged as a well-contemplated primary contributor to disease burden around the world. It has been demonstrated that there is a high propensity of heart failure, chronic kidney disease (CKD) and metabolic dysfunction to cluster together owing to identical biological processes, which encompass neurohormonal activation, persistent inflammation, and injury to the endothelium [10]. Research has also proved that metabolic diseases like obesity and type 2 diabetes are greatly accelerating the processes of cardiovascular and renal degeneration, which further supports the concept of cardiovascular and renal degeneration interactions, which are two-way [11].

The increase in prevalence of overlapping conditions in aging populations has recently been pointed out in epidemiologic studies, with some studies indicating that multimorbidity rates are over 10-15 percent in adults aged over 50 years [12]. Notably, combined cardiac, renal, and metabolic disease is associated with significant hospital admission, medication, and premature mortality risks in comparison with single diseases. The health systems research also indicates that fragmented specialty care is the factor that promotes the late diagnosis, poor-quality treatment plans, and inadequate combination of evidence-based treatments [13].

3 Materials & Methods

Study design

The provided cross-sectional observational study was carried out on the basis of electronic health records (EHR) of a large, integrated healthcare organization comprising of academic, tertiary, and community hospitals. The time interval of the study was from January 2018 to December of 2023. The institutional review board accepted the study procedure and waived the informed consent as de-identified data were to be used.

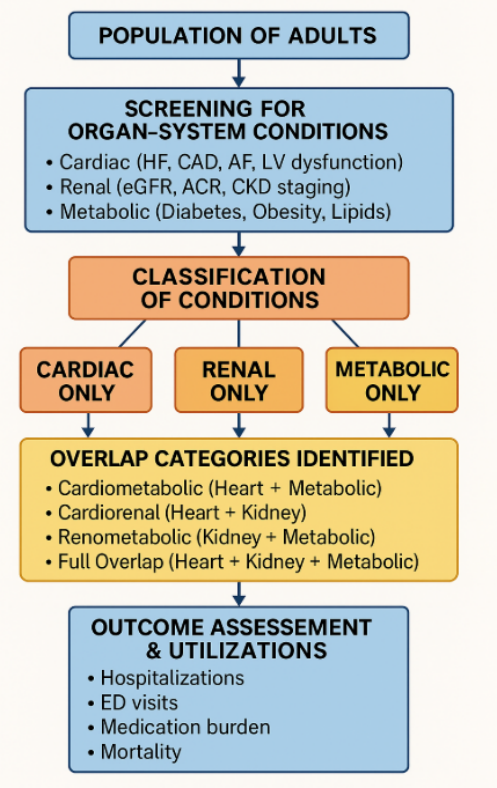


Fig.1. Block diagram model

This figure 1 is a comparison of the impact that microplastics and nanoplastics have on cell viability in 24, 48 and 72 hours. The viability of both types of particles is high at 24 hours (98%), but decays with time. At 48 hours, microplastics make viability to reduce to 91 and nanoplastics decline to 88. At 72 hours, the harm is escalated with microplastics being 76 per cent and nanoplastics being 71 per cent causing growing cytotoxicity as more time passes.

Study Population

Respondents aged 18 years and above who had one or more instances of interaction with the health system within the study period were included in the study. Patients were

supposed to possess verified laboratory data and diagnosis history so that it could be evaluated on cardiac, renal, and metabolic conditions. Exclusions were pregnancy, lacking echocardiographic or renal laboratory measurements, anda. end-stage non cardiac diseases that may obstruct theb. outcome measure.

Cardiac, Renal, and Metabolic Conditions Definitions

Diagnostic definitions were based on a mixture of code sets used to diagnose the conditions, laboratory and imaging values, and medication history:

Cardiac disease: history of left ventricular ejection fraction, which is below 50, ischemic cardiac disease, atrial fibrillation, or echocardiography structural abnormalities.

Renal disease: chronic kidney disease (CKD) characterised by eGFR less than 60 mL/min/1.73m2 or albuminuria [?]30 mg/g on at least two determinations 90 days separated.

Metabolic disease: either type 2 diabetes, obesity (BMI [?]30 kg/m2) or metabolic syndrome based on the ATP III agreement.

Multimorbidity categories were developed by isolating people with single disease, two overlap or cardiorenal-metabolic complete overlap.

Data Collection

Standardized EHR query system was used to extract the data. Variables included:

a. Demographics: age, sex, race/ethnicity, type of insurance.
b. Clinical aspects: blood pressure, body mass index, comorbidity, smoking status, drugs.
c. Laboratory: creatinine, eGFR, HbA1c, lipid screen, albuminuria/creatinine ratio.
d. Routine heart tests: echocardiography evidence, natriuretic peptide.
e. Healthcare chapters: Emergency department visits, hospitalization and outpatient visits in the last 12 months.
f. Measures: all-cause mortality and hospitalization.

Exposure Groups

The following four groups of patients were created:

a. Cardiac only
b. Renal only
c. Metabolic only
d. Complete overlap: cardiac, concomitant renal, and cardiac metabolic disorders.

Secondary comparisons were also conducted on dual-overlapping groups (cardiometabolic, cardiorenal, renometabolic).

Outcome Measures

The most common consequence was prevalence of cardiorenal-metabolic multimorbidity. Secondary outcomes were:

Hospitalization rate in one year.
Emergency department accountability.
c. Medication burden (amount of chronic medication)
d. One-year all-cause mortality

Statistical Analysis

The continuous variables were reported as means (standard deviations) or medians (interquartile ranges). Frequencies and percentages were given as the categorical variables. Student t -test, Kruskal-Wallis tests, or chi-square tests were applied to group comparisons.

Multivariable logistic regression models were used to determine relationships between multimorbidity and clinical outcomes with age, sex, race, socioeconomic status, and comorbidity index. Sensitivity analyses were stratified by age groups and patients having diabetes. A p-value of less than 0.05 was said to be significant. Stata 17 was used in making the analyses.

4 Results and Discussion

This study shows that overlapping cardiac, renal, and metabolic conditions are common and strongly associated with worse outcomes. Patients with full overlap had the highest hospitalization rates, medication burden, and mortality, demonstrating the amplified risk of multimorbidity and the need for integrated, multidisciplinary management strategies.

A total of 182,406 adults met inclusion criteria. The mean age was 58 ± 14 years; 52% were women. Overall, 27% had at least one cardiac, renal, or metabolic condition, while 11.3% met criteria for full cardiorenal–metabolic overlap. Metabolic disease was most common (19%), followed by cardiac disease (14%) and renal disease (12%).

Prevalence of Multimorbidity

Dual-overlap conditions were frequent: 8.2% had cardiometabolic disease, 6.1% had renometabolic disease, and 4.7% had cardiorenal disease shown the table 1. Prevalence increased with age, reaching 22% among individuals ≥70 years.

Table 1. Cardiac, Renal, and Metabolic Conditions Prevalence.

Condition Category	Prevalence (%)	n
Cardiac only	6.8	12,390
Renal only	5.4	9,861
Metabolic only	14.1	25,714
Any single condition	27.0	49,965

Full overlap (CRM)	11.3	20,566
Dual overlap (any)	19.0	34,672

Healthcare Utilization

Patients with full overlap had substantially greater one-year healthcare use. Hospitalization rates were 1.9 admissions/year compared with 0.7 in isolated disease groups ($p < 0.001$) shown the table 2. Emergency visits and outpatient encounters were similarly elevated.

Table 2. Healthcare Utilization Across Overlap Groups

Outcome	Isolated Disease	Dual Overlap	Full Overlap	p-value
Hospitalizations/year	0.7	1.2	1.9	<0.001
ED visits/year	1.1	1.7	2.4	<0.001
Outpatient visits/year	5.6	8.3	11.2	<0.001

Clinical Outcomes

One-year mortality was highest among individuals with full overlap (9.8%) versus isolated disease (3.1%, $p < 0.001$) shown the table 3. Medication burden was related to the number of overlapping conditions, having 100 percent overlap persons with a median of 9 chronic drugs.

Table 3. One-Year Clinical Outcomes

Outcome	Isolated Disease	Full Overlap	p-value
Mortality (%)	3.1	9.8	<0.001
CV hospitalization (%)	12.6	31.4	<0.001
Medication burden (median)	5	9	<0.001

Clinical Implications

The discoveries noted in this research indicate a number of crucial implications to the daily practice of clinical settings. To begin with, the existing disproportionate rates of overlapping conditions of cardiac, renal, and metabolism problems dictate the necessity of early screening programs that target the prevention of patients who can experience multimorbidity. Regular evaluation of renal functionality, metabolic condition, and heart anatomy could assist clinicians to diagnose overlap earlier and treat it earlier.

Second, even worse results experienced by fully multimorbid adults facilitate the formulation of interdisciplinary care pathways. Systemic coordination of cardiology and nephrology and endocrinology could help curb fragmentation, enhance treatment adherence, and achieve optimal outcomes of evidence-based therapies that are known to affect various organ systems.

Third, the robust correlation between multimorbidity and healthcare use indicates that preventive care and risk-factor interventions in introducing the drivers of hypertension, diabetes, obesity, and chronic inflammation need to be considered to ensure the eradication of disease combinations.

Conclusion

This paper illustrates the fact that cardiorenal-metabolic multimorbidity is not only very widespread but also firmly linked with poor clinical outcomes in adults. Over one out of ten people had cardiac, renal, and metabolic disease overlap completely and these patients had significantly increased hospitalization, emergency department utilization, medication burden, and one-year mortality rates, in comparison with the separated state. The results demonstrate the reinforcing impacts of having multimorbidity, in which the breakdown of the other systems is hastened by the breakdown of the others, and thus leads to the most unequal health results. Such findings highlight the shortcomings of traditional, disease-focused care models and justify the necessity to adopt the multidefensive approach of management that responds to shared risk factors and overlapping biological mechanisms. Early warning of vulnerable patients, anticipation, and integrated treatment among cardiologists, nephrologists, and metabolic specialists could assist in the prevention of the disease progression and decrease the use of healthcare facilities. Future studies are required on specific intervention and interventions at the population level in order to achieve better effects in this high risk population that continues to expand.

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