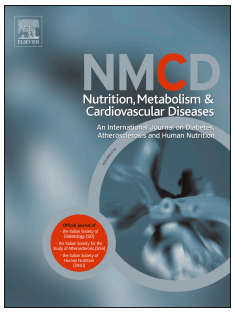
Journal Pre-proof



Organisational initiatives to improve care in the prevention and management of cardiometabolic conditions: A scoping review.

Hellena Hailu Habte-Asres, Chuyou Hou, Angus Forbes, David C. Wheeler

PII: S0939-4753(24)00353-3

DOI: https://doi.org/10.1016/j.numecd.2024.09.004

Reference: NUMECD 3734

To appear in: *Nutrition, Metabolism and Cardiovascular Diseases*

Received Date: 7 March 2024

Revised Date: 14 August 2024

Accepted Date: 4 September 2024

Please cite this article as: Habte-Asres HH, Hou C, Forbes A, Wheeler DC, Organisational initiatives to improve care in the prevention and management of cardiometabolic conditions: A scoping review., *Nutrition, Metabolism and Cardiovascular Diseases*, https://doi.org/10.1016/j.numecd.2024.09.004.

Organisational initiatives to improve care in the prevention and management of cardiometabolic conditions: A scoping review.

Hellena Hailu Habte-Asres[1,2], Chuyou Hou[3], Angus Forbes[1] David C Wheeler[3]

1. Florence Nightingale Faculty of Nursing, Midwifery and Palliative Care, King's College London, UK
2. Royal Free London NHS Foundation Trust, UK
3. UCL Department of Nephrology, University College London, Royal Free Campus, Rowland Hill Street, London, UK

Corresponding author

Dr. Hellena Habte-Asres

Room 4.26 James Clerk Maxwell Building

57 Waterloo Road

London

SE1 8WA

hellena.habete-asres@kcl.ac.uk

Or

Dr. Hellena Habte-Asres

St Pancreas Kidney Diabetes & Eye Centre

4 St Pancreas way

London, NW1 0PE

Hellena.Habte-Asres@nhs.net

Abstract

Aim: Cardiometabolic conditions such as cardiovascular disease, type 2 diabetes, and chronic kidney disease contribute to multimorbidity, posing a global health challenge. However, existing healthcare frameworks often struggle to adequately address the intricate needs of individuals living with these conditions. The review aims to map existing research on cardiometabolic care initiatives for the primary and secondary prevention of metabolic conditions.

Data synthesis: A scoping review was conducted following the methodology of the Joanna-Briggs-Institute. We searched Medline, Embase, and CINAHL. The review primarily sought studies comparing the effectiveness of cardiometabolic services/clinics in primary or secondary prevention of cardiometabolic conditions with standard care. The data from these studies were charted and summarised in tabular form, with a narrative synthesis.

The search identified 97 records across three databases, and 18 documents met inclusion criteria. Two studies addressed cardiometabolic care in primary prevention, while twelve focused on secondary prevention. Positive outcomes were observed in primary prevention, including reductions in waist circumference, body mass index, blood pressure, and cholesterol levels. For secondary prevention, the studies demonstrated positive metabolic outcomes, such as reductions in HbA1c, weight, blood pressure, and cholesterol levels. Additionally, data from the available studies reported improved adherence to diabetes care processes and the implementation of guideline-directed therapies.

Conclusion: This scoping review highlights the potential benefits of services such as cardiometabolic clinics for primary and secondary prevention in metabolic conditions. Future studies should use standardised outcome measures and include details on the structure, staffing and treatment intensity of clinics to aid their wider implementation.

Keywords: cardiometabolic, cardiorenal, multimorbidity, multidisciplinary clinics, Joint cardio renal clinic

Introduction

Cardiometabolic conditions such as cardiovascular disease (CVD), type 2 diabetes(T2DM), and chronic kidney disease (CKD) significantly contribute to the prevalence of multimorbidity, presenting a substantial global public health challenge [1]. These conditions are associated with reduced quality of life and increased mortality [2]. Cardiometabolic conditions are interconnected with diabetes, hence, the prevalence of diabetes patients in cardiology and renal clinics is high.

Despite the rising prevalence of cardiometabolic multimorbidity, our current healthcare system primarily focuses on managing individual diseases in silo [3, 4]. This approach can lead to difficulties in adequately meeting the complex needs of those with multimorbidity, resulting in fragmented care and suboptimal communication between specialists and general practitioners [5]. Consequently, there is a pressing need to implement effective management strategies to improve clinical outcomes, enhance the quality of life, and reduce the burden and cost of these conditions to the healthcare system. The landscape of interventions and clinics targeting these disorders is dynamic, with a multitude of strategies emerging to address the complex interplay of metabolic and cardiovascular risk factors.

Cardiometabolic care is a speciality that focuses on assessing, preventing, and managing conditions related to both cardiovascular disease and metabolic disorders. Such care is offered as part of tailored assessments, prevention strategies, and management plans for individuals living with conditions like diabetes, obesity, hypertension, dyslipidaemia, and other metabolic abnormalities. By providing comprehensive care, cardiometabolic outpatient services or “clinics” aim to mitigate the heightened risk of heart disease and stroke associated with these conditions. Such services tend to be multidisciplinary, and can include a range of staff including cardiologists, endocrinologists, pharmacists, nurses, psychologists and dietitians .

Cardiometabolic care involves joint-working initiatives between specialist in different departments or multi-professional teams to provide more integrated care. Within the different models of cardiometabolic services, the interventions delivered can also be multifaceted and include a combination of medical intervention, lifestyle support, and behavioural approaches. While specific interventions may vary based on individual needs and clinic protocols, a lack of guidelines and standards informs the implementation of cardiometabolic organisational initiatives. Indeed, both the UK and the US, consensus groups like the Cardiometabolic UK group and the Cardiometabolic Alliance, do not provide specific specifications on how best to develop services or on how to deliver specialist interventions.

Therefore, this scoping review was undertaken to systematically identify, categorise, and map the diverse range of cardiometabolic services/clinics that are currently documented in the literature and to determine their role in improving patient outcomes.

2. Materials and methods

2.1 Protocol and registration

Given the exploratory nature of our investigation into the range of initiatives implemented in real-world clinical settings, the broader approach of a scoping review was considered to be most appropriate method. Using a scoping methodology allowed us to map the breadth and depth of existing literature detailing the care delivered and structural configurations of cardiometabolic clinics. Given the relative infancy of these services, it also allowed for the inclusion of all types of study designs from both peer reviewed and grey literature sources to identify gaps in current knowledge and areas for future research [6]. The protocol was registered with the Open Science (https://doi.org/10.17605/OSF.IO/73BR8)

2.2 Information sources

We collaborated with a senior health science librarian to create a systematic search strategy using core terms like 'cardiometabolic,' 'cardiorenal,' 'multidisciplinary,' and 'multimorbidity.'. As our study focused specifically on diabetes, cardiovascular conditions, and renal conditions due to their significant overlap and the established burden of comorbidity in these populations, we chose not to include wider search terms related to metabolic conditions such as obesity or endocrinology. Our full search strategy, included in the appendix, focused on English-language literature involving human participants.

We conducted a time-unrestricted search to encompass all potentially relevant research, including research articles and conference proceedings. A comprehensive electronic database literature search was initially conducted in May 2023, updated on February 28, 2024, and further updated in August 2024, to identify any subsequent publications. The searches were conducted in the following electronic databases: MEDLINE, EMBASE, and CINAHL. Citations and reference lists of the articles included in the review were screened to identify additional relevant studies or reports.

2.3 Eligibility criteria

Initially, two reviewers, HH-A and CH, independently screened titles and abstracts. During this stage, documents were excluded only if they did not pertain to cardiometabolic or joint clinics for people with cardiometabolic multimorbidity. Any title or abstract deemed relevant by either reviewer progressed to the second stage. Duplicate or irrelevant publications were excluded. In the second stage, two reviewers, HH-A and CH, independently conducted full-text reviews of the documents selected from stage one.

The inclusion and exclusion criteria for the full-text review were as follows.

The inclusion criteria for the studies were:

1) Studies conducted on adult patients (⩾18 years) focused on cardio-metabolic clinics, either for primary or secondary prevention of metabolic conditions
2) Studies that report on multi-professional initiatives which aimed to improve cardiometabolic outcomes in people with at least one chronic condition (e.g., cardiometabolic, cardiorenal or joint diabetes-renal clinics).
3) Studies that report on screening initiatives for cardiometabolic conditions, which include outcomes on disease progression, symptom management, assessment, education, mortality or quality of life.
4) Research articles, systematic reviews, or conference proceedings and abstracts of clinical trials, clinical audits, or observational studies comparing the efficacy of cardiometabolic clinic interventions with usual care.
5) Studies published in English.

Exclusion criteria were:

1) Studies that did not specifically screening initiatives or multi-professional initiatives which aimed to improve cardiometabolic outcomes in people with at least one chronic condition.
2) Studies focused solely on the management of a single disease.
3) Editorials or opinion pieces.

The reviewers (HH-A, CH) discussed any disagreements during both stages of screening. If agreement was not reached, a third and fourth reviewer (AF & DW) helped to reach consensus.

2.4 Synthesis of results

Two reviewers (HHA, CH) developed the data charting sheet, which was reviewed by the co-authors (AF and DW). HH-A guided CH in conducting data extraction. HH-A then undertook verification of the extracted data. The co-authors (AF and DW) provided feedback on the final literature table. The development and completion of this table allowed us to summarise and synthesise the data.

The extracted data included: author, place of publication, study design, and sample size. Background information (study population, number of participants, type, and number of chronic conditions), intervention and usual treatment information and duration of follow-up, and outcome of interests

2.5 Data Synthesis

Study characteristics, methods, and outcomes were organised in tabular form. Given the heterogeneity of the different studies, the extracted data were tabulated to present a comprehensive overview of each of the identified studies detailing the context, cardiometabolic or cardiorenal interventions and reported outcomes in a standardised format. These data were used to inform a narrative review explicating the salient elements of the identified interventions.

3. **Results**

The search process involved three databases, which yielded 212 records, and an additional five records from other sources, resulting in a total of 217 records. Out of these, Eighteen met the

inclusion criteria and were included in the review. The entire search and selection process is visually represented in the PRISMA flowchart (Figure 1).

Figure 1: Flow diagram of study selection.

3.1 Study and participants' characteristics

This scoping review followed the Joanna Briggs Institute methodology. The reporting of items is in accordance with the PRISMA extension for Scoping Reviews (PRISMA-ScR) reporting guidelines.

The 18 records included in the review employed a variety of study designs: seven cross-sectional analyses[7-13], two randomised controlled trials [14, 15], six clinical audits [16-21] one nested case-control study [22] and two cohort studies [23, 24]. The observation periods in these studies ranged from 6 months to 10 years. Geographically, seven of the studies included were conducted in UK, one in Ireland, six in the United States, two in the Netherlands, one in Australia, and one in China. Detailed characteristics of the studies, including clinic populations (sample sizes, purpose of clinics), type of clinic/interventions, composition of staff delivering clinics, and outcome measures, are presented in Table 1. The reported outcomes for each study are presented in Table 2.

Table 1 here

Table 2 here

3.2 Narrative synthesis

The scoping review is presented in two parts under the following subheadings: 'Models of Cardiometabolic Interventions'; and 'Key Reported Outcome Measures.' In the first part the different intervention strategies are considered to summarise the current models for cardiometabolic care. The second part provides an overview of cardiometabolic initiatives in relation to their reported clinical outcomes and cost effectiveness.

3.3 Models of cardiometabolic interventions/ clinics

Cardiometabolic clinics are specialised healthcare interventions designed to address the complex interplay of metabolic and cardiovascular risk factors. Various types of cardiometabolic clinics exist, each tailored to meet specific needs and conditions. Some common types identified from the included studies were joint renal diabetes clinics [16-18, 21-23], joint cardiorenal clinics[19] standalone cardiometabolic clinics for primary cardiovascular prevention [14, 25] and cardiometabolic clinics for secondary prevention [8-13, 20, 24]. In addition, the staffing constitution of cardiometabolic clinics varied widely in the included studies. Some clinics offered a multidisciplinary approach, combining services from various healthcare professionals, including endocrinologists, cardiologists, dietitians, psychiatrists, nephrologists. Some of the cardiometabolic clinics explicitly reported the number of sessions offered to patients[16, 17, 25] while others did not.

3.3.1 Focus of cardiometabolic clinic in primary prevention of metabolic conditions

Two studies explored the impact of cardiometabolic clinics on primary prevention. Stol et al [14] conducted a study between 2014 and 2017 to evaluate the effectiveness of a stepwise cardiometabolic disease (CMD) risk assessment followed by individualised treatment compared to standard care. Their randomised controlled trial aimed to identify CMD cases, prescribe suitable medication during a one-year follow-up, and assess changes in CMD risk

profiles among participants who completed the intervention steps compared to matched controls. The intervention resulted in the detection of two- to threefold more patients with CMD and a significant decrease in systolic blood pressure and cholesterol levels after one year of treatment.

Coates et al [25] studied a cardiometabolic clinic co-located with a clozapine clinic for individuals with severe mental illness. Analysis of first-visit data for 73 clients showed a high prevalence of untreated metabolic syndrome, leading to metformin prescriptions. The results indicate positive outcomes, with the majority of clients experiencing improvements such as weight loss and a reduction in body mass index. Additionally, nearly half of the clients observed a decrease in waist circumference. Furthermore, the majority reported increased physical activity and positive dietary changes since their initial appointment.

3.3.2 Focus of cardiometabolic clinic in secondary prevention of metabolic conditions

Fifteen papers examined the role of cardiometabolic clinics in the secondary prevention of metabolic conditions, focusing specifically on those individuals with diabetes. Jayapaul et al [23] evaluate a joint diabetic-renal clinic's impact on renal disease progression and clinical targets, reporting significant improvements in blood pressure and cholesterol levels, as well as a notable reduction in the decline of glomerular filtration rate over three years. Junarta et al [19] study of a cardio-renal multidisciplinary team's effectiveness in managing cardiovascular risk in waitlisted transplant patients, resulting in a higher transplantation rate without significant differences in adverse events or survival rates. Idowu et al [18] conducted a retrospective review comparing joint renal clinics to general diabetes clinics, revealing higher completion rates for care processes in specialised renal diabetes clinics.

Habte-Asres et al [16] audited a diabetes renal transplant clinic, demonstrating positive clinical outcomes, including glucose and HbA1c reductions, emphasising the effectiveness of specialised multidisciplinary diabetes care. Habte-Asres et al [17] evaluated a new diabetes care model for people with advanced CKD in renal satellite units. Their study demonstrated significant improvements in metabolic outcomes and a reduction in health disparities by enhancing access to guideline-directed therapies and diabetes technologies. Low et al [22] explored the long-term renal outcomes of a joint endocrinologist-nephrologist clinic for patients with type 2 diabetes and diabetic kidney disease, finding a lower risk of progressing to Stage 5 CKD in the clinic group. Modarressi and colleagues [20] established a cardiometabolic clinic to address the underutilisation of pharmacologic therapies in patients with type 2 diabetes and atherosclerotic cardiovascular disease (ASCVD). Thabit et al [21] examined the effects of a joint diabetes-renal clinic on diabetic patients with advanced CKD. They aimed to understand the prevalence of diabetes-related complications and clinical characteristics at clinic entry and assess any improvements during follow-up. Data from 60 initial clinic patients over 12 months indicated promising multidisciplinary care, potentially preserving renal function and delaying end-stage renal failure in diabetic CKD patients.

Thomas et al [24] compared patients receiving care at a cardiometabolic clinic to those in conventional care settings, showing higher rates of guideline-directed medical therapy, increased medication use, and greater reductions in various health indicators. Sammour et al [13] conducted a two-year study at a Cardiometabolic Centre, observing significant improvements in patients with type 2 diabetes and cardiovascular disease, including increased medication utilization and reductions in various health markers. Narin et al [12] explored the association between diabetes mellitus and increased cardiovascular risks, studying an innovative cardiometabolic clinic to address high-risk patients, resulting in positive outcomes based on medication recommendations and lifestyle interventions. Narin et al[11] discussed the

Cardiometabolic Clinic at St. George's University Hospitals NHS Foundation Trust, emphasising its multidisciplinary approach and positive outcomes in antidiabetic drug interventions during a 36-month retrospective review.

The study led by Kosiborod [10] evaluated 606 individuals with Type 2 Diabetes (T2D) and Cardiovascular Disease/Chronic Kidney Disease (CVD/CKD) across six sites. The participants, with a median age of 64 years and comprising 44% women and 78% white individuals, were followed up for a median duration of 6 months. Following the initiation of care at Cardiometabolic Centres of America (CMCA) sites, significant improvements were observed in Guideline-Directed Medical Therapy (GDMT) adherence. Additionally, there were notable reductions in weight, HbA1c levels, blood pressure, total/LDL cholesterol, triglycerides, and insulin requirements. The improvements were statistically significant ($p< 0.001$). Kosiborod et al [9] demonstrated that the Cardiometabolic Centre Alliance (CMCA) significantly increased the use of guideline-directed medical therapies (GDMT) and reduced cardiovascular risk factors with their coordinated care model. An evaluation of 1,528 individuals across six sites revealed sustained improvements in GDMT utilisation, weight, HbA1c, cholesterol levels, and insulin requirements, with consistent performance across racial subgroups. This suggests that the CMCA's team-based approach can enhance the quality of care for patients with cardiometabolic disease. Gustafson et al [8] used a team-based collaborative care model that utilises evidence-based protocols aimed at improving patients' cardiometabolic health. With this approach, they were able to optimise 65% of patients on guideline-directed therapies, increase uptake of diabetes care processes, and achieve a significant reduction in HbA1c.

3.4 Key Reported Outcome Measures for cardiometabolic clinics

The outcome measures reported for cardiometabolic clinics varied across studies, reflecting the diverse approaches and focuses of these interventions. Some commonly reported outcome measures include screening for cardiometabolic conditions, disease progression, assessment or education metabolic outcomes and cost-effectiveness.

Seventeen of the studies included reported on the effectiveness of cardiometabolic clinics. These studies assessed various metabolic outcomes, including changes in HbA1c, blood pressure, and cholesterol levels from baseline to end of follow up period. Others used process measures, such as evaluating the number of patients who underwent nephropathy screening, attended lower extremity checks, participated in diabetes education sessions, or achieved a HbA1c level <9%. Additionally, two studies examined the economic cost associated with cardiometabolic clinics; and three studies compared the metabolic outcomes of patients from cardiometabolic clinic with those from standard single disease clinics.

3.4.1 Glycaemic outcomes

Nine studies demonstrated a reduction in post-intervention HbA1c levels [9-13, 16, 17, 22]. Gustafson et al [8] undertook a cross-sectional review of the cardiometabolic clinic and documented an increased proportion of people with diabetes achieving HbA1c levels below 9% (75 mmol/mol). Narain et al [12] conducted a review of their CMC and reported mixed results, with reductions in HbA1c for 11 patients (mean reduction of 3.8% (17.7 mmol/mol)) and an increase in HbA1c for the other patients (n=3) (mean increase of 2.6% (4.7 mmol/mol)). In the 36-month follow-up period, the results from Narain et al [11] 's study showed an average reduction of mean HbA1c by 3.8% (18 mmol/mol) among 40 participants and an increase in mean HbA1c by 2.8% (7 mmol/mol) among 14 participants . Conversely, Idowu et al[18] Thabit et al [21] and Jayapaul et al [23] found no difference in HbA1c outcomes between the different speciality clinics.

3.4.2 Kidney outcomes

Seven studies examined kidney-related outcomes [8, 18, 19, 21-23, 25]. Among these studies, two specifically focused on evaluating the diabetes process of care, particularly the proportion of individuals who underwent nephropathy screening [8, 18]. They found that a substantial proportion of patients underwent nephropathy screening, increasing from 91.6% at baseline to 97.43% at the end of the follow-up period [8]. Idowu reported a higher proportion of patients seen in the joint renal diabetes clinic had their urine ACR tests completed compared to those seen in a standalone diabetes clinic[18]. Two studies reported the prevalence of CKD in their study populations[23, 25].

Low et al [22] reported that in their integrated diabetes kidney clinic, patients had a 45% lower risk of reaching CKD stage 5 (Hazard ratio 0.55; 95% CI, 0.36-0.83) compared to those in non-DKD clinics, with 45.8% versus 54.2% reaching CKD stage 5, respectively. Conversely, Idowu et al[18] assessed changes in eGFR over one year and found no significant differences between patients treated at a joint diabetes renal clinic and those treated in a single-specialty clinic. Similarly after 12 months of follow-up at the joint clinic, Thabit et al [21] observed no significant changes in serum creatinine clearance ($p = 0.2$) or serum creatinine levels ($p = 0.5$). Furthermore, Junarta et al[19] assessed the effectiveness of a cardio-renal Multidisciplinary Team (MDT) protocol in managing high cardiovascular risk waitlisted kidney transplant patients compared to a standard protocol over a 2.7-year follow-up period. In the comparison between the Cardio-Renal MDT and the Standard Group, the Cardio-Renal MDT protocol demonstrated a significantly higher transplantation rate (35% vs. 21%; $P = 0.02$).

3.4.3 Blood pressure outcomes

Seven studies assessed changes before and after cardiometabolic interventions in various clinical settings [8, 10, 17, 21-24]. Among these, four studies demonstrated a reduction in blood pressure following cardiometabolic clinic interventions, with reductions ranging from 3.6 to 17mmHg [10, 17, 23, 24]. Thabit et al[21] noted a trend of improvement in systolic and diastolic blood pressure; nevertheless, these changes did not achieve statistical significance (systolic: 159.4 ± 30.8 vs. 141.8 ± 35.5 mmHg, p = 0.13; diastolic: 73.2 ± 9.3 vs. 69.2 ± 9.4 mmHg, p = 0.075). Gustafson et al[8] noted that the percentage of participants who attained blood pressure levels below 130/80 increased from 54.28% at baseline to 55.4% after the intervention. Habte-Asres et al [17] reported significant reductions in blood pressure among both non-dialysis CKD and haemodialysis populations. In the non-dialysis population, systolic blood pressure decreased by 13.9 mmHg and diastolic blood pressure decreased by 3.5 mmHg. In the Hemodialysis population, systolic blood pressure dropped by approximately 18 mmHg and diastolic blood pressure dropped by 10.3 mmHg. In contrast, Low et al [22] observed an increase in systolic blood pressure but a reduction in diastolic blood pressure.

3.4.4 Weight-related outcomes

Five studies reported on weight-related outcomes, including reduction in weight, the proportion of people who achieved weight loss, changes in body mass index or waist circumference from baseline to the end of cardiometabolic interventions [10, 13, 17, 24, 25]. Among these four studies weight reductions ranged from 10.9 to 111.4 lbs. Coates et al[25] noted that a significant proportion of individuals achieving a decrease in waist circumference and body mass index following the cardiometabolic clinic intervention.

3.4.5 Cholesterol outcomes

Nine studies evaluated lipid-related outcomes, including reduction in LDL cholesterol levels, triglycerides, total cholesterol levels or the proportion of individuals achieving LDL level below 70mg/dL[8-10, 14, 17, 21-24]. Among these, four studies assessed changes in LDL cholesterol, with reductions ranging from 2.8 to 17 mg/dL [9, 10, 22, 24]. Two studies reported reductions in total cholesterol ranging from 10.8 mg/dL to 19 mg/dL[9, 23], while Habte-Asres et al[17]. and Thabit et al[21] observed no significant changes in the total cholesterol profile of patients compared to baseline across the cohort. Two studies reported reductions in triglyceride levels post cardiometabolic intervention ranging from 18 mg/dL to 19.5 mg/dL [9, 10]. Gustafson et al [8] observed a significant increase in the proportion of patients achieving LDL levels below 70 mg/dL, rising from 62.50% at baseline to 74.51% by the end of the follow-up period.

3.4.6 Medication related outcomes

Medication-related outcomes were evaluated through various approaches, encompassing changes in insulin requirements, initiation of glucose-lowering, lipid-lowering, and blood pressure-lowering medications. Some also examined the use of disease-modifying therapies like sodium-glucose cotransporter-2 inhibitors (SGLT2i) and Glucagon-like peptide-1 receptor agonists (GLP-1 RA). These studies measured the proportion of patient who are managed with guideline-directed therapies or initiated or optimised on newer agents before and after cardiometabolic interventions.

Three studies[10, 13, 24] reported a significant reduction in insulin requirements following cardiometabolic clinic intervention. Additionally, nine studies[8-10, 12-14, 17, 20, 24]. compared the proportion of patients who were initiated or optimised on guideline-directed therapies at baseline and post-cardiometabolic intervention, and they found a significant increase in the use of disease-modifying agents such as GLP-1 RAs or SGLT2i.

3.4.7 Cost effectiveness of cardiometabolic interventions

The cost-effectiveness of cardiometabolic clinic interventions was evaluated by Stol et al[15] and Junarta et al [19] in different settings. Junarta et al [26] conducted a study to assess the cost-effectiveness of a cardio-renal multidisciplinary team (MDT) protocol for high cardiovascular risk waitlisted kidney transplant patients compared to a standard protocol. The 2.7-year analysis involving 207 patients revealed that the cardio-renal MDT protocol achieved higher transplantation rates (35% vs. 21%; P = .02) and lower managing cost per patient per year (£610 vs. £692). The increased cost in the standard group was linked to more echocardiograms and tests per patient, with no significant differences observed in adverse events, death, re-hospitalisation, or graft/patient survival rates in transplanted patients. In a randomised controlled trial involving 1934 participants aged 45–70, Stol et al[15] assessed the long-term cost-effectiveness of a stepwise cardiometabolic disease (CMD) risk assessment and individualised treatment compared to standard care. Despite initial improvements in blood pressure and cholesterol, the intervention, including risk assessment and follow-up treatment, led to higher costs after 1 year, primarily due to healthcare costs. Over 60 years, it was deemed not cost-effective, with an Incremental Cost-Effectiveness Ratio (ICER) of 306,000 Euro per Quality-Adjusted Life Year (QALY), and scenario analyses confirmed this conclusion.

4 . Discussion

Our scoping review identified eighteen reports and studies related to cardiometabolic clinics. The evidence suggests that cardiometabolic clinics can have a positive impact on diagnosing conditions (e.g. hypertension, hypercholesterolemia and diabetes) and lowering certain risk factors to prevent their progression. Our review also highlights some evidence supporting the effectiveness of cardiometabolic clinics in improving clinical outcomes compared to general

or single-specialty clinics. Several of the studies included show that patients with multiple health conditions experience better outcomes in cardiometabolic clinic settings compared to single speciality clinic, including improved glycaemic control, blood pressure, kidney function, weight, and lipid profiles. Additionally, attendance for diabetes education and screening for chronic kidney disease (CKD) and foot care can be improved, along with medication optimisation with increased use of guideline-directed therapies. The cost-effectiveness of cardiometabolic clinics was evaluated in two studies with relatively small sample sizes. The INTEGRATE randomised controlled trial by Stol et al[14] which assessed the implementation of a primary care-based cardiometabolic risk prevention program, did not show long-term cost-effectiveness. However, the INTEGRATE analysis is based on a population without a previous cardiovascular history. The primary aim of most cardiometabolic clinics is secondary prevention through risk factor modification, which has the potential to demonstrate cost-effectiveness.

The review highlighted the heterogeneity of cardiometabolic services were structured to achieve their aims. These ranged from joint-renal diabetes clinics with two specialist consultants to stand alone cardiometabolic clinics with multi-professional teams which included dieticians and psychiatrists. However, the level of detail provided on the organisational aspects of these cardiometabolic services in the literature was limited. Indeed, few of the studies mentioned specific staffing requirements, the frequency of patient attendance, or whether there was an increase or reduction in patient contact time compared to standard care. Due to the significant variation among these clinics and the lack of detail provided on implementation, it was difficult to identify either the key components, optimal staffing or effective structuring of clinics and services that were crucial for positive patient outcomes. Nonetheless, it is clear that effective collaboration within multidisciplinary teams is crucial to achieve high quality cardiometabolic care. Therefore, further research is urgently

needed to determine the optimal structure and function of these cardiometabolic clinics. To be effective in clinical settings, it will be important for cardiometabolic clinics to adapt their approach to meet the needs of individuals and population context. For example, self-management advice, medication management and exercise programmes will need to be adapted for sub-populations to consider the age, capacity and the social situations of patients with multi-morbidity. Nicholson and colleagues [27] scoping review on interventions to improve the health of adults and older adults with multimorbidity highlights the need for multi-faceted interventions which are tailored to populations to ensure the development of personalised care for individuals. However, tit is important to acknowledge that here are resource implications in providing individualised integrated care models, therefore more research to estimate their cost-effectiveness is required.

4.1 Limitations

The studies in this scoping review had limitations, including variations in measuring metabolic outcomes, differing follow-up durations, and a lack of covariate adjustments. In scoping reviews, quality assessment is not mandatory; therefore, studies were not excluded based on their quality. Concerns about identification and selection biases are especially relevant in non-randomised reviews without standardised study registration. To reduce identification bias, we conducted an extensive search across multiple databases and reviewed reference lists of included studies. This scoping review represents the first systematic and comprehensive analysis of cardiometabolic clinics for multimorbidity management, summarising existing knowledge in the field.

4.2 Implication for clinical practice and research

The high prevalence of multimorbidity emphasises the importance of routinely implementing cardiometabolic clinic interventions, which holds significant implications for clinical practice. In the UK, we eagerly await the outcomes of seven pilot cardiometabolic clinics [28]. There is emerging evidence supporting the effectiveness of the centre of excellence cardiometabolic clinics in the US [29]. We have included two evaluations published by the alliance in our scoping review. The Cardiometabolic Centre Alliance (CMCA) is a cohesive network of healthcare institutions and professionals dedicated to enhancing care for patients with cardiometabolic diseases, including cardiovascular conditions and diabetes. The CMCA prioritises integrated, comprehensive care models aimed at improving patient outcomes through prevention, early detection, and innovative treatments. By fostering collaboration among multidisciplinary teams and specialists, the alliance strives for coherent efforts to optimise cardiometabolic health outcomes. The alliance's centre of excellence cardiometabolic clinics exemplify this commitment, providing top-tier, multidisciplinary care to patients. (Cardiometabolic Centre Alliance[29])

Multimorbidity cardiometabolic disorders have stimulated a growing discussion around the training requirements for healthcare professionals. Instead of specialising in a single specialty, such as nephrology or cardiology, there is a question of whether a cardiometabolic specialty needs to be developed to meet the needs of this growing population of patients.

It is noteworthy that common research designs in this field, such as cross-sectional analyses and clinic audits, provide lower levels of evidence. To strengthen the evidence base, conducting more rigorous research, including randomised controlled trials, is imperative. Furthermore, the

diverse range of clinical outcomes reported in these studies highlights the need to establish well-defined core outcome sets for cardiometabolic clinics. These core outcomes should encompass measures related to glycaemic control, blood pressure, lipid profiles, weight, kidney function, and liver outcomes. Qualitative research is also essential to gain deeper insights into the experiences of individuals utilising these clinics. While most studies in this review were conducted in high-income countries, it is essential to recognise that there is a higher burden of these conditions in low to middle-income countries. Therefore, conducting further research in low-middle income settings to establish the potential for cardiometabolic clinics to improve healthcare outcomes is important [30]. Further investigation is necessary in several domains, including the identification of optimal team configurations, the net increase or reduction in patient contact time compared to standard care, the examination of sustainability factors, the evaluation of costs, and the assessment of long-term clinical outcomes.

4.3 Conclusion

Our scoping review emphasises the accumulating evidence supporting cardiometabolic clinics for primary and secondary prevention of metabolic conditions. With the growing prevalence of multimorbidity, these clinics are becoming increasingly important. The reported metabolic outcomes consistently show improvements, affirming their clinical effectiveness. Additionally, the review highlights better adherence to diabetes care processes and increased use of guideline-directed therapies. In conclusion, this review provides valuable insights into cardiometabolic clinics for primary and secondary prevention of metabolic conditions. However, further research, including randomised controlled trials, may validate these findings and promote wider adoption.

Reference

1. Alssema, M., et al., *One risk assessment tool for cardiovascular disease, type 2 diabetes, and chronic kidney disease.* Diabetes Care, 2012. **35**(4): p. 741-8.
2. Ho, I.S., et al., *Variation in the estimated prevalence of multimorbidity: systematic review and meta-analysis of 193 international studies.* BMJ Open, 2022. **12**(4): p. e057017.
3. Méndez Fernández, A.B., et al., *Cardiorenal syndrome and diabetes: an evil pairing.* Front Cardiovasc Med, 2023. **10**: p. 1185707.
4. Reiter-Brennan, C., et al., *Comprehensive Care Models for Cardiometabolic Disease.* Curr Cardiol Rep, 2021. **23**(3): p. 22.
5. Manla, Y. and W. Almahmeed, *Cardiometabolic Clinics: Is There a Need for a Multidisciplinary Clinic?* Front Clin Diabetes Healthc, 2022. **3**: p. 880468.
6. Peters, M.D.J., et al., *Scoping reviews: reinforcing and advancing the methodology and application.* Syst Rev, 2021. **10**(1): p. 263.
7. Coates, D., et al., *Evaluation of a general practitioner-led cardiometabolic clinic: Physical health profile and treatment outcomes for clients on clozapine.* International Journal of Mental Health Nursing, 2018. **27**(1): p. 303-310.
8. Gustafson, P. *Team Based Care: Overcoming Clinical Inertia to Improve Patient Outcomes*. in *ADCES23*. 2023.
9. KOSIBOROD, M.N., et al., *1937-LB: Coordinated Approach to Improve Quality of Care and Address Disparities in Patients with Cardiometabolic Disease—Analysis from the Cardiometabolic Center Alliance Registry.* Diabetes, 2024. **73**(Supplement_1).
10. KOSIBOROD, M.N., et al., *1077-P: A Multicenter Initiative to Improve Care in Cardiometabolic Disease—Initial Report From Cardiometabolic Center Alliance (CMCA).* Diabetes, 2023. **72**(Supplement_1).
11. Narain, R., L. Bijman, and M. Chen, *128 Progress and early outcomes of a cardiometabolic clinic in a uk tertiary cardiology centre.* Heart, 2022. **108**(Suppl 1): p. A96-A97.
12. Narain, R., et al., *Novel multidisciplinary cardiometabolic clinic in a UK tertiary cardiology centre: early activity, interventions and potential for cardiovascular risk optimisation.* European Heart Journal, 2021. **42**(Supplement_1).
13. Sammour, Y., et al., *Cardiometabolic Center of Excellence: Analysis of Two-year Outcomes.* American Heart Journal, 2021. **242**: p. 168-169.
14. Stol, D.M., et al., *Effectiveness of a stepwise cardiometabolic disease prevention program: Results of a randomized controlled trial in primary care.* Prev Med, 2020. **132**: p. 105984.
15. Stol, D.M., et al., *Cost-effectiveness of a stepwise cardiometabolic disease prevention program: results of a randomized controlled trial in primary care.* BMC Medicine, 2021. **19**(1): p. 57.
16. Habte-Asres HH, H.M., Rosenthal M, *Optimising Diabetes Care for Kidney Transplant Recipients.* J Clin Nephrol Res, 2024. **11**(1): p. 1117.
17. Habte-Asres, H.H., et al., *Closing the policy gap in diabetes care for individuals with advanced CKD.* Diabet Med, 2024: p. e15381.
18. Idowu, O., et al. *A Comparison between the Joint Renal Diabetes Clinic and General Diabetes Clinics in a District General Hospital*. in *ABCD*. 2017.
19. Junarta, J., et al., *Role of a cardio-renal multi-disciplinary team meeting in managing cardiovascular risk in patients on kidney transplant waitlists.* Clin Transplant, 2020. **34**(11): p. e14061.
20. Modarressi, T.J.M.F., Mahmoud S. Ghusson, and Jay K. Patel. *ESTABLISHING A CARDIOMETABOLIC CLINIC: INTERVENTIONS FOR THE FIRST 400 PATIENTS*. in *American College of Cardiology*. 2023 JACC.
21. Thabit, H., et al., *Complications and characteristics of patients referred to a joint diabetes renal clinic in Ireland.* Irish Journal of Medical Science, 2012. **181**(4): p. 549-553.

22. Low, S., et al., *Long-term outcomes of patients with type 2 diabetes attending a multidisciplinary diabetes kidney disease clinic.* J Diabetes, 2018. **10**(7): p. 572-580.
23. Jayapaul, M.K., et al., *The joint diabetic-renal clinic in clinical practice: 10 years of data from a District General Hospital.* QJM: An International Journal of Medicine, 2006. **99**(3): p. 153-160.
24. Thomas, M., et al., *Cardiometabolic Center of Excellence: A Novel Care Delivery Model for Secondary Prevention of Cardiovascular Disease in Type 2 Diabetes.* Circ Cardiovasc Qual Outcomes, 2021. **14**(10): p. e007682.
25. Coates, D., et al., *Evaluation of a general practitioner-led cardiometabolic clinic: Physical health profile and treatment outcomes for clients on clozapine.* Int J Ment Health Nurs, 2018. **27**(1): p. 303-310.
26. Junarta, J., et al., *Role of a cardio-renal multi-disciplinary team meeting in managing cardiovascular risk in patients on kidney transplant waitlists.* Clinical Transplantation, 2020. **34**(11): p. e14061.
27. Nicholson, K., et al., *Strategies to improve health status among adults with multimorbidity: A scoping review.* Maturitas, 2023. **167**: p. 24-31.
28. UK, C. *Cardio-Renal-Metabolic UK*. 2023 July 2024].
29. CMCA. *The Cardiometabolic Centre Alliance: Groundbreaking Approach to Treating Patients with Type 2 Diabetes and Cardiovascular Disease*. 2024.
30. Miranda, J.J., et al., *Understanding the rise of cardiometabolic diseases in low- and middle-income countries.* Nature Medicine, 2019. **25**(11): p. 1667-1679.

Table 1: Study characteristics of the included records

Study	Study design/period of follow-up	Participants characteristics	Cardiometabolic interventions	Outcomes
Coates et al (Australia)	**Design:** Cross-sectional analysis **Period of follow-up**: 6 months	**Sample:** 73 with Severe mental health and cardiometabolic problems **Age:** 43 **Sex:** 76.7% Male	**Purpose of intervention:** To identify the physical needs of people with Severe Mental illness. **Type of intervention:** Cardiometabolic clinic **Staffs:** GP, mental health nurse, psychiatrist	**Primary**: Changes in Weight. BMI, Waist-circumference
Gustafson et al (United States)	**Design:** Cross sectional analysis **Period of follow-up:** 12 months	**Sample:** Not reported **Age:** Not reported **Sex**: Not reported	**Purpose of intervention:** Enhance metabolic outcomes for people with type 2 diabetes by increasing knowledge, promoting patient engagement, and improving communication. **Type of intervention:** Cardiometabolic Clinic & Virtual Clinic Follow-up **Staffs:** Nephrologist, cardiologist, diabetes Educator	**Primary:** Changes HbA1c, LDL, BP, Changes in screening CKD, Lower extremity-assessment, Diabetes education and support and optimisation of guideline directed.
Habte-Asres et al (United Kingdom)	**Design:** Clinical Audit **Period of follow-up:** 12 months	**Sample:** 23, kidney transplant recipient with diabetes **Age:** 54.8 years **Sex:** 54.6% Male	**Purpose of intervention:** Improve cardiometabolic outcomes of kidney transplant recipients with diabetes. **Type of intervention:** Joint transplant and diabetes clinic **Staffs:** Diabetes nurse, diabetes dietician, diabetologist & transplant nephrologist	**Primary:** Changes in HbA1c and Serum glucose

Habte-Asres et al (United Kingdom)	**Design:** Clinical Audit **Period of follow-up:** 12 months	**Sample:** 291, advanced CKD with diabetes **Age:** 72.1 (±11.7) (non-dialysis) & 64.7 (±13.4) years **Sex:** 57.7% Male	**Purpose of intervention:** To evaluate a new diabetes care model for people with advanced CKD in renal satellite units. **Type of intervention:** nurse-led low clearance diabetes clinic weekly, conducted a weekly haemodialysis ward round, and supported weekly low clearance multidisciplinary case discussions. **Staffs:** senior diabetes nurse, a senior consultant nephrologist, renal psychologist, renal dietitian, and CKD nurses	**Primary:** Changes in metabolic outcomes, Changes in NICE-approved therapies and technologies. from the baseline to 12 months. The number of diabetes Clinical Session required.
Idowu et al (United Kingdom)	**Design:** Cross-sectional audit **Period of follow-up**: 1 year	**Sample:** 479 with T2DM and CKD Age: >19 **Sex:** Not reported	**Purpose of intervention:** To compare joint renal diabetes clinics with general diabetes clinics in a district general hospital. **Type of intervention:** Multi-specialty Renal and Diabetes Clinic & MDT Diabetes Clinic **Staffs:** Not reported	**Primary Outcome:** Changes in HbA1c, eGFR
Jayapaul et al (United Kingdom)	**Design:** Retrospective cohort study **Period of follow-up**: 10 years	**Sample:** 130, diabetes and CKD **Age:** 56 years **Sex:** 58.46% Male	**Purpose of intervention:** To assess the impact of a joint diabetes-renal clinic on the progression of renal diseases and its success in achieving clinical targets. **Type of intervention:** Joint renal diabetes clinic **Staffs:** Nephrologist, Renal Dietician, Diabetologist, Diabetes Nurse, Podiatrist	**Primary**: Changes in Blood pressure, Cholesterol, Glycated-haemoglobin, and Proteinuria

Junarta et al (United Kingdom)	**Design:** Clinical Audit **Period of follow-up**: 2.7 years	**Sample:** 207 kidney transplant candidates with± CV **Age:** 59.42 (standard protocol); 61.15(cardio-renal MDT protocol) **Sex:** 54.32% Male (standard protocol); 59.52% Male (cardio-renal MDT protocol)	**Purpose of intervention:** To investigate the effectiveness of a cardio-renal Multidisciplinary Team (MDT) in managing patients on the waiting list for transplant. **Type of intervention:** Joint cardiorenal clinic & MDT discussion **Staffs:** Nephrologist, Cardiologist & transplant nurse	**Primary**: Compared Mortality rate, Morbidity rate and Transplantation rate and adverse events in the two groups
Kosiborod et al (United States)	**Design:** Cross-sectional analysis **Period of follow-up**: 6 months (Median follow up)	**Sample:** 606, T2DM and CVD/CKD **Age:** 64 **Sex:** 56% Male	**Purpose of intervention:** Multi-center initiative to improve care in cardiometabolic diseases. **Type of intervention:** Cardiometabolic Clinic **Staffs:** Nephrologist, cardiologist, diabetes Educator	**Primary Outcome:** Changes in Weight, HbA1c, Blood pressure, Total LDL cholesterol, Triglyceride, and Insulin requirement
Kosiborod et al (United States)	**Design:** Cross-sectional analysis **Period of follow-up**: 6 months (Median follow up)	**Sample:** 1528 T2D and CVD and/or CKD **Age:** 66 (median) **Sex:** 56.9 % Male	**Purpose of intervention:** Multi-center initiative to improve care in cardiometabolic diseases. **Type of intervention:** Cardiometabolic Clinic **Staffs:** Nephrologist, cardiologist, diabetes Educator	**Primary Outcome:** Changes in Weight, HbA1c, Blood pressure, Total LDL cholesterol, Triglyceride, and Insulin requirement
Low et al (China)	**Design:** Nested case control study **Period of follow-up**: 3.0 years (Median)	**Sample:** 837, T2DM and CKD **Age:** 48.9 ± 12.3 years **Sex**: 53.4% Male	**Purpose of intervention:** To investigate the long-term kidney outcomes of a Joint Endocrinology and Nephrology Clinic **Type of intervention:** Joint Endocrinology and Nephrology Clinic	**Primary Outcome**: occurrence of CKD Stage 5 **Secondary Outcome**: changes HbA1c, Urine ACR, DBP, SBP, LDL

			Staffs: Nephrologist, Endocrinologist, Advance practice nurse, clinical pharmacist, dietitians & social workers	
Modarressi et al (United States)	**Design:** Clinical Audit **Period of follow-up:** Not stated	**Sample:** 400 **Age:** 60 ± 12.4 **Sex:** 32% Male	**Purpose of intervention:** To increase the uptake of NICE-approved therapies among patients with type 2 diabetes or atherosclerotic cardiovascular disease. **Type of intervention:** Cardiometabolic clinic **Staffs:** Not Stated	**Primary Outcome**: Changes in the use of NICE-approved therapies, including GLP1RA, SGLT2i, and lipid-lowering therapies
Narain et al (United Kingdom)	**Design:** Cross-sectional review, stratified by diabetes treatment regimen. **Period of follows up:** 36 months	**Sample:** 64, people with diabetes referred to CMC **Age:** Not reported **Sex:** Not reported	**Purpose of intervention:** To review the initial activities and clinical interventions stemming from an innovative cardiometabolic clinic (CMC) service in an NHS tertiary cardiac center, involving a consultant diabetologist. **Type of intervention:** CMC **Staffs:** Cardiologist and Diabetologist	**Primary**: Changes in HbA1c, number of participants initiation or optimisation of guideline directed therapies.
Narain et al (United Kingdom)	**Design:** cross-sectional review **Period if follow up:** 36 months	**Sample:** 174 people with diabetes or heart failure or CKD **Age:** 63.6 years **Sex:** 69% Male	**Purpose of intervention:** To describe the activities, interventions, and clinical impact of the CMC. **Type of intervention:** CMC **Staffs:** Cardiologist and Diabetologist	**Primary Outcome:** Glycaemic outcome and Weight reduction
Sammour et al (United States)	**Design**: Cross-sectional analysis **Period of follow-up**: 1 year	**Sample:** 382 T2DM **Age:** 64.8 years **Sex:** 62% Male	**Purpose of intervention:** To assess the outcomes of a cardiometabolic clinic for individuals with type 2 diabetes.	**Primary Outcome:** Changes in cardiometabolic outcomes from baseline and last CMC visits.

			Type of intervention: Cardiometabolic clinic **Staffs:** Nephrologist, cardiologist, diabetes Educator	
Stol et al (Netherlands)	**Design**: Stepped wedge RCT **Period of follow-up**: 1 year	**Sample:** 30,934 without recorded CMD **Age:** 63 years **Sex:** 45% Male	**Purpose of intervention:** To establish the effectiveness of a stepwise CMD risk assessment followed by individualised treatment, if indicated, compared to standard care. **Type of intervention:** The intervention involved inviting the intervention group for a stepwise CMD risk assessment, including a risk score (step 1), additional assessment at the practice in case of elevated risk (step 2), and individualised follow-up treatment if needed (step 3). **Staffs:** Not reported	**Primary Outcomes:** The number of patients newly diagnosed with CMD. Reduction in absolute 10-year CVD mortality risk (SCORE-EU)
Stol et al (Netherlands)	**Design**: RCT **Period of follow-up**: 1 year	**Sample:** 1,934 without recorded CMD **Age:** 45-70 **Sex:** Not reported	**Purpose of intervention:** To assess the long-term cost-effectiveness of a stepwise CMD risk assessment followed by individualised treatment. **Type of intervention:** The intervention involved inviting the intervention group for a stepwise CMD risk assessment, including a risk score (step 1), additional assessment at the practice in case of elevated risk (step 2), and individualised follow-up treatment if needed (step 3). **Staffs:** Not reported	**Primary Outcome:** Cost per quality-adjusted life year (QALY)

Thabit et al (Ireland)	**Design**: Retrospective audit **Period of follow-up**: 1 year	**Sample:** 60 people with diabetes and advanced CKD **Age**: 67.3 (±11.7) **Sex**: 63% Male	**Purpose of intervention:** To assess the impact of a joint diabetes-renal clinic on clinical outcomes of patients with diabetes and advanced CKD. **Type of intervention:** Monthly Joint renal diabetes clinic **Staffs:** Nephrologist and Diabetologist	**Primary Outcome:** The prevalence of diabetes related complications Changes in clinical outcomes from baseline and last clinic visits.
Thomas et al (United States)	**Design**: Propensity-match cohort study **Period of follow-up**: No reported	**Sample:** 130 CMC patients **Age:** 65.4 years **Sex:** 63.6%Male	**Purpose of intervention:** To provide a collaborative model of care focused on comprehensive secondary cardiovascular risk reduction in patients with T2D and CVD **Type of intervention:** Cardiometabolic clinic **Staffs:** Nephrologist, cardiologist, diabetes Educator	**Primary Outcome:** Comparing patients under center's care with matched cohort receiving treatment in other care settings. Cardiometabolic process measure outcomes
Abbreviations: *AF* Atrial Fibrillation *HbA1c* glycated haemoglobin, *LDL* low-density lipoprotein, *ACR* albumin creatine ratio, *CAD* coronary artery disease, *CKD* chronic kidney disease, *CVD* cardiovascular disease, *CaReMe* cardio-renal-metabolic, *DB* diastolic blood pressure, *SBP* systolic blood pressure, *LDL* low-density lipoprotein cholesterol, *BMI* body mass index, *T2DM* Type 2 Diabetes Mellitus, *CMC* Cardiometabolic Centre, *CMD* cardiometabolic diseases				

Table 2: Reported outcomes from the included studies

Authors	Aim/objectives of study	Data Source and data analysis	Outcome

Coates et al (Australia)	To assess the effectiveness of cardiometabolic clinic for individuals treated with clozapine.	**Data source**: Electronic medical record **Data analysis:** Descriptive analysis and case studies	**Prevalence of cardiometabolic condition:** **Hypertension:** 14.8% **Hyperlipidaemia:** 87.5% **Obesity:** 55.6% **CKD:** 72.73% **Raised HbA1c:** 50% **Metabolic outcome:** For clients who had three or more sessions. **Lost Weight:** 82.5% **Reduction in BMI:** 84.6% **Reduction in waist circumference:** 44.4% **GP appointments:** Engagement levels high levels **Three or more sessions:** 55% **Two sessions:** 19% **One session:** 26%
Gustafson et al (United States)	To assess the effectiveness of team-based care model in addressing clinical inertia and improving patients' metabolic outcomes	**Data source**: Clinical electronic record **Data analysis:** Descriptive analysis	**Cardiometabolic outcomes**: The proportion of patients meeting the following clinical target at baseline and after six months. **HbA1c<9%:** 83.8% to 95.9% **Blood pressure< 130/80**: 54.28 to 55.4%

			LDL<70: 62.50% to 74.51% **Care Processes:** Proportion of patients completed the following care processes at baseline and after six months. **Diabetes Education**: 16.66% to 74.35% **Nephropathy screening**: 91.6% to 97.43% **Lower extremity Assessment:**75% to 82.05% **Medication optimisation**:42.8% to 65.57%
Habte-Asres et al (United Kingdom)	To determine the necessary level of diabetes clinical care essential for the safe, effective, and timely management of kidney transplant recipients with diabetes	**Data source**: Electronic patient record databases **Data analysis:** Descriptive analysis and comparative analysis	**Metabolic outcomes**: Measured at baseline and 12 months. **Mean Serum Glucose:** 17.8 to 8.2mmol/L **HbA1c**:10% (85.8 mmol/mol) to 7.9% (63.2 mmol/mol) **MDT Appointments Required**: Mean number of sessions. **Diabetes Nurse:** 3 (±1.1) **Dietician:** 0.8 (±0.7) **Diabetologist**: 1.5(±0.9)
Habte-Asres et al (United Kingdom)	To evaluate a new diabetes care model for people with advanced CKD in renal satellite units.	**Data source**: Electronic patient record databases **Data analysis:** Descriptive analysis and comparative analysis	**Metabolic outcomes**: Measured at baseline and 12 months in non dialysis population. **HbA1c:** 69.4 (±26.5) Vs 56.4 (±16.5) **SBP:** 149.4 (±21.4) Vs 135.7 (±18.5) **DBP:** 76.2 (±10.1) Vs 72.6 (±10.8)

			Total cholesterol: 4 (±1.15) Vs 4.0 (±1.3) **Optimisation/initiation Guideline directed:** **SGLT2i (Eligible n = 108):** 13 (9.3%) 78 (72.2%) **GLP1-RA (Eligible n = 148):** 12 (8.1%) 54 (36.5%) **Metabolic outcomes**: Measured at baseline and 12 months in haemodialysis population: **HbA1c**: 55.3 (±23.2) Vs 49.6 (±15.2) **SBP**: 154.9 (±23.1) Vs 137.0 (±23.3) **DBP**: 76.1 (±13.6) Vs 65.8 (±13.1) **Total cholesterol**: 3.8 (±1.2) Vs 3.6 (±1.00) **Access to diabetes technology individuals treated on insulin (N = 66):** 3 (4.5%) 59 (89.3%) **Mean diabetes clinical sessions provided:** 2.0 (±1.9) in non-dialysis CKD and 1.4 (±1.0) in HD
Idowu et al (United Kingdom)	To compare the clinical outcomes of patients attending a Joint Renal Diabetes Clinic with those attending a General Diabetes Clinic	**Data source**: Clinical records **Data analysis:** Cross-section analysis	**Metabolic outcomes:** **HbA1c:** No difference **Change in eGFR over one year:** No difference.

			Care Process attainment: **uACR:** Completion rates for uACR were higher among patients in joint renal clinics when compared to individuals in general diabetes clinics. **Foot complication:** 43% of patients had accurate documentation of foot examination. **Bone health:** 60% of patients underwent calcium and vitamin D testing. 58% received a parathyroid hormone measurement
Jayapaul et al (United Kingdom)	To determine whether a joint diabetic-renal clinic influenced the progression of renal disease.	**Data source**: Electronic medical records **Data analysis:** Descriptive analysis, Linear regression analysis	**Prevalence of cardiometabolic condition (baseline):** **Vascular diseases:** 56% **Hypercholesterolemia:** 43% **Hypertension:** 88% **Proteinuria≥2g/24h**: 44% **Metabolic outcomes (changes from baseline):** **HbA1c:** 8.4% to 8.6% **Systolic blood pressure:** 158 to 141 mmHg **Diastolic blood pressure:** 84 to 77mm Hg **Total cholesterol**: 5.9 to 5.3mmol/l **Mortality:** 32% (41 patients)

Junarta et al (United Kingdom)	To investigate the effectiveness of a cardio-renal multidisciplinary team (MDT) in managing high cardiovascular risk waitlisted transplant patients	**Data source**: Electronic heath record **Data analysis:** Descriptive analysis	**Comparing the number of patients removed from the transplant waitlist between the Cardio-renal MDT protocol and the standard protocol:** 7 Vs 12 (p=0.02) **Comparing the transplantation rate and adverse outcomes between the Cardio-renal MDT protocol and the standard protocol:** **Transplanted:** 35% Vs 21% (P=0.02) **Adverse Event:** 33% Vs 36% (P=0.66) **Death:** 12.7% Vs 10.0% (P=0.21) **Comparing clinical outcomes, including- morbidity and mortality rates, between the Cardio-renal MDT protocol and the standard protocol:** **Hospitalised 1 year post transplant:** 40.9% Vs 18% (P=0.99) **Graft survival 1 year after transplant:** 95.5% Vs 100% (P=0.37) **Patient survival 1 year after transplant:** 97.7% Vs 100% (P=0.83) **Patient survival 2 year after transplant:** 97.7%Vs 94.1% (P=0.53) **Cost analysis:** **Standard protocol:** £151,483 (£692/patient/year) **Cardio-renal MDT protocol**: £207,652 (£610/patient/year)
Kosiborod et al	To assess the effectiveness of CMCA's care program	**Data source**: Multicenter registry	**Metabolic outcomes (changes from baseline):**

(United States)		**Data analysis:** Descriptive analysis	**Weight** (220 to 108.6 pounds) **HbA1c** (7.3 (56 mmol/mol) to 6.6% (49mmol/mol) **Systolic BP** (128 to 124 mmHg) **LDL cholesterol** (74 to 57 mg/dL) **Triglyceride** (157.5 to138 mg/dL) **Insulin requirement** (60 to 40 units/day)
Kosiborod et al (United States)	To assess the effectiveness of CMCA's care program	**Data source**: Multicenter registry **Data analysis:** Descriptive analysis	**Metabolic outcomes (changes from baseline):** **HbA1c** (7.1 (5 mmol/mol) to 6. 5% (48mmol/mol) **Total cholesterol**: 146 Vs 127 mg/dL) **LDL cholesterol** (73.7 to 58 mg/dL) **Triglyceride** (153 to135 mg/dL) **Insulin requirement** (60 to 40 units/day) **Optimisation/initiation Guideline directed:** **SGLT2i/ GLP1-RA (Baseline Vs 6 month)** **T2D and ASCVD**: 42.2% Vs 95.3% **SGLT2i (Baseline Vs 6 month)**

			T2D and CKD: 33.3% Vs 82.3% **Optimal Lipid lowering agents (Baseline Vs 6 month):** **T2D and ASCVD**: 78.7 % Vs 86.8%
Low et al (United Kingdom)	To investigate the Long-term Renal Outcome of a Joint Endocrinologist-Nephrologist Clinic	**Data source**: Descriptive analysis **Data analysis:** Multivariable cox regression	**Cardiometabolic outcomes:** 249 (28.7%) of patients reached stage 5 DKD clinic: 45.8% Vs 54.2 % Non-DKD clinic reached CKD stage 5. **Comparing changes in metabolic outcomes between the DKD and the non DKD clinics** **HbA1c:** -0.28 (P=0.036) **Diastolic blood pressure:** -43.91 (P<0.001) **uACR:** -0.39 (P0.006) **SBP:** 30.93 (P=0.106) **LDL:** -0.11 (P=0.083) **Adjusted hazard ratio for the occurrence of CKD:** DKD clinic group: 0.55 (0.36-0.83)
Modarressi et al (United States)	To increase the uptake of NICE-approved therapies among patients with type 2 diabetes or atherosclerotic cardiovascular disease.	**Data source:** Electronic medical record **Data analysis:** Descriptive analysis	**Optimisation/initiation Guideline directed therapies (**n=400**):** **GLP1-RA: increase 7**% to 61%. **SGLT2i**: Increase 9% to 28%

			Lipid lowering therapies in patients ASCVD (n=216): **Statin: Increase 91**% to 93% **Ezetimibe:** 9% to 27% **PCSK9i:** 2% to 10%
Narain et al (United Kingdom)	To evaluate the outcomes of a Novel cardiometabolic clinic (CMC)	**Data source:** Electronic medical record **Data analysis:** Descriptive analysis	**Metabolic outcome:** **Reduction in HbA1c:** 3.8%17.7 mmol/mol **Increase in HbA1c:** 4.7 mmol/mol. **Care process:** **Initiation:** 31 for SGLT2, 9 for GLP-1 **Up-titration:** 2 for both SGLT2i and GLP-1 **Optimisation/initiation:** 5 diuretics, 3 antihypertensives, 3 lipid lowering agent, 2betablockers and 3 glucose lowering agents
Narain et al (United Kingdom)	To describe the activity, interventions, and clinical impact of the cardiometabolic clinic	**Data Source:** Electronic health record **Data analysis:** Descriptive analysis	**Metabolic outcomes:** **Reduction in HbA1c: 3.6% (**18 mmol/mol, in 40 patients) **Reduction in Fructosamine:** 39 umol/L **Increase in HbA1c:** 2.8% (7 mmol/mol (Mean), 14 patients) **Weight loss**: 18/ 88 patients initiated or optimised on SGLT2 inhibitors

			7/27 on metformin 12/ 19 on GLP-1 agonists
Sammour et al (United States)	To assess the two- years clinical outcomes of CMC	**Data source:** Electronic medical record **Data analysis:** Descriptive analysis	**Changes in cardiometabolic outcomes from baseline to end of the follow up period:** **Weight:** 235.2 lbs (±51.7) to 220.1 lbs (±50.9) ($p<0.001$) **HbA1c:** 7.4% (±1.7) (57 mmol/mol) to 6.7% (±1.3) (50 mmol/mol) ($p<0.001$) **Insulin requirement:** 56(30-109) to 32(8-65) units ($p<0.001$) **Cardiometabolic process measures:** **GLP1-RA:** 89% Vs 1% **SGLT2 inhibitor:** 63% Vs 23% **Discontinued GLP1-RA:** 5% **Discontinued SGLT2 inhibitor:** 3.6%
Stol et al (Netherland)	To evaluate the effectiveness of the CMD prevention program	**Data source:** Electronic medical record, self-reported questionnaire **Data analysis:** Multivariable multilevel regression analysis	**Comparing the intervention and control group for newly detected CMD** **Hypertension:** 13.1 % Vs 6.0% **Hypercholesterolemia:** 12.7% Vs 4 .2% **Diabetes mellitus:** 2.2% Vs 0.3% **Comparing newly prescribed interventions between groups:** **Antihypertensives:** 10.9 % Vs 4.1%

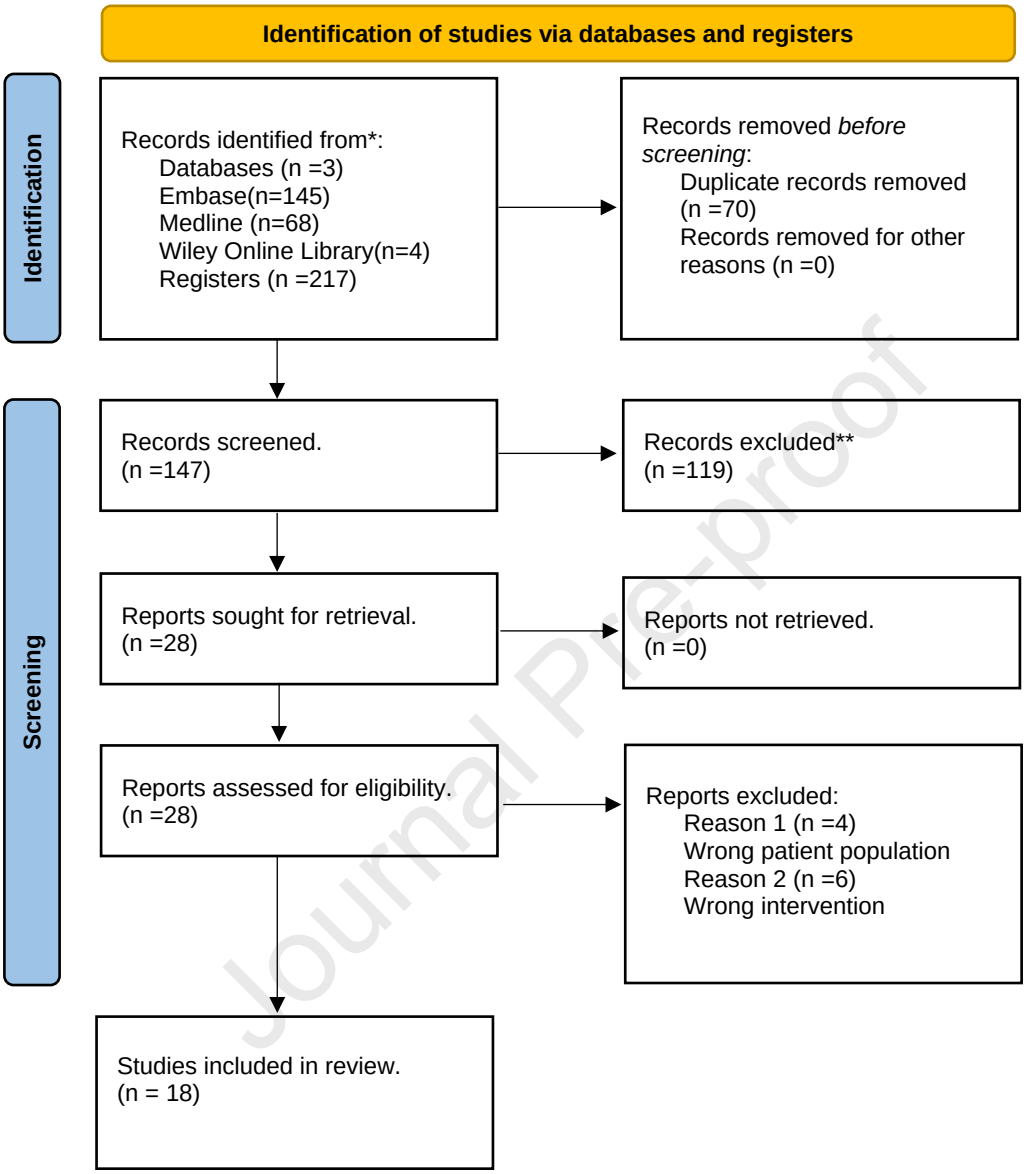
			Lipid-lowering drugs: 7.8% Vs 2.6% **Antidiabetics:** 1.0% Vs 0.1 % **Changes in CMD risk factors between groups:** **No. of participants with a newly diagnosed CMD**: 26.7% Vs 11.6% OR 2.90 (CI 95%, 2.25- 3.72) **No. of participants with a new prescription:** 16.6Vs 6.0 OR 3.13(CI 95%, 2.29- 4.30) **No. of participants with a new recorded CMD or prescription:** 29.3 Vs 13.6 OR 2.75 (CI 95% 2.17- 3.49)
Stol et al (Netherland)	To evaluate the cost-effectiveness of the CMD prevention program	**Data source:** Cost data were based on EHR, CRF and questionnaire data and data on productivity losses using Productivity Cost Questionnaire (iPCQ) **Data analysis:** Long-term cost effectiveness analysis and The RIVM Chronic Disease Model	**Cost effectiveness analysis:** Claimed (GP practice) consultations per patient: 133.94 Vs 244.75 Productivity costs: 65.54 Vs102.87 Total cost: 199.48 Vs 459.42
Thabit et al	To evaluate the effectiveness of a joint diabetes-renal clinic.	**Data source:** Electronic medical record	**Prevalence of diabetes related complication at baseline:**

(Ireland)		**Data analysis:** Descriptive statistics and paired sample t-test	**Peripheral neuropathy:** 56% **Diabetic retinopathy:** 43% **Peripheral arterial Disease:** 36% **Lowe limb Amputation:** 10% **Changes in clinical outcomes:** **HbA1c:** 7.6 (±2) (60 mmol/mol) Vs 7.0 (±1.6) (53 mmol/mol) (P 0.14) **Cholesterol**: 4.5 (±0.52) Vs 5 (±1.5) (P0.44) **Systolic blood pressure:** 159.4(±30.8) Vs 141.8 (±35.5) (p 0.13) **Diastolic blood pressure**: 73.2 (±9.3) Vs 69.2 (±9.4) (p 0.07) **Creatinine Clerance (ml/min):** 40.1 (±15.5) Vs 39 (±16.3) (p 0.2)
Thomas et al (United States)	To assess the clinical and process outcome of CMC in comparison to standard clinic.	**Data Source:** Prospective registry and Electronic medical record **Data analysis:** logistic regression, a propensity score (1:3) linear regression and Poisson regression	**Changes in cardiometabolic outcomes compared to the control group:** **Weight:** −10.9 vs 1.5 lbs (p<0.001) **HbA1c:** −0.5 vs −0.2% (p = 0.02) **Systolic Blood Pressure:** −3.6 vs +1.4 mmHg (p<0.01) **LDL:** 12.1 vs −2.8 mg/dL (p<0.01) **Total daily insulin dose:** −31.6 vs +1.1 units (p<0.001)

			Comparing cardiometabolic process measures between the CMC group and the control group: **GDMT**: 41.1% Vs 2.3% **SGLT-2i/GLP-1RA**: 96.1% Vs 25.7% **ACEi:** 30.2% Vs 9.1% **Statin**: 86.0% Vs 77.7% **High Intensity Statin:** 62.8% Vs 51.4% **ARB:** 30.2% Vs 33.2%

Abbreviations: *HbA1c* glycated haemoglobin, *LDL* low-density lipoprotein, *uACR* urine albumin creatine ratio, *CKD* chronic kidney disease, *SBP* systolic blood pressure, *LDL-C* low-density lipoprotein cholesterol, *eGFR* Estimated glomerular filtration rate, *BMI* body mass index, *CMD* cardiometabolic diseases, *GP* general practitioner, *MDT* multidisciplinary team, *DKD* diabetic kidney disease, *GLP-1* glucagon-like peptide 1 receptor agonists, *SGLT2* sodium-glucose co-transporter 2 inhibitors, *SGLT-2i* sodium glucose cotransporter-2 inhibitors, *GLP-1RA* glucagon-like peptide-1 receptor antagonist, *ACEi* angiotensin converting enzyme inhibitor, *ARB* angiotensin receptor blockers, GDMT guideline directed medical therapy

Figure 1: Flow diagram of study selection.



Highlights

- First review on initiatives improving cardiometabolic condition prevention and management.
- Review detail types of cardiometabolic clinics, outcome measures, and summarises interventions.
- Interventions linked to improved outcomes, highlighting need for further research.

Conflict of interest : The authors

CH has declared no conflict of interest to declare.

HH-A received speaker honoraria from AstraZeneca and Bayer

AF has declared no conflict of interest to declare

DW has an ongoing consultancy contract with AstraZeneca. He has received payments for consultancy working and/or speaking activities from Amgen, Astellas, Bayer, Boehringer Ingelheim, Eledon, GSK, Galderma, Gilead, Janssen, Mundipharma, Menarini, MSD, NovoNordisk, Pharmacosmos, Tricida and Vifor

Funding sources: None

Data availability statement : Data are available from the first author upon reasonable request.