A Systematic Review of Rural Cardiovascular Disease Clinical Trials

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Abstract

Background: Rural cardiovascular outcomes research is scant, and attention must be focused on evidenced-based interventions to better inform policy for population-based care and distribution of rural healthcare resources.

Objective: This review explores the current state of clinical trial cardiovascular literature with samples that included rural women and men.

Methods: A systematic review was conducted of cardiovascular disease research from 2010 through 2022. The search included PubMed, Medline, and Cumulative Index of Nursing and Allied Health Literature through EbscoHost databases, as well as a hand search of rural specific journals. Search terms included cardiovascular disease, heart disease, and rural. The final review included 25 cardiovascular research articles.

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Results: Synthesis by modifiable risk factors, cardiovascular outcomes, general findings, and social determinates of health are presented. Anthropomorphic measures and biomarkers were provided in 11 studies. Data on hospitalizations, admissions, emergency department use, length of stay, and hospital protocols were analyzed in nine studies. Mortality rates were analyzed in six of the 25 studies. Modifiable risk factors synthesis indicates mixed findings in the research. A previously unreported finding was that all but five articles reported sample recruitment entirely from a rural place.

Conclusions: Research involving rural communities is essential to understanding the unique characteristics of rural populations that influence their cardiovascular health and mortality risk. Exploration of the social determinants of health that increase cardiovascular disease risk is necessary to inform policy driving public health interventions that aim to reduce health disparities in rural populations. The findings update the evidence-base available for practice.

Keywords: cardiovascular disease, rural health, systematic review

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Cardiovascular disease (CVD) is the leading cause of death globally taking approximately 17.9 million lives each year (World Health Organization, 2021). Cardiovascular disease has been widely studied; although, less attention has been paid to CVD in rural populations. Mortality rates from CVD have been found to be consistently highest in non-core metropolitan (rural) areas, and lower in medium-large metropolitan areas (Callaghan et al., 2020). The American Heart Association published a call to attend to rural health in 2020, because CVD-related mortalities are decreasing at a slower rate among rural populations than others. Research in rural health is urgently needed to address the unique population characteristics that contribute to higher CVD risk among rural dwellers (Harrington et al., 2020). There is inadequate research in rural-specific CVD

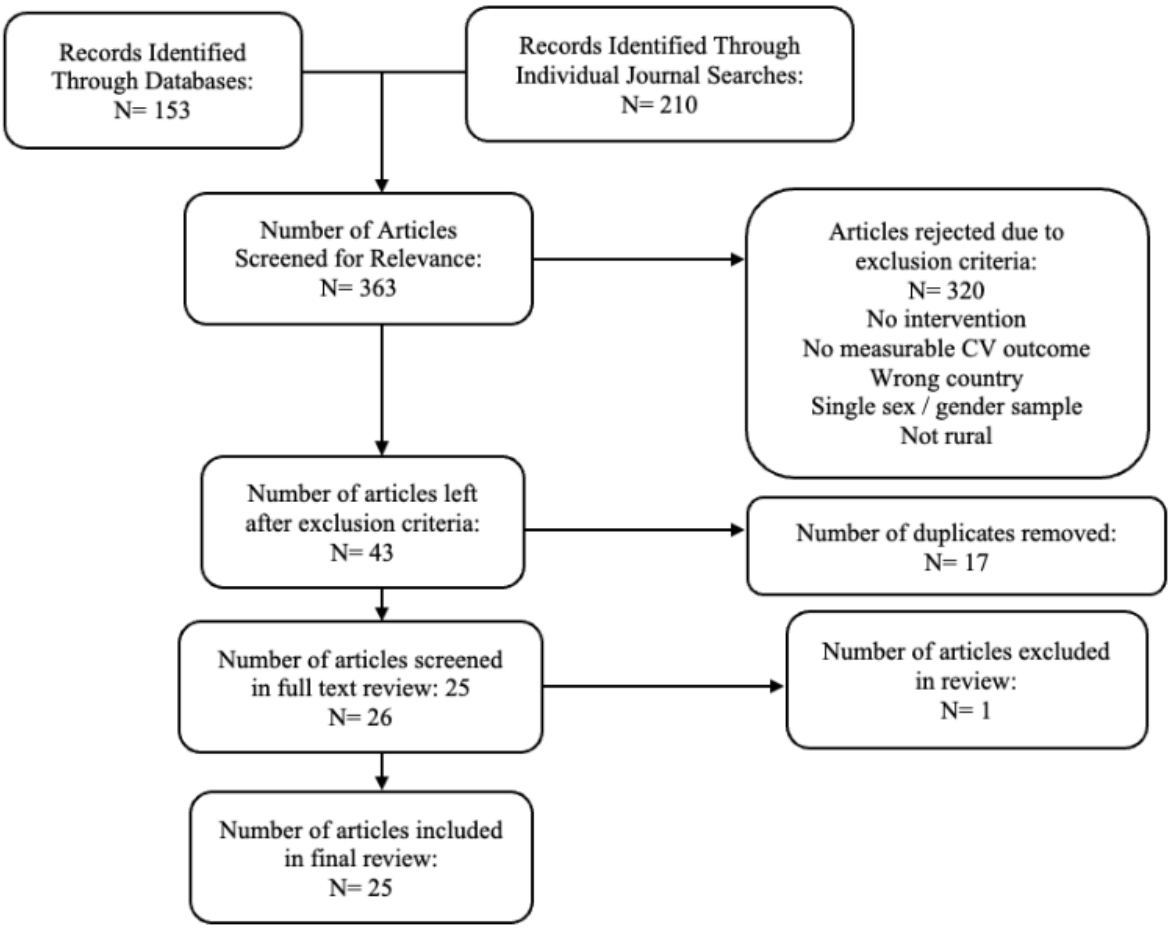
(Harrington et al., 2020; Pierce et al., 2021). Exploration of the social determinants of health (SDoH) that increase CVD risk is necessary to inform public health interventions and policy that aims to reduce health disparities in rural populations (Pierce et al., 2021). As research on CVD continues to be published, it becomes important to conduct systematic reviews to organize and synthesize current literature. The purpose of this review is to explore the current state of rural clinical trial cardiovascular literature that include women and men in the samples, taking into consideration the National Institutes of Health inclusion policy that encourages the recruitment of women in clinical research (Office of Research on Women's Health, 2021).

Methods

This systematic literature review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines (PRISMA) (Page et al., 2021). These guidelines provide reporting of literature search procedures, including the screening process with inclusion and exclusion criteria, illustrated in a flow diagram (Figure 1).

Figure 1

PRISMA Flowchart



Inclusion criteria were peer-reviewed research articles, in English, from the United States, Canada, Australia, or New Zealand, published from January 2010 through December 2022. Articles were included with available abstracts and full text, involving clinical trials and randomized-controlled trials (RCTs) with measurable cardiovascular outcomes. Female and male adult participants were required and the term rural was stated or defined in any way.

Articles were excluded if they only sampled one sex because this review aimed to include those articles that complied with current inclusion guidelines for equality in research (Office of

Research on Women's Health, 2021). Articles published from countries other than those noted in the inclusion criteria, had no cardiovascular outcome or solely focused on one of the following topics: diet, physical activity (PA), stroke, heart neoplasms, kidney disease, or blood pressure (BP) were excluded. Levels of evidence I or V (systematic reviews) were excluded, as this review itself was a systematic review. Additional exclusion criteria were participants under age 18, maternal/child or psychology related, no intervention, not research, or if there was no mention of rural.

The databases searched were PubMed/Medline and Cumulative Index of Nursing and Allied Health Literature, via EBSCOhost. Search terms included: heart disease, Myocardial Infarction, hyperlipidemia, fibrillation, cardiovascular diseases, male, rural areas, rural communities, rural population, rural health services, rural health, not heart neoplasms, kidney diseases, stroke. Filters were used to ensure that articles were published in English, using adult subjects, and published since 2010. For the PubMed database, the RCT and clinical trial filters were also used to filter search results further and to ensure that the results had intervention studies. In the EbscoHost searches, RCTs and clinical trials were separated into two different searches, using one search yielded no results but separating them did yield results.

In addition, seven rural-specific journals were searched for CVD intervention studies: *Australian Journal of Rural Health, Canadian Journal of Rural Medicine, Journal of Rural Health, Journal of Rural Studies, Online Journal of Rural Nursing and Healthcare, Rural and Remote Health*, and *Rural Health Quarterly*. Another, well-known for publishing rural research, *Western Journal of Nursing Research* was searched. These journals were searched separately to ensure that all articles meeting criteria were found.

A total of 363 studies were found from the database and journal searches (See Figure 1), and each of these articles' titles and abstracts were screened. Exclusion criteria culled 320 articles. Of the remaining 43 articles, 17 duplicates were removed. The remaining 26 articles were screened through full text by two reviewers. Upon full-text review, one non-intervention study was removed. Twenty-five articles were reviewed (Abbott et al., 2017; Aufderheide et al., 2011; Barnason et al., 2010; Barnason et al., 2019; Blackford et al., 2016; Bosak et al., 2010; Bove et al., 2011; Dracup et al., 2014; Jancey et al., 2019; Kinsman et al., 2012; Kranker, 2018; Krum et al., 2013; Lear et al., 2021; Lear et al., 2015; Moser et al., 2015; Nesbitt et al., 2014; Park et al., 2017; Piatt et al., 2016; Samuel-Hodge et al., 2020; Seo et al., 2016; Stuckey et al., 2011; Wells et al., 2017; Williams et al., 2014; Wu et al., 2016; Young et al., 2016).

A standardized review sheet was used by all reviewers (Association of Women's Health Obstetric and Neonatal Nurses, 2003). Each article was initially reviewed by two authors and inter-rater reliability of scientific merit was calculated. All articles received a second review from the last author, who would decide any classification discrepancies.

Results

General Findings

An interrater reliability of 100% was calculated on measurement of scientific merit. A nurse was the primary author for 11 articles (Abbott et al., 2017; Barnason et al., 2010; Barnason et al., 2019; Bosak et al., 2010; Dracup et al., 2014; Kinsman et al., 2012; Moser et al., 2015; Park et al., 2017; Seo et al., 2016; Wu et al., 2016; Young et al., 2016). An additional seven articles had at least one nurse author (Bove et al., 2011; Krum et al., 2013; Lear et al., 2021; Lear et al., 2015; Nesbitt et al., 2014; Samuel-Hodge et al., 2020; Williams et al., 2014). All authors were nurses in three articles (Abbott et al., 2017; Barnason et al., 2010; Bosak et al., 2010) but seven articles

included no nurse authors (Aufderheide et al., 2011; Blackford et al., 2016; Jancey et al., 2019; Kranker, 2018; Piatt et al., 2016; Stuckey et al., 2011; Wells et al., 2017). Articles were published in five types of journals.

Rural journals published two articles (Jancey et al., 2019; Kinsman et al., 2012) focused on rural health in Australia. An unexpected finding was that no articles were published in United States based rural journals. Non-cardiac nursing journals published five articles (Abbott et al., 2017; Barnason et al., 2010; Barnason et al., 2019; Bosak et al., 2010; Seo et al., 2016). General medical journals published seven articles (Aufderheide et al., 2011; Blackford et al., 2016; Lear et al., 2021; Piatt et al., 2016; Stuckey et al., 2011; Wells et al., 2017; Williams et al., 2014), eight studies were in cardiac journals (Bove et al., 2011; Dracup et al., 2014; Krum et al., 2013; Moser et al., 2015; Nesbitt et al., 2014; Park et al., 2017; Wu et al., 2016; Young et al., 2016) and public health journals published three articles (Abbott et al., 2017; Kranker, 2018; Samuel-Hodge et al., 2020).

Among the articles chosen for study, seven included an operational definition of rural or cited a parent study operational definition (Abbott et al., 2017; Dracup et al., 2014; Krum et al., 2013; Nesbitt et al., 2014; Park et al., 2017; Seo et al., 2016; Williams et al., 2014) and three presented conceptual definitions (Lear et al., 2021; Stuckey et al., 2011; Young et al., 2016), There were three articles where a rural location was noted but no specific definition provided (Aufderheide et al., 2011; Barnason et al., 2010; Barnason et al., 2019). The remaining specified rural locations by name (Blackford et al., 2016; Bosak et al., 2010; Bove et al., 2011; Jancey et al., 2019; Kinsman et al., 2012; Kranker, 2018; Moser et al., 2015; Nesbitt et al., 2014; Piatt et al., 2016; Williams et al., 2014; Wu et al., 2016).

Five articles that utilized theoretical frameworks included social cognitive theory (Barnason et al., 2010; Barnason et al., 2019; Bosak et al., 2010; Seo et al., 2016; Williams et al., 2014). The theory of planned behavior was used once (Abbott et al., 2017). Bandura's self-efficacy concept (Bandura, 1986) was used twice (Piatt et al., 2016; Young et al., 2016), Hibbard's patient activation model once (Young et al., 2016) and self-management of chronic disease models was applied three times (Jancey et al., 2019; Lear et al., 2021; Young et al., 2016). A population level approach was pursued by eight (Aufderheide et al., 2011; Bove et al., 2011; Kinsman et al., 2012; Kranker, 2018; Krum et al., 2013; Moser et al., 2015; Samuel-Hodge et al., 2020; Wells et al., 2017) and the remaining utilized individual level approaches (Abbott et al., 2017; Barnason et al., 2010; Barnason et al., 2019; Blackford et al., 2016; Bosak et al., 2010; Bove et al., 2011; Dracup et al., 2014; Jancey et al., 2019; Lear et al., 2021; Lear et al., 2015; Nesbitt et al., 2014; Park et al., 2017; Piatt et al., 2016; Seo et al., 2016; Stuckey et al., 2011; Williams et al., 2014; Young et al., 2016).

Outcome variables were classified into themes. Anthropomorphic measures and biomarkers (Blackford et al., 2016; Bosak et al., 2010; Bove et al., 2011; Jancey et al., 2019; Lear et al., 2015; Piatt et al., 2016; Samuel-Hodge et al., 2020; Stuckey et al., 2011; Young et al., 2016), health behaviors (Abbott et al., 2017; Barnason et al., 2010; Barnason et al., 2019; Bosak et al., 2010; Bove et al., 2011; Kinsman et al., 2012; Lear et al., 2015; Samuel-Hodge et al., 2020; Seo et al., 2016; Stuckey et al., 2011; Young et al., 2016), knowledge, self-management, and/or self-efficacy (Barnason et al., 2010; Barnason et al., 2019; Bosak et al., 2010; Bove et al., 2011; Dracup et al., 2014; Lear et al., 2021; Moser et al., 2015; Nesbitt et al., 2014; Williams et al., 2014; Wu et al., 2016; Young et al., 2016). Cardiac risk scores were in three articles (Bove et al., 2011; Jancey et al., 2019; Piatt et al., 2016). Hospitalizations, admissions, emergency department use, length of

stay, and protocols were in 10 studies (Dracup et al., 2014; Kinsman et al., 2012; Krum et al., 2013; Lear et al., 2021; Nesbitt et al., 2014; Park et al., 2017; Wells et al., 2017; Williams et al., 2014; Wu et al., 2016; Young et al., 2016). Survival or mortality were outcomes in nine studies (Aufderheide et al., 2011; Dracup et al., 2014; Krum et al., 2013; Lear et al., 2021; Moser et al., 2015; Nesbitt et al., 2014; Seo et al., 2016; Williams et al., 2014; Wu et al., 2016) and disability, cardiac events, and quality of life (QoL) measures were extracted from nine (Aufderheide et al., 2011; Bandura, 1986; Krum et al., 2013; Lear et al., 2021; Moser et al., 2015; Nesbitt et al., 2014; Seo et al., 2016; Williams et al., 2014; Wu et al., 2016).

Study Characteristics

Of the 25 studies reviewed 14 were RCT (Aufderheide et al., 2011; Barnason et al., 2019; Blackford et al., 2016; Bove et al., 2011; Dracup et al., 2014; Jancey et al., 2019; Kinsman et al., 2012; Kranker, 2018; Krum et al., 2013; Lear et al., 2021; Lear et al., 2015; Seo et al., 2016; Wells et al., 2017; Young et al., 2016). Secondary analysis of a parent study accounted for six articles (Abbott et al., 2017; Moser et al., 2015; Nesbitt et al., 2014; Park et al., 2017; Wells et al., 2017; Wu et al., 2016) while four were quasi-experimental (Barnason et al., 2010; Bosak et al., 2010; Piatt et al., 2016; Samuel-Hodge et al., 2020). Table 1 includes extracted data from each study.

Table 1

Data Elements Extracted from Reviewed Articles.

Journal **Nurse authors**	**Definition** **Type/Place**	**Purpose** **Theory**	**Sample**	**Design** **Intervention**	**Instruments**
Public Health Nursing (Abbott et al., 2017) All nurse authors	Rural only. Rural defined via Census Bureau codes. Rural south, United States	To examine moderator effects of a CVD intervention study. theory of planned behavior	N = 229 in 12 AA churches Power = .80 Female: 71% Male: 29%	Secondary analysis of RCT Primary study intervention on PA and diet	12-item 5-a-day survey 14-item dietary fat subscales 10-item exercise scale
Abbott Findings: 1. Intervention effects were significantly moderated in the following outcomes: Dietary fat intake intentions (p = .019); Attitudes regarding produce intake (p = .035); Dietary fat intake perceived norms (p = .028); Dietary fat intake self-efficacy (p = .043) Authors also reported non-significant findings for some factors in the 3-way interaction analysis, for example between heart disease history and exercise (p not provided). 2. Those without heart disease & produce intake (intention & attitudes (p=.001) & norms (p=.002), fat intake intention (p=.001) & norms (p=.001), exercise attitudes (p=.001), self-efficacy fat intake (p=.002) & exercise (p=.006). 3. Age group moderated dietary norms (p=.037).					
Lancet (Aufderheide et al., 2011) No nurse authors	Rural, suburban, & urban areas No specific definition. U.S. counties in five states	To establish survival to discharge with 2 types of cardio-pulmonary resuscitation No theory noted.	N = 1,653 Adequately powered at .80 despite early closure Female: 33% Male: 66%	RCT Active compression and decompression CPR	Chart review and classification into Rankin Scale Neurological Impairment Disability Scale 0 -29 (9 levels)
Aufderheide Findings: 1. Fewer (n = 47, 6%) of 813 controls survived to discharge with favourable neurological function compared with intervention subjects (n = 75, 9%) of 840 (p = 0.19). 2. Secondary endpoint: Survival to discharge with intervention, n =104 compared to n = 80 control (p=.12). Survival to 1-year (n = 48, 74, 9%) intervention compared to control group n= 48, 6% (p = .03). Survivors in both groups had equivalent cognition, disability ratings and mental health status. 3. There was no difference between groups in overall major adverse events;					

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
however, the intervention group exhibited more pulmonary edema (n = 94, 11%) than the control group (n = 62, 7%) p = .015. Negative outcomes also reported.					
Western Journal of Nursing Research (Barnason et al., 2010) Two nurse authors	Unable to assess Rural / Urban mix No specific definition Mentioned rural as important due to limited transportation. No specific place	Pilot study to examine transition for older adults with HF for medication use and self-care. social cognitive theory and medication adherence framework	N = 40, End N = 38. No power analysis Female: 35% Male: 65%	Prospective repeated measures design Hospital transition intervention on medication use and self-care management	Drug Regimen Unassisted Grading Scale (DRUGS) Self-efficacy Subscale of Kansas City Cardiomyopathy Questionnaire Health Related QoL subscale Medication Regimen Complexity Index Brief Medication Questionnaire
Barnason 2010 Findings: 1. Medication adherence is better in the intervention group (p=.001). 2. Self-efficacy by GROUP (p < .001). 3. Health Related QoL (p=.006). 4. Barriers to medication use skills (p < .5) .5. Medication use behavior skills (p = .09)					
Journal of Clinical Nursing (Barnason et al., 2019) All nurse authors	Rural only Stated rural community No specific rural definition No specific place	To use a weight management intervention to improve outcomes of cardiac rehabilitation subjects social cognitive theory	Purposive and randomized to group N = 50, end: N = 43 Female: 30% Male: 70%	RCT Telehealth weight management intervention of cardiac rehabilitation participants	BMI, weight change while in cardiac rehabilitation and self-report at follow-up Actigraph® Patient Activation Measure Heart Healthy Eating Self-Efficacy scale Cardiac Exercise Self-Efficacy instrument

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
					Diet and Exercise Self-Management tool
Barnason 2019 findings: 1. Group weight change from baseline, with the weight management intervention group losing a mean of 13.8 (+/- 2.8) pounds compared to the control loss of a mean of 7.8 (=/- 2.2) pounds $p < .05$. 2. Perceptions of subjects' patient activation for managing their own healthcare ($p = .02$). 3. Perceived self-efficacy for specific eating habits ($p = .001$). 4. Managing diet behavior in different situations ($p = .006$). 5. Self-efficacy for exercise not significant. 6. Use of weight management strategies demonstrated one group were higher ($p = .002$).					
Preventive Medicine (Blackford et al., 2016) No nurse authors	Rural only Rural stated as Albany Western Australia Australia	To examine a 6-month home-based PA and diet intervention for rural adults with metabolic syndrome No theory noted	N = 401, End: N = 312, Blood analysis on n = 274. Female: 66.5% Male: 33.5%	RCT 6-month home-based PA and diet intervention	Fasting blood samples Electronic sphygmomanometer Tanita digital scale/waist-hip ratio/height using stadiometer/BMI
Blackford Findings: 1. Improvements in triglycerides ($p = .01$) total cholesterol ($p = .04$), remnant cholesterol ($p = .003$), and both systolic ($p < .001$) and diastolic BP ($p = .002$). 2. The intervention group significantly improved in waist circumference ($p < .001$), hip circumference ($p < .001$), waist-to-hip ratio ($p = .002$), weight (−0.7 kg, $p < .001$), BMI ($p < .001$), and body fat ($p < .001$) from baseline to post-intervention.					
Western Journal of Nursing Research (Bosak et al., 2010) All nurse authors	Rural only No specific rural definition Location by name as rural Nebraska United States	To test the feasibility of an internet delivered intervention by the to improve metabolic syndrome outcomes Bandura's social cognitive theory and the construct of self-efficacy	N = 22, End: N = 19 Female: 37.5% Male: 62.5%	Non-randomized with control Telehealth PA intervention	Accelerometer and fasting blood work 7-day PA Recall Items Instrument – self-report Cardiac Exercise Self-Efficacy instrument 12-item Self-Efficacy Exercise Scale - self-report Risk Classification Guidelines for Exercise Training

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
Bosak findings: 1. Median PA minutes and kilocalories expended did not change in control group but improved in intervention group (p = .09). 2. Median change in total energy expenditure declined in control group; no change in intervention group (p = .09). 3. Median change in cardiorespiratory fitness (VO2max) increased in both groups; increased more in intervention group (p = .14). 4. Non-HDL cholesterol (p = .26) and low-density lipid cholesterol (p = .71) got worse in control group; no change in intervention group. Median change in high-density cholesterol did not change in control group; improved in intervention group (p = .12). Median change triglycerides worsened in control group; improved in intervention group (p = .79). 5. No change in self-efficacy for PA in control group compared with slight improvement in intervention group (p = .10). 6. Self-efficacy to overcome barriers to PA increased in control group compared with no change in intervention group (p = .81).					
American Heart Journal (Bove et al., 2011) Two nurse authors	Rural & Urban No rural definition Rural stated as from Geisinger Medical Center Pennsylvania United States	To evaluate methods for lowering CVD risk in asymptomatic urban and rural underserved subjects No theory noted.	N = 455, End: N = 388 Female: 46% Male: 54%	RCT Compared telemedicine to telemedicine + nurse management to facilitate weight, BP and PA reporting	Framingham Risk Score Taylor Digital Scale, self-reported Self-reported BP, except for 12% randomly chosen – digital BP device with memory Digi-Walker pedometer, self-reported Clinical exam Survey Fasting bloodwork
Bove findings: 1. No difference in Framingham CVD risk score at endpoint 15.1 +/- 9.3 (SD). Nurse managed compared to 15.0 +/ - 9.3 (SD). 2. In patients with grade I hypertension (systolic BP < 160 and > or = 140 mm Hg), the Telemedicine group had a more rapid and larger reduction in Systolic BP than the nursed managed group (p = .05). 2. Subjects with grade II hypertension (Systolic > or = 160 mm Hg) at baseline, systolic BP decreased significantly over the 1-year study period with no difference in average BP between nurse managed and telemedicine groups (p = .05). 3. Among subjects who had elevated total cholesterol levels at baseline, 37.6% in the nurse managed group and 35.4% in telemedicine group reached a goal of < or = 200 mg/dL (p = .05). 4. In subjects with elevated low-density cholesterol at baseline, 25.6% in the nurse managed group and 26.9% in the telemedicine group reached a goal of < or = 100 mg/dL (p = .05). 4. Reduction in risk was greater in high-risk group (p = .004). 5. No differences in medication adherence high-risk vs intermediate-risk groups. Telemedicine had no influence on adherence when					

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
compared to nurse managed group. (p value and significance not noted). 6. The high-risk subjects showed a higher total number of visits (p = .044). (significance not noted). 7. Total blood cholesterol and low-density lipids reduced in both groups (p = .05). 8. No statistically significant differences between groups for weight, waist circumference, BMI (p = .05). 9. Tables III, IV and V demonstrated reductions in smoking, but this outcome was not discussed and significance was not stated.					
Circulation (Dracup et al., 2014) Four nurse authors	Rural only Operational definition rural town of < 2,500 people, metropolitan center of < 50,000 people, or open area. California, Kentucky, Nevada United States	To examine the composite end point of heart failure rehospitalization / cardiac No theory noted	Beginning: N = 614 End: N = 602 Female: 41% Male: 59%	RCT Education on HF	9-item European HF Self-Care Behavior Scale Chart review (blinded assistant & family interview for out of hospital deaths). Report of subject's doctor Cause determined by chart review Social Security Death Index
Dracup findings: 1. The results demonstrated a lack of significant difference across the 3 groups in the combined end point of HF hospitalization or cardiac death, although there was a trend favoring the LITE group. 2. Fluid Watchers group had significantly fewer cardiac deaths (7.5% versus 17.7%) over the 2 years of follow-up compared with either the control or the second PLUS group. 3. Demographic outcomes showed 65% of sample had income (combined) of under $40,000 / yr.					
Australian Journal of Rural Health (Jancey et al., 2019) No nurse authors	Rural only No specific definition of rurality Rural town of Albany in	To examine a 6-month home-based behaviour change intervention on metabolic syndrome status and cardiovascular risk score self-determination theory	Beginning: N = 401, End: N = 310 Female: 33.5% Male: 66.5%	2-arm RCT Educational program on metabolic syndrome and CVD risk	Australian Absolute CVD Risk Calculator International Diabetes Federation criteria

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
	Western Australia				
Jancey Findings: 1. Significant improvements in metabolic syndrome status were observed for the intervention group (p = .03). 2. No significant changes in status were seen in the control group. 3. Overall, the intervention group demonstrated a significant decrease in CVD risk score (p < .001) from baseline to post-test. 4. Significant difference between groups at post-test for metabolic syndrome status (p = .02).					
Australian Journal of Rural Health (Kinsman et al., 2012) Two nurse authors	Rural only No specific rural definition Stated rural Victoria, Australia	To measure the outcomes of a 5-step implementation process for an acute myocardial infarction clinical pathway on thrombolytic administration in rural emergency departments No theory noted	N = 108Female: 20% Male: 80%	RCT Clinical pathway for treatment of acute myocardial infarction intervention	Chart review
Kinsman Findings: 1. Proportion of eligible patients receiving a thrombolytic drug (p = .191) 2. Mean door-to-needle time for thrombolysis (p= .404). 3. Percentage receiving thrombolytic within 30 minutes (p = .072). 4. Mean door-to-ECG time (p = .817. 5. Percentage having ECG within 10 minutes (p = .571).					
American Journal of Health Promotion (Kranker, 2018) No nurse authors	Rural only No specific rural definition Stated rural Mississippi United States	To measure the effects of weight loss medication compliance, and PA financial incentives. No theory	N = 544 Female: 61.2% Male: 38.4%	Full factorial experimental design-RCT Financial incentives for weight loss medication compliance and PA	BMI Medication Compliance Score (self-report) medication log and prescription drug fills Pedometers
Kranker Findings: 1. Weight loss incentive treatment group's BMI was lower than the control groups in the follow-up period, but failed to reach significance (p = .385). 2. The point estimate of a 3.7-lb weight loss due to the weight loss incentive was statistically insignificant (p = .106). 3. Medication compliance incentives on medication compliance scores was negligible at 2.4 percentage points (p = .411). 4. Patients in the weight loss incentive treatment group lost additional weight each quarter, ending with a statistically insignificant estimated effect of a 3.1-lb weight loss to 0.8 lb., at the end of the study (p = 0.114). 5. Did not analyze PA. 6. (secondary analysis) weight loss incentive on patient's weight indicated that effects were large and statistically significant for women (5.6 lb. loss; p= .020) but not for men (1.2 lb. loss; p = .643).					

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
Cardiovascular Therapy (Krum et al., 2013) One nurse author	Rural only Operationally defined: Rural, Remote, Metropolitan Area classification Australia	To examine whether an automated telephone support system improved QoL and reduced death and hospital admissions for rural and remote heart failure No theory noted	N = 405 Female: 37% Male: 63%	Clustered Randomized Trial Chronic heart failure assessment by telephone, (CHAT)	Packer Clinical Composite Score (unclear if self-report or gathered in some other form). Hospitalizations, death, or health failure hospitalizations
Krum Findings: 1. There was no difference in the percentage of patients who were worse, unchanged, or better between the usual care and usual care + I (p = .98). 2. (approximately 20%) reduction in risk of heart failure hospitalization in usual care+I (unadjusted: p = .43; adjusted p = .36). 3. No difference in all-cause mortality (unadjusted p = .43; adjusted: p = .439). 4. Significant reduction for usual care+I group in the risk of the composite of all-cause death or hospitalization, as well as all-cause hospitalization alone (unadjusted: p = .021; adjusted p = .006).					
JAMA Network Open (Lear et al., 2021) Three nurse authors	Rural and small urban Defined as places without ambulatory clinics British Columbia Canada	To compare the effect of an internet-based self-management and symptom monitoring program targeted to patients with two or more chronic diseases with usual care on hospitalizations over a 2-year period Self-management	N = 230 Power analysis =.78, if N = 270. Under powered. Female: 38.4% Male: 61.6%	RCT Internet program of five chronic diseases, two were cardiac	Telephone interview, website, and hospital records. Self-management measures on Health Education Impact Questionnaire. QoL, Medical Outcomes Study -36 Social Support Medical Outcomes Study -36
Lear 2021 Findings: 1. The intervention group had 30.9% fewer hospitalizations; 229 fewer in hospital days p = .09, there were fewer patients with at least 1 hospitalization, p = .03 and fewer composite hospitalizations and deaths, p = .04. Improved self-management and social support, occurred in the intervention group. There were no between group differences in QoL.					

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
Studies in Health Technology and Informatics (Lear et al., 2015) One nurse author	Rural and small urban Conceptually defined Communities British Columbia Canada	To evaluate the virtual cardiac rehabilitation program internet based, for rural and small urban cardiac patients. No theory noted	N = 78 Female: 15% Male: 85%	RCT Evaluation of virtual cardiac rehabilitation program	Treadmill Fasting labwork (and random glucose checks at home for diabetics). Ecteronic BP in clinic; Lifesource UA779 and Polar s610i heart rate home monitor. Self-report weight and height for calculated BMI. Minnesota Leisure Time PA Questionnaire 3-day food record
Lear 2015 Findings: 1. Participants in virtual cardiac rehabilitation program group had greater increase in maximal time on treadmill compared to usual care group (p =.045); after adjustment for potentially confounding variables significance was lost, no p value provided. 2. Total cholesterol (p=.026) and low-density lipids (p =.022) were lower for virtual group [initially significant]; after adjustment for potentially confounding variables, significance was lost, no p value provided. 3. Virtual group had higher dietary protein (p = .04) and lower dietary saturated fat (p = .018) compared to usual care and maintained significance after adjustment for potential confounding variables. 4. Virtual group had fewer (6, 18%) with at least one emergency room visit, hospital admission or major events than usual care group (11, 30%) (p = .275) However the difference did not reach significance.					
Journal of Cardiac Failure (Moser et al., 2015) Five nurse authors	Rural only Defined as rural parts of three states California, Kentucky Nevada	To examine the association of health literacy with the composite end points of heart failure readmission rates and all-cause mortality No theory noted	N = 614, End N = 575 Female: 41% Male: 59%	Secondary analysis of RCT (Dracup et al., 2014) Heart Failure readmissions or all cause death, three levels of functional	Shortened Test of Functional Health Literacy in Adults Charlson Comorbidity Index Patient Health Questionnaire, and New

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
	United States			health literacy in adults	York Heart Association functional classification Blood work, medical records. Patient & family interview, medical records, hospital administration database review, healthcare provider contact, or death records
Moser Findings: 1. Patients with inadequate (p = .001) or marginal health literacy (p = .001) were more likely to experience death or readmission outcomes on unadjusted Cox regression. 2. Patients with inadequate (p .003) or marginal health literacy (p = .006) were more likely to experience death or readmission outcomes on adjusted Cox regression. 3. New York Heart class (p = .001), comorbidity burden (p = .012), depression score (p = .002) predicted death or readmission outcomes. 4: Patients with worse New York Heart class, greater comorbidity burden, and higher depression scores have worse outcomes (all p = .001).					
Circulation: Heart Failure (Nesbitt et al., 2014) Five nurse authors	Rural only Rural operationally defined in parent study (Dracup et al., 2014) California, Kentucky, Nevada United States	To test the Rural Education to Improve Outcomes in Heart Failure No theory noted	N = 612 Female: 41.3% Male: 58.7%	Secondary analysis of RCT (Dracup et al., 2014) HF education and counseling intervention	Minnesota Living with Heart Failure Questionnaire Heart Failure Knowledge questionnaire Charlson Comorbidity Index European Heart Failure Self-Care Behavior Scale Control Attitude Scale - Revised Brief Symptom Inventory and Patient Health Questionnaire

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
					Short Test of Functional Health Literacy in Adults
Nesbitt Findings: 1: Heart related QoL associated with age (p = .0026), sex (p = .0001), New York Heart class (p = .0001), depression (p = .0001), anxiety (p = .0001), perceived control (p = .036), heart failure knowledge (p = 0048) and geographic location (p = .0005). 2. Heart related QoL not associated with B type natriuretic peptide, reduced ejection fraction, income, number of comorbid conditions, anemia, marital status, education, employment, number of individuals in household, smoking and race/ethnicity. 3. Weak evidence of association between heart related qualify of life and self-care (p = .01). 4. Being male associated with lower QoL. 5. Heart failure impacts QoL of rural men more than rural women (not influenced by marital status). 6. Nevada residence predicted higher QoL than California or Kentucky residence. 7. Older residents have better QoL than younger rural residents. 8. As depression scores increase, QoL scores decrease. 9. As anxiety scores increase, QoL scores increase. 9. Other variables examined, due to surprising geographic variable outcomes led to: Type of medication was associated with location of residence (p = .02). Provider type was not associated with location of residence. Type of insurance was not associated with location (p = .20).					
Circulation: Heart Failure (Park et al., 2017) Seven nurse authors	Rural only Stated as living in a rural area No specific places listed; however, parent study (Dracup et al., 2014) operational defined and was in rural places of three states California, Kentucky, Nevada	to compare clinical outcomes in rural patients who did and did not keep a daily weight and symptom diary No theory noted	N 393, End = N = 388 (five died). Female: 41% Male: 51%	Secondary analysis of RCT (Dracup et al., 2014) Heart failure education of self-care on diary use	Medical record review, questioning patients, contacting physicians

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
	United States				
Park Findings: 1. no significant difference in cardiac mortality between patients in the PLUS and control groups. 2. Lite group has less (7.5%) cardiac death compared to control (17.7%), p = .003. 3. There was a statistically significant difference between groups (Diary use: none, low, medium, high or very high) for all-cause mortality (p =.02); largest difference between No Diary (27%) and Very High diary group (10%). For testing of diary use, data from Lite and Plus groups were pooled.					
The Diabetes Educator (Piatt et al., 2016) No nurse authors	Rural only Rural stated as rural community near Pittsburgh Pennsylvania United States	to determine whether weight loss and cardiovascular disease risk factor reduction was maintained following a lifestyle intervention Self – efficacy theory	N = 434 Female: 81.6% Male: 18.4%	Non-randomized with control Lifestyle intervention on weight change and risk factor reduction	Cardiovascular risk calculated with data from: 8-hour fasting blood samples, triglycerides and LDLs measured by enzymatic assays blood glucose measured by the hexokinase method Height, weight, BP and waist circumference (standard protocol)
Piatt Findings: 1. Participants in the self-selection group sustained an average of 2.4 lbs. more at 18 months than all other groups (p = .16). 1a. Participants in the self-selection group were 3.3 times more likely to maintain 5% weight loss at 18 months compared to the other 3 groups after adjusting for the clustering of participants within communities, baseline weight, age and gender (p = .0007). 2. Of the participants who achieved 5% weight loss at 3 months over 65% in each group sustained the weight loss at 18 months p = .09). 4. Participants who entered the study with fewer risk factors were 11 times more likely to not develop additional risk factors over the course of 18 months. (p < .0001).					
BMC Public Health (Samuel-Hodge et al., 2020) One nurse author	Rural only Rural stated as rural Hertford County North Carolina United States	To evaluate the implementation and effectiveness of an adapted, evidence-based CVD risk reduction intervention among rural high-risk adults. No theory noted	N = 105, End, N= 76 Male: 18% Female: 82%	Non-randomized with control Carolina Health Alliance Networking for Greater Equity for CVD prevention	Electronic sphygmomanometer & electronic scale Self-reported food frequency survey Adapted Reside survey – PA
Samuel-Hodge Findings: 1. Mean differences in pre/post-intervention measures showed significant mean reductions in BP (p = .006) diastolic, (p = .04) and body weight (p = .02). 2. Self-reported dietary and PA behaviors improved significantly (p value not specified). 3. Those with					

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
uncontrolled hypertension at baseline, at follow-up 24% ($p < .001$) had systolic pressure < 140 mmHg, and 11% ($p = .05$) reduced their diastolic pressure to < 90 mmHg.					
Western Journal of Nursing Research (Seo et al., 2016) Five nurse authors	Rural only Large rural communities (10,000-49,000 residents), small rural communities (2,500-9,999 residents), or isolated areas of <2,499). United States	to evaluate the feasibility of a home-based diaphragmatic breathing intervention on dyspnea, PA and functional status social cognitive theory	N = 36, End, N = 27 Male: 71% Female: 29%	RCT Diaphragmatic breathing retraining	Kansas City Cardiomyopathy Questionnaire dyspnea with activities of daily living and physical functioning ActiGraph 6-minute walk test
Seo Findings: 1. No statistically significant differences in the marginal group mean change on any of the outcome variables: dyspnea- $p = .759$; dyspnea with activities of daily living, $p = .890$; dyspnea with physical functioning, $p = .819$; average daily minutes of moderate activity, $p = .720$; average daily activity, $p = 0.385$; average daily kilocalories, $p = .333$; 6-minute walk test, $p = .360$. 2. Average daily activity Group × Time interaction ($p = .041$).					
Journal of Diabetes Science and Technology (Stuckey et al., 2011) No nurse authors	Rural only Rural stated as in a rural population Place not stated	to test the effectiveness of a lifestyle intervention driven by self-monitoring of cardiovascular risk factors No theory noted	N = 25, End N = 24 Male: 33% Female: 67%	Secondary analysis of parent study Lifestyle interventions on PA and monitoring blood glucose and weight	Calculated BMI Waist circumference Blood work Electronic sphygmomanometer Pedometer STEP test

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
					Glucometer
Stuckey Findings: 1. Blood pressure measurements in clinical: mean systolic did not decrease significantly (p = .475) but diastolic did decrease significantly (p = .046) by 5 mmHg which is also clinically significant. 2: Self-monitored BP, diastolic decreased (p = .001). 3. There were no significant changes in low or high-density cholesterol, triglycerides or Cardiac-reactive protein. 4. Total cholesterol decreased (p = .009). 5. Pedometer steps improved (p = .003).6. maximum oxygen intake increased (p < .001). 7: BMI decreased (p = .03). 8. Waist circumference decreased (p = .002). 9. There was no significant change in fasting clinic or self-monitored blood glucose (p = .221 and p = .264, respectively).					
PLOS One (Wells et al., 2017) No nurse authors	Rural and Urban Operationally defined: NZDep New Zealand Index of Deprivation Place not stated	To assess the effect of a point of care device for testing lipids and glycohemoglobin, in addition to testing by community laboratory facilities (usual practice) on the completion of CVD risk assessments No theory noted	N = 9,055 (phase 1 pre-trial, 20 clinics (10 each group); End: N = 13,638 (phase 2, data from 10 clinics each group). Male: 55% Female: 45%	Pragmatic, clustered RCT and qualitative measures Evaluating a Point of Care device in Heart healthcare	PREDICT web-based CVD risk assessment system PREDICT
Wells Findings: 1. No difference in completion of risk assessments with or without device, rural or urban (Adj OR = 1.02, 95% CI .061 - 1.69). 2: Stated no difference in partial completion of risk assessments with or without device, rural or urban OR, CI not provided.					
The Diabetes Educator (Williams et al., 2014) Three nurse authors	Rural only Rural stated as rural central Virginia United States	"To test the feasibility of conducting a community-based randomized controlled trial evaluating a culturally tailored community-based group diabetes self-management education (DSME) program among rural African American." (p. 231). Bandura's social cognitive theory	N = 32, End, N = 25 Male: 20% Female: 80%	Non-randomized with control Taking care of sugar: Diabetes education culturally tailored and community based	Spoken Knowledge in Low Literacy Patients with Diabetes questionnaire Diabetes Empowerment Scale – Short Form (self-report) Diabetes Problem-Solving Skills instrument (self-report) Laboratory testing

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
					Medical Outcome Study SF-12 Stanford Diabetes Health Care Utilization Form
Williams findings: 1: Levels of glycohemoglobin decreased from post-intervention and three-month follow up; decreased further at 1 year (p = .22). 2: Systolic BP (p = .34) and waist circumference (p = .11) decreased. 3: BMI decreased over first three months (p = .03) and decreased further at 12 months (p = .30). 4. Level of exercise increased post-intervention at 3 months (p = .007). 5. Knowledge about diabetes increased post-intervention (p = .001). 6. Attention to foot care improved at 3 months (p = .013) and 12 months (p = .001). 7. Self-efficacy highest soon after intervention (p = .11). 8. Mental health well-being increased at 3 months (p = .05) and after (p = .09). 9. Physical health improved at 3 months (p = .43) but declined at 12 months (p = .06).					
Circulatory Heart Failure (Wu et al., 2016) Three nurse authors	Rural only Rural stated as, living in rural areas of 3 states California, Kentucky, Nevada United States	to examine the association between age and health outcomes by severity of heart failure, evidence-based medication use, and health literacy No theory noted	N = 575 Male: 60% Female: 40%	Secondary analysis of parent RCT (Dracup et al., 2014) Parent RCT – education and counseling intervention	New York Heart Association risk assessment B-natriuretic peptide test and Left Ventricular Ejection Fraction Interview and medical record review Short Test of Functional Health Literacy in Adults Patient/family interview, hospital database review and death certificates.
Wu Findings: 1: Older patients had higher composite hospitalizations and cardiac mortality than younger patients (p = .004). Cardiac mortality higher in older patients than younger (p < .001). Cardiac event risk higher for older group (p = .006). 2: No associations between age and medications angiotensin-converting enzyme inhibitor (p < .001) or beta-blockers (p = .008). No associations between cardiac events and either medication use (p > .05). 3: Association between age and health literacy (p < .001). Patients with higher health literacy scores had lower risk to experience cardiac event (p < .001). 4. In the final model (age and literacy), age no longer a significant predictor of cardiac event-free survival (p = .28) with and without adjustments. 5. Older patients 3.3 times more likely to have lower health literacy (p < .001). 6. Patients with lower					

Journal Nurse authors	Definition Type/Place	Purpose Theory	Sample	Design Intervention	Instruments
health literacy had 1.8 times greater risk of cardiac event ($p < .001$). 7. Older HF patients had 1.5 times greater risk of cardiac event ($p = .007$). 8. Patients with class 3 or 4 had 2 times the risk of cardiac event than those with lower risk level ($p < .001$). 9. No relationship between cardiac-free survival and gender ($p = .066$), ethnicity ($p = .909$), income ($p = .248$), marital status ($p = .264$), employment ($p = .984$), Ejection fraction ($p = .447$), B peptides ($p = .638$), Angiotensin inhibitors ($p = .356$) or beta-blockers ($p = .749$).					
BMC Cardiovascular Disorders (Young et al., 2016) Three nurse authors	Rural only Rural stated as rural critical access hospital Place not stated	To assess the effects of 12-week Patient Activated Care at Home [PATCH] on the improvement of self-management adherence and health outcome Lorig's chronic disease self-management model, Hibbard's patient activation theory and Bandura's conceptualization of self-efficacy.	N = 100 Male: 36% Female: 64%	RCT Intervention for self-management training and coaching	Self-report and accelerometer B-natriuretic peptide test and Sodium Creatine laboratory tests Primary care records and self-report survey
Young findings: 1. PATCH had higher adherence to self-management behaviors, including average days per week weighing ($p < .0005$), low sodium diet ($p < .0005$) and exercising ($p < .0005$). 2. Intervention group self-reported fewer days missed medication doses ($p = .030$). 3. No differences in group mean activity ($p = .780$), energy expenditure ($p = .773$) or minutes in moderate or more intense activity ($p = .897$). 4: B-natriuretic peptide ($p = .282$) and sodium intake ($p = .234$) similar between groups. 5: Contrary to expectations, 30-day hospital readmission rate higher for PATCH group than control ($p = .088$).					

Blood Pressure (BP), Body Mass Index (BMI) Cardiovascular Disease (CVD), Heart Failure (HF), Physical Activity (PA), and Randomized-Controlled Trial (RCT).

Risk of Bias in Studies

Most studies presented both positive and negative results. Only positive, statistically significant findings were noted in five articles (Abbott et al., 2017; Blackford et al., 2016; Lear et al., 2015; Moser et al., 2015; Nesbitt et al., 2014) and all negative or nonsignificant findings were noted in three (Kinsman et al., 2012; Seo et al., 2016; Wells et al., 2017). Publication bias was not evident in this review.

Synthesis of Studies

A synthesis of study results is presented through modifiable risk factors, cardiovascular outcomes, and general findings. This pattern was chosen as the best way to provide analysis of a body of literature with a wide range of variables. The significance or non-significance of findings, as indicated by *p* values, may be found in Table 1.

Modifiable Risk Factors

Self-efficacy

A self-care skill influencing CVD outcomes includes health literacy (Dracup et al., 2014; Moser et al., 2015; Wu et al., 2016). In a secondary analysis of an RCT with 614 rural Heart Failure (HF) patients from California, Nevada, and Kentucky, the relationships between level of health literacy and HF readmissions and deaths were explored (Moser et al., 2015). The Short Test of Functional Health Literacy in Adults was employed to determine three health literacy levels. About 1/3 of participants were found to have poor health literacy, raising their HF risks. Cox regressions revealed that HF patients with low or insufficient health literacy were statistically significantly more likely to have a negative cardiovascular outcome such as hospital readmission. Those who scored higher health literacy levels had less mortality and rehospitalizations for HF (Moser et al., 2015). Another publication (Wu et al., 2016) reported on data from the same parent study (Dracup

et al., 2014). Those HF patients who have inadequate health literacy are 1.8 times more likely to have a cardiac event than those scoring high literacy levels, and older rural patients tend to have low health literacy scores (Wu et al., 2016). Health literacy is identified as a modifiable variable in HF self-efficacy. Assessment and development of health literacy is essential to effective HF treatment (Moser et al., 2015; Wu et al., 2016) and should not be overlooked among well-educated patients (Park et al., 2017). For rural patients, remotely provided patient education reduces barriers to healthcare and improves disease management skills (Wu et al., 2016).

Telehealth improved self-efficacy skills for 50 overweight cardiac patients in an RCT (Barnason et al., 2019). Activation to initiate improved dietary behaviors was significantly enhanced in the intervention group. Outcome variables focused on intention and attitudes, were at times, supported by the application of social cognitive theory (Bandura, 1986). Cardiac rehabilitation patients' self-management improved willingness to make changes to PA and diet with the addition of the telehealth intervention (Barnason et al., 2019). A quasi-experimental telemedicine intervention study slightly increased the PA self-efficacy of 22 adults diagnosed with metabolic syndrome, although the intervention group's ability to reduce barriers to exercising did not improve (Bosak et al., 2010).

Physical Activity

Self-efficacy regarding PA was measured with self-reported survey tools (Barnason et al., 2019) as well as in a secondary analysis of a parent study of intervention moderators (Abbott et al., 2017). Neither study yielded significant results (Abbott et al., 2017; Barnason et al., 2019). An analysis of data from a health promotion program surprisingly demonstrated that a small sample of African American church members with no history of CVD demonstrated better post-

intervention attitude and self-efficacy for physical exercise than those with a history or a family history of CVD (Abbott et al., 2017).

Physical activity was directly measured with mixed results (Abbott et al., 2017; Barnason et al., 2019; Bosak et al., 2010; Lear et al., 2015; Samuel-Hodge et al., 2020; Seo et al., 2016; Stuckey et al., 2011; Williams et al., 2014; Young et al., 2016). A telehealth PA program yielded increased PA time for the intervention group (Bosak et al., 2010), as did a lifestyle intervention for a small sample with inadequate access to healthcare services; however, the result was nonsignificant (Seo et al., 2016). A self-management training intervention, to improve patient activation to improve adherence to CVD care, demonstrated significant results for PA time but not for moderate to intense exercise (Young et al., 2016). In a quasi-experimental diabetes self-management intervention with a small sample of African Americans, one education program significantly improved attendee PA level, 3-months after intervention (Williams et al., 2014). Similar results were noted for pedometer monitored activity from a diabetes lifestyle intervention (Stuckey et al., 2011), as well as for a quasi-experimental intervention seeking to reduce CVD risk factors among a sample with healthcare access issues, although without significance (Samuel-Hodge et al., 2020). A cardiac rehabilitation program provided via the internet successfully encouraged intervention group participants to spend more time using a treadmill; however, this result lost significance after adjusting for confounders (Lear et al., 2015). The challenge to motivate participants to increase exercise was noted when 544 uninsured CVD patients' pedometers showed no increased exercise even with a financial incentive (Kranker, 2018).

Energy expenditure was unchanged for participants, as measured with accelerometers (Bosak et al., 2010; Young et al., 2016). Rate of oxygen consumption during exercise increased significantly among those attending a technology based diabetic lifestyle intervention (Stuckey et

al., 2011), as well as for adults with metabolic syndrome participating in an exercise program via telehealth (Bosak et al., 2010). A diaphragmatic breathing program intended to reduce exercise-induced dyspnea had no group differences for self-reported respirations, physical functioning, or kilocalorie expenditures (Seo et al., 2016).

Dietary Intake

Patients with HF demonstrated insignificantly improved dietary compliance behaviors regarding B-type natriuretic peptides and sodium regulation following discharge, but the intervention group's ability to maintain a low-sodium diet at home was successful (Young et al., 2016). Dietary behavior improvements were significant following other interventions (Young et al., 2016) as well as among other findings specific to self-efficacy for dietary factors such as controlled fats intake (Abbott et al., 2017; Kranker, 2018), fruit and vegetable intake attitudes (Abbott et al., 2017) and increasing protein intake (Kranker, 2018). Overall dietary self-efficacy improved with telehealth interventions (Barnason et al., 2010; Barnason et al., 2019) and another intervention improved self-management of weight monitoring (Young et al., 2016). Financial incentives did improve CVD medication adherence (Kranker, 2018).

Medication Adherence

The effect of financial incentives on medication compliance was scant (Kinsman et al., 2012). Self-management and medication adherence were target outcomes for HF patients without adequate transportation to health services (Barnason et al., 2010). In this prospective, repeated measures study, self-report instruments were used to measure medication self-efficacy for participants transitioning to home from hospital discharge. In addition to demonstrating better medication compliance, the intervention group had statistically significant improvement in skills needed to reduce barriers to medication adherence, although no group differences occurred for

competence in the use of medications" (Barnason et al., 2010). Self-report instruments and medical records were also used to measure medication self-management resulting from a coaching intervention for HF patients who had fewer episodes of missed doses, but failed to reach significance (Young et al., 2016). An intervention that added nurse management to a telemedicine program to lower CVD risk factors for underserved Pennsylvanians, high and intermediate risk groups had similar medication compliance, telemedicine did not improve adherence and Framingham risk scores remained unchanged between groups at the conclusion of the study (Bove et al., 2011).

Risk Score Factors

The Framingham risk model was used with a purposive sample to compare the efficacy of a CVD risk reduction intervention with usual care (Bove et al., 2011). Although there were no overall group differences in risk, a significant decrease in scores was noted for those at the highest CVD risk. A successful risk score reduction was found following an educational program intervention for Australians with metabolic syndrome and at risk for CVD (Jancey et al., 2019). However, another study failed to yield an increase in CVD risk assessment completion by health providers after the addition of a laboratory device to collect lipids and glycohemoglobin data (Wells et al., 2017). Risk score measures are utilized to predict the likelihood of developing CVD (Bove et al., 2011; Jancey et al., 2019; Piatt et al., 2016; Wells et al., 2017), critical in identifying patients most in need of lifestyle changes and medical intervention since those with less CVD risk are 11 times less likely to develop CVD (Piatt et al., 2016).

Hypertension

Intervention studies that aimed to reduce CVD risk yielded significantly lowered BP post-intervention (Williams et al., 2014) including reductions in systolic and diastolic BP (Blackford et

al., 2016; Park et al., 2017), although in one study systolic BP reduction was minimal (Williams et al., 2014). A finding of lowered systolic BP in participants with more severe hypertension was positive, but group differences diminished over time (Bove et al., 2011). A surprising result of this study was that the control group systolic BP improved slightly more than the intervention group.

Cholesterol

There were mixed findings in the literature on interventions designed to lower CVD risk. Significant reductions in total cholesterol occurred in one study (Stuckey et al., 2011), but not in two others (Bove et al., 2011; Lear et al., 2015). A fourth study found total cholesterol reductions were similar between groups (Blackford et al., 2016). Changes in low-density lipids post-intervention were modest (Bove et al., 2011; Lear et al., 2015; Stuckey et al., 2011). Results were mixed on high-density lipids and triglycerides, one study demonstrated similar group mean levels of high-density lipid and triglycerides (Lear et al., 2015), in contrast to another with a significant reduction in triglycerides following a home-based intervention to lower CVD risk with exercise and diet (Blackford et al., 2016).

Obesity

Body fat, calculated as BMI was significantly reduced following interventions, as well as waist and hip circumference, waist-to-hip ratio, and weight (Blackford et al., 2016). Self-management skills in weight loss were significantly improved following a telehealth weight management program (Barnason et al., 2019). Reductions in weight and body mass index between groups also occurred. In another study (Kinsman et al., 2012), significant post-intervention weight losses occurred over 18 months, with a between-groups difference that increased over time. A study of shorter duration had successful short-term effects in measures of BMI and waist circumference post-intervention (Stuckey et al., 2011); however, similar results lost significance

after one year in a longer post-intervention measure (Williams et al., 2014). Financial incentives had a large effect on weight loss among women, but not men (Kranker, 2018).

Presence of Diabetes and Smoking Status

There were small group differences found post-intervention in blood glucose levels (Kranker, 2018) and measurements of glycohemoglobin levels (Williams et al., 2014). Another research team noted significant risk score reductions related to metabolic status following a behavior change program (Jancey et al., 2019). Diabetes knowledge and foot care skills improved following an intervention, but self-efficacy for diabetes care had only slight, brief improvement (Williams et al., 2014). Among improved health behaviors post-intervention, smoking was reduced, although significance levels were not provided (Bove et al., 2011).

Cardiovascular Outcomes

Hospitalization

An Australian study measured the efficacy of a clinical pathway to improve the delivery of thrombolytics to myocardial infarction patients. In this small sample chart review findings indicated that the new, 5-step intervention marginally increased the number of patients given thrombolytics and these medications were administered within 30 minutes of arrival. Small group differences were also noted for the speed with which thrombolytics and electrocardiograms were initiated (Kinsman et al., 2012).

In a Canadian study (Lear et al., 2021), a self-management intervention reduced those with at least one hospitalization and length of time until initial hospitalization. No significant group differences were found in the numbers of hospitalization days.

Patient education programs for HF patients, did not result in adequate improvement in rehospitalizations (Dracup et al., 2014; Young et al., 2016); however, a surprising finding was that

a self-management intervention group had slightly higher hospital readmissions than the usual care group (Young et al., 2016). A secondary analysis found those with inadequate/marginal health literacy were significantly likely to have a readmission to the hospital (Moser et al., 2015). This same study linked depression and hospitalizations. A virtually delivered cardiac rehabilitation intervention yielded a non-significant trend of 18% less hospitalizations or emergency department visits (Dracup et al., 2014). A telephone support program for chronic HF patients minimally lowered patient risk of cardiac related hospitalization; however, risk for all-cause hospitalization and all-cause hospitalization plus death were significantly reduced (Krum et al., 2013). Older HF patients are significantly more likely to have cardiac related hospitalizations, and adverse outcomes, than younger patients (Wu et al., 2016).

Morbidity and Mortality

Telephone support for those with HF did not influence cardiac morbidity outcomes as a single variable (Krum et al., 2013) as compared to the combination of all cause hospitalization and death reported above, nor did a large study of alternative cardiopulmonary resuscitation, whose intervention group had an unexpected increased pulmonary edema than those with usual care (Aufderheide et al., 2011). However, one self-management intervention significantly improved combined hospitalization and death measure in a Canadian study (Lear et al., 2021). Virtual rehabilitation did not greatly reduce the number of cardiac event occurrences (Lear et al., 2015). Older patients, and those with higher cardiac event risk, are significantly more likely to experience a cardiac event, although this study found no associations between cardiac events and medications prescribed (Lear et al., 2015).

More people survived cardiac hospitalization without severe neurological impairment post-intervention following cardiopulmonary resuscitation that was supplemented with intrathoracic

pressure, however, there were no group differences in survival to discharge (Aufderheide et al., 2011). Significantly more participants who received the intervention were still alive after one year. No association was found between survival without CVD, gender, ethnicity, socioeconomic, marital or job status, or heart risk assessment measures.

Significantly less deaths occurred due to cardiac events 2-years post-intervention than deaths between groups immediately after a HF education program (Dracup et al., 2014). Another group of authors reported there were significantly fewer all-cause deaths post-intervention, but cardiac related deaths were similar between groups (Krum et al., 2013). Findings of a large RCT showed that one intervention group had fewer cardiac deaths at the 2-year mark than either the control or second intervention groups (Dracup et al., 2014). Secondary analysis of this parent study, indicated that those who received a modest intervention had fewer cardiac related deaths than those in the control group or those who received an enhanced intervention (Park et al., 2017). There was an association between the amount of diary use and deaths from all causes (Park et al., 2017). Older cardiac patients were more likely to have a cardiac related death than those younger (Wu et al., 2016). Secondary analysis also found significantly more deaths with inadequate or marginal health literacy (Moser et al., 2015). Furthermore, the same study showed depression, heart risk factor severity, and comorbidities were significant and positively associated predictors of mortality and hospital readmission.

Quality of Life

In a secondary analysis of a HF education intervention, age was a significant factor in patients' QoL, as was gender, cardiac risk level, presence of depression or anxiety, self-regulation, HF literacy, or place (Nesbitt et al., 2014). Self-care had a weak influence on QoL. Rural men had lower QoL than rural women. Additionally, geographic location correlated with type of medication

treatment, but type of provider or insurance was not associated with place, yet Nevada was associated with a higher life satisfaction. Depression and anxiety are negatively associated with QoL (Nesbitt et al., 2014) and educational interventions that facilitate heart-related self-care improve QoL (Barnason et al., 2010). A diabetes self-management intervention improved emotional health significantly, although effects moderated over time (Williams et al., 2014). In a Canadian study, self-management and social support had improved significantly and there were no significant findings for QoL (Lear et al., 2021). Quality of life did not correlate with heart risk assessment criteria, socioeconomic or marital status, comorbidities, job or educational status, presence of anemia, household size, smoking status, or race and ethnicity (Nesbitt et al., 2014).

Social Determinants of Health

Disadvantaged groups experience chronic stress caused by long-term adversity, and this stress can increase CVD risk factors. Chronic stress from adverse social determinants causes biological change throughout the body because of inflammatory reactions, raising CVD risk factors (Powell-Wiley et al., 2022). Studying the relationship between SDoH and cardiovascular outcomes is critical to the development of interventions that target those subpopulations most at risk, and these factors should be considered in addition to known modifiable factors as well as those that are nonmodifiable. Social determinants of CVD risk include educational attainment, family income, job status, race or ethnicity, and healthcare barriers that make accessing cardiovascular care difficult.

Educational level and employment status negatively impacted health literacy that would enable cardiovascular care (Moser et al., 2015). However, the same variables showed no group differences post-intervention (Abbott et al., 2017). No statistically significant group differences were associated with race or ethnicity in three reports of different outcomes (Nesbitt et al., 2014;

Park et al., 2017; Wu et al., 2016) from one RCT parent study (Dracup et al., 2014) as well an additional study (Wells et al., 2017). Neither did employment, income level, nor educational level reach significance in a set of studies in relation to cardiovascular outcomes (Dracup et al., 2014; Nesbitt et al., 2014; Park et al., 2017; Wu et al., 2016). Barriers to medication access in the calculation of medication were discussed in one study (Barnason et al., 2010). The above measures of SDoH were not explored in the remaining articles reviewed.

Population level interventions must supplement individually administered cardiovascular care to reduce CVD risk factors among communities facing adversity. Health policies that address higher CVD risk among the disadvantaged should be prioritized as a means of delivering equitable cardiovascular healthcare (Powell-Wiley et al., 2022). Expanding research to include SDoH can identify modifiable factors affecting disadvantaged groups and results can enable public health program development and policy that lowers CVD risk for whole populations (Havranek et al., 2015).

Discussion

The purpose of this systematic review was to explore the current trends and gaps within the literature. The current CVD intervention literature base is focused on quantitative methods that measured anthropomorphic features, clinical biomarkers, health behaviors, efficacy/knowledge, risk score, hospitalizations/emergency department use/admissions/length of stay/protocols, survival and mortality, as well as disability/cardiac events and QoL. All, except one mixed methods study (Wells et al., 2017), were quantitative, as typical in RCT and clinical trials. This finding implies a qualitative literature gap regarding CVD. The importance of CVD qualitative literature is that it captures the experience of participants and can provide insight into their behaviors in relation to behavior change. Qualitative data could yield better insight into what was

effective, from the person's point of view, leading to refinement of future interventions. These data would allow researchers to tailor future CVD research to best fit their target population.

The concept of identifying and measuring risk of CVD was highlighted in the classic Framingham study (Kannel et al., 1961). In this early report, researchers followed participants over six years, analyzing personal characteristics more likely noted in those who developed CVD. Hypertension, elevated cholesterol levels, presence of smoking and cardiac arrhythmias were the Framingham CVD Risk Score factor. Newer research has demonstrated that presence of diabetes, inadequate exercise, obesity, age, race and heredity are additional CVD risk factors (Niiranen & Vasan, 2016). Risk score was only measured in four articles (Bove et al., 2011; Dracup et al., 2014; Jancey et al., 2019; Wells et al., 2017). Risk score quantifies individual risk and can provide a sense for what preventative measures are needed for CVD. It is important to study prevention with CVD because putting funding into prevention will allow for more CVD early intervention and perhaps lead to a lower mortality rate (Callaghan et al., 2020). To strengthen the prevention literature data base, more studies should be conducted that include risk scores in this population.

The CVD-related mortality rate among rural communities has been decreasing at a slower rate than those in more urban settings; thus, a widening mortality gap has developed (Harrington et al., 2020; Pierce et al., 2021). Rural dwellers experience cardiovascular risks uniquely within the context of their population characteristics and this must be taken into consideration in developing healthcare interventions that aim to lower CVD risk (Harrington et al., 2020). Cardiovascular interventions should target rural SDoH to lower CVD risk among rural dwellers, and health policy must be built to lower health disparities in rural communities (Pierce et al., 2021).

Rural-specific CVD research that includes results that are categorized by sex is critically needed to understand which rural dwellers experience the worst CVD risk factors. Rural men and

women are not likely to be impacted by place-specific SDoH in the same ways (Office of Research on Women's Health, 2021), so CVD research findings that include study outcomes by sex would be beneficial in addressing this knowledge gap. Inclusion guidelines that call for increased sampling among under-represented groups underscore the need to seek out opportunities to recruit participants from sub-populations to illuminate health disparities among people who have not been given enough attention by researchers (Office of Research on Women's Health, 2021).

Limitations

This review included studies that were either stated as taking place in a rural area or rural locations were defined in an operational or conceptual manner. Including articles that had a mix of rural and urban samples is a limitation. The decision to include studies with samples inclusive or rural, suburban, and urban was made based on an assumption that there would not be enough rural only studies to have a sufficient number of research articles on which to base a strong systematic review. However, there were only five studies that noted anything other than a rural sample (Aufderheide et al., 2011; Bove et al., 2011; Lear et al., 2021; Lear et al., 2015; Wells et al., 2017). Unfortunately, this information was not uncovered until the analysis phase of the review. The number of rural only studies is on the cusp of providing enough information for a quality systematic review.

Systematic review guidelines require strict inclusion and exclusion criteria, following these guidelines limits the number of studies included in the review. Many studies not focused on clinical trials or RCT levels of evidence were eliminated and likely skewed the methodology toward quantitative. Some secondary analysis studies originated from the same parent study. These studies may have been representative of the same population or subgroups of that population. The focus

on research from the United States, Australia, New Zealand, and Canada limits the generalization of findings to other less-developed countries.

Another notable absence in this literature review, was the scant exploration of SDoH in rural populations beyond place (Powell-Wiley et al., 2022). What is known is that there is a difference in occurrence in cardiovascular outcomes in regards to place, with rural lagging urban areas in the amount of decrease and a resulting widening gap in morbidity and mortality (Harrington et al., 2020). Intersectionality of SDoH and health outcomes are being brought to the forefront in scientific and social literature. Rural dwellers have long been thought to have less health care access but are there also more negative SDoH factors that could shed light on the difference in outcomes that exist? Actual measures, beyond place, of the effects of SDoH on cardiovascular outcome were minimal in this review.

Conclusion

This systematic review adds to the literature on CVD in rural and non-rural women and men. The findings of CVD research include a wide breadth of outcome measures but inadequate usage of established risk score instruments. Focus on clinical trials or RCTs limited the amount of qualitative CVD research to be analyzed. The literature provides abundant, although sometimes contradictory, examples of which interventions are effective. However, there is a gap in knowledge, from a failure to explore individual experiences, that reveals exactly what motivates the individual to make difficult lifestyle changes. The addition of qualitative questions, in a mixed methods approach, could provide insight into why some interventions motivate behavior change while others do not. Operationally defining rural allows researchers and policy makers to generalize findings to other rural areas with similar characteristics.

Based upon the above conclusions, one recommendation is that future research include qualitative approaches to bring depth to understanding behavioral changes needed to prevent or reduce CVD. Authors, reviewers, and journal editors need to continue to strive to assure that rural samples are clearly defined. These suggestions would more appropriately reflect interventions that effectively improve CVD risk and identify motivators of health-focused behavior change among rural dwellers.

Policy advocacy on including SDoH variables in research grants is needed. Researchers need to explore in more depth the possible hidden effects of upstream factors in the identified gaps in cardiovascular outcomes among rural dwellers and populations.

Conflicts of Interest

These authors declare no conflicts of interest.

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