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Measurement Properties of Physical Activity and Sedentary Behaviors in Heart Failure: A Systematic Review Protocol

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ADMINISTRATIVE INFORMATION

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Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 29 June 2025 and was last updated on 29 June 2025.

INTRODUCTION

Review question / Objective The objectives of this systematic review are: 1) synthesize the methodological approaches utilized by studies to measure physical activity and sedentary behavior in patients with heart failure, and 2) examine the levels of free-living physical activity and sedentary behavior among adult patients with heart failure as reported in the published literature. As a secondary objective, we will investigate the quality of accelerometer methods reporting in studies utilizing accelerometers in adults with heart failure.

Rationale Heart failure (HF) is a chronic, progressive clinical syndrome associated with a low quality of life, high mortality rate, and billions of dollars in national healthcare costs. Previous research has documented the beneficial health effects of physical activity (PA) in the general population, resulting in national recommendations in the US. Many of the health benefits of PA in the general population have also been observed in adults with HF. Sedentary behavior (SB) has historically been used to describe physical inactivity but is now recognized as a distinct behavior independently associated with poor cardiovascular outcomes in the general population. The Canadian Society for Exercise Physiology recently established national guidelines recommending that adults limit time in SB to <8 hours/day due to the risk of adverse health outcomes. Growing research suggests that SB is associated with the risk of developing HF, as well as the risk of mortality in adults with HF. However, most of the evidence in adults with HF has been gathered in controlled laboratory and clinical settings, and there is a need to understand PA and SB in real-world, free-living conditions. Despite the potential benefits of engaging in PA and minimizing SB, it is unknown whether the PA and SB levels of adults with HF in free-living settings are sufficient to achieve health benefits.

Accurately assessing PA and SB is necessary for evaluating the effectiveness of PA/SB interventions on health. Numerous methods have been developed to measure habitual PA and SB in the

general population, but evidence suggests that subjective measures, such as self-report questionnaires, have low validity and reliability compared to objective instruments like accelerometers. Still, many studies measuring PA and SB in the HF population rely on subjective measures, possibly due to the accessibility of questionnaires for research in real-world settings, potentially leading to inaccurate estimates. Although accelerometers offer advantages compared to subjective measures, their effectiveness depends on careful considerations for measurement procedures, data processing and interpretation, and protocol non-compliance. While some previous HF studies have utilized accelerometers, the quality of accelerometer methods reporting in HF research is unknown. Overall, assessing PA and SB in HF research is complex, and the choice of measurement tools can significantly influence results. Given the variability in PA and SB measurement methods across different research settings, it is crucial to understand the approaches used to evaluate activity levels in adults with HF in free-living conditions.
Given the increasing recognition of the role of PA and the detrimental effects of SB in adults with HF, there is still a need to establish clear guidelines regarding the optimal types and amounts of activity and inactivity for this population. This gap in knowledge is partly due to the diverse methodologies employed to measure these behaviors, many of which are conducted in research environments that may not be generalizable to free-living conditions. Consequently, it is essential to evaluate and understand the different methods used in assessing PA and SB in adults with HF in real-world, free-living settings.

Condition being studied Heart failure (HF) is best understood as a clinical syndrome with diverse causes and mechanisms, rather than a single, clearly defined disease. This complexity makes HF more difficult to define than conditions like cancer, which have specific pathological criteria. As a result, definitions of HF vary across the literature, clinical guidelines, and everyday medical practice. Different definitions serve different purposes - for example, pathophysiology-based textbook definitions contrast with research-focused case definitions like the Framingham criteria. Traditional definitions often describe HF as the heart's inability to pump enough blood to meet the body's needs or to deliver sufficient oxygen to tissues. However, these descriptions can be difficult to confirm in clinical settings and may only apply to a subset of patients. In practice, diagnostic tools like plasma natriuretic peptide levels are frequently used to support the diagnosis. Major guidelines (including those from the ACC/AHA, HFA/ESC, and JHFS) offer definitions that, while differing in specifics, generally agree on core features: HF is a syndrome marked by a characteristic set of signs and symptoms (e.g., shortness of breath, fatigue, fluid retention), and there must be evidence of underlying structural or functional heart disease. Some guidelines also include reduced cardiac output or elevated cardiac pressures as diagnostic criteria. In sum, most modern definitions of HF incorporate three main elements: structural heart abnormalities, hallmark symptoms, and objective clinical signs. A position paper from Bozkurt et al. (2021) proposed a universal definition of the condition "as a clinical syndrome with symptoms and/or signs caused by a structural and/or functional cardiac abnormality and corroborated by elevated natriuretic peptide levels and/or objective evidence of pulmonary or systemic congestion."

Bozkurt, B., Coats, A.J.S., Tsutsui, H., Abdelhamid, C.M., Adamopoulos, S., Albert, N., Anker, S.D., Atherton, J., Böhm, M., Butler, J., Drazner, M.H., Michael Felker, G., Filippatos, G., Fiuzat, M., Fonarow, G.C., Gomez-Mesa, J.-E., Heidenreich, P., Imamura, T., Jankowska, E.A., Januzzi, J., Khazanie, P., Kinugawa, K., Lam, C.S.P., Matsue, Y., Metra, M., Ohtani, T., Francesco Piepoli, M., Ponikowski, P., Rosano, G.M.C., Sakata, Y., Seferović, P., Starling, R.C., Teerlink, J.R., Vardeny, O., Yamamoto, K., Yancy, C., Zhang, J. and Zieroth, S. (2021), Universal definition and classification of heart failure: a report of the Heart Failure Society of America, Heart Failure Association of the European Society of Cardiology, Japanese Heart Failure Society and Writing Committee of the Universal Definition of Heart Failure. Eur J Heart Fail, 23: 352-380. https://doi.org/10.1002/ejhf.2115.

METHODS

Search strategy Databases searched include PubMed and ProQuest. Search results will be filtered to include any articles published prior to September 1, 2024. MeSH terms and keywords for the three concepts utilized in the systematic literature search for studies measuring either physical activity or sedentary behavior among heart failure populations (MeSH terms were only utilized in PubMed) are listed below.
Sedentary Behavior concept -
MeSH: Sedentary behavior
Keywords: Sedentary, "Sedentary behavior", "Sedentary lifestyle", "Sedentary time", Sitting, "Physical inactivit*";

Physical Activity concept -
Keywords: "Physical activit*", "MET-hours", "MET-minutes", "Step count", "Energy expenditure";

Heart Failure concept -
MeSH: Heart failure, Congestive heart failure, Ventricular dysfunction
Keywords: "Heart failure", "Cardiac failure", "Cardiac decompensation", "Myocardial failure", "Heart decompensation", "Cardiac dysfunction", "Heart dysfunction", "Systolic dysfunction", "Diastolic dysfunction";

The detailed search terms and filters per database are listed below.
Pubmed:
Heart failure and physical activity concept - ((((((((((((((heart failure[MeSH Terms]) OR (congestive heart failure[MeSH Terms])) OR (ventricular dysfunction[MeSH Terms])) OR ("heart failure"[Title/Abstract])) OR ("congestive heart failure"[Title/Abstract])) OR ("cardiac failure"[Title/Abstract])) OR ("cardiac decompensation"[Title/Abstract]))) OR ("myocardial failure"[Title/Abstract])) OR ("heart decompensation"[Title/Abstract])) OR ("cardiac dysfunction"[Title/Abstract])) OR ("heart dysfunction"[Title/Abstract])) OR ("systolic dysfunction"[Title/Abstract])) OR ("diastolic dysfunction"[Title/Abstract])) AND (alladult[Filter]) AND (alladult[Filter])) AND ((((((("physical activit*"[Title/Abstract])) OR ("MET-hours"[Title/Abstract])) OR ("MET-minutes"[Title/Abstract])) OR ("Step count"[Title/Abstract])) OR ("energy expenditure"[Title/Abstract]) AND (alladult[Filter]) AND (alladult[Filter]) AND (alladult[Filter]))

Heart failure and sedentary behavior concept - ((((((((((((((heart failure[MeSH Terms]) OR (congestive heart failure[MeSH Terms])) OR (ventricular dysfunction[MeSH Terms])) OR ("heart failure"[Title/Abstract])) OR ("congestive heart failure"[Title/Abstract])) OR ("cardiac failure"[Title/Abstract])) OR ("cardiac decompensation"[Title/Abstract]))) OR ("myocardial failure"[Title/Abstract])) OR ("heart decompensation"[Title/Abstract])) OR ("cardiac dysfunction"[Title/Abstract])) OR ("heart dysfunction"[Title/Abstract])) OR ("systolic dysfunction"[Title/Abstract])) OR ("diastolic dysfunction"[Title/Abstract])) AND (alladult[Filter]) AND (alladult[Filter])) AND (((((((sedentary behavior[MeSH Terms]) OR ("sedentary behavior"[Title/Abstract])) OR ("sedentary lifestyle"[Title/Abstract])) OR ("sedentary"[Title/Abstract])) OR ("sedentary time"[Title/Abstract])) OR (sitting[Title/Abstract])) OR ("physical inactivit*"[Title/Abstract]) AND (alladult[Filter]) AND (alladult[Filter]))

Proquest:
Heart failure and physical activity concept - ((((((((ab("heart failure") OR ab("congestive heart failure") OR ab("cardiac failure") OR ab("cardiac decompensation") OR ab("myocardial failure") OR ab("heart decompensation") OR ab("cardiac dysfunction") OR ab("heart dysfunction") OR ab("systolic dysfunction") OR ab("diastolic dysfunction")) AND stype.exact("Scholarly Journals")) AND at.exact("Article")) AND la.exact("English")) AND peer(yes)) AND stype.exact("Scholarly Journals")) AND at.exact("Article")) AND la.exact("English")) AND PEER(yes)) AND ((((((((ab("physical activity") OR ab("MET-hours") OR ab("MET-minutes") OR ab("step count") OR ab("energy expenditure")) AND stype.exact("Scholarly Journals")) AND at.exact("Article")) AND la.exact("English")) AND peer(yes)) AND stype.exact("Scholarly Journals")) AND at.exact("Article")) AND la.exact("English")) AND PEER(yes))

Heart failure and sedentary behavior concept - ((((((((ab("heart failure") OR ab("congestive heart failure") OR ab("cardiac failure") OR ab("cardiac decompensation") OR ab("myocardial failure") OR ab("heart decompensation") OR ab("cardiac dysfunction") OR ab("heart dysfunction") OR ab("systolic dysfunction") OR ab("diastolic dysfunction")) AND stype.exact("Scholarly Journals")) AND at.exact("Article")) AND la.exact("English")) AND peer(yes)) AND stype.exact("Scholarly Journals")) AND at.exact("Article")) AND la.exact("English")) AND PEER(yes)) AND ((((((((ab("sedentary behavior") OR ab("sedentary") OR ab("sedentary lifestyle") OR ab("sedentary time") OR ab("sitting") OR ab("physical inactivity")) AND stype.exact("Scholarly Journals")) AND at.exact("Article")) AND la.exact("English")) AND peer(yes)) AND stype.exact("Scholarly Journals")) AND at.exact("Article")) AND la.exact("English")) AND PEER(yes)).

Participant or population Eligible articles must include non-institutionalized human adults aged 18+ with heart failure. The articles must not include other populations unless results are stratified in a manner that reports results for the heart failure population separately from other populations. Participants must undergo physical activity or sedentary behavior measurement in a free-living setting (not during or immediately following an intervention or procedure that is likely to influence normal activity patterns).

Intervention Not applicable. This review does not evaluate the effect of any intervention. Eligible

studies must assess physical activity or sedentary behavior in adults with heart failure during a timepoint in which participants are not actively undergoing an intervention or medical procedure likely to influence normal movement behavior. Studies involving interventions are excluded if physical activity/sedentary behavior data are only collected during or immediately following the intervention period.

Comparator Not applicable. This review does not include comparisons between interventions. The aim is to synthesize studies that report on physical activity or sedentary behavior in adults with heart failure, regardless of study design, as long as data were collected at a minimum of one timepoint that is outside of an intervention context.

Study designs to be included This review will include all primary study designs (e.g., randomized controlled trials, non-randomized trials, cohort studies, cross-sectional studies, case-control studies, case series, and case reports) as long as they report that physical activity or sedentary behavior was measured in human adults (≥18 years) with heart failure during at least one timepoint not influenced by an intervention or medical procedure likely to disrupt normal activity patterns.

Eligibility criteria Articles will be considered for inclusion if they meet the following two criteria: (1) measured quantitative sedentary behavior (SB) and/or physical activity (PA) level of non-institutional adults with heart failure (HF (separately from other populations)); (2) SB/PA was not measured during or immediately following an intervention or procedure that likely to influence normal activity patterns. Studies will be excluded for meeting any of the following criteria: (1) non-English publication; (2) non-peer-reviewed research; (3) subject aged<18 years or nonhuman; (4) mixed populations (for example, included adults with heart failure and adults with cancer) or no HF diagnosis at baseline; (5) no SB/PA outcomes meeting inclusion criteria; (6) unsuitable study design (i.e., case studies, qualitative research, PA/SB measured during intervention); (7) review article.

Information sources The electronic databases PubMed and ProQuest will be searched and any peer-reviewed manuscripts meeting eligibility criteria that are identified by the database search will be considered for inclusion. We will not identify articles by any methods outside of the electronic database search (e.g., no contact with authors, trial registers, or grey literature).

Main outcome(s) The primary outcomes of interest are (1) descriptive methodological information how physical activity and/or sedentary behavior were measured in adults with heart failure, and (2) summary values or distributions of physical activity and sedentary behavior as reported by included studies. Measurement approaches may include objective tools (e.g., accelerometers, pedometers, wearable monitors) or subjective instruments (e.g., self-report questionnaires, diaries). Outcomes will be described in terms of measurement instruments used (survey/questionnaire/pedometer/accelerometer and objective or subjective instrument type) and behavioral metrics (e.g., daily step count, minutes of moderate-to-vigorous physical activity, sitting time). Timing of outcome measurement will vary by study but must occur during a timepoint in which participants are not undergoing an intervention or procedure likely to affect typical behavior patterns. No specific health or clinical outcomes (e.g., survival or quality of life) are required for inclusion, as the primary focus is on measurement characteristics and descriptive summaries of behavior.

Additional outcome(s) Additional outcomes include:
(1) Whether physical activity or sedentary behavior levels reported in each study meet public health recommendations (e.g., ≥150 minutes/week of moderate-to-vigorous physical activity).
(2) The proportion of included studies that used objective versus subjective measurement instruments.
(3) The quality of accelerometer methods reporting, as assessed using a standardized tool.

Data management One reviewer will screen titles, abstracts, and full texts for eligibility using Endnote 9. The same reviewer will perform data extraction manually using Microsoft Excel. Extracted variables included study characteristics, participant information, details of physical activity or sedentary behavior measurement, and behavioral outcomes. Inter-rater reliability will be examined by comparing the primary reviewer's results with the co-authors' via a randomly selected subsample of articles. Statistical analyses will be conducted using SAS 9.4.

Quality assessment / Risk of bias analysis Because the primary aim of this review is to evaluate how physical activity (PA) and sedentary behavior (SB) are measured and reported among studies involving individuals with heart failure, a traditional risk of bias tool (e.g., Cochrane Risk of Bias, ROBINS-I) is not applicable. Given that the

review does not aim to synthesize intervention effects or clinical outcomes, we will assess the quality and completeness of accelerometer methods reporting using a structured 10-item checklist adapted from Montoye et al. (2018). This tool evaluates whether key elements of accelerometer methodology (such as device brand, epoch length, placement, wear-time criteria, and outcome interpretation) were reported satisfactorily. Each item is scored dichotomously (1 = adequate reporting, 0 = inadequate or missing), with a total score ranging from 0 to 10. This approach allows us to quantitatively summarize methodological quality across studies and to identify specific reporting domains needing improvement (risk of bias).

To examine the inter-rater reliability of the 10-item checklist, two reviewers independently rated studies using this form, and inter-rater reliability was assessed using Cohen's kappa and percent agreement. Discrepancies were resolved through discussion to reach consensus. Percent agreement across all items averaged 96%, indicating high consistency in scoring between reviewers. Cohen's kappa values for individual items ranged from 0.78 to 1.00, with a mean of 0.94, reflecting substantial to almost perfect agreement (Landis & Koch, 1977).

Montoye, A. H. K., Moore, R. W., Bowles, H. R., Korycinski, R., & Pfeiffer, K. A. (2018). Reporting accelerometer methods in physical activity intervention studies: a systematic review and recommendations for authors. British Journal of Sports Medicine, 52(23), 1507-1516. https://doi.org/10.1136/bjsports-2015-095947.

Strategy of data synthesis This systematic review will use a predominantly qualitative narrative synthesis approach to summarize how physical activity (PA) and sedentary behavior (SB) are measured and reported across studies involving adults with heart failure. Because the review is not focused on evaluating intervention effectiveness or estimating effect sizes, no meta-analyses or formal quantitative synthesis will be conducted. However, we will also examine whether the likeliness of each included article's sample meeting national activity recommendations is associated with the type of activity measurement tool used (subjective vs objective tools) using a Chi-square test of independence. In brief, for studies reporting quantitative PA and/or SB, we will create variables (sufficiently active and sedentary) to indicate whether the sample met PA and/or SB recommendations. For the studies reporting PA values (steps count, moderate- to vigorous-intensity PA (MVPA), MET-min, or PA energy expenditure (PAEE)), the sample will be considered sufficiently active if >50% of the participants or the mean/median PA of the sample met the ACSM recommendations for PA; otherwise, the sample will be considered insufficiently active. For studies reporting more than one type of PA (i.e., MVPA min/week and steps count), we will consider the sample sufficiently active if any of the reported PA results satisfied the PA recommendation. For studies reporting an SB value, the sample will be considered sedentary if >50% of the participants or the mean/median SB of the sample reached ≥8 hours/day in SB; otherwise, the sample will be considered not sedentary.

Key methodological features (e.g., accelerometer device brand, placement, wear-time criteria, outcome variables, and data processing methods) will be tabulated and summarized descriptively. Studies will be grouped and compared based on accelerometer measurement characteristics, study design, population characteristics (e.g., inpatient vs. outpatient), and reported outcomes. Frequencies and proportions will be calculated to summarize how often each reporting criterion was adequately described, based on a structured 10-item accelerometer reporting tool adapted from Montoye et al. (2018).
No effect measures (e.g., odds ratios, mean differences) or inferential statistical tests comparing intervention groups are planned, as this review is not focused on treatment comparisons or outcome effect estimation. Therefore, methods related to meta-analysis models, heterogeneity assessment, indirect comparisons, or missing outcome data will not apply.

Subgroup analysis In a subsample of studies that report a quantitative value of physical activity or sedentary behavior, we will examine whether the likeliness of each included article's sample meeting national activity recommendations is associated with the type of activity measurement tool used (subjective vs objective tools) using a Chi-square test of independence.

Sensitivity analysis To establish the inter-rater reliability of the review methods, coauthors will repeat the article selection, data extraction, and quality assessment in a randomly selected subsample of articles and compare with the complete results of the primary reviewer using percent agreement and Cohen's kappa.

Language restriction Articles not published in English will be excluded during the multi-stage screening process.

Country(ies) involved United States.

Keywords physical activity; sedentary behavior; heart failure.

Dissemination plans The results of this systematic review will be submitted for publication in a peer-reviewed academic journal in the fields of physical activity, sedentary behavior, or heart failure. Findings will also be shared through presentations at relevant national and international conferences, and may be summarized in non-technical formats (e.g., slide decks, infographics) for dissemination to clinicians and researchers interested in physical activity measurement in heart failure populations.

Contributions of each author

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