Workplace and rehabilitation-based approaches to enhancing long-term wellbeing and physical activity in sedentary populations

by

Justin Luke Montney

B.S., Fort Hays State University, 2017
M.S., Fort Hays State University, 2019

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Kinesiology
College of Health and Human Sciences

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2025

Abstract

OBJECTIVE: Long-term adherence to physical activity (PA) following worksite or clinical interventions typically diminishes over time, stemming from a critical gap between theory-based program design and real-world implementation feasibility. While research shows that long-term adherence is driven by the value of short-term intrinsic rewards like improved mood, self-efficacy, and feelings of accomplishment, most interventions fail to bridge the gap between this knowledge and real-world practice. Therefore, the purpose of this dissertation is to examine the barriers and facilitators of implementing PA interventions in sedentary populations from the multiple perspectives of the existing literature, employee participants, and clinical providers, while exploring how practical implementation factors—specifically, perceived benefits, program simplicity, adaptability, and user burden—impact feasibility.

METHODS/RESULTS: The first paper, a systematic review of worksite PA programs (N=8 studies), examined their effects on PA, sedentary behavior (SB), and occupational wellbeing. The review found that all 8 interventions reported improvements in PA or SB, with the most common wellbeing benefits being improved energy (reported in 62.5% of studies), reduced fatigue (reported in 50% of studies), and reduced work absenteeism (reported in 37.5% of studies). The most promising results were observed in multi-component interventions that incorporated both equipment and education/behavioral support.

The second paper reports on a social ecological model-based 8-week pilot randomized controlled trial (N=36) which found that a walking intervention was as effective as a novel, culturally-adapted Radio Taiso (RT) routine, a form of Japanese synchronized music and rhythm based calisthenics, in reducing objective sedentary time (main effect of Time, $F(2, 25.9) = 12.06$, p <

.001). Additionally, the simpler walking intervention resulted in significantly higher implementation fidelity from an employee perspective and reported more qualitative enjoyment.

The third paper details a mixed-methods implementation study of a novel, Health Action Process Approach (HAPA)-based "Cardio Commitment Course" (C3) within cardiac rehabilitation (N=9 staff). Staff attended a 4-week training intervention consisting of live, interactive sessions on HAPA theory, examples of how to use the program's educational tools, and expert-led guidance for motivational interviewing and conducting group education. This study revealed that while the training produced a large and significant improvement in staff confidence for key areas (e.g., setting goals with patients, p = .018, d = 0.79), program complexity and time constraints were significant barriers that hindered implementation fidelity, with only 20% of patients receiving the target number of educational sessions from the provider perspective.

CONCLUSION: Collectively, these studies demonstrate that the value of theory-based programs is realized only when they are designed to be simple, adaptable, and place a low burden on both participants and providers. Successful implementation requires prioritizing simplicity, adaptability, and low participant and provider burden to achieve sustained engagement and positive outcomes in both worksite and clinical environments.

Keywords: cardiac rehabilitation, health action process approach, implementation science, physical activity, sedentary behavior, self-efficacy theory, worksite wellness

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Major Professor
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The completion of this dissertation marks the beginning of a new chapter, one I have long dreamed of. I am deeply grateful for the opportunity to become a professor and to contribute to a field I love.

Finally, to anyone whose name may have been inadvertently omitted, your contribution has not gone unnoticed and is deeply appreciated.

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Dedication

For Rodney Montney and Alexis-Athena Wyatt.

You taught me what it means to persevere.

This work is a testament to the love and strength you gave me.

Chapter 1 - Introduction

1.1 The Challenge of Sedentary Behavior in Modern Life

Cardiovascular disease (CVDs) remains a leading cause of morbidity, mortality, and healthcare expenditure globally (Benjamin et al., 2019; Martin et al., 2024; Tsao et al., 2023). Sedentary behavior (SB), a primary contributor to this burden is SB, defined as any waking behavior with an energy expenditure of ≤1.5 metabolic equivalents (METs) while in a sitting, reclining, or lying posture (Tremblay et al., 2017). Modern society, such as the United States (U.S.), necessitates prolonged periods of sitting, especially in occupational settings. Office-based employees is the U.S. may spend upwards of 75-80% of their workday seated (Buman et al., 2017). This workplace SB is significantly to a public health challenge where a majority of adults fail to meet recommended physical activity (PA) guidelines (Elgaddal et al., 2020).

This high prevalence of SB can be hazardous to health (Puig-Ribera et al., 2017). Specifically, extensive research has linked it to a host of adverse health outcomes, including an increased risk of type 2 diabetes, certain cancers, and all-cause mortality (Biswas et al., 2015; Patterson et al., 2018). In addition to physiological consequences, prolonged occupational sitting is also associated with worse mental health outcomes and may negatively impact work-related factors like productivity and presenteeism (Puig-Ribera et al., 2017; Teychenne et al., 2015). As a direct countermeasure, PA is well-established to mitigate these risks by improving cardiometabolic health, enhancing mental wellbeing, and boosting work performance (Elgaddal et al., 2020). In response, interventions have been developed to promote PA in a wide range of settings, from preventative workplace programs to clinical rehabilitation environments. However, despite their proven potential, exercise intervention programs consistently face a critical barrier that undermines their long-term success—combining complex behavior theory with real world implementation (Ryan & Deci, 2017).

1.2 Real World Implementation: A Shared Problem in Worksite and Clinical Settings

Both worksite PA programs (WPAPs) and clinical programs like cardiac rehabilitation (CR) have been developed to address the health consequences of a sedentary lifestyle. While they serve different populations on the health spectrum, they share a common, persistent challenge which is poor long-term adherence (Fang et al., 2017; Collado-Mateo et al., 2021). This suggests the fundamental issue is not a lack of evidence for *what* behaviors to change, but a failure in understanding *how* to maintain long term PA behaviors sustainably in complex, real-world environments (Damschroder et al., 2009; Collado-Mateo et al., 2021).

This dissertation views two settings—the sedentary office space and the cardiac rehab clinic—as parallel environments for exploring issues in PA programing implementation. Both are real-world contexts where individuals face significant personal and unique barriers to adopting and maintaining PA. More importantly, they are settings where the success of an intervention often hinges less on its theoretical elegance and more on its practical feasibility (Damschroder et al., 2009). Factors such as time constraints, intervention complexity, and the perceived burden on both the participant (employee or patient) and the provider (supervisor/wellness manager or clinician) consistently emerge as critical barriers (Damschroder et al., 2009). This highlights a fundamental tension in the field: the need for interventions that are not only evidence-based and theoretically sound but also feasible, adaptable, and sustainable in complex, real-world settings where as without feasibility, interventions in real-world settings are frequently degraded.

This "theory-to-implementation gap" is particularly difficult because interventions that are too complex or poorly suited to the real world fail to foster the immediate, positive experiences (such as enjoyment and a sense of accomplishment) that are essential for building sustainable motivation. Decades of health behavior research suggests that long-term change is rarely sustained by abstract, extrinsic goals like weight loss or disease prevention—the "wrong whys" for behavior change (Segar, 2015). Instead, adherence is driven by immediate, intrinsic rewards: the "right whys," such as improved daily mood, increased energy, and feelings of competence and enjoyment (Ryan & Deci, 2017). However, when an intervention is overly complex, burdensome, or ill-suited to its context, it stifles any opportunity for these positive experiences to emerge (Damschroder et al., 2009; Ryan & Deci, 2017). An employee confused by a novel exercise routine is unlikely to find it enjoyable, similar to the ways a clinician rushed for time cannot effectively build a patient's self-efficacy. Thus, this dissertation builds the concept that practical feasibility (e.g. time constraints, intervention complexity) is not merely a logistical consideration; it is the essential bridge to fostering the intrinsic motivation that is paramount for lasting success in sedentary populations.

1.3 The Present Dissertation

This dissertation addresses critical gaps between theory and implementation through a three-paper, mixed-methods approach within two different environments (worksite and clinical), aiming to provide a comprehensive view of the challenges and opportunities in implementing PA interventions by examining them from multiple perspectives: the existing literature, the employee participant, and the clinical staff provider.

Chapter 2 presents a systematic review of the literature on worksite PA interventions, focusing specifically on their impact on the PA and/or SB as well as combined outcomes of occupational wellbeing. This review establishes the current state of the field and identifies the specific gaps that the subsequent empirical studies aim to address.

Chapter 3 presents findings from a pilot randomized controlled trial comparing two distinct online-delivered worksite exercise break programs: a simple, familiar Walking Reminder (WR) and a culturally-novel, structured Japanese exercise routine, Radio Taiso (RT). This study examines differences in objective PA, self-reported psychosocial outcomes, and, crucially, patterns of engagement and adherence.

Chapter 4 evaluates the initial implementation of the "Cardio Commitment Course" (C3), a novel, HAPA-based education program designed for this study to be used in cardiac rehabilitation settings. This study takes a staff-centric approach, using a mixed-methods design to explore the feasibility, acceptability, and implementation fidelity from the perspective of the CR staff delivering the intervention.

Together, these three papers provide a multi-faceted exploration of the critical factors that influence the success of PA interventions, moving beyond simple efficacy to a more nuanced understanding of implementation, adaptation, and real-world applicability.

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Chapter 2 - The Impact of Workplace Physical Activity Interventions on Occupational Wellbeing: A Systematic Review

2.1 ABSTRACT

BACKGROUND: Sedentary behavior (SB) is a leading cause of chronic disease. Workplace physical activity programs (WPAPs) are an evidence-based strategy to improve employee health, but to maximize investment, they must also demonstrate value by enhancing "occupational wellbeing"—an integrated concept encompassing physical health, psychological state, and work performance. This systematic review compiles evidence from U.S.-based WPAPs to summarize the effectiveness of different intervention components on occupational wellbeing.

METHOD: Following PRISMA guidelines, a systematic search of 82 databases was conducted for peer-reviewed studies published between January 2012 and July 2025. Inclusion criteria required studies to be U.S.-based WPAP interventions that measured outcomes related to physical activity (PA) and/or SB, and occupational wellbeing. Data on intervention components, delivery mode, and outcomes were extracted and synthesized.

RESULTS: Of 3,677 records identified, eight studies met the inclusion criteria. All eight studies demonstrated improvements in PA/SB or occupational wellbeing. A clear hierarchy of effectiveness was observed: the four multi-component interventions that combined equipment (e.g., sit-stand desks) with theory-based education yielded the most robust and quantitatively significant improvements across all domains. In contrast, interventions providing only equipment or education produced more limited improvements. Although the benefits were primarily identified through qualitative data rather than significant quantitative changes, participants did not mention benefits consistently across all study participants or between interventions. A significant heterogeneity in the measurement tools used to assess wellbeing was noted across studies.

CONCLUSION: U.S.-based WPAPs are an effective strategy for improving employee occupational wellbeing. The evidence strongly suggests that multi-component interventions combining supportive equipment with theory-based education are most effective. To build a stronger business case for these comprehensive programs, future research should prioritize the development of standardized outcome measures and the inclusion of cost-benefit analyses.

2.2 INTRODUCTION

Inactive individuals have a 20% to 30% increased risk of all-cause mortality compared to their active counterparts (World Health Organization, 2012). Globally 27.5% of adults are not meeting recommended amounts of physical activity (PA; Garwood, 2018; *Global Status Report on Physical Activity 2022*, 2022), whereas in the United States, there is a much higher rate (75.8%) of adults who do not meet U.S. PA guidelines (at least 30 minutes of moderate-intensity PA five days a week plus two strength training sessions a week; Elgaddal et al., 2020). Physical inactivity has been identified as one of three primary risk factors (along with diet and smoking) that contribute to four chronic diseases (heart disease, type 2 diabetes, lung disease, and some cancers), which in turn contribute to about 80% of premature deaths in the U.S. (Ablah et al., 2019). Most major health issues can be prevented or improved with PA (Malik et al., 2014) (CDC, 2016). Therefore, increasing PA is a crucial public health priority (Ablah et al., 2019; CDC, 2016; Elgaddal et al., 2020; Gray, 2017; Statistics, 2024a, 2024b). Given the large portion of the day that adults spend at work, U.S. workplaces could provide a valuable opportunity to encourage more PA among citizens (Ablah et al., 2019; CDC, 2016; Elgaddal et al., 2020; Fritz et al., 2013; Gray, 2017; Statistics, 2024a, 2024b). Reducing long bouts of job-related sedentary behavior (SB) can also minimize the risk of developing several chronic diseases (CDC, 2016).

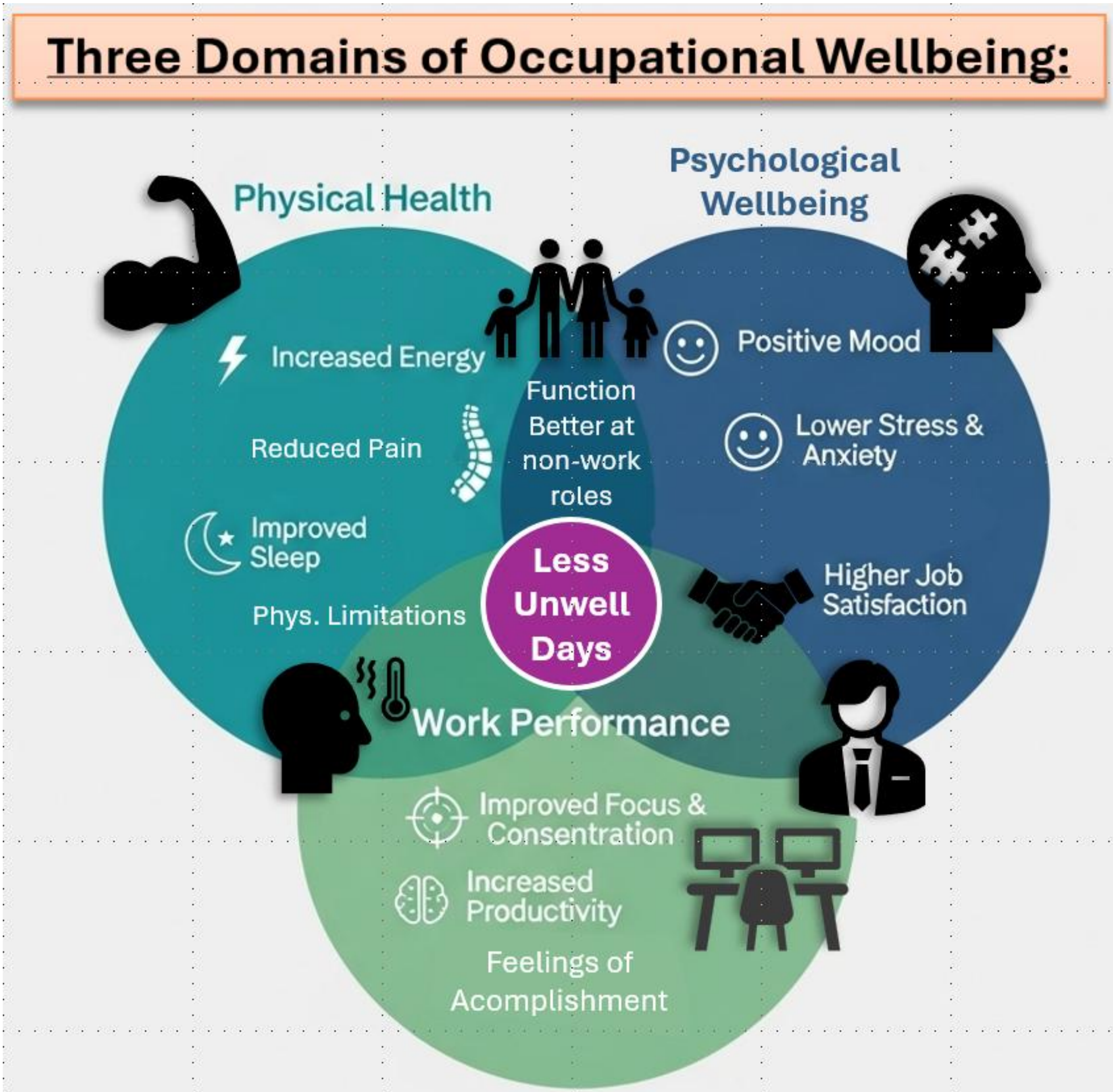
Within the scope of this review, there are several core concepts that should be defined. The World Health Organization defines PA as any bodily movement produced by skeletal muscles that requires energy expenditure (*WHO Guidelines on Physical Activity and Sedentary Behaviour*, 2020). PA can occur in various domains, including during leisure-time or during work (*WHO Guidelines on Physical Activity and Sedentary Behaviour*, 2020). SB is not merely the absence of PA, but is defined as any waking behavior characterized by an energy expenditure

≤1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture (on behalf of SBRN Terminology Consensus Project Participants et al., 2017; *WHO Guidelines on Physical Activity and Sedentary Behaviour*, 2020). For many U.S. employees, long bouts of job-related SB are common and represent a distinct health risk (Dunstan et al., 2021). Given that adults spend a significant portion of their day at work, the workplace is a high potential setting for health interventions. Workplace PA programs (WPAPs) are structured initiatives designed to improve employee health by increasing PA and/or decreasing SB (Malik et al., 2014). These programs are typically implemented at the worksite and target employees through various components, which can include educational content, environmental modifications (such as providing equipment), and theoretically-based behavioral strategies including addressing barrier/facilitators and risk perceptions (Malik et al., 2014; Pereira et al., 2015).

As of 2024, out of the 132.9 million American employees, 101.3 million (76.2%) are inactive during their workday (Statistics, 2024a, 2024b). There is a lack of implemented PA programs in U.S. workplaces that use behavioral change strategies encourage PA among employees and employers (Malik et al., 2014). As of 2018, 62% of employers in the U.S. report having a WPAP, namely, resources and encouragement from their employer to be more physically active (Safi et al., 2022). More recently, according to the 2023 Society of Human Resource Management Employee Benefits Survey, the most common type of WPAP offered by U.S. employers is providing standing desks (63%) with others directly promoting PA by offering a fitness center membership subsidy or reimbursement (37%), or providing an on-site fitness center (23%; SHRM, 2023). Although these types of WPAPs provide resources to increase PA and reduce SB of employees, they do not target behavior change of the employees or aim to educate employees on the benefits of workplace PA (SHRM, 2023). WPAPs can range from single-component approaches, such as providing only equipment, to multi-component interventions that combine equipment with theory-based education and behavioral support (Leso et al., 2024). Emerging research suggests that integrated, multi-component designs (e.g., including components such as counseling, education, equipment, and incentives) are often the most effective at changing sedentary behavior leading to other benefits (Leso et al., 2024). Implementing WPAPs can be an effective way to change PA and SB, thus reducing rates of chronic disease and premature death in inactive U.S. employees (CDC, 2016; Gray, 2017). WPAPs are also known to have a host of work performance benefits, including employee wellbeing, increased vigor, positive mood, and less fatigue (Gray, 2017). Additionally, adopting healthy work break PA behaviors can help replace unhealthy workplace habits—such as skipping employer-allotted breaks, taking smoke breaks, or using cell phones—that have been shown to increase employee fatigue, reduce productivity, and contribute to burnout (Fritz et al., 2013; Peters et al., 2022).

The success of WPAPs often pivots on aligning the interests of employees, who prioritize improvements in their personal psychological health and wellbeing, with those of employers, who are often focused on organizational productivity (Grimaud et al., 2022; Malik et al., 2014; Safi et al., 2022). Therefore, this review conceptualizes these interconnected outcomes under the unified term occupational wellbeing, defined as a comprehensive construct encompassing both an employee's physical health, psychological state, and their behavioral outcomes related to work productivity (such as time on task compared to off task, presenteeism, or energy/mood/focus; Zheng et al., 2015). Physical health components include outcomes such as a reduction in musculoskeletal pain and a decrease in illness-related absenteeism (Losina et al., 2017). Psychological components include factors such as mood, energy/fatigue, stress, and job satisfaction (*WHO Guidelines on Mental Health at Work*, 2022; *WHO Guidelines on Physical Activity and Sedentary Behaviour*, 2020). Productivity components include behavioral outcomes such as perceived productivity, focus, and concentration (Harter et al., 2003). There are also concepts that overlap between physical health, psychological state, and productivity such as fatigue, general-absenteeism, workplace satisfaction, and supervisor relationships (Harter et al., 2003). To visually represent this integrated construct and guide this scoping review, a conceptual model was designed (Figure 2.1). This model illustrates the three core domains of occupational wellbeing: physical health, psychological wellbeing, and work performance. The overlapping areas represent interconnected concepts, such as how fatigue impacts both physical and psychological states, demonstrating the integrated nature of an employee's experience at work. A simplified infographic summarizing these core concepts is presented in Figure 2.1, while Appendix Figure A.1 provides a more detailed model that includes the specific outcomes and validated measurement tools identified in the literature.

Figure 2.1: Occupational Wellbeing and Overlap of its Core Concepts



Although the benefits of WPAPs are well known, barriers and facilitators for WPAPs adherence have only recently been explored (Fritz, 2012; Grimaud et al., 2022). Recent studies have found employer and coworker support was the most common facilitator for increasing WPAP adherence (Bredahl et al., 2019; Lyubykh et al., 2022; Malik et al., 2014). In contrast, common reported employee WPAP barriers included lack of time, lacking management support, and workplace culture as the primary barriers to workplace PA participation (Grimaud et al., 2022). A systematic review (including 28 studies) factors influencing employer adoption of wellness programs found that the primary motivators for implementation were the perceived benefits to the organization, including improved employee productivity and morale (McCoy et al., 2014)**.** From the employee perspective, a separate review (including 24 studies) identified that the strongest facilitators for participation in workplace PA interventions were the perceived benefits to their personal health and the belief that the activity would be enjoyable and beneficial (Grimaud et al., 2022). These studies suggest that emphasizing the benefits of occupational wellbeing (particularly mental health and productivity) can simultaneously encourage more employers to implement WPAPs while increasing employee adherence to PA behaviors (Fritz, 2012; Grimaud et al., 2022). Despite this, a clear synthesis of how different WPAP strategies impact the *integrated* concept of occupational wellbeing is lacking in the literature (Shiri et al., 2023). Furthermore, there is a specific need to understand these dynamics within the context of U.S. workplaces and to characterize the measurement tools used to assess these outcomes (Goetzel & Ozminkowski, 2008).

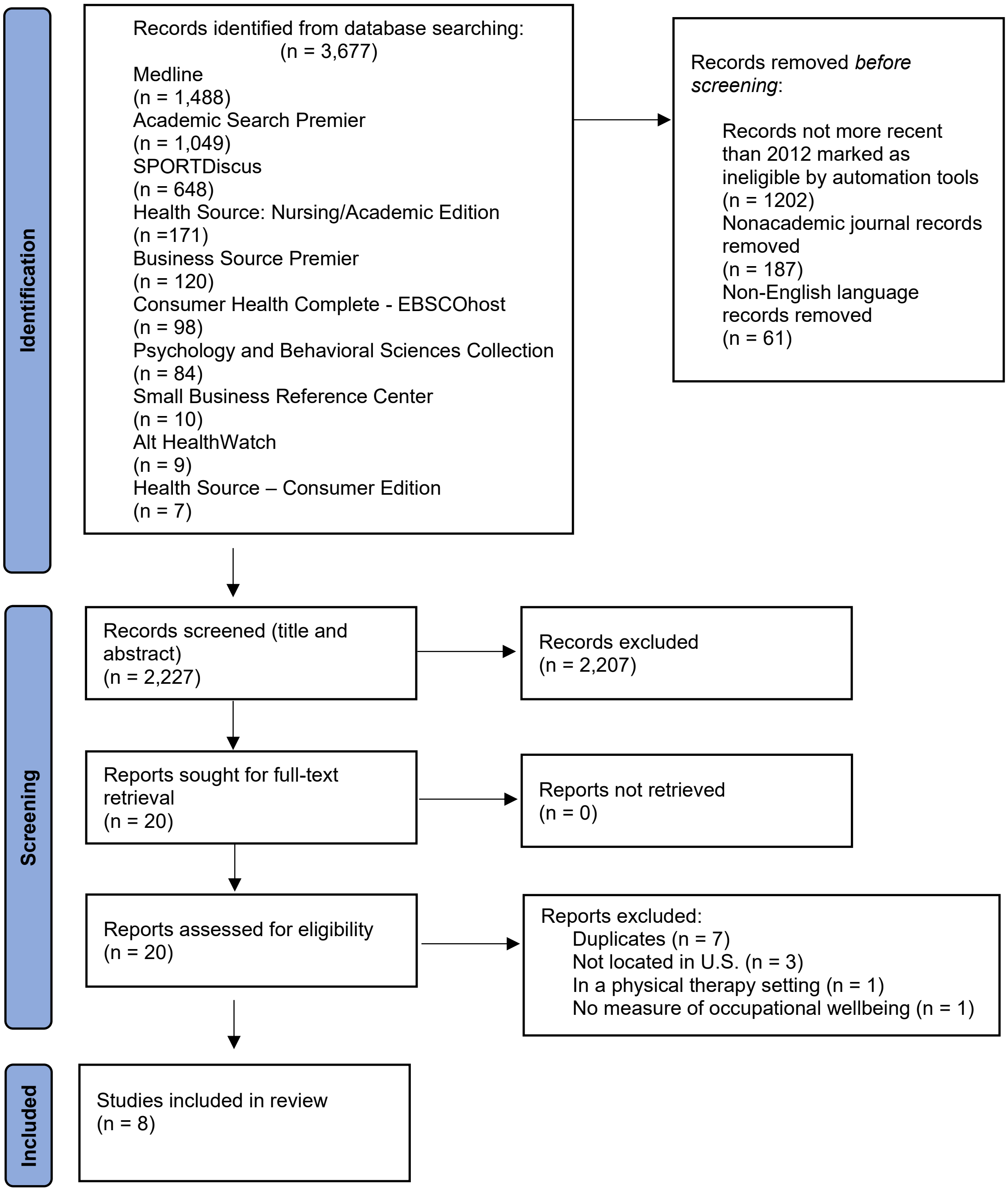
This systematic review aims to fill several critical gaps. First, it provides a needed synthesis of WPAP effectiveness, focused specifically on the U.S. workplace context. Second, it is the first to systematically analyze this literature through the unified outcome of occupational wellbeing. Finally, by characterizing the different intervention strategies (e.g., providing equipment like sit-stand desks, offering educational programs, or a combination of both), it explores which components may be most effective. Therefore, the purpose of this review is to: 1) identify and synthesize evidence from U.S.-based WPAPs published between 2012 and 2025 that measured impacts on physical activity, sedentary behavior, and occupational wellbeing; 2) characterize and compare the effectiveness of different WPAP strategies based on their core components (i.e., multi-component, equipment-only, and education-only); and 3) summarize the measurement strategies used to assess these outcomes.

2.3 METHODS

Data Sources

The protocol was prepared following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for publishing systematic reviews (PRISMA-P Group et al., 2015). The following databases were searched and returned results within EBSCOhost muti-database search between January 2012 and July 2025: *Alt HealthWatch, Consumer Health Complete - EBSCOhost, Health Source - Consumer Edition, Health Source: Nursing/Academic Edition, MEDLINE, Psychology and Behavioral Sciences Collection, Small Business Reference Center, SPORTDiscus, Academic Search Premier*. While PA in the workplace reviews have been published after 2012 (Grimaud et al., 2022; Lyubykh et al., 2022; Shiri et al., 2023; Soler et al., 2010), none focused on the integrated concept of occupational wellbeing as the primary outcome. Many reviews in the early 2010's are now more than a decade old, and the epidemic of inactivity while at work continues to grow, especially in the last 10 years (Malik et al., 2014; Pereira et al., 2015). This timeframe also captures a decade of evolution in workplace wellness, including the rise of remote work and technology-based interventions accelerated by the COVID-19 pandemic (Peters et al., 2022). This has resulted in increased rates of online WPAPs and increased remote job opportunities (Peters et al., 2022). Figure 2.2 displays the Prisma flow diagram for identified records and studies in this review.

Figure 2.2: Prisma Flow Diagram



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71

Systematic search terms and strategies were developed using assistance of a health sciences librarian and exercise behavior expertise from two-coauthors. Four key concepts were selected to categorize the 26+ terms of the search. The key concepts include workplace, PA, occupational wellbeing (which includes health and productivity-related outcomes), and WPAP intervention terms. The full list of search terms can be found in Table 2.1. Each of these terms were combined using AND/OR search functions to create a unified final search. The final search was inserted into the search field of EBSCO with the databases mentioned above selected. The entire final search is as follows: (work* OR "work environment" OR "work spaces" OR job OR office Or employ* OR "work places") AND (sedentary OR fitness) AND (employ* OR work*) AND ("physical activity" OR exercise OR fitness OR "physical exercise") AND (interven* OR program OR strategy*) AND (enjoy* OR satisf* OR control OR "social support" OR stress OR anxi* OR "well being") AND (productiv* OR perform* OR absent* OR efficien* OR capa*). Finally, utilizing EBSCO's refine results tools, articles were filtered by year (2012 – 2025), English Language, and only results from academic journals.

Table 2.1: Full List of Search Terms

Workplace Terms	**Physical Activity Terms**	**Occupational Wellbeing Terms**		**Intervention Terms**
Work* *OR* "Work Environment" *OR* "Work Spaces" *OR* Job *OR* Office *OR* Employ* *OR* "Work places"	"Physical activity" *OR* Exercise *OR* Fitness *OR* "Physical exercise" *OR* Sedentary	Enjoy* *OR* Satisf* *OR* Control *OR* "Social Support" *OR* Stress *OR* Anxi* *OR* "well being"	Productiv* *OR* Perform* *OR* Absent* *OR* Efficien* *OR* Capa*	Interven* *OR* Program *OR* Strateg*

Search Strategy and Selection Criteria

A systematic search was conducted utilizing the EBSCOhost platform, which searched across 82 health and social sciences databases, yielding relevant results from 10 unique databases. The detailed search terms are provided in Table 2.1.

The initial search yielded 3,677 articles. After automated filters were applied to remove non-English articles (n=61), pre-2012 publications (n=1,202), and non-peer-reviewed sources (n=187), a total of 2,227 articles remained for screening. The primary author independently screened titles and abstracts, excluding 2,207 articles that did not meet the inclusion criteria. Twenty full-text articles were retrieved for final eligibility assessment. Of these, 12 were excluded for the following reasons: duplicate publication (n=7), study not located in the U.S. (n=3), intervention in a clinical physical therapy setting (n=1), and no relevant outcomes reported (n=1). This resulted in a final sample of eight studies for inclusion in the review.

The following inclusion and exclusion criteria determined article eligibility. Inclusion criteria included: a.) A work-based intervention/program that has a PA or SB primary focus (Not multicomponent, e.g. PA + healthy eating, or mental health interventions with a PA component) b.) published between 2012 and 7/10/2025 c.) article was peer-reviewed d.) intervention must target employees who are reported in the study as typically sedentary during their workday e.) the PA intervention must measure at least 1 outcome/measure of occupational wellbeing f.) English language and in the U.S.. Articles that did not meet all of these inclusion criteria were excluded.

Data Extraction and Analysis

Data extraction was performed by one author and verified by a second, with any disagreements resolved through consensus discussion. The following data were extracted from each study into a standardized Excel workbook: author and publication year, study design, intervention characteristics (type, setting, duration, theoretical basis), participant characteristics, and all reported PA/SB and occupational wellbeing outcomes.

A narrative synthesis approach was used to analyze the findings (Popay et al., 2006). First, to identify and synthesize the evidence on program impacts (Aim 1), the results were categorized by the primary outcome domains of PA/SB and occupational wellbeing. Next, to characterize and compare the effectiveness of different WPAP strategies (Aim 2), interventions were grouped by their core components (i.e., equipment-only, education-only, or combined). Finally, to summarize the measurement strategies used (Aim 3), the various assessment tools reported in each study were extracted and tabulated for comparison.

2.4 RESULTS

Characteristics of Included Studies

The search identified eight U.S.-based studies published between 2012 and 2025 that met the inclusion criteria. All eight studies implemented a WPAP and reported on at least one component of occupational wellbeing. Table 2.2 summarizes the characteristics of the included studies. The eight included studies (Carr et al., 2016; Cifuentes et al., 2015; Dutta et al., 2019; Falk et al., 2022; Quinn et al., 2018; Rollo & Prapavessis, 2021; Santa Barbara et al., 2022; Smith et al., 2018), represented a variety of workplace settings, including multi-site corporations (Cifuentes et al., 2015; Rollo & Prapavessis, 2021; Smith et al., 2018), single-site offices (Carr et al., 2016; Dutta et al., 2019; Falk et al., 2022), and college campuses (Falk et al., 2022; Quinn et al., 2018; Santa Barbara et al., 2022), with one study using local YMCA facilities for delivery (Smith et al., 2018). The populations targeted were also diverse, including generally sedentary employees (Dutta et al., 2019; Falk et al., 2022; Quinn et al., 2018), employees with obesity, (Cifuentes et al., 2015; Smith et al., 2018) and employees with low back pain (Carr et al., 2016). Intervention durations ranged from 6 weeks to 6 months (Carr et al., 2016; Cifuentes et al., 2015;

Falk et al., 2022; Quinn et al., 2018; Rollo & Prapavessis, 2021; Santa Barbara et al., 2022; Smith et al., 2018), with one study reporting a 1-year follow-up (Dutta et al., 2019).

A majority of the interventions (n=6) were grounded in established behavioral theories, most commonly Social Cognitive Theory (SCT; Carr et al., 2016; Falk et al., 2022; Santa Barbara et al., 2022) while Cognitive Behavioral Therapy (CBT) (Quinn et al., 2018), Social Learning Theory (SLT; Smith et al., 2018), and the Health Action Process Approach (HAPA; Rollo & Prapavessis, 2021) were also utilized.

Table 2.2: Study Characteristics

Study	**N**	**Intervention Description**	**Measures**	**Employee Traits**	**Intervention Location**	**Intervention Type**	**Setting**	**Duration & Follow-up**
Carr et al., 2016	n=54	RCT: Workstation optimization + SCT emails + pedals vs. Ergonomic intervention + emails only.	PA: Accelerometer, Self-report, and iPod tracking. Prod/Well: NMQ, & HPQ	Full Time, Obese and Sedentary	In-person and via email	Equipment & Education	Large multi-site univ. Midwest Company	16 weeks (6-month Follow-up)
Cifuentes et al., 2015	n=5	Pre-post focus group data from an under-desk treadmill intervention.	Focus Group Analysis	Sedentary	In Person	Equipment Only - Treadmill	College	6 months Focus group Follow-up
Dutta et al., 2018	n=41	Pre-post follow-up measures & focus groups from a sit-to-stand desk (SSD) intervention.	Focus Group Analysis	Sedentary	In person	Equipment Only-ActiveWork	Single location company	1 year total (incl. Follow-up)
Falk et al., 2022	n=146	RCT 4-arm: Desk Only vs. Online SCT program vs. Desk+Program vs. Control. Online modules + prompts.	ActivPALs, PANAS, PSS, FSI, HWQ, and Qualitative Response Analysis	Full Time, Remote, Sedentary	Online	Equipment & Education	College	12 weeks (Measured at intervals)
Quinn et al., 2018	n=18	RCT Pre-post: Monthly CBT + Sit-stand attachment + wrist prompt + cognitive behavioral	Self Reported Sitting, SF-36, SPS, HWQ, and ODI	Full Time, Chronic low back pain	In person	Equipment & Education	Office	8 months (12-week Follow-up)

		therapy for pain self-management.						
Rollo et al., 2021	n=40	RCT Pre-post HAPA model: SB planning + text messages vs. Control.	OSPAQ, Self-Report Performance, and SF-36	Full Time, Healthy Employees	In person and via email	Equipment & Education	Large businesses, office spaces, & colleges	8 weeks (12-week Follow-up)
Santa Barbara et al., 2022	n=46	Pre-post virtual SCT program: 2x/wk. PA sessions + 1x/wk. nutrition webinar + optional consult.	# days of light, moderate, & vigorous activity and strength training. Anthropometric, Plank Time, and Steps in meters	Active and Inactive	Online	Education Only	College	10 weeks (No Follow-up specified)
Smith et al., 2018	n=47	RCT Pre-post SLT-based: 8wk, 2x50min sessions + leader/bridge training vs. Control (CRSMA program).	Self-report (exercise, sitting time, stress, pain, fatigue, and sleep), WLQ, WAI, and HRQoL	Full Time, primarily white, Sedentary	In person at YMCA at various worksites	Education Only	Multi-site business sites and schools	6 months (3-month Follow-up)

Measures Used in Included Studies

A wide range of measurement tools were used across the eight studies to assess the primary outcomes, please view Table 2.3 for more details about measures and outcomes.

Physical Activity and Sedentary Behavior: PA and SB were assessed using both objective methods and subjective self-report. Objective measures included accelerometry (e.g., ActivPALs, iPod tracking) to quantify activity and sedentary time (Carr et al., 2016; Falk et al., 2022). Subjective self-report measures were more common as studies used validated questionnaires like the Occupational Sitting and Physical Activity Questionnaire (OSPAQ)(Rollo & Prapavessis, 2021) and self-report sitting questionnaires (Quinn et al., 2018; Smith et al., 2018). Two studies (Santa Barbara et al., 2022; Smith et al., 2018) used simpler self-report items, such as asking for the number of days participants exercised per week. Finally, qualitative data from focus groups or interviews were used to explore perceived changes in PA (Cifuentes et al., 2015; Dutta et al., 2019; Falk et al., 2022).

Occupational Wellbeing: The measurement of occupational wellbeing was similarly varied. Four studies utilized multi-faceted, validated instruments capable of assessing both psychological and work performance components simultaneously, such as the Health and Work Questionnaire (HWQ; Falk et al., 2022; Quinn et al., 2018), WHO Health and Work Performance Questionnaire (HPQ; Carr et al., 2016), and the Work Ability Index (WAI) and Short-Form Work Limitations Questionnaire (WLQ; Smith et al., 2018). Other studies measured wellbeing using more specific instruments, including the Research and Development (RAND) Short Form (SF-36) for health status (Quinn et al., 2018; Rollo & Prapavessis, 2021) the Standardized Nordic Musculoskeletal Symptom Questionnaire (NMQ) for pain, (Carr et al., 2016) and a suite of psychological tools like the Positive and Negative Affect Schedule (PANAS), Perceived Stress Scale (PSS), and Fatigue Severity Inventory (FSI; Smith et al., 2018).

Table 2.3: Validated Productivity & Wellbeing Measures Included in Review Interventions

Measure	**Productivity Outcomes**	**Phys./Mental Health Outcomes**	**Multicomponent Occ. Wellbeing Outcomes**
Health and Work Questionnaire (HWQ)	Productivity, Focus	Impatience/irritability, Nonwork Satisfaction	Supervisor Relations, Work Satisfaction
Health and Work Performance Questionnaire (HPQ)	Work Functioning (Presenteeism)	Critical Instances (Health Status)	Work Sickness Absence (Absenteeism)

Short-Form Work Limitations Questionnaire (WLQ)	Time Management, Output Demands		Physical Demands, Mental Interpersonal Demands
Work Ability Index (WAI)	Current Work Ability Compared with Lifetime Best, Work Ability in Relation to Job Demands, Prognosis of Work Ability Two Years from Now	Mental Health/ Resources	Estimated Work Impairment Due to Diseases, Sick Leave During the Past Year
Stanford Presenteeism Scale (SPS)	Completing Work Tasks, Concentration and Focus, Work Quality, Work Quantity		Physical and Mental Interference
RAND 36 Item Health Survey (SF-36)	Role Functioning	Bodily Pain, General Health	Physical Functioning
CDC Healthy Days Scale (HRQoL)		General Health	Physically Unhealthy Days, Mentally Unhealthy Days, and Activity Limitation Days
Standardized Nordic Musculoskeletal Questionnaire (NMQ)		Pain: Neck, Shoulders, Upper back, Lower back, Elbows, Wrists/hands, Hips/thighs, Knees, and Ankles/feet	

Occupational Wellbeing Outcomes by Intervention Type

For the synthesis of findings, the interventions were categorized by their primary components: Combined Equipment & Education (n=4;Carr et al., 2016; Falk et al., 2022; Quinn et al., 2018; Rollo & Prapavessis, 2021), Equipment-Only (n=2; Cifuentes et al., 2015; Dutta et al., 2019), and Education-Only (n=2; Santa Barbara et al., 2022; Smith et al., 2018). See Table 2.4 for a summary of intervention effects on PA/SB and occupational wellbeing outcomes.

Combined Equipment & Education Interventions. The four equipment and education interventions were delivered in various settings, including hybrid (in-person and electronic) models at multi-site companies (Carr et al., 2016; Rollo & Prapavessis, 2021), an exclusively online program for remote college employees (Falk et al., 2022), and an in-person program at a single office (Quinn et al., 2018). Studies that combined equipment and education intervention components demonstrated the broadest improvements in PA/SB and occupational wellbeing outcomes.

The four studies that provided a physical tool alongside behavioral education were highly effective at modifying PA/SB behaviors. All four demonstrated significant reductions in sedentary time or increases in PA (Carr et al., 2016; Falk et al., 2022; Quinn et al., 2018; Rollo & Prapavessis, 2021). For example, Quinn et al. (2018) reported that their intervention group sat 1.5 hours less per day ($p < .001$), Falk et al. (2022) found a large effect size for reduced sitting time ($d = -1.84$;), and Carr et al. (2016) showed a significant increase in occupational PA ($p = .04$, $d = 0.38$).

From a psychological wellbeing perspective, Falk et al. (2022) found a large effect on positive affect ($d = 1.11$) and moderate improvements in fatigue duration ($d = -0.533$) and fatigue interference ($d = -0.648$). Rollo et al. reported significant improvements in emotional wellbeing ($F(1, 58) = 6.47$, $p = .014$) and fewer emotional related role limitations ($F(1, 58) = 4.90$, $p = .031$; Rollo & Prapavessis, 2021). Regarding physical wellbeing, Quinn et al. (2018) found significant reductions in low back pain (Oswestry Disability Index score change of -7.8%, $p =$

.027) and general pain ($\beta = 8.85$, $d = 0.48$, $p = .036$), alongside highly significant reductions in fatigue ($\beta = 18.79$, $d = .84$, $p < .001$). From a work performance perspective, the intervention by Carr et al. (2016) was associated with improved concentration ($p = .03$) and fewer missed work days (average under desk bike pedal time was negatively correlated with days missed, $r = -0.41$; $p = .03$). The Falk et al. (2022) study also showed significant effects on work focus ($d = 0.702$) and work satisfaction ($d = 0.751$).

Equipment-Only Interventions. The two equipment-only interventions were both qualitative studies delivered in-person at single-site workplaces, one in a college setting (Cifuentes et al., 2015) and one at a private company (Dutta et al., 2019). Both also successfully modified PA/SB behaviors. Dutta et al. (2019) observed a significant increase in work PA (95% CI: 7150 to 42,347; $p < .01$) and a 22% reduction in self-reported sitting time ($p < .001$). Cifuentes et al. (2015) also qualitatively reported reduced sedentary time among treadmill desk users. These studies primarily reported qualitative improvements in occupational wellbeing. Participants in both interventions noted that the equipment did not negatively impact their normal work productivity. Both interventions led to participant reports of psychological benefits, such as improved energy and postural awareness (Dutta et al., 2019), as well as better mood and enjoyment (Cifuentes et al., 2015).

Education-Only Interventions. The two education-only interventions utilized different delivery modes; one was delivered entirely online to college employees (Santa Barbara et al., 2022), while the other was delivered in-person at worksites and local community YMCA locations to employees from various multi-site businesses/schools (Smith et al., 2018). The two interventions relying solely on educational or behavioral components also led to significant changes in PA and health behaviors (Santa Barbara et al., 2022; Smith et al., 2018). The in-person program by Smith et al. resulted in significantly increased PA ($u\Delta = 2.88$, $SE = 1.40$, $p = .039$) and a significant reduction in SB ($u\Delta = -4.49$, $SE = 1.90$, $p = .018$; Smith et al., 2018). The online program by Santa Barbara et al. (2022) reported significant improvements in muscular endurance and plank time, $t(6) = 4.50$, $p < .01$.

The intervention by Smith et al. (2018) demonstrated significant improvements across multiple domains of occupational wellbeing. For physical and psychological wellbeing, they reported significantly fewer physically unhealthy days ($u\Delta = -2.07$, $SE = 0.87$, $p = .018$), reduced fatigue ($u\Delta = -2.88$, $SE = 0.92$, $p = .002$), and improvements in dietary habits, including reduced soda/sugar beverage consumption ($u\Delta = -0.78$, $SE = 0.35$, $p = .028$) and fast food intake ($u\Delta = -0.76$, $SE = 0.29$, $p = .009$; Smith et al., 2018). For work performance, this study also found a significant reduction in mental work limitations compared to the control group ($u\Delta = -30.56$, $SE = 14.87$, $p = .040$; Smith et al., 2018). The online program by Santa Barbara et al. (2022) reported significant improvements in physical wellbeing, including reductions in body weight ($p < .01$) and BMI ($p < .02$), but found no significant changes in self-reported stress ($p > .05$).

Table 2.4: Employee Physical Activity and Occupational Wellbeing Outcomes

Study	Physical Activity Outcomes		Occupational Wellbeing Outcomes			
			Productivity Outcomes		Physical/Mental Health Outcomes	
Carr et al., 2016	Increased light PA; Total PA counts (w/in group)	++	Concentration (within-group change, p = .03)	++	Musculoskeletal pain (group diff); Cardiometabolic markers (group diff)	0
	Trend decreased sedentary time	+	Overall productivity	0	Improved cardiometabolic markers (adherence assoc.)	+
			Fewer missed days (adherence assoc.)	+		
Cifuentes et al., 2015	Variable use reported; Usability issues (setup, noise, height); Planning helped	Q+	Affected by speed/task (esp. drawing/spreadsheets); Need for coaching mentioned	0/Q+	Initial discomfort (resolved); Enjoyment/ energy/mood; Peer pressure reported	Q+
Dutta et al., 2019	Decreased sitting (self-report); Increased standing (self-report)	+++	No negative impact reported	Q+	Energy; Postural awareness	Q+
	Increased overall activity (accelerometer); Increased Vigorous PA (accelerometer)	++				
	Trend decreased sedentary time (accelerometer, p = 0.17)	+				
	Walking/Heavy work (self-report)	0				
Falk et al., 2022	Decreased Sitting Time vs Control (Desk Only d = -0.98; Program Only d = -1.13; Desk+Program d = -1.84)	++	(vs Control) Desk+Program: Focus (d = 0.70); Work Satisfaction (d = 0.75)	++	(vs Control) Desk+Program: Positive Affect (d = 1.11)	++

	(Qualitative) Increased PA (Desk 32%; Program <45%); Increased exercise outside work (Prog 36%); Taking more breaks (Prog 24%)	Q+	(vs Control) Desk+Program: Productivity (d = 0.57); Non-work Satisfaction (d = 0.60)	+	(vs Control) ***Desk+Program***: Fatigue Duration (d = -0.53); Fatigue Interference (d = -0.65); ***Program:*** Positive Affect (d = 0.57), Fatigue Severity (d = 0.58)	+
			Improved work performance (Desk 49%; Program 14%)	Q+	(vs Control) ***Desk***: Positive Affect (d = 0.135), Negative Affect (d = 0.43)	0
					Desk: Improved energy (39%); Less pain/stiffness (32%); Improved mental wellbeing/mood (17%); Improved sleep (5%). *Program*: Increased awareness/other behaviors (36%); Spending more time outside (12%). *Both*: Physiological health imp. (Desk 22%; Prog 12%)	Q+
Quin et al., 2018	Decreased sitting time ($p < .001$)	+++	Productivity; Concentration/Focus; Presenteeism (SPS); Supervisor relations; Work Satisfaction	0	Low back pain; Social functioning; Pain; Non-work Satisfaction; Impatience/Irritability; Emotional wellbeing (all $p < .05$)	++
					Energy/Fatigue ($p < .001$)	+++
					General Health; Role Limit (Physical)	0
Rollo et al., 2021	***From Parent Study:*** Decreased sitting time; Increased standing time; Increased stretching time	++	Work performance (Both groups improved over time, NS between groups)	0	Role limitations (emotional) (p = .014); Emotional wellbeing (p = .014; Trend mediation via sitting)	++

					Energy/fatigue (Both groups improved over time, $p = .072$ between)	+
					Role limitations (physical) (Both groups improved over time, NS between groups)	0
Santa Barbara et al., 2022	Muscular endurance ($p < .01$) Aerobic fitness ($p > .05$)	++ 0	Not measured	N/A	Weight loss ($p < .01$); BMI reduction ($p < .02$) Stress ($p > .05$) Acceptability/Enjoyment; Logistical issues / Pref. for working alone	++ 0 Q+
Smith et al., 2018	SB (w/in group); Physical Activity days (between group difference)	++	Mental work limitations (w/in & between)	++	Physical unhealthy days; Fast food intake; Patient communication	++
			Work Ability	0	Fatigue (between); Soda/sugar intake (between)	+++
			WLQ- Time, Physical, Interpersonal, Output	0	Self-efficacy (between group trend, $p = .056$)	+
					Mentally unhealthy days; Pain; Depression; Fruit/veg intake; Med adherence; Job stress; Stress (w/in group); Sleep problems (w/in group)	0

Code Key:
0: No change / Not significant ($p > .05$)
+: Reported improvement based on quantitative data (e.g., $.05 < p < 0.10$, moderate/large effect size without $p < .05$)
Q+: Participant reported improvement based on qualitative data (e.g., focus groups, participant reports/feelings, acceptability)
++: Significant improvement (e.g., $p < .05$)
+++: Highly significant improvement (e.g., $p < .001$)

2.5 DISCUSSION

This systematic review identified/synthesized evidence from U.S.-based WPAPs measuring their impact on PA, SB, and the integrated outcome of occupational wellbeing. This review of eight studies revealed three primary findings. First, WPAPs are consistently effective at modifying employee PA behaviors, resulting in significant increases in PA and reductions in SB. Second, these programs also lead to broad improvements in occupational wellbeing, encompassing psychological states, physical health, and work performance. Lastly, the most comprehensive benefits appear to be associated with multi-component interventions that combine existing theory, PA equipment, and educational support.

Interpretation of Findings by Intervention Type

A key finding of this review is the difference in amount of significant outcomes based on intervention components. The four multi-component interventions yielded the broadest/most robust quantitative improvements across all domains of occupational wellbeing (Carr et al., 2016; Falk et al., 2022; Quinn et al., 2018; Rollo & Prapavessis, 2021). In contrast, interventions that provided only equipment or only education tended to produce more inconsistent improvements (education only) or benefits that were primarily perceived/qualitative in nature (Equipment only; Cifuentes et al., 2015; Dutta et al., 2019; Santa Barbara et al., 2022; Smith et al., 2018). This narrative strongly aligns with the total worker health framework, which suggests that integrating health protection elements (e.g., ergonomics, equipment) with health promotion strategies (e.g., education, behavior change support) is more effective than implementing either approach in isolation (Leso et al., 2024).

While providing physical tools like sit-stand desks or under-desk ellipticals is an effective starting point for changing behavior, these findings suggest the impact of such environmental modifications can be significantly enhanced by adding supportive educational and behavioral components. This is consistent with broader reviews which have found that without supportive educational components, the impact of equipment-based interventions can be limited (Chau et al., 2010; Commissaris et al., 2016). The addition of educational and behavioral components, grounded in established theories like SCT, appears crucial for translating behavioral changes into more comprehensive and sustainable wellbeing and performance outcomes (Prestwich et al., 2014). Equipment and educational components empower employees with the knowledge, skills, and self-efficacy needed to overcome personal and organizational barriers, turning a simple environmental change into a meaningful shift in work habits and health (Malik et al., 2014).

Beyond the specific components used, the mode of delivery also appears to influence outcomes, reflecting the evolving nature of the American workplace. The successful studies in this review utilized a variety of delivery modes, including fully in-person at a single worksite (Cifuentes et al., 2015; Quinn et al., 2018), exclusively online for remote employees (Falk et al., 2022), and hybrid models that blended in-person and electronic components for multi-site corporations (Carr et al., 2016; Rollo & Prapavessis, 2021). Notably, the exclusively online intervention demonstrated a large and significant effect on reducing sitting time among remote workers, suggesting that well-designed digital programs can be highly effective in the absence of a shared physical environment (Falk et al., 2022). This finding is critical in the post-pandemic era, where remote and hybrid work arrangements have become standard. It aligns with recent literature indicating that technology-based interventions (e.g., using smartphone apps, wearables, and virtual coaching) can overcome logistical barriers and offer scalable, flexible solutions that are often more cost-effective than traditional in-person programs (Direito et al., 2017; Vandelanotte et al., 2016). The effectiveness across these different delivery modes suggests that the *principles* of the intervention (i.e., combining education and equipment) may be more important than the specific mode of delivery, providing organizations with the flexibility to choose the approach that best fits their unique operational context, whether their workforce is centralized, distributed, or fully remote.

The Measurement Landscape in Work Research

This review highlights a significant and persistent challenge in the field: the heterogeneity of measurement tools used to assess occupational wellbeing, which is resulting in reduced ability to compare outcomes between interventions. While some of the included studies employed validated, multi-faceted instruments like the Health and Work Questionnaire (HWQ) or the SF-36 (Falk et al., 2022; Quinn et al., 2018; Rollo & Prapavessis, 2021; Smith et al., 2018), others relied on qualitative data or non-validated self-report measures for key outcomes (Cifuentes et al., 2015; Dutta et al., 2019). This observation is consistent with broader critiques of health-related productivity research, which have long noted concerns about the validity and reliability of self-report instruments, particularly for quantifying work performance and presenteeism (Cancelliere et al., 2011; Noben et al., 2014; Prasad et al., 2004).

The primary consequence of this measurement diversity is that it impedes the ability to synthesize findings quantitatively across studies. The lack of a standardized measurement approach makes direct comparisons of effectiveness across different intervention strategies difficult, precluding a formal meta-analysis. This points to a critical need for the field to move towards a consensus on a core set of outcome measures for WPAP research. To build a more robust business case for employers, future studies should complement subjective employee reports with more objective assessments of work performance, such as supervisor metrics, analysis of output quality and quantity, or on-task behavior assessments via tools like electronic performance monitoring (Prakash et al., 2017; Ravid et al., 2023). Adopting a standardized measurement toolkit (including HWQ, WAI, guide for accelerometer/ActivPAL, and examples of possible KPIs), as called for by recent reviews of worker wellbeing measures (Hone et al., 2023), would significantly enhance the accuracy, comparability, and ultimate impact of future research in this domain.

The Role of Theory in WPAP Design

It is noteworthy that a majority of the included interventions (n=6) were explicitly grounded in established behavioral theories, most commonly Social Cognitive Theory (SCT) (Carr et al., 2016; Falk et al., 2022; Santa Barbara et al., 2022), alongside Cognitive Behavioral Therapy (CBT) (Quinn et al., 2018), Social Learning Theory (SLT) (Smith et al., 2018), and the Health Action Process Approach (HAPA) (Rollo & Prapavessis, 2021). The two interventions in this review that did not specify a theoretical framework were Cifuentes et al. (2015) and Dutta et al. (2019). Notably, these were also the two interventions that yielded only qualitative results. This indicates a maturation of the field, moving beyond simply providing equipment towards designing interventions that strategically target the known drivers of behavior change and to measure outcomes related to theory or core occupational wellbeing concepts.

This approach aligns with foundational principles of implementation science, which show that theory-based interventions are more likely to be effective because they provide a clear framework for understanding and addressing key determinants of health behaviors (Davis et al., 2015; Glanz et al., 2015). Theory provides a blueprint for an intervention, ensuring that components like education, goal setting, and social support are designed to influence specific psychological constructs like self-efficacy or outcome expectations (Bandura, 1986). The successful outcomes reported by the theory-based programs in this review reinforce the conclusion from meta-analyses that a strong theoretical base enhances program adherence and effectiveness (Prestwich et al., 2014). Therefore, to maximize impact, future WPAP designs should continue to integrate evidence-based models.

Strengths and Limitations

This review has several strengths, including its specific focus on the U.S. workplace context and its novel synthesis of outcomes under a unified "occupational wellbeing" framework in the U.S. derived by outcomes measured in this review. However, the findings must be interpreted in the context of several limitations. The primary limitation is that the search strategy was intentionally focused on psychological wellbeing and productivity and did not use explicit search terms such as "pain" or "illness". This focused approach was adopted because health behavior literature suggests that framing PA around immediate, positive experiences is a more effective motivator than focusing on future-oriented disease prevention (Grimaud et al., 2022; Pereira et al., 2015), and because general WPAPs are often conceptualized as distinct from more clinical or rehabilitative programs (Safi et al., 2022). Consequently, it is possible that studies with a primary focus on pain management were not captured. Additional limitations include the small number of included studies (N=8) as well as most studies' small sample sizes and the significant heterogeneity in their populations, intervention components, and measurement tools, which precludes a quantitative meta-analysis. Finally, this review did not perform a formal assessment of study quality or risk-of-bias assessment for the included studies, and the reliance on self-report for many outcomes introduces a potential for reporting bias.

Conclusions and Future Directions

This systematic review provides evidence that U.S.-based WPAPs are effective at improving PA/SB and a broad range of occupational wellbeing outcomes. The findings strongly suggest that multi-component interventions that combine equipment with theory-based education yield the most comprehensive benefits. This review's unique contribution is its synthesis of disparate productivity and wellbeing outcomes into a unified conceptual framework, providing a more holistic understanding of WPAP effectiveness.

Based on the gaps identified, future research should prioritize the following. First, the development and use of a standardized set of core outcome measures for occupational wellbeing, including objective metrics for work performance, to allow for quantitative comparison across studies. Objective metrics for work performance include output-based measures of work quantity and quality (Prakash et al., 2017), behavior-based measures of task adherence derived from electronic performance monitoring (Ravid et al., 2023), and organizational-level data like project completion rates and absenteeism (Losina et al., 2017), some of which can be tracked by existing company software such as project management software (e.g., Jira, Asana) (Salah et al., 2014) or Human Resource Information Systems (HRIS) (Marler & Boudreau, 2017). Second, future research should include the design of randomized controlled trials that systematically compare different intervention packages (e.g., a combined equipment and education intervention vs. an equipment-only intervention, similar to Falk et al., 2022) to determine the most effective combination of components and clarify the added value of including educational and behavioral support. Third, the inclusion of cost-benefit analyses, following established frameworks (Baicker et al., 2010; Goetzel & Ozminkowski, 2008), to provide employers with a clear business case for investing in comprehensive, theory-based WPAPs. None of the eight studies implemented this tactic. By addressing these areas, future research can further enhance the adoption and impact of programs designed to improve the health and performance of the U.S. workforce.

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Chapter 3 - Walking Breaks vs. Culturally-Adapted Radio Taiso for Reducing Workplace Sedentary Time: A Pilot Randomized Trial in a U.S. University Setting

3.1 ABSTRACT

Background: High occupational sedentary behavior (SB) poses significant health risks. This pilot study aimed to compare the effects of two 8-week, online-delivered worksite exercise break programs—a Walking Reminder (WR) and an adapted Japanese Radio Taiso (RT; short full body exercise routines with a song)—on physical activity (PA) behavior, psychosocial outcomes, adherence, and satisfaction among U.S. university employees.

Methods: University employees (N=36 enrolled) were randomized to either WR (3x10-minute daily walks) or RT (3x10-minute daily RT exercise videos), supplemented with weekly online educational modules. Outcomes, including objective SB and PA (activPAL), self-reported physical activity (IPAQ), enjoyment (PACES), pain (NRS), work-related wellbeing (HWQ), adherence (logs), and program satisfaction, were assessed at baseline, post-intervention (8/9 weeks), and follow-up (16 weeks). Linear mixed-effects models analyzed changes over time and between groups.

Results: Both groups significantly reduced objective sitting time (main effect of Time, $F(2, 25.9)=12.06$, $p < .001$) and increased stepping time (PA; $F(2, 28.2)=4.09$, $p = .028$) from baseline to follow-up. However, no significant Group × Time interactions were found for objective sitting or stepping, nor for self-reported enjoyment, pain, or productivity. Both groups reported decreased irritability over time ($F(2, 33.8)=4.08$, $p = .026$). Adherence logs revealed different engagement patterns ($\chi^2(3, N=2464)=22.62$, $p < .001$); the WR group completed a

higher proportion of prescribed-length sessions, while the RT group reported more sessions lasting less than 10 minutes and trended towards more skipped sessions. Qualitative feedback indicated workload as a common barrier, and RT was perceived by some as challenging to integrate.

Conclusion: Both online-delivered walking breaks and RT exercises effectively reduced objective workplace sitting time in this pilot study. However, the culturally novel RT intervention did not demonstrate superiority over the simpler walking intervention in terms of behavioral change patterns or improvements in self-reported psychosocial outcomes. Differing engagement patterns indicate potential variations in acceptability and implementation fidelity, highlighting the importance of considering intervention simplicity and cultural context when designing worksite wellness programs.

3.2 INTRODUCTION

Sedentary behavior (SB), defined as any waking behavior characterized by an energy expenditure ≤1.5 metabolic equivalents (METs) while in a sitting, reclining, or lying posture (Tremblay et al., 2017), is highly pervasive in modern society, particularly in occupational settings. Office-based employees, for instance, may spend upwards of 75-80% of their workday seated (Buman et al., 2017; Owen et al., 2010; Parry & Straker, 2013). This high volume of workplace SB, often compounded by sedentary time during commuting and leisure (Clemes et al., 2014), contributes significantly to overall daily SB. Extensive research has linked prolonged SB to numerous adverse health outcomes, including an increased risk of cardiovascular disease, type 2 diabetes, certain cancers, and all-cause mortality (Biswas et al., 2015; Patterson et al., 2018). Beyond physical health, prolonged occupational sitting has also been associated with poorer mental health outcomes, such as an increased risk of depression and anxiety (Teychenne et al., 2015; Zhai et al., 2015; Huang et al., 2020), and can negatively impact work-related factors like productivity and presenteeism, potentially leading to increased employer healthcare costs (Parker et al., 2009; Puig-Ribera et al., 2017). Furthermore, developing/evaluating effective, acceptable, and sustainable worksite interventions to reduce SB and promote physical activity (PA) remains a critical public health and occupational wellness priority (Shrestha et al., 2018; Gao et al., 2022).

Recognizing the detrimental impacts of occupational SB, significant efforts have focused on developing and implementing worksite interventions (Shrestha et al., 2018). These interventions often incorporate environmental strategies, such as providing height-adjustable workstations (Edmund et al., 2013; Neuhaus et al., 2014), or behavioral strategies, including education, goal setting, self-monitoring, social support, and prompts to interrupt sitting time

(Falk et al., 2022; Gardner et al., 2016). Multi-component interventions combining environmental and behavioral approaches have shown promise in reducing workplace sitting time (Edwardson et al., 2018; Pereira et al., 2020). Specifically, strategies incorporating short, frequent activity breaks throughout the workday are common behavioral targets, as they are perceived as feasible and can effectively disrupt prolonged sitting periods (Mailey et al., 2016; Thorp et al., 2014; Ben-Ner et al., 2014). These breaks can range from simple self-paced walking bouts to more structured exercise routines and have demonstrated potential benefits for improving employee mood, fatigue levels, and musculoskeletal comfort (Mailey et al., 2017; Thorp et al., 2014).

One short, structured, culturally specific exercise routine is Radio Taiso (RT), a form of synchronized calisthenics widely practiced in Japan for nearly a century (Radio Taiso, n.d.). RT consists of short (typically 3-5 minute) routines of self-selected intensity involving rhythmic movements designed to engage major muscle groups and improve flexibility and circulation (Otsuka et al., 2022). In Japan, RT is deeply embedded in the culture and commonly performed collectively in various settings, including schools, communities, and workplaces, often broadcast via radio or television (Otsuka et al., 2018; Otsuka et al., 2022). This cultural normalization contributes to high participation rates and general acceptance of engaging in light exercise during the workday in Japan (Inoue et al., 2010). In contrast, workplace culture in the United States (U.S.) often presents barriers to PA, including lack of time, inadequate facilities, unsupportive workplace norms, and concerns about appearing unprofessional or less productive (Ryde et al., 2020; McCoy et al., 2014). While structured group exercise exists in some U.S. workplaces, it is far less common and culturally ingrained than RT is in Japan. Understanding the relative effectiveness and potential adherence differences between a readily accessible, self-paced walking break strategy and a structured, moderate-intensity but culturally less familiar RT routine may be crucial for optimizing worksite wellness programs in a U.S. context. If found to be feasible and effective in a U.S. context, the RT routine offers potential added value as a structured, whole-body exercise that requires no special equipment or change of location, making it highly accessible for immediate implementation at an employee's desk (Radio Taiso, n.d.; Otsuka et al., 2022). This is particularly relevant given the limited research directly comparing these distinct break types, especially via online delivery for remote or hybrid employees (Shrestha et al., 2018). While barriers hindering PA in U.S. workplaces are recognized (Ryde et al., 2020), this study addresses a critical gap by examining the potential transferability, acceptability, and adherence related to adapting a culturally distinct, structured routine like RT for U.S. employees (Castro et al., 2010), directly comparing its effects against a standard recommendation like walking breaks—a comparison seldom explored in existing intervention research (Shrestha et al., 2018).

To effectively address complex health behaviors like PA and SB, theoretical frameworks are essential for guiding intervention design and understanding potential influences (Glanz et al., 2015; Prestwich et al., 2014). The Social Ecological Model (SEM) is a widely adopted framework in health promotion, positing that behavior is shaped by dynamic interrelationships across multiple levels: individual (e.g., knowledge, skills), interpersonal (e.g., social support from family, peers, coworkers), organizational (e.g., workplace policies, environment), community (e.g., access to facilities), and policy (e.g., public health regulations) (McLeroy et al., 1988; Stokols, 1996). Worksite interventions often utilize the SEM to target multiple levels of influence, such as implementing supportive policies or modifying the physical environment (organizational level) while also providing individual education, skill-building, and social support (individual and interpersonal levels) to promote behavior change (Golden & Earp, 2012; Sallis et al., 2006; Sorensen et al., 2002;). By considering this multi-level context, the SEM provides a comprehensive lens for understanding the diverse factors that can enable or inhibit behavior change. In the context of this study, while the primary intervention compared specific exercise break types (walking vs. RT), the SEM was utilized to structure the supplementary weekly educational content delivered to all participants via an online course. This approach was chosen to acknowledge that even simple behavioral changes are influenced by factors beyond individual motivation. The educational content was therefore designed to provide holistic support by addressing these broader influences, such as perceived workplace norms (organizational) or encouragement from colleagues (interpersonal).

Despite the evidence supporting various worksite SB reduction strategies, including activity breaks, there is limited research directly comparing the effectiveness and adherence between a simple/familiar, commonly recommended strategy like walking breaks and a structured, culturally distinct program like RT, particularly within a U.S. population. Understanding potential differences in adherence, PA accumulation, and other health-related outcomes between these approaches is crucial for designing effective and sustainable worksite wellness programs. Therefore, the primary purpose of this pilot study was to develop and evaluate two distinct 8-week, online-delivered worksite exercise break programs: a simple, familiar Walking Reminder (WR) and a novel, adapted Japanese Radio Taiso (RT) routine. The primary aim was to evaluate their effectiveness in changing objective physical activity (PA) and sedentary behavior (SB). Because the ultimate goal is to identify sustainable and acceptable interventions, a secondary aim was to explore key implementation outcomes evaluating the program. These included participant adherence, program satisfaction, and relevant psychosocial factors such as exercise enjoyment, perceived occupational pain, and wellbeing.

It was hypothesized that both the WR and RT interventions would be effective at reducing SB compared to baseline. However, we explored competing hypotheses regarding their relative effectiveness. The convenience and novelty of the RT routine, performed at the workstation, could lead to greater adherence compared to walking breaks, which require leaving the office and may be affected by weather. Conversely, the simplicity and cultural familiarity of walking, along with the benefit of stepping away from the work environment, could lead to higher enjoyment and sustained engagement. Therefore, we hypothesized that the interventions would be largely equivalent in their primary outcomes but might prove beneficial for different reasons, with potential variations in adherence and qualitative experiences.

3.3 METHOD

Overview of Study Design

This parallel-group randomized trial examined an 8-week intervention comparing two work exercise break strategies, delivered via an online course (Physical Activity Work Environment Study - PAWES, hosted on Canvas – the online course learning management system). All participants were instructed to complete 3 ×10-minute (30 minutes per day) breaks of self-selected activity intensity during each workday. This daily exercise volume was selected to align with the U.S. Physical Activity Guidelines (2018), which recommend at least 150 minutes of moderate-intensity activity per week, often broken down into 30 minutes per day, five days a week. Eighteen participants were randomly assigned to a WR group, and eighteen were assigned to an RT group. Specifically, participants in the WR group were instructed to walk for 10 continuous minutes during their workday, outdoors if possible. Participants in the RT group were instructed to complete an RT (until comfortable with the routine) or similar exercise video (when seeking variety/more enjoyment) at their offices/desks during their 10-minute breaks each workday. The intervention also included weekly online educational modules, within group between participant discussion posts, and activity log submissions via the online course. Outcomes were assessed at baseline, post-intervention (Week 8/9), and follow-up (Week 16). All procedures were approved by the Kansas State University institutional review board (protocol 11292). Participant recruitment occurred in two waves to acquire a larger number of total participants, beginning in February 2022 and September 2022. Data collection was completed in January 2023.

Participants

Participants were recruited via university email lists. Interested individuals were directed to an online survey to assess eligibility. To be eligible to participate, individuals had to be university employees with access to a computer, employed full-time [≥35 hrs./wk.], and sedentary (self-reported sitting ≥80% of work hours). Participants were excluded if they had any physical limitations that prevented them from completing the prescribed physical activities, even with self-selected modifications (e.g., seated versions, marching in place), which participants were encouraged to adopt if needed after consulting with the research team. Participants were university employees in office settings with set hours (8:00 a.m.-5:00 p.m.) but not set break schedules.

Procedures

Based on common practices for pilot feasibility studies, a target sample size of approximately 30-40 participants was established (Sim & Lewis, 2012). A formal *a priori* power analysis was not conducted, as the primary aims of this study were to assess the feasibility and acceptability of the interventions and to generate preliminary data on effect sizes (Sim & Lewis, 2012). This data can be used to inform power calculations for a future, larger scale randomized controlled trial. Following an approximate one-month recruitment period for each wave, interested individuals completed simultaneous online screening and informed consent via Qualtrics. Eligible participants who met the inclusion criteria (*N*=36) were then randomized 1:1 into one of two intermediate groups ('A' or 'B') using a computer-generated random allocation sequence (Microsoft Excel's RAND function) prepared by the primary investigator. Following randomization, participants were invited to complete the online baseline survey. To minimize potential comparison effects or contamination between the interventions, participants were only informed of the specifics of their own assigned exercise protocol and were not given details about the activities of the other group. To maintain allocation concealment, the specific intervention condition (WR or RT) linked to group labels 'A' and 'B' was determined only *after* all participants had been assigned to an intermediate group; at this point, the group labels 'A' and 'B' were randomly assigned (using further random number generation) to represent either the WR or RT intervention condition, thereby finalizing group allocation. Due to limited number of activPALs (objective PA measure), data collection was staggered across two weeks at each measurement point. Concurrently with baseline survey completion, 1 or 2 weeks before intervention start (Week -1 or 0), participants designated for objective monitoring wore an activPAL device with an associated work hours log for seven days to objectively measure workplace PA and sedentary time. Eight remote participants (4 per group) did not use activPALs. The 8-week intervention period commenced the following week (Week 1). Post-intervention assessments, including the survey (which included added program evaluation questions) and a second 7-day activPAL wear period for designated participants, were completed during either

Week 8 or 9. Following the 8-week intervention, participants were instructed via the online course and email to continue logging their daily work exercise breaks and submit the log weekly via email. A final follow-up assessment, including the survey/evaluation and a third 7-day activPAL wear period for designated participants, occurred approximately 16 weeks after the baseline assessment (during Week 15 or 16), with final data collection completed in January 2023.

Intervention

The development of the weekly educational modules was guided by the Social Ecological Model (SEM), which posits that behavior change is influenced by factors at multiple levels (McLeroy et al., 1988). This framework was chosen because the success of worksite physical activity programs is known to depend on a combination of individual, social, and organizational factors (Sorensen et al., 2002; Malik et al., 2014). Each weekly module was designed to target a specific level of the SEM, providing participants with a holistic set of skills for behavior change (see Appendix B.1 for course outline). The modules targeting the individual level (Week 2: Self-Motivation & Regulation; Week 5: Self-Motivation Regulation Pt2: Relapse Prevention & Autonomy) focused on building intrinsic motivation and self-regulatory skills, which are critical for long-term adherence (Ryan & Deci, 2017; Prestwich et al., 2014). The content on the interpersonal level (Week 4: Gathering Social Support from Coworkers/Group; Week 7: Gathering Social Support from Friends and Family) was designed to help participants cultivate a supportive social network, a key facilitator of sustained physical activity (Carron et al., 1996). The design of these social modules was informed by research on structured, group-based exercise like Radio Taiso, which highlights the benefits of normalized, collective activity in a worksite context (Otsuka et al., 2022). Finally, modules targeting the organizational and policy levels (Week 3: Environment Changing; Week 6: Organization/Workplace Implementation) provided strategies for navigating the workplace. This included content on understanding and utilizing official company policies regarding break times and wellness, as well as modifying one's personal work environment to address common structural barriers to physical activity at work (Goetzel & Ozminkowski, 2008). The overall progression, from orientation (Week 1) to a focus on long-term transition (Week 8), was designed to systematically build skills and confidence over the 8-week intervention period (Glanz et al., 2015).

The week before the first week of the intervention period, participants were sent emails inviting them to the online course (PAWES on Canvas). The first week of the intervention (Week 1: Orientation) covered an overview of the study objectives and procedures, and participants were informed of their assigned exercise routine. Each week, in addition to the 3 ×10-minute exercise breaks, participants were asked to complete an educational assignment, discussion boards, and exercise work break log, as well as encouraged to participate in bi-weekly 30-minute Zoom calls. The intervention included weekly online educational modules which took an estimated 30 minutes to an hour to complete covering topics structured according to SEM levels. Because the primary intervention comparison was the type of exercise break assigned (WR vs. RT), the SEM framework was utilized to structure the content of supplementary weekly educational modules, which were identical for both groups, and were designed to not influence any one group’s outcomes disproportionately. At the end of each week, participants submitted their assignments and logs via the online course submission portals. Participants interacted with the research team during zoom calls to address questions and discuss the last two weeks of the course as well as when exchanging ActivPALs. Participants also interacted with each other via discussion boards and during/after week 4 they were assigned a partner and encouraged to motivate each other and/or complete their excise together.

Participants also received a list of computer/mobile applications they could use to prompt daily 3 ×10-minute activity breaks and were encouraged to use music as a reminder/motivator to start and continue the exercise breaks. The RT group was instructed to listen to rhythmic music either accompanied by the RT videos or supplied by themselves once they were comfortable. The WR group was instructed to use music as a reminder and motivator during their walk.

Measures

Demographics

Participants completed a brief demographics survey to identify gender, age, disability status, race/ethnicity, highest education level, and household income.

(see demographics table 3.1 for all items).

Sedentary behavior and physical activity (activPALs and IPAQ*)*

SB and light/moderate PA were assessed objectively using activPAL activity trackers. The thigh-worn activPAL monitors are considered a highly valid and reliable objective measure for quantifying free-living sedentary time, standing time, and stepping, making it a suitable tool for assessing workplace PA patterns (Edwardson et al., 2012). Data were collected over 15-second epochs over 24 hours at a sampling frequency of 10 Hz. Data was considered if the participant recorded wear time of 3 workdays or more during the week (workday must have been >6 hours; Clemes et al., 2014). Data was downloaded and analyzed using the activPAL software suite (PAL Technologies Ltd., Glasgow, UK). Log diaries were used to determine time at work. SB was defined as times the activPAL recorded bouts of sitting. Standing behavior was defined as times the activPAL recorded bouts of standing. Active behavior was defined as when the activPAL recorded bouts of walking or movement (i.e., stepping). Key variables extracted specifically during work hours: (e.g., total sitting time, standing time, stepping time, number/duration of sitting/standing/stepping bouts).

Additionally, the International Physical Activity Questionnaire short form (IPAQ-SF) (Craig et al., 2003) was also used to assess self-reported PA at work. The IPAQ was modified from the original to only ask about workplace PA in the last 7 days and not outside of work. Questions were asked such as "During **the last 7 days at work,** on how many days did you do **vigorous** physical activities like heavy lifting, jogging, aerobics, or high-paced activity?" or "How much time did you usually spend doing vigorous physical activities during an average workday?". The IPAQ outputs MET minutes of moderate, vigorous, and light PA based on the intensity, frequency, and duration of the activity reported. The outputs calculated included: minutes/day or MET-minutes/week of VPA, MPA, LPA, and sitting time *during work hours*.

Work Break and Activity Logs

Participants were provided with a weekly online activity log (Appendix B.5) to be submitted at the end of each week. The log was used to track engagement with the assigned intervention and to record real-time comments, perceptions, and experiences. For each workday, participants recorded the number of exercise breaks taken (up to three), the duration in minutes of each break, and their response to this question "Please describe how you felt this week at work and if or how exercise breaks impacted your work performance or health". The log also included directions of "If you had to skip an exercise break, please put 0 on that line. Put DNW for Did Not Work on days off". For data analysis, each daily log entry was categorized into one of four adherence patterns: 'active', 'inactive', 'did not work', or 'not reported'. Breaks skipped were counted by the number of breaks the participant put a "0". Duration of breaks were categorized by breaks greater than 0 but less than 10 minutes, equal to 10 minutes, or more than 10 minutes. Data from these logs were used to calculate adherence metrics, including the total minutes of PA and the number of sessions completed/skipped per week, day, and group.

Physical Activity Enjoyment Scale PACES

The original 18-item PACES (Kendzierski, 1991) scale was slightly modified to assess enjoyment for PA at the workplace. Respondents were asked questions such as "how do you feel at the moment about the physical activity *at work* you have been doing" using a 7-point bipolar rating scale, with items anchored by opposing statements (e.g., 1 = "I dislike it" to 7 = "I like it"). Eleven items are reverse-scored. Scores are totaled and higher PACES scores reflect greater participant enjoyment. Internal consistency for PACES in the current study, as measured by Cronbach's alpha, was 0.97 at baseline, 0.95 at post-test, and 0.97 at follow-up.

Numeric Pain Rating Scale (NRS)

The Numeric Pain Rating Scale was adapted to target specific pain related to work function. Questions were asked on a 0 to 10 Likert scale (0="no pain", 5="moderate pain", 10="worst possible pain") regarding pain related to daily work function, overuse injuries, body positioning during the workday, non-work-related injuries, and overall daily pain. The score from these questions was averaged. Internal consistency for the NRS (5 items) in the current study, as measured by Cronbach's alpha, was 0.74 at baseline, 0.85 at post-test, and 0.90 at follow-up.

Health and Work Questionnaire (HWQ)

To evaluate employee work performance and satisfaction, the HWQ was used (Shikiar et al., 2004). This survey measures subscales including irritability, focus, work satisfaction, non-work satisfaction, and productivity. Office employees' self-reported scores from the HWQ adequately measure productivity, as reported by employee supervisors (vonThiele Schwarz, 2014). For each subscale, results are averaged to produce a score from 1 to 10, with higher scores reflecting increased levels (except for irritability, where lower scores are favorable meaning reduced irritability). The scores for each subscale are interpreted on a continuum, as there are no established clinical benchmarks for this instrument. Internal consistency (Cronbach's alpha) for the HWQ subscales used in this study were: Productivity (5 items): Baseline α=0.69, Post-test α=0.79, Follow-up α=0.89. Focus (8 items): Baseline α=0.86, Post-test α=0.56, Follow-up α=0.76. Irritability (3 items): Baseline α=0.72, Post-test α=0.70, Follow-up α=0.92. Work Satisfaction (4 items): Baseline α=0.47, Post-test α=0.52, Follow-up α=0.76. Non-Work Satisfaction (2 items): Baseline α=0.18, Post-test α=0.39, Follow-up α=0.55. (The poor consistency for non-work satisfaction should be considered when interpreting results related to this subscale).

Program evaluation and acceptance

Participant feedback regarding the intervention was collected during the post-intervention (Week 8/9) and final follow-up (Week 16) surveys using a combination of quantitative ratings and open-ended qualitative questions (Moore et al., 2015; Sekhon et al., 2017; Weiner et al., 2017;). Quantitative measures assessed overall program satisfaction ("How satisfied were you with the program overall?") and likelihood to continue taking exercise breaks ("How likely are you to continue to take exercise breaks after the study?") using 5-point Likert scales (1=very unlikely, 3=neutral, 5 = very likely). Likelihood to recommend the program and perceived usefulness of specific program components (e.g., "the educational assignments," "the discussion boards," "the weekly physical activity log") were also assessed (on a scale of 0-10). Open-ended questions prompted participants to provide feedback on changes noticed, program components liked/disliked, recommendations, barriers, and facilitators. Qualitative responses were analyzed using an inductive thematic analysis approach (Braun & Clarke, 2006).

Statistical Analysis

All statistical analyses were conducted using R (version 4.5.1; R Core Team, 2025). Preliminary analyses, including independent samples t-tests and chi-squared tests, were used to examine baseline demographic differences between the WR and RT groups among enrolled participants and completers.

Handling of missing data: Due to participant dropout and intermittent missing items, missing data were handled using Multiple Imputation (MI) via the 'mice' package in R. A total of m=40 complete datasets were generated using predictive mean matching (20 iterations). The imputation model included all outcome variables and key demographic variables (e.g., age, gender). Subsequent analyses were performed on each dataset, and results were pooled using Rubin's Rules. Baseline survey data for 2 participants (ID 32, 37) who completed post-intervention and follow-up measures were entirely imputed.

Primary and secondary outcomes: Longitudinal outcomes (activPAL, HWQ, PACES, NRS, IPAQ) were analyzed using Linear Mixed-Effects Models (LMM) via the ‘lme4' package. For each outcome, a 2 (Group: WR vs. RT) x 3 (Time: Baseline, Post-test, Follow-up) model was specified, including fixed effects for Group, Time, and the Group × Time interaction. A random intercept for each participant (1 | ID) was included. Omnibus *F*-tests and *p*-values used the Satterthwaite approximation. Post-hoc pairwise comparisons for significant effects used estimated marginal means via the ‘emmeans' package, with p-values adjusted for multiple comparisons. An alpha level of .05 was used to determine significance. Adherence data (total minutes/sessions) were compared using independent t-tests, and categorical adherence patterns (e.g., session length distribution, daily adherence categories) were compared using chi-squared tests.

Qualitative Data Analysis

To gain a deeper understanding of the participant experience, qualitative data were collected from two sources: open-ended comments on the 16 weekly work break logs and responses to open-ended questions on post-intervention and follow-up surveys. A thematic analysis approach was used to systematically identify, analyze, and report patterns within the data (Braun & Clarke, 2006).

Weekly Work Break Logs: All qualitative comments from the weekly logs were transcribed and compiled. The analysis was an iterative and inductive process. A primary coder developed an initial set of codes based on emergent themes from the early weeks of data. This codebook was then systematically refined throughout the analysis of all 141 participant comments to ensure it comprehensively captured the range of participant experiences. To enhance the trustworthiness of the analysis, the primary coder met regularly with the lead researcher for peer debriefing and to reach consensus on the application and definition of codes. This process resulted in a final, hierarchical codebook used for a comprehensive re-coding of the entire dataset.

Post-Intervention and Follow-Up Surveys: A separate thematic analysis was conducted for the qualitative data from the post- and follow-up surveys. The initial themes identified in the provided survey summaries were used to develop a distinct codebook specific to the nature of the survey questions, which focused on participants' retrospective and summative perceptions of the program's impact, benefits, and barriers.

For this paper, key themes and illustrative quotes from both the weekly logs and surveys were selected to complement and provide context for the quantitative findings.

3.4 RESULTS

Participant Characteristics

A total of 37 individuals were assessed for eligibility, and 36 university employees were randomized into two groups: Walking Reminder (WR; n=18) and Radio Taiso (RT; n=18). The flow of participants through each stage of the trial is detailed in the CONSORT diagram (Figure 3.1).

During the 8-week intervention, 8 participants were lost to attrition (n=5 from the WR group; n=3 from the RT group). An additional 4 participants (n=2 from each group) were lost between the post-intervention and final follow-up assessments. This resulted in 19 participants completing the final follow-up survey (WR, n=7; RT, n=11).

The primary longitudinal analyses utilized imputation and included 22 participants (WR, n=10; RT, n=12) who provided data for at least two of the three assessment points. Baseline demographic characteristics of all enrolled participants (Table 3.2) were well-balanced, with no significant differences between the intervention groups (all $p > .05$). Furthermore, an analysis comparing the baseline demographics of the 22 participants included in the final analysis versus the 14 non-completers also revealed no significant differences, suggesting that attrition was not systematically related to these measured characteristics.

Figure 3.1: CONSORT Flow Diagram

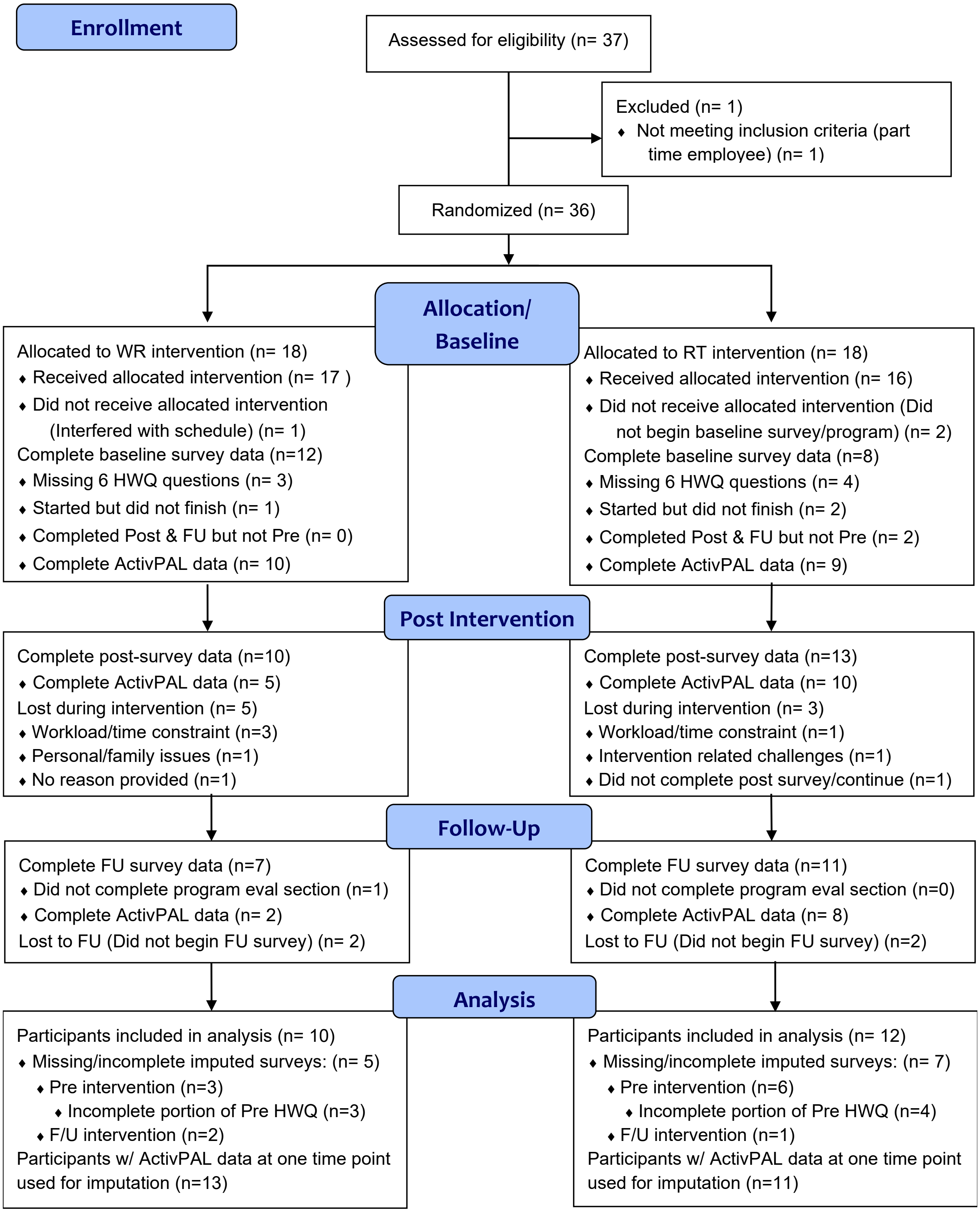


Table 3.1: Baseline Demographic Characteristics of Study Participants (Overall and by Intervention Group)

Characteristic	All Participants (N=36)	Group 1 (Walking) (n=18)	Group 2 (Radio Taiso) (n=18)	Test Statistic	p-value
Age (years)					
Mean (SD)	49.2 (11.7)	47.5 (12.4)	50.8 (11.0)	t = -0.82	0.418
Median (IQR)	52.5 (42.3 - 56.8)	52.5 (38.8 - 55.0)	53.0 (42.8 - 58.5)	U = 141.5	0.406
Gender					
Female, n (%)	34 (94.4)	17 (94.4)	17 (94.4)	χ^2 = .00	1
Male, n (%)	2 (5.6)	1 (5.6)	1 (5.6)		
Disability					
No, n (%)	36 (10.0)	18 (10.0)	18 (10.0)	N/A	N/A
Race/Ethnicity					
White or Caucasian, n (%)	32 (88.9)	16 (88.9)	16 (88.9)		
Multi-racial / Other, n (%)	3 (8.3)	1 (5.6)	2 (11.1)	χ^2 = 0.23	0.893
Prefer not to say, n (%)	1 (2.8)	0 (.0)	1 (5.6)		
Highest Education Level					
High school diploma or GED, n (%)	1 (2.8)	1 (5.6)	0 (.0)		
Some college, no degree, n (%)	1 (2.8)	1 (5.6)	0 (.0)	χ^2 = 2.00	0.368
Bachelor's degree, n (%)	12 (33.3)	8 (44.4)	4 (22.2)		
Graduate or professional degree, n (%)	22 (61.1)	8 (44.4)	14 (77.8)		
Annual Household Income					
\$25,000 - \$49,999, n (%)	1 (2.9)	0 (.0)	1 (5.9)		
\$50,000 - \$74,999, n (%)	4 (11.8)	3 (17.6)	1 (5.9)		
\$75,000 - \$99,999, n (%)	6 (17.6)	4 (23.5)	2 (11.8)	χ^2 = 4.05	0.399
\$100,000 - \$149,999, n (%)	11 (32.4)	4 (23.5)	7 (41.2)		
\$150,000 or more, n (%)	10 (29.4)	6 (35.3)	4 (23.5)		
Prefer not to say, n (%)	2 (5.9)	0 (.0)	2 (11.8)		

Notes for Table 1:

- Data are presented as Mean (Standard Deviation) for age, and *n* (%) for categorical variables.
- *T*-tests (for age mean) or Mann-Whitney *U* tests (for age median) were used for continuous variables. Chi-squared tests or Fisher's exact tests were used for categorical variables to compare groups.
- For Race/Ethnicity, the "Multi-racial / Other" category combines all responses other than "White or Caucasian" due to small cell sizes.
- For Annual Household Income, percentages are based on those who provided income data (N=21 for All Completers; n=9 for Group 1 Completers; n=11 for Group 2 Completers, as one "Prefer not to say" was in Group 2).
- *P*-values > .05 indicate no statistically significant baseline demographic differences between the completers in Group 1 and Group 2.

Changes in Physical Activity and Sedentary Behavior

Analysis of objective activPAL data revealed significant behavioral changes over the course of the study (Table 3.2). A significant main effect of time was observed for sitting time ($F(2, 25.9) = 12.06$, $p < .001$). Post-hoc analyses confirmed that this effect was present in both groups, with the Walking Reminder (WR) group significantly reducing sitting time from baseline to follow-up ($p = .019$) and the Radio Taiso (RT) group showing a similar significant reduction ($p = .004$). A significant main effect of time was also found for stepping time ($F(2, 28.2) = 4.09$, $p = .019$). Within-group post-hoc tests indicated that both groups significantly increased their stepping time by the final follow-up, although their patterns of change differed; the WR group's increase was significant between post-intervention and follow-up ($p = .026$), while the RT group's increase was significant when comparing baseline to follow-up ($p = .039$). No significant main effects of group or Group × Time interactions were found for any objective activPAL outcomes.

In contrast to the objective data, there were no significant main effects of time or group, nor any significant interactions, for any self-reported PA or SB outcomes measured by the IPAQ (all $p > .49$). It is worth noting, however, that mean values for self-reported moderate and vigorous PA almost reached a significant increase for both groups from pre to post.

Changes in Occupational Wellbeing

The interventions demonstrated a significant impact on several measures of self-reported occupational wellbeing (Table 3.2). A significant main effect of time was found for focus ($F(2, 72) = 5.125$, $p = .010$) and irritability ($F(2, 77) = 5.058$, $p = .011$). For irritability, post-hoc tests showed that both the WR group ($p = .006$) and the RT group ($p = .004$) reported significantly improved irritability at the final follow-up compared to baseline.

The results for focus were more nuanced. There was a significant main effect of group ($F(1, 73) = 6.009$, $p = .024$), which post-hoc analysis revealed was due to the RT group reporting significantly higher focus than the WR group at baseline ($p = .044$). However, both groups improved over time. The RT group experienced a significant increase in focus between baseline and post-intervention ($p = .049$), while the WR group's most significant gain occurred between post-intervention and the final follow-up ($p = .001$).

Furthermore, a significant main effect of time was observed for self-reported productivity ($F(2, 66) = 2.110$, $p = .047$). Post-hoc analysis indicated this effect was driven entirely by the WR group, which showed a significant increase in self-reported productivity from baseline to post-intervention ($p = .008$) and from baseline to follow-up ($p = .047$). The RT group reported no significant changes in self-reported productivity.

For the remaining wellbeing outcomes—including enjoyment of exercise (PACES), physical pain (NRS), work satisfaction, non-work satisfaction, and supervisor relations—no significant main effects of time or group, nor any Group × Time interactions, were found.

Table 3.2: Combined Results Table: Descriptive and Inferential Statistics

Outcome & Measure	Time Point	Group	Mean (SD)	Main Effect of Time[1]	Main Effect of Group[2]	Group × Time Interaction[3]	Post-Hoc: Between Groups (*p*-value)[4]	Post-Hoc: Within-Group Changes (*p*-value)[5]
Physical Activity and Sedentary Behavior Outcomes								
Sitting Time (activPAL)				**<.001**	0.337	0.831		
	Baseline	WR	401.07 (37.43)				0.55	vs. Post: **.011** vs. F/U: **.019**
		RT	412.62 (47.59)					vs. Post: **.012** vs. F/U: **.004**
	Post	WR	339.40 (50.59)				0.291	vs. F/U: .841
		RT	367.05 (63.72)					vs. F/U: .705
	Follow-Up	WR	345.40 (66.19)				0.664	
		RT	357.77 (63.73)					
Stepping Time (activPAL)				**0.019**	0.908	0.876		
	Baseline	WR	44.74 (16.71)				0.671	vs. Post: .601 vs. F/U: **.010**
		RT	47.92 (17.16)					vs. Post: .725 vs. F/U: **.039**
	Post-Intervention	WR	47.54 (11.47)				0.83	vs. F/U: **.026**
		RT	46.19 (16.01)					vs. F/U: **.016**
	Follow-Up	WR	58.51 (13.20)				0.966	
		RT	58.22 (17.61)					
Sitting Time (IPAQ)				0.774	0.746	0.491		
	Baseline	WR	430.00 (226.50)				0.529	vs. Post: .157 vs. F/U: .881
		RT	384.23 (105.27)					vs. Post: .913 vs. F/U: .607
	Post-Intervention	WR	363.33 (97.72)				0.555	vs. F/U: .118
		RT	407.89 (205.93)					vs. F/U: .682

	Follow-Up	WR	436.67 (147.82)				0.416	
		RT	393.85 (94.56)					
Light PA METs (IPAQ)				0.367	0.845	0.697		
	Baseline	WR	995.50 (1771.81)				0.78	vs. Post: .851 vs. F/U: .490
		RT	850.39 (486.15)					vs. Post: .614 vs. F/U: .730
	Post-Intervention	WR	913.00 (1309.85)				0.671	vs. F/U: .571
		RT	718.85 (809.28)					vs. F/U: .991
	Follow-Up	WR	639.84 (1345.27)				0.87	
		RT	718.46 (884.18)					
Moderate PA METS (IPAQ)				0.469	0.553	0.434		
	Baseline	WR	244.45 (329.36)				0.343	vs. Post: .074 vs. F/U: .242
		RT	435.39 (519.37)					vs. Post: .792 vs. F/U: .941
	Post-Intervention	WR	517.78 (163.84)				0.262	vs. F/U: .415
		RT	376.93 (337.42)					vs. F/U: .855
	Follow-Up	WR	793.34 (1616.60)				0.446	
		RT	421.54 (536.99)					
Vigorous PA METS (IPAQ)				0.42	0.683	0.588		
	Baseline	WR	6.67 (13.22)				0.505	vs. Post: .454 vs. F/U: .488
		RT	3.55 (8.48)					vs. Post: .243 vs. F/U: .299
	Post-Intervention	WR	16.12 (25.46)				0.906	vs. F/U: .902
		RT	14.24 (41.92)					vs. F/U: .380
	Follow-Up	WR	15.01 (23.71)				0.544	
		RT	49.62 (165.83)					
Occupational Wellbeing Outcomes								

PACES (Enjoyment)				0.633	0.324	0.211		
	Baseline	WR	4.59 (1.04)				0.307	vs. Post: .062 vs. F/U: .963
		RT	5.06 (1.04)					vs. Post: .780 vs. F/U: .302
	Post-Intervention	WR	5.17 (0.73)				0.658	vs. F/U: .066
		RT	4.99 (1.07)					vs. F/U: .172
	Follow-Up	WR	4.60 (1.54)				0.15	
		RT	5.33 (0.72)					
PAIN (NRS)				0.297	0.731	0.872		
	Baseline	WR	1.82 (1.30)				0.634	vs. Post: .132 vs. F/U: .705
		RT	2.12 (1.52)					vs. Post: .368 vs. F/U: .655
	Post-Intervention	WR	1.29 (1.38)				0.69	vs. F/U: .089
		RT	1.56 (1.58)					vs. F/U: .265
	Follow-Up	WR	1.98 (1.91)				0.918	
		RT	1.91 (1.31)					
Work Satisfaction (HWQ)				0.853	0.769	0.798		
	Baseline	WR	6.69 (1.30)				0.85	vs. Post: .615 vs. F/U: .429
		RT	6.81 (1.52)					vs. Post: .531 vs. F/U: .990
	Post-Intervention	WR	6.94 (1.36)				0.585	vs. F/U: .791
		RT	6.56 (1.75)					vs. F/U: .532
	Follow-Up	WR	7.06 (1.80)				0.778	
		RT	6.83 (1.88)					
Non-Work Satisfaction (HWQ)				0.521	0.888	0.521		
	Baseline	WR	8.48 (0.99)				0.454	vs. Post: .325 vs. F/U: .099
		RT	7.95 (1.91)					vs. Post: .524

								vs. F/U: .991
	Post-Intervention	WR	8.11 (1.19)				0.857	vs. F/U: .371
		RT	8.21 (1.19)					vs. F/U: .467
	Follow-Up	WR	7.74 (1.94)				0.791	
		RT	7.95 (1.67)					
Supervisor Relations (HWQ)				0.788	0.706	0.777		
	Baseline	WR	7.56 (1.79)				0.566	vs. Post: .607 vs. F/U: .920
		RT	6.85 (3.31)					vs. Post: .452 vs. F/U: .203
	Post-Intervention	WR	7.28 (1.82)				0.967	vs. F/U: .552
		RT	7.31 (1.52)					vs. F/U: .679
	Follow-Up	WR	7.61 (1.71)				0.924	
		RT	7.54 (1.75)					
Productivity (HWQ)				**0.047**	0.358	0.227		
	Baseline	WR	6.92 (0.55)				0.517	vs. Post: **.008** vs. F/U: **.047**
		RT	7.17 (1.04)					vs. Post: .796 vs. F/U: .926
	Post-Intervention	WR	8.04 (1.17)				0.171	vs. F/U: .188
		RT	7.27 (1.29)					vs. F/U: .749
	Follow-Up	WR	7.61 (1.16)				0.391	
		RT	7.14 (1.27)					
Focus (HWQ)				**0.01**	**0.024**	0.321		
	Baseline	WR	4.83 (2.29)				***0.044***	vs. Post: .510 vs. F/U: **.005**
		RT	6.83 (2.04)					vs. Post: **.049** vs. F/U: .845
	Post-Intervention	WR	4.42 (1.93)				0.077	vs. F/U: **.001**
		RT	5.71 (1.34)					vs. F/U: **.012**

	Follow-Up	WR	6.61 (2.10)				0.642	
		RT	6.96 (1.41)					
Irritability (HWQ)				**0.011**	0.641	0.556		
	Baseline	WR	4.37 (1.78)				0.537	vs. Post: **.041** vs. F/U: **.006**
		RT	3.92 (1.55)					vs. Post: .862 vs. F/U: **.004**
	Post-Intervention	WR	3.59 (1.50)				0.697	vs. F/U: .230
		RT	3.87 (1.71)					vs. F/U: **.001**
	Follow-Up	WR	3.15 (1.45)				0.378	
		RT	2.64 (1.18)					

Notes:

WR = Walking Reminder; RT = Radio Taiso. Descriptive statistics (Mean, SD) are from the imputed dataset.

[1]Main effect of Time from the "Tests of Within-Subjects Effects" table (Sphericity Assumed).

[2]Main effect of Group from the "Tests of Between-Subjects Effects" table.

[3]Group × Time interaction from the "Tests of Within-Subjects Effects" table (Sphericity Assumed).

[4]Post-hoc comparisons of the WR vs RT groups at each time point from the "Pairwise Comparisons" table.

[5]Post-hoc comparisons of time points (Baseline, Post-Intervention, Follow-Up) within each group separately.

***Bold** indicates $p < .05$.*

****** Indicates a statistically significant difference between the WR and RT groups at that specific time point.*

Work Break Engagement and Adherence

Participant engagement with the assigned interventions was monitored via self-reported activity logs. All participants logged combined averages of 1.73 (*SD* = ± .7) breaks per workday (1.83 ± .7 WR vs. 1.62 ± .6 RT), with average session durations of 10.92 minutes per session (11.78 ± 3.7 WR vs. 10.08 ± 2.2 RT). Independent samples *t*-tests revealed no statistically significant differences between the WR and RT groups for any engagement/adherence variables including average total minutes of reported exercise breaks or total number of break sessions reported (Table 3.3). There was a non-significant trend suggesting the RT group skipped more individual sessions on average, and no significant difference in the average number of inactive days where zero activity was reported.

However, while the average quantities of engagement were similar, the patterns of break frequency and duration of engagement differed significantly. A chi-square test revealed a statistically significant relationship between the groups and their daily adherence patterns ($\chi^2(3, N=2464) = 22.62$, $p < .001$); however, the effect size was small (Cramér's $V = 0.096$). This difference was primarily driven by the RT participants being more likely to have completely inactive days. Furthermore, the distribution of session lengths was also significantly different ($\chi^2(2, N=1818) = 44.51$, $p < .001$), with a small-to-medium effect size (Cramér's $V = 0.156$). This indicates the WR Group was more consistent, completing a higher proportion of sessions at the prescribed 10-minute length, while the RT group showed more variability, reporting more sessions lasting both less than and more than 10 minutes.

Table 3.3: Between-Group Comparisons of Participant Engagement from Activity Logs

Engagement Metric	Walking Group (n=11) (Mean ± SD)	Radio Taiso Group (n=11) (Mean ± SD)	Statistical Test & Result

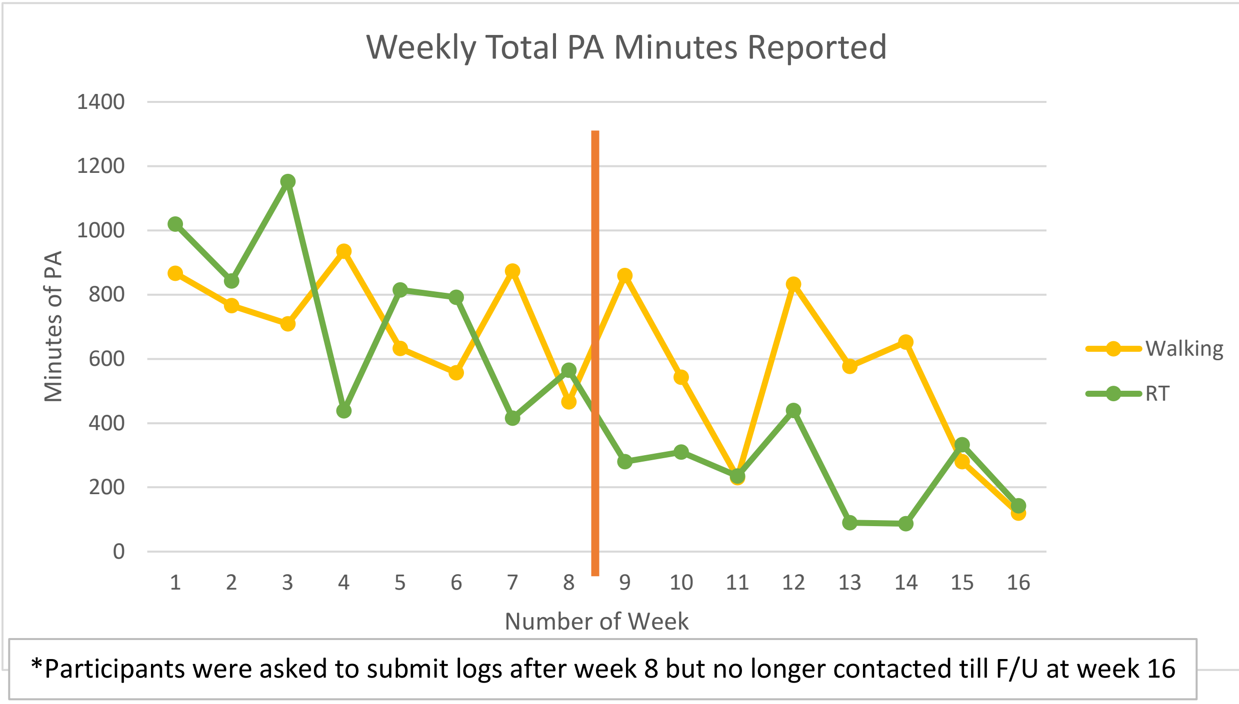
Breaks Per Day	1.8 ± 0.7	1.6 ± 0.6	$t(20) = 0.76$, $p = .455$
Average Session Duration (min)	11.8 ± 3.7	10.1 ± 2.2	$t(20) = 1.30$, $p = .207$
Total Minutes Logged	947.1 ± 686.4	841.8 ± 610.7	$t(20) = 0.38$, $p = .708$
Total Sessions Logged	87.9 ± 68.3	77.4 ± 52.5	$t(20) = 0.41$, $p = .690$
Sessions Skipped	21.0 ± 23.2	40.0 ± 30.6	$t(20) = -1.64$, $p = .119$
Days Inactive	1.9 ± 3.2	5.4 ± 7.3	$t(20) = -1.42$, $p = .171$
Daily Adherence Pattern	(See Counts Below)	(See Counts Below)	**$\chi^2(3, N=2464) = 22.30$, $p < .001$, $V = 0.096$**
Days Active	387	384	
Days Not Reported	525	539	
Days Did Not Work (DNW)	299	250	
Days Inactive	21	59	
Session Length Distribution	(See Counts Below)	(See Counts Below)	**$\chi^2(2, N=1818) = 44.51$, $p < .001$, $V = 0.156$**
Sessions = 10 min	674	564	
Sessions > 10 min	284	301	
Sessions < 10 min	102	177	

Note: Data presented as Mean ± Standard Deviation or as total counts (N). The t-tests compare group means. Cramér's V (V) is reported as a measure of effect size for the Chi-Squared (χ²) tests; it indicates the strength of the association between the variables, which is important context for interpreting statistical significance with large sample sizes. An effect size of ~0.1 is considered small, ~0.3 medium, and ~0.5 large.

An analysis of weekly self-reported PA, depicted in Figure 3.2, reveals distinct patterns of engagement over the 16-week study. Figure 3.2 illustrates the dynamic, fluctuating nature of weekly participation. While both groups show considerable variability, there is a general downward trend in active minutes, particularly after week 8, when direct contact with participants ceased.

Figure 3.2 clarifies these long-term trends using linear regression. The regression lines for both the WR and RT groups show a decline in participation over the 16-week period. However, the rate of this decline differed notably between the groups. The equation for the Walking group ($y = -32.642x + 896.18$) indicates that, on average, participants began with approximately 896 minutes of activity per week (the intercept), and their participation decreased by about 32.6 minutes each week (the slope). In contrast, the slope of the regression line for the RT group ($y = -59.778x + 1005.4$) is considerably steeper. While this group started with a higher intercept of approximately 1005.4 weekly minutes, their participation decreased by nearly 60 minutes per week, indicating a more rapid decline in weekly active minutes.

Figure 3.2*: Weekly Total PA Minutes Reported Between Group*



Qualitative Insights on Program Experience from Activity Logs

A thematic analysis of participant comments from weekly work break logs revealed several key themes regarding their experience, with both shared similarities and distinct differences emerging between the Walking Reminder (WR) and Radio Taiso (RT) intervention groups (Table 3.4).

Participants in both groups reported similar primary barriers and benefits. The most significant barriers to adherence were consistently related to *High Workload / Busyness* (42.2% of WR comments; 33.3% of RT comments), as well as *Illness / Physical Ailment and Absence from Work*. Conversely, the most powerful facilitators for both groups were the *Social Aspect of Involving Others* and the positive *Perceived Benefits* derived from the breaks, such as improved energy and a sense of enjoyment.

Despite these similarities, the qualitative data highlighted distinct differences in the nature of the participant experience. A key difference was in the *Experience of the Prescribed Exercise*, where the 'Physical Challenge & Difficulty' was a barrier reported exclusively by participants in the RT group (7.8% of comments). As one RT participant noted, "Radio Taiso exercises are a bit challenging in an early workplace setting." Furthermore, the groups demonstrated different *Adherence Challenges*. The WR group's comments indicated a greater struggle with *protocol adherence* (e.g., fitting in all three breaks), while the RT group reported a higher prevalence of themes related to *self-consciousness* and the social dynamics of performing the exercises at work.

Table 3.4*:* Key Qualitative Themes from Participant Logs, by Intervention Group

Key Themes	Thematic Focus	N / % of WR Comments (N=90)	N / % of RT Comments (N=51)	Illustrative Quote Example
SIMILARITIES *(Prominent in Both Groups)*				
Key Barriers to Adherence	High Workload / Busyness	**38 / 42.2%**	**17 / 33.3%**	*"This was a busy work week for me."* (P10, WR, Week 1)
	Illness / Physical Ailment	**7 / 7.8%**	**7 / 13.7%**	*"I was sick on Friday, so I did not walk."* (P3, WR, Week 5)
	Absence from Work	**7 / 7.8%**	**8 / 15.7%**	*"I was on vacation most of this week."* (P11, RT, Week 2)
Key Facilitators to Adherence	Social Aspect / Involving Others	**4 / 4.4%**	**4 / 7.8%**	*"This was the first week I walked consistently with a co-worker..."* (P11, RT, Week 7)
	Scheduling / Ease of Finding Time	**3 / 3.3%**	**4 / 7.8%**	*"It was easier to get the exercise in when I scheduled it..."* (P25, RT, Week 4)
Perceived Benefits & Experience	Enjoyment & Positive Affect	**26 / 28.9%**	**7 / 13.7%**	*"I really enjoy the Radio Taiso exercise breaks..."* (P8, RT, Week 12)
	Improved Energy & Focus	**20 / 22.2%**	**10 / 19.6%**	*"When I was able to get all three walks in I felt great. Clear headed..."* (P4, WR, Week 2)

	Benefits as Motivator (e.g., pain relief)	**4 / 4.4%**	**2 / 3.9%**	*"My back quit hurting at the end of each day. Helped my back to get out of my chair and stretched it out."* (P9, WR, Week 1)
DIFFERENCES *(Different Emphasis Between Groups)*				
Experience of Exercise	**RT Group Only:** Physical Challenge & Difficulty	**0 / 0%**	**4 / 7.8%**	*"Radio Taiso exercises are a bit challenging in a early workplace setting"* (RT, Week 1)
Adaptation of Intervention	**WR Group:** Adapted for *preference*.	**13 / 14.4%**		*"I tried listening to books while walking..."* (P2, WR, Week 5)
	RT Group: Adapted for difficulty.		**7 / 13.7%**	*I went back to doing the shorter videos twice. (P17, RT, Week 2)*
Adherence Challenges	**WR Group Higher:** Struggled with *protocol adherence*.	**8 / 8.9%**	**4 / < 8%**	*"...I find myself struggling to get the third 10 minute walk in during the day."* (WR, Week 5)
	RT Group Higher: Focus on *self-consciousness*.	**3 / < 9%**	**6 / 11.8%**	*"My coworkers were able to see me doing Radio Taiso...and it felt awkward"* (RT, Week 1)

Note: *Percentages indicate the proportion of all qualitative comments within each group that contained a reference to the corresponding theme. Frequency of Mention (N) is the raw count of comments containing the theme.*

Program Evaluation

Participants' evaluation of the program was assessed at the post-intervention time point, with independent samples *t*-tests used to compare the WR and RT groups (Table 3.5). Overall, there were no statistically significant differences between the groups on any satisfaction, time use, or component usefulness measures. For example, overall program satisfaction was similar between the WR (M = 3.67, SD = 1.22) and RT (M = 3.31, SD = 1.11) groups, $t(20) = 0.82$, p = .42. The calculated effect sizes for most outcomes were negligible to small (Cohen's d range = -0.20 to 0.35), indicating that the perceived experience with the two programs was not meaningfully different. Notably, while not statistically significant, the perceived usefulness of the discussion boards (d = -0.57) and zoom calls (d = -0.56) showed a medium effect size, suggesting the RT group trended towards finding these interactive components more useful than the WR group. However, this higher perceived usefulness of the interactive components did not translate into superior adherence for the RT group; in fact, adherence data indicated that the WR group was more consistent in completing their breaks.

Table 3.5: Between-Group Comparison of Program Experience Outcomes at Post-Intervention

Outcome Variable	Walking Reminder (WR) (n=9) (Mean ± SD)	Radio Taiso (RT) (n=13) (Mean ± SD)	$t(20)$	p-value	Effect Size (Cohen's d)
Program Satisfaction & Continuation (1-5)					
Likelihood to Continue	4.00 ± 0.94	3.77 ± 1.17	0.46	0.65	0.2
Recommend to a Friend	3.44 ± 0.97	3.23 ± 1.09	0.51	0.62	0.21
Recommend to a Supervisor	3.11 ± 1.20	3.15 ± 1.07	-0.11	0.91	-0.05
Overall Program Satisfaction	3.67 ± 1.22	3.31 ± 1.11	0.82	0.42	0.35
Time Spent (Self-Reported) (1-5)					
Time on Canvas	3.22 ± 0.79	3.23 ± 1.01	-0.08	0.94	-0.03
Time on PA Breaks	4.11 ± 0.88	3.85 ± 1.21	0.56	0.58	0.23
Time on Program Overall	3.56 ± 0.85	3.62 ± 0.96	-0.1	0.92	-0.13
Usefulness of Program Components (0-10 Scale)					
Educational Modules	3.67 ± 2.84	4.15 ± 2.50	-0.45	0.65	-0.19
Discussion Boards	1.56 ± 2.50	3.00 ± 2.45	-1.35	0.19	-0.57
Zoom Calls	1.33 ± 2.54	2.69 ± 2.46	-1.33	0.2	-0.56
Weekly PA Log	5.33 ± 3.59	5.46 ± 3.57	-0.11	0.92	-0.05
Program Overall	5.00 ± 2.87	5.54 ± 2.63	-0.47	0.64	-0.2

Note: Degrees of freedom (df) = 20. Effect sizes are interpreted as small (0.2), medium (0.5), and large (0.8).

Qualitative Insights Into Program Experience

Qualitative feedback from participant surveys provided rich insights into their experiences with the interventions, with key themes summarized in table 6. The most frequently cited barrier to adherence for both the WR and RT groups was Work Commitments. Participants often described finding time during a busy workday as the primary challenge to consistently completing their breaks.

Despite this common barrier, participants in both groups reported several positive outcomes. A primary theme was a behavioral change in Added/Increased Exercise Breaks, indicating that participants were successful in integrating the new routines. Furthermore, many participants described the breaks as Good/Beneficial and noted specific health and work-life benefits, including Improved Focus/Productivity and Reduced Pain.

Interestingly, distinct patterns emerged regarding program-specific challenges. While participants in both groups disliked aspects of the Program Structure, participants in the RT group uniquely cited difficulties with the Type of Exercise, describing the RT routine itself as physically challenging or awkward to perform in a work setting. Finally, a shared facilitator for engagement was Involving Others, with participants from both groups noting that encouragement from co-workers or family was beneficial for adherence.

Table 3.6: Summary of Key Qualitative Themes by Intervention Group from Survey

Thematic Category & Key Theme	Frequency of Mention by Time Point (WR / RT)	Illustrative Quote Example(s)
Behavioral Change		
Added/Increased Exercise Breaks	**Post:** 8 (80%) / 6 (86%) **Follow-Up:** 6 (100%) / 5 (100%)	"I started taking intentional breaks from my desk and walking 30 minutes each day."
Perceived Health		

Reduced Pain	**Post:** 3 (33%) / 3 (38%) **Follow-Up:** 3 (50%) / 3 (50%)	"Before the program, I was having issue with back pain. It has greatly improved, my back pain is now minimal."
Improved Focus/Productivity	**Post:** 2 (22%) / 2 (25%) **Follow-Up:** 2 (33%) / 2 (33%)	"I have felt more capable of focusing on tasks and better able to work on new things right away."
Program Experience		
Breaks Felt Good/Beneficial	**Post:** 5 (56%) / 3 (38%) **Follow-Up:** 4 (80%) / 3 (60%)	"The program motivates me to take breaks from my computer screen as well as increased my steps per day."
Program Structure (Disliked)	**Post:** 4 (57%) / 4 (44%) **Follow-Up:** 3 (60%) / 3 (43%)	"Trying to find 3 different times a day to do the Radio Taiso program. It was very difficult..."
Type of Exercise (RT Disliked)	**Post:** 0 (0%) / 4 (44%) **Follow-Up:** 0 (0%) / 2 (29%)	"The Radio Taiso (at first I felt like it was something old people would watch...)"
Barriers & Facilitators		
Work Commitments (Barrier)	**Post:** 9 (90%) / 6 (86%) **Follow-Up:** 5 (83%) / 4 (80%)	"Work. It is very difficult to take breaks multiple times throughout the day... Just because it is allowed, does not mean it is realistic."
Involving Others (Facilitator)	**Post:** 4 (57%) / 3 (50%) **Follow-Up:** 3 (75%) / 1 (33%)	"I had a couple of co-workers who joined me a few times and encouraged me along the way."

Notes: The number of participants providing qualitative feedback varied by question. At post-intervention, the number of respondents (N) ranged from 7-10 for the WR group and 6-9 for the RT group. At follow-up, the N ranged from 4-6 for WR and 3-7 for RT.

3.5 DISCUSSION

This pilot study found that both a walking program and a RT exercise program successfully reduced objectively measured sitting time among U.S. university employees. A primary success of this study was the significant reduction in objectively measured sedentary time across both groups, evidenced by the strong main effect of time for sitting time. This finding aligns with a large body of literature confirming that brief, regularly prompted activity breaks are effective for reducing workplace SB (Pereira et al., 2020; Mailey et al., 2016; Shrestha et al., 2018).

However, a crucial finding, and one that aligned with our primary hypothesis, was the lack of superiority of the novel RT intervention over simple walking breaks. We found no significant group by time interaction for sitting or stepping, indicating that the magnitude of change was comparable between groups. This supports our initial hypothesis that the interventions would be largely equivalent. This suggests that for an initial behavioral change, a familiar, low-barrier activity like walking is just as effective as a more structured routine, a concept that aligns with habit formation principles favoring simplicity and accessibility (Gardner et al., 2012). In fact, for promoting overall activity, the WR intervention was arguably more successful. While both groups increased their daily steps, the post-hoc analysis revealed the WR group had a particularly meaningful increase in stepping time between post-intervention and the final follow-up, suggesting a more durable habit formation.

This interpretation is strongly supported by the adherence and qualitative data as themes of enjoyment and the activity being beneficial remained constant throughout the study. The WR group was more consistent, completing a higher proportion of prescribed 10-minute sessions. Conversely, the RT group skipped more sessions and reported more breaks lasting less than 10 minutes, with participants citing the difficulty of the exercises as a barrier. The exercise difficulty barrier is noteworthy given that U.S. workplace culture often presents challenges to PA, including lack of time and concerns about appearing unprofessional (Ryde et al., 2020; McCoy et al., 2014). This study's findings and other research suggest that without more intensive support or a longer acculturation period, adopting a culturally distinct and physically complex routine can be challenging (resulting in lower adherence and increased barriers). This concept of additional barriers for intervention tailoring adaptations aligns with research on cultural adaptation, which highlights that simply transplanting an intervention from one culture to another without deeper modification can impact fidelity and effectiveness (Castro et al., 2010).

Improvements in Wellbeing Were Significant but Nuanced

Both interventions positively impacted occupational wellbeing, most notably with both groups reporting significantly less irritability by the study's end, reinforcing the general mental health benefits of participating in a worksite wellness initiative (Coffeng et al., 2014). More complex patterns emerged for other outcomes. An improvement in focus was qualified by different improvement timelines: the RT group improved significantly right away (baseline to post-test), while the WR group's improvement was a potentially delayed effect becoming significant later (post-test to follow-up). Furthermore, the significant main effect of time on productivity was driven exclusively by the WR group, which saw a significant increase from baseline to post-intervention. This exploratory finding connects with research suggesting that simple walking, in particular, can enhance creative cognition and productivity. In their seminal work, Oppezzo and Schwartz (2014) found that the simple act of walking boosted the generation of novel ideas, a key component of productivity.

The general lack of significant changes in other psychosocial outcomes (e.g., PACES, Pain) is not entirely unexpected. The short 8-week active intervention period may have been insufficient for such changes to manifest perceivably (Leibiger et al., 2012). Moreover, the well-documented discrepancy between objective behavioral change and subjective reports likely played a role, a common challenge in PA research (Sallis & Saelens, 2000; Prince et al., 2008).

Limitations and Future Directions

As a pilot and feasibility trial, this study has several limitations. First, the pre-post design lacked a non-intervention control group, making it difficult to isolate the effects of the program from external factors. Because the interventions were conducted during the university's spring and fall academic semesters, natural fluctuations in workload and stress associated with the academic calendar could have acted as confounding variables, particularly for psychosocial outcomes. Second, the small sample size (N=36 randomized) limits statistical power and the generalizability of the results. While drawn from a single university, the significant participant attrition is itself a key feasibility finding, highlighting the challenge of sustained engagement and informing the need for enhanced retention strategies in a future trial. Finally, the reliance on self-reported logs for adherence, while a common practice, introduces potential recall bias (Prince et al., 2008). Methodologically, the 8-week active intervention may be too short for sustained psychosocial changes, and the lack of activPAL data from remote participants required imputation, which can influence results. Finally, modifications to the IPAQ and the low internal consistency of some HWQ subscales necessitate cautious interpretation of those specific findings.

Future research should aim to replicate this study in larger, more diverse samples with longer-term follow-up to assess the sustainability of behavioral changes. Implementing objective adherence measures (e.g., app-based tracking) would eliminate recall bias and provide more accurate engagement data. Investigating the mechanisms behind the observed differences—such as the role of self-efficacy, enjoyment, and cultural tailoring—is a critical next step for optimizing intervention design.

Conclusion

Both an online-delivered walking break program and an adapted Japanese Radio Taiso exercise program effectively reduced objective workplace sitting time among U.S. university employees in this pilot study. However, RT was not superior to simpler walking breaks for objective behavioral changes or self-reported psychosocial improvements. Differing engagement patterns and qualitative feedback suggest potential variations in acceptability and implementation fidelity, underscoring the importance of intervention simplicity and cultural context in worksite wellness program design.

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Chapter 4 - Creating and Evaluating a Theory-Based Cardiac Rehab Education Program (C3) to Improve Long-Term Physical Activity Behaviors and Wellbeing: A Pilot Study

4.1 ABSTRACT

Background: Long-term adherence to physical activity (PA) following cardiac rehabilitation (CR) is often poor, partly due to a lack of standardized, theory-based patient education and potential staff burden in developing such materials. The Health Action Process Approach (HAPA) offers a robust framework for behavior change interventions. To address this need, the "Cardio Commitment Course (C3)" was developed to provide a structured, theory-based, and feasible education program. Therefore, the primary purpose of this study was to evaluate the initial feasibility, acceptability, and implementation of the C3 program from the perspective of CR staff.

Method: A mixed-methods, pre-post, single-group design was employed at two CR sites. All nine CR staff delivering patient education at the two sites were invited to participate. Following a 4-week training program, staff implemented the C3 program over a 14-week period. An exploratory sample of their patients was also recruited to assess preliminary outcomes. Staff training included how to use patient education tool (PET)s and theoretical background of the HAPA model. Staff feasibility and acceptability were assessed via surveys (pre-training, post-training, post-implementation) measuring confidence, perceived burden, and satisfaction. Implementation fidelity was tracked using education logs. Qualitative data from staff focus groups (post-implementation), training sessions, and monthly support meetings explored experiences, barriers, facilitators, and necessary program adaptations.

Results: Quantitative analyses indicated significant improvements in staff confidence for prescribing PA (p = .041), setting goals (p = .018), and helping patients overcome barriers (p = .034) immediately post-intervention. Staff also reported delivering more verbal recommendations (p = .032) and engaging in more goal setting (p = .029) post-intervention. The number of weekly patients educated significantly increased from pre-intervention to 3-month follow-up (p = .017). Implementation fidelity varied, with 20% of patients receiving the target three one-on-one sessions, and Patient Education Tool (PET) usage constituting 6% of educational contacts. Qualitative themes highlighted C3's practical tools and peer support as strengths, while program complexity and time constraints were key barriers. Staff self-efficacy was influenced by mastery experiences and information overload, and iterative adaptations focused on simplification.

Conclusion: The C3 program and training demonstrated potential to enhance CR staff confidence and some educational behaviors. While staff perceived value in the C3 tools and collaborative support, successful implementation requires significant simplification of materials and processes, robust strategies to build staff self-efficacy, and consideration of practical time constraints. Future iterations should prioritize these elements to improve fidelity and broader adoption.

Keywords: cardiac rehabilitation, patient education, implementation science, feasibility studies, health behavior theory, Health Action Process Approach, staff training

4.2 INTRODUCTION

Cardiovascular diseases (CVDs) remain a leading cause of morbidity, mortality, and healthcare expenditure globally (Benjamin et al., 2019; Tsao et al., 2023). Cardiac rehabilitation (CR) is a cornerstone of secondary prevention, proven to reduce mortality and improve quality of life (Anderson et al., 2016). A key component of comprehensive CR is patient education, designed to empower individuals to make sustained healthy lifestyle changes, particularly regarding physical activity (PA) (Balady et al., 2007). However, long-term adherence to PA post-CR remains suboptimal, with only a minority of patients maintaining regular exercise (Bjarnason-Wehrens et al., 2010; Fang et al., 2017), suggesting a critical gap in the effectiveness or implementation of current educational practices.

One significant challenge has been the lack of standardized, theory-based education programs within many CR settings, especially in the U.S. (Balady et al., 2007; Varnfield et al., 2011). CR staff are often tasked with developing their own educational materials, despite frequently lacking formal training in behavior change theory or curriculum development (Daw et al., 2022). This can lead to increased staff burden, variability in the quality and content of education, and potentially less effective interventions (Ghisi et al., 2014). Consequently, there was a pressing need for a standardized, evidence-based, practical, and implementable educational program that could be consistently delivered by CR staff.

The Health Action Process Approach (HAPA; Schwarzer, 2008) provides a robust theoretical framework for understanding and promoting health behavior change. HAPA delineates motivational and volitional phases, incorporating constructs such as self-efficacy (task, maintenance, recovery), outcome expectancies, risk perception, intention, and planning (action and coping) (Schwarzer et al., 2011). Programs based on HAPA have shown promise in various health contexts, including increasing PA-particularly in the CR setting (Lippke et al., 2010; Parschau et al., 2014). These interventions typically focus on building PA self-efficacy and translating intentions into action through detailed action planning (specifying when, where, and how to act) and coping planning (developing strategies to overcome barriers). For instance, a key study from Germany successfully used a modified HAPA model-based group intervention within cardiac rehabilitation to promote PA (Wurst et al., 2019). More recently, a pilot study from a Canadian group evaluated a comprehensive patient education intervention for a hybrid cardiac rehab model, demonstrating the feasibility of applying these structured principles (Arrieta-Bartolomé et al., 2022). Despite this promising international work, the application of structured, theory-based educational programs like HAPA remains uncommon in many U.S. cardiac rehab settings (Balady et al., 2007; Ghisi et al., 2014; Varnfield et al., 2011). The C3 program was therefore developed to adapt these proven principles specifically for the U.S. healthcare context and the structured environment of U.S. phase 2 CR.

This study describes the development and evaluation of the Cardio Commitment Course (C3), a HAPA-based education program designed for integration into phase 2 CR. Recognizing the critical role of CR staff in program delivery, this study primarily aimed to evaluate the feasibility, acceptability, and implementation of the C3 program from the perspective of CR staff. Secondary exploratory aims involved assessing preliminary changes in patient PA behaviors, HAPA-related psychosocial constructs, and wellbeing.

This study addresses a critical gap in the effectiveness or implementation of current educational practices/standards resulting in patients not improving their long-term physical activity behaviors. The central research questions guiding this study were threefold. First, was the C3 training and program feasible and acceptable for CR staff to implement within their existing workflow? Second, to what extent was the C3 program implemented by CR staff as intended, assessing fidelity? Third, what were CR staff perceptions of the barriers and facilitators to implementing C3, and what adaptations are necessary for broader dissemination?

It was hypothesized that CR staff would find the C3 training effective and the program acceptable and feasible to implement, demonstrating good fidelity. It was further hypothesized that the iterative feedback process would identify key adaptations to enhance future program design and implementation.

4.3 METHOD

Design

This study employed a mixed-methods design, primarily focused on evaluating the feasibility, acceptability, and implementation of the C3 program by utilizing a pre-post, single-group design was used to assess changes in CR staff outcomes following C3 training and implementation. Qualitative data were collected throughout the study to understand staff experiences and inform program refinement. Exploratory patient data were also collected using a pre-post design to assess preliminary program effects. The study was conducted at two phase 2 CR sites (outpatient, whereas phase 1 is inpatient and phase 3 is personal maintenance) in a midwestern state. Ethical approval for this study was obtained from the research team's Institutional Review Board (IRB# 11917).

Participants

Staff participants included nine CR employees, including nurses, exercise physiologists, clinical exercise physiologists, clinic supervisors, and rehabilitation assistants involved in direct patient care and education at the two participating CR sites, were recruited. Staff and sites were recruited through professional connections within a regional affiliate of the American

Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), a professional organization for cardiac rehabilitation specialists. The primary investigator met with the site directors to describe the study's goals and procedures, and the directors subsequently agreed to participate and facilitate staff recruitment. Staff inclusion criteria required staff to have started their appointment as a CR employee before baseline testing and for staff to agree to attending four C3 training sessions. All staff delivering patient education were invited to participate. Participating staff members received an incentive of approximately $111.11 each for their time and effort throughout the study duration (awarded after the final post-study focus group). An small sample of patients, enrolled in phase 2 CR were also recruited to receive the C3 program delivered by the trained staff (staff delivered new education protocol to all patients, participants or not). Patient inclusion criteria stipulated that individuals must have been enrolled in phase 2 CR, physically able to complete CR, and planning to complete 36 visits. Medically, patients must have experienced a recent cardiac event such as a heart attack in the last 12 months, undergone a major heart procedure, or had chronic heart failure. Patients were excluded if they had orthopedic limitations impacting PA participation or did not plan to complete all 36 CR visits. Patients provided informed consent prior to participation.

The Cardio Commitment Course (C3) Intervention

The C3 program is a novel educational curriculum developed by two authors of this study with expertise in exercise behavior change. The program was designed specifically for integration into standard Phase 2 CR and is grounded in the HAPA model (Schwarzer, 2008). It includes several evidence-based components. The first is a patient education packet (PEP; Appendix C.3) containing worksheets and patient education tools (PETs). Each PET addresses a specific HAPA construct (e.g., task self-efficacy, action planning) to provide patients with tangible materials that support self-management, a strategy known to be effective in chronic conditions (Ghisi et al., 2014). Second, a brief motivational-volitional (M/V) screener was created to help staff efficiently identify patient-specific barriers and meet the mandatory 30-day education documentation required by many insurance providers. Third, the C3 program structures the delivery of this content through both individual and group sessions. It requires at least three structured one-on-one sessions to provide the tailored, patient-centered counseling necessary to build self-efficacy (Bandura, 1986). It also includes at least three group sessions, as group-based formats are highly effective for fostering peer social support. This addresses outcomes like loneliness and is a key "resource" construct within the HAPA model, crucial for long-term behavior maintenance (Grace et al., 2012).

Staff Training and Support

Participating CR staff underwent a structured training program led by the research team before implementing C3. These group trainings consisted of 4 initial sessions and 4 biweekly support sessions. The initial training spanned four weeks, with weekly sessions of approximately one hour each. These sessions covered HAPA theory and its application to behavior change in CR; a detailed review of all C3 program materials, including the PEP, PETs, and screeners; strategies for delivering effective one-on-one and group education sessions, incorporating principles such as motivational interviewing and effective communication; and study procedures, data collection protocols, and ethical considerations. Qualitative feedback on the training content and delivery was collected during and after each session to facilitate immediate adjustments and ensure clarity. Following the initial training, ongoing support and iterative refinement occurred throughout the 14-week C3 implementation period. This included biweekly support meetings facilitated by the research team, providing a forum for staff to discuss implementation progress, challenges, share experiences, and engage in collaborative problem-solving with other staff and the research team. Qualitative data, in the form of transcripts from training and meetings and informal feedback from staff, were systematically collected to identify necessary program adaptations. The training and support models differed between the two sites. For the Remote Site (RS), all materials, training, and subsequent support meetings were exchanged entirely via video conferencing, mail, and email, with no in-person contact from the research team. For the On-Site (OS) location, the research team conducted the initial 4-week training sessions in-person, while all subsequent monthly support meetings were held via video conference, consistent with the remote site.

Measures

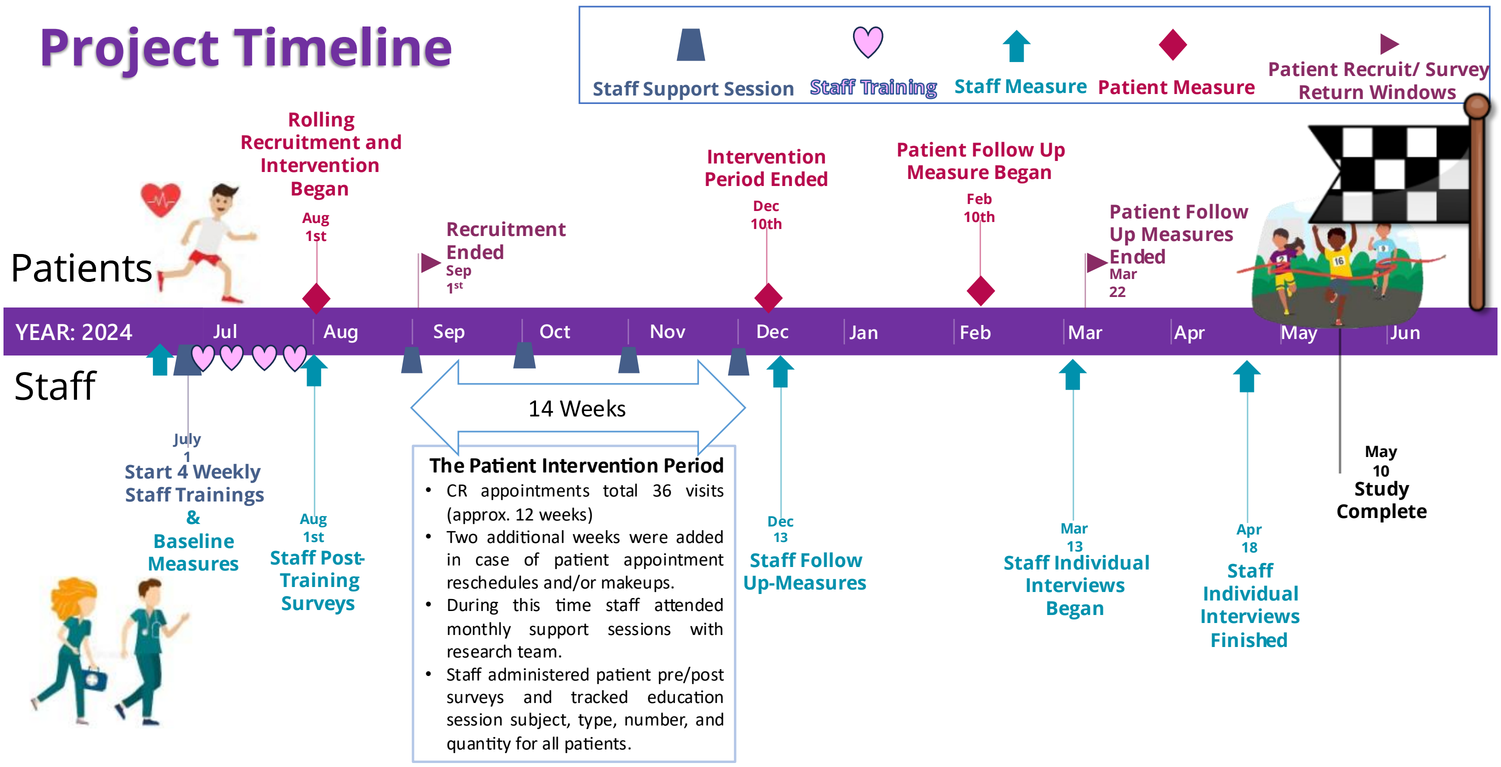
The primary outcomes of this study focused on staff acceptability, feasibility, and implementation fidelity. Staff acceptability and feasibility were assessed using staff surveys administered pre-training, immediately post-training, and post-C3 implementation (after 14 weeks of delivery). These surveys measured changes in staff knowledge and confidence regarding HAPA and theory-based education; the acceptability of the C3 training and program components; and the feasibility of the C3 program, including perceived ease of use, compatibility with existing workflow, and perceived burden. Staff perceptions of the C3 program's potential to improve patient outcomes were also rated. Further qualitative insights into acceptability and feasibility were gathered through staff focus groups conducted post-C3 implementation. These focus groups explored in-depth perceptions of the program, specifically through the lens of self-efficacy theory (Bandura, 1977, 1986). The focus group guide was structured to elicit discussion around staff members' confidence in their ability to perform C3-related tasks (self-efficacy expectations) and their beliefs about the likely outcomes of implementing the C3 program (outcome expectations), including both positive and negative aspects. This deductive approach allowed for a targeted exploration of how self-efficacy and outcome expectations influenced staff engagement, perceived feasibility, and acceptability of the C3 program. Additionally, field notes and summaries from all training sessions and monthly support meetings served as qualitative data, documenting staff feedback, challenges they encountered, solutions they generated, and any real-time adaptations made to the C3 program or its delivery. This iterative process of coding and discussion between the three researchers was also used to determine thematic saturation. For both the survey and focus group data, saturation was considered reached when the analysis of the final staff responses yielded no new major themes, and the developed codebook was able to comprehensively capture the full range of experiences within the dataset.

Staff implementation fidelity was assessed through Education Tracking Logs. CR staff completed these logs for each C3 education component delivered, such as one-on-one sessions, group sessions, and PET discussions, over the 14-week intervention period. These logs captured the date and type of educational contact, the duration of the contact, specific HAPA constructs or C3 topics covered, and the PEP/PET materials used or prescribed. This information allowed for an assessment of adherence to the intended C3 curriculum, including the proportion of core topics covered and the frequency of one-on-one sessions.

A secondary aim of the study was an exploratory assessment of patient-level outcomes. The intention was to measure changes in subjective PA, key HAPA constructs (e.g., self-efficacy, intentions), and wellbeing using validated questionnaires at baseline, post-CR, and a 4-month follow-up. However, the study encountered unforeseen challenges that limited data collection. These included patient-related barriers to completing and returning surveys, significant time constraints on CR staff which impacted their ability to facilitate data collection, and limitations on research team resources. These factors resulted in a smaller than anticipated number of complete patient surveys, rendering the collected data insufficient for any meaningful statistical analysis.

Procedure

Figure 4.1: Project Timeline- Training, Intervention, Follow-Up, and Focus Group



The study unfolded in several phases (please see Figure 4.1). Initially, CR staff were recruited, provided informed consent, and completed pre-training surveys. Subsequently, the 4-week C3 staff training program was delivered, during which qualitative feedback was collected. Staff then completed post-training surveys. Following the staff training and post-training surveys, the 14-week C3 implementation period commenced. During this period, trained CR staff delivered the C3 program to all patients as part of their standard clinical practice. To gather exploratory outcome data, a small sample of eligible patients was also recruited. These specific patients provided informed consent to complete baseline outcome measures. Throughout this period, staff completed Education Tracking Logs, and monthly support meetings with the research team occurred, with ongoing collection of qualitative data on program adaptation. Post-intervention data collection then took place. Patients completed outcome measures at the end of their CR program (approximately 14 weeks) and again at a 4-month follow-up. Staff completed post-C3 implementation surveys and participated in focus groups. Finally, qualitative data from staff were analyzed on an ongoing basis to inform minor adjustments during implementation and major refinements for future iterations of the C3 program. Measures for surveys and their time points are displayed in table 4.1.

Table 4.1: Staff Outcome Measures, Descriptions, and Assessment Timeline

Construct	**Measure / Instrument**	**Description**	**Time Points**
Feasibility & Acceptability	C3 Training Evaluation Survey	5-point Likert scale items assessing staff perceptions of the training's effectiveness, relevance, and clarity.	Post-Training, Follow-Up
Feasibility & Acceptability	C3 Program Evaluation Survey	5-point Likert scale items assessing perceived ease of use, compatibility with workflow, and burden of the C3 program.	Follow-Up
Acceptability	C3 Tool & Theory Evaluation	7-point Likert scale items assessing the perceived usefulness of specific program components (PEP, PETs, M-V Screener).	Follow-Up
Implementation Fidelity	Education Tracking Logs	Staff-completed logs documenting the date, type, duration, and content of each educational contact with patients.	During Implementation
Staff Confidence (Self-Efficacy)	Staff Confidence Survey	10-point Likert scale items assessing staff confidence in performing key educational tasks (e.g., setting goals, overcoming barriers).	Pre-Training, Post-Training, Post-Implementation

Staff Behaviors	Self-Reported Behaviors Survey	Items assessing the frequency of key educational behaviors (e.g., number of verbal recommendations, number of patients educated per week).	Pre-Training, Post-Training, Post-Implementation
Qualitative Perceptions	Focus Groups, Training & Support Meeting Transcripts, Open-Ended Survey Questions	Semi-structured discussions and written feedback exploring in-depth staff experiences, perceived barriers, facilitators, and suggestions for adaptation.	Throughout Study

Quantitative Data Analysis

Data Cleaning and Preparation. The raw dataset was imported in R (Version 4.5.1; R Core Team, 2025), and an extensive renaming process was undertaken to convert descriptive column names to a standardized snake_case format, preserving time point suffixes (_Pre, _Post, _FU). Categorical Likert scale data, initially coded as text, were systematically converted to their corresponding numeric values. To address any remaining data-type mismatches, a programmatic conversion of all outcome columns to numeric was implemented in R (Version 4.5.1; R Core Team, 2025), with non-numeric entries appropriately coded as *NA*. The participant identification column was standardized, and redundant ID columns were removed. Finally, the data were reshaped from a wide to a long format using tidyr::pivot_longer(), creating a time variable (pre-intervention, post-intervention, 3-month follow-up) essential for repeated measures analyses.

Main Analyses of Staff Outcomes. For variables with data collected at all three time points (Pre, Post, FU), multiple imputation was performed using the mice package in R (Version 4.5.1; R Core Team, 2025; m=10 imputations, predictive mean matching method) to address missing Follow-Up data for one participant and utilize the full sample (N=9). A series of one-way repeated measures analyses were conducted using linear mixed-effects models (lme4::lmer package) on each imputed dataset, with models specified as outcome ~ Time + (1 | participant_id). Results from the 10 imputed datasets were then pooled using the mice::pool.table() function to obtain robust estimates, t-statistics, and p-values for specific planned comparisons: post-intervention vs. pre-intervention, and follow-up vs. pre-intervention. Effect sizes (Cohen's *d*) were calculated for these comparisons. The overall effect of time for these 3-time-point variables was assessed using ANOVA-type summaries derived from the pooled mixed models.

For variables measured at only two time points (post-intervention and follow-up; e.g., training evaluations), paired-samples t-tests were used to assess changes between these points. For variables measured at a single time point (e.g., specific intervention or tool evaluations asked only at post-test or only at follow-up), descriptive statistics (means and standard deviations) were calculated for the combined staff group, given the absence of between-site differences. Effect sizes (Cohen's *d*) were also calculated for paired comparisons where appropriate. Statistical significance was set at an alpha level of .05 for all analyses.

Preliminary Analyses and Strategy Adaptation. Initial diagnostic analyses revealed that certain sets of questions (e.g., intervention evaluations, tool usefulness) were structurally absent at specific time points (e.g., intervention evaluation questions were only asked at Post-intervention, and tool usefulness questions only at Follow-Up). This necessitated a revised analysis plan tailored to the data structure for different variable sets. A preliminary analysis, employing MANOVA for 3-time-point variables and independent samples t-tests for 1- and 2-time-point variables, were conducted to test for differences between the two cardiac rehabilitation sites. As no statistically significant differences were found between the sites on any outcome measure at any time point (all ps > .05), data from both sites were combined for all subsequent main analyses focusing on the effect of time.

Qualitative Data Analysis

Audio recordings from staff focus groups, along with detailed notes from training sessions and monthly support meetings, were transcribed verbatim. The qualitative data were analyzed using a thematic analysis approach, following the phases outlined by Braun and Clarke (2006). This process involved two distinct strategies.

For the post-implementation focus group data, a deductive, theory-driven analysis was utilized. The core constructs of Self-Efficacy Theory (Bandura, 1977, 1986) served as the analytical framework to guide coding, allowing for a targeted exploration of staff confidence and outcome expectations. In contrast, for data gathered from open-ended survey questions and meeting transcripts, an inductive, data-driven analysis was employed to identify emergent themes related to program feasibility, acceptability, and implementation without being constrained by a pre-existing theoretical framework.

To ensure analytical rigor, two researchers independently coded a subset of the data to establish an initial coding framework. They then met to compare codes, resolve discrepancies, and develop a consolidated codebook through a consensus process. This final codebook was then applied to the full dataset. The analysis of feedback from the training and support meetings was an ongoing, iterative process, allowing for real-time adaptations to the C3 program based on these emergent themes.

4.4 RESULTS

Quantitative Staff Results

The quantitative data from staff participants (*N*=9) across the two cardiac rehabilitation sites were analyzed to assess changes in self-reported behaviors, routines, confidence, and evaluations of the C3 training and intervention over time. To provide context for these findings, the demographic and professional characteristics of the participating staff are detailed in Table 4.2.

Table 4.2: Staff Demographics

Characteristic	Total (*N*=9)	Remote Site (*n*=4)	On-Site (*n*=5)
Gender			
Female	8 (89%)	3 (75%)	5 (100%)
Male	1 (11%)	1 (25%)	0 (0%)
Years in Cardiac Rehab			
>10 Years	4 (44%)	2 (50%)	2 (40%)
5-10 Years	2 (22%)	1 (25%)	1 (20%)
<1 Year	3 (33%)	1 (25%)	2 (40%)
Years of Clinical Experience			
>10 Years	6 (67%)	2 (50%)	4 (80%)
5-10 Years	2 (22%)	1 (25%)	1 (20%)
<1 Year	1 (11%)	1 (25%)	0 (0%)
Highest Level of Education			
Masters Degree	3 (33%)	1 (25%)	2 (40%)
College Degree	6 (67%)	3 (75%)	3 (60%)
Professional Role(s)*			
Exercise Physiologist	6	4	2
Nurse	5	1	4
CR Director	1	1	0

Volunteer	1	1	0
Employment Status*			
Full-time	4	3	1
Part-time	1	0	1
PRN	3	0	3
Volunteer	1	1	0
Weekly Patient Education			
Avg. Patients/Week	11.9	14.5	9.8
Avg. Hours/Week	5	7.3	3.2
PA Enjoyment Score (0-10)	Avg: 8.2	Avg: 9.0	Avg: 7.6
	(N=9)	(n=4)	(n=5)
Physical Activity Training			
UG Coursework	5 (56%)	3 (75%)	2 (40%)
UG Degree	5 (56%)	3 (75%)	2 (40%)
Graduate Coursework	5 (56%)	2 (50%)	3 (60%)
Graduate Degree	4 (44%)	1 (25%)	3 (60%)
Other Cert/Training	6 (67%)	4 (100%)	2 (40%)

Preliminary analyses of the quantitative data from staff participants (*N*=9) revealed no significant between-site differences on any outcome measures (all *p*s > .05). Therefore, data from both sites were combined for all subsequent analyses.

All quantitative staff outcomes are presented in Table 4.3. This comprehensive table is organized into three main sections: (1) core staff outcomes (e.g., confidence, behaviors) measured across three time points; (2) evaluations of the C3 training and overall program, which were compared between Post-intervention and Follow-Up; and (3) descriptive evaluations of specific tools and HAPA theory collected at a single time point.

Table 4.3: Changes in Staff Self-Reported Outcomes Over Time (*N*=9)

Outcome Variable and Overall Time Effect (*p*-value)	**Mean (*SD*) Pre**	**Mean (*SD*) Post**	**Mean (*SD*) Follow-Up**	**Pre vs. Post Comparison (*p*-value & Cohen's *d*)**	**Pre vs. Follow-Up Comparison (*p*-value & Cohen's *d*)**
Staff Confidence, Behaviors, & Routines (3 Time Points)					
Confidence: Set Goals (p = .077)	8.89 (1.69)	9.22 (1.09)	9.00 (1.12)	**.018** (*d* = 0.79)	.104 (*d* = 0.54)
Confidence: Overcome Barriers (p = .118)	8.78 (1.72)	9.00 (1.12)	8.89 (1.05)	**.034** (*d* = 0.71)	.167 (*d* = 0.46)
Confidence: Written Rx (p = .142)	8.56 (2.35)	9.78 (0.67)	9.67 (0.45)	**.041** (*d* = 0.68)	.197 (*d* = 0.43)
Behavior: # Verbal Rec. (p = .112)	11.78 (5.54)	12.56 (8.06)	18.88 (13.39)	**.032** (*d* = 0.72)	.220 (*d* = 0.41)
Behavior: # Set Goals (p = .093)	5.00 (4.09)	6.67 (3.97)	9.63 (8.58)	**.029** (*d* = 0.73)	.120 (*d* = 0.52)
Workload: Weekly Patients (*p* = .011)	11.89 (6.85)	11.67 (7.31)	11.50 (6.78)	.927 (*d* = -.03)	**.017** (*d* = 0.80)
Workload: Weekly Hours Edu. **(*p* = .032)**	5.00 (6.02)	9.33 (9.67)	7.13 (6.88)	**.017** (*d* = 0.79)	.098 (*d* = 0.55)
Routine: Verbal Rec. (p = .114)	4.67 (1.00)	2.56 (2.19)	4.00 (1.77)	.085 (*d* = -0.57)	**.029** (*d* = -0.73)
C3 Training Evaluation (1-5 Scale)	*(Comparison is Post vs. Follow-Up)*			**Post vs. Follow-Up Comparison (*p*-value & Cohen's *d*)**	
Changed my perspective		3.22 (1.09)	2.89 (0.60)	.438 (*d* = 0.27)	
Want to discuss PA more		3.11 (0.93)	3.22 (0.83)	.759 (*d* = -0.11)	
Will prescribe PA more		2.89 (0.60)	2.89 (0.78)	1.000 (*d* = .00)	
Enhanced my confidence		3.44 (0.53)	3.78 (0.83)	.382 (*d* = -0.31)	
C3 Program Evaluation (1-5 Scale)	*(Comparison is Post vs. Follow-Up)*			**Post vs. Follow-Up Comparison (*p*-value & Cohen's *d*)**	

Program was complex		4.22 (0.83)	3.88 (0.48)	0.315 (*d* = 0.50)	
Program was time-consuming		3.89 (0.93)	3.88 (0.63)	0.972 (*d* = .01)	
Program was applicable		3.78 (0.67)	3.75 (0.43)	0.889 (*d* = .05)	
Program was flexible		3.56 (0.53)	3.50 (0.50)	0.749 (*d* = 0.12)	
Overall satisfaction		3.11 (0.33)	3.63 (0.48)	.06 (*d* = 1.26)	
Tool & Theory Evaluations (1 Time Point)					
PEP was useful (1-7 Scale)			6.50 (0.50)		
PETs were useful (1-7 Scale)			6.63 (0.48)		
M-V Screener useful (1-7 Scale)			6.50 (0.50)		
HAPA changed my behavior (1-5 Scale)			3.63 (0.92)		

Note: Statistically significant p-values (p < .05) are shown in bold. The 1-5 scale items used a Likert scale where 3 = Neutral. The 1-7 scale items used a scale where 4 = Neutral.

Significant improvements in staff confidence were observed immediately following the intervention. Specifically, staff reported increased confidence in providing written PA prescriptions from Pre- to Post-intervention (mean change = 1.30, SE = 0.64, t = 2.045, p = .041, Cohen's d = 0.68), setting goals with patients (mean change = 0.94, SE = 0.40, t = 2.360, p = .018, d = 0.79), and helping patients overcome barriers to PA (Mean Change = 0.81, SE = 0.38, t = 2.122, p = .034, d = 0.71). These increases in confidence were accompanied by significant changes in reported behaviors. Staff reported providing significantly more verbal recommendations for PA (mean change = 6.64, SE = 3.09, t = 2.151, p = .032, d = 0.72) and engaging in significantly more instances of goal setting with patients (mean change = 4.71, SE = 2.16, t = 2.179, p = .029, d = 0.73) from pre- to post-intervention.

Regarding the variables that showed a significant overall ANOVA effect, post hoc comparisons revealed that the number of weekly patients educated significantly increased from Pre-intervention to the 3-month follow-up (mean change = 5.83, SE = 2.44, t = 2.394, p = .017, d = 0.80). The number of weekly hours staff reported educating patients significantly increased from pre- to post-intervention (mean change = 4.33, SE = 1.83, t = 2.373, p = .017, d = 0.79). This increase was also maintained with a medium, though non-significant, effect size at the 3-month follow-up when compared to pre-intervention (mean change = 3.02, SE = 1.82, t = 1.657, p = .098, d = 0.55). Furthermore, the reported routine of providing verbal recommendations for PA showed a significant improvement (increase on the Likert scale) from pre-intervention to the 3-month follow-up (mean change = -0.54, SE = 0.25, t = -2.183, p = .029, d = -0.73).

Staff Evaluation of C3 Training and Intervention Components

Staff evaluations of the C3 training were assessed immediately post-intervention and at the 3-month follow-up. Paired-samples t-tests indicated no statistically significant changes in staff perceptions of the training between these two time points (all ps > .05), suggesting that initial evaluations regarding the training changing their perspective, increasing their intention to discuss PA, leading them to prescribe PA more, or enhancing their confidence were maintained (see Table 4.3).

Evaluations of the C3 intervention components were also collected at post-intervention and the 3-month follow-up whereas the associated tools were only evaluated at the 3-month follow-up. As established by preliminary analyses showing no significant between-site differences in these evaluations, the data were combined. Overall staff ratings indicated general satisfaction with the intervention components and found the tools to be useful (all above 3=neutral and many with promising effect sizes; see Table 4.3).

Implementation Fidelity of C3 Components

Implementation fidelity was assessed through the analysis of 303 education logs documenting contacts with 54 unique patients (37 at remote site, 17 at on-site) over the 14-week implementation period. Overall, 68 formal one-on-one sessions were delivered across both sites. However, adherence to the target of delivering at least three one-on-one sessions per patient was achieved for only 20% (11 of 54) of patients. Regarding group sessions, remote site showed much higher implementation, logging 41 attendances compared to just one at on-site. Beyond session counts, the logs revealed stark site-specific differences in the general topics discussed. As detailed in table 3, on-site's delivery was heavily concentrated on stress/energy management and resistance exercise. In contrast, the remote site focused more on healthier choices and medications. Finally, usage of the structured C3 PETs was low, accounting for only 6% of all educational contacts. Education log results depicted in Table 4.4.

Table 4.4: Implementation Fidelity of C3 Components by Site and in Total

Fidelity Metric	Remote Site	On-Site	Total
Overall Educational Delivery			
Total patients with logged contact (*N*)	37	17	**54**
Total educational contacts logged	131	172	**303**
Formal Session Delivery			
One-on-One Sessions (Target: ≥3)			
Total Delivered	45	23	**68**
Patients Receiving ≥3	22% (8 of 37)	18% (3 of 17)	**20% (11 of 54)**
Total Logged Group Session Attendances	41	1	**42**
Frequency of Top Educational Topics Discussed			
Stress / Energy Management	3 (2%)	25 (15%)	28 (9%)

Resistance Exercise	5 (4%)	24 (14%)	29 (10%)
Healthier Choices / Risk Factors	14 (11%)	21 (12%)	35 (12%)
Medications	14 (11%)	7 (4%)	21 (7%)
C3 Patient Education Tool (PET) Usage	*n (%PET)*	*n (%PET)*	*n (% PET; % tot)*
Total PETs Logged	**11 (61%)**	**7 (39%)**	**18 (6% of tot.)**
Task Self-Efficacy (PET #1)	4 (22%)	3 (16%)	**7** (39%; 2%)
Action/Coping Planning (PET #8)	2 (11%)	0 (0%)	**2** (11%; <1%)
Maintenance/Recovery (PET #10)	2 (11%)	1 (6%)	**3** (17%; 1%)

Note. Fidelity data were derived from 303 education logs for 54 unique patients (37 at Remote Site, 17 at On-Site) over the 14-week C3 implementation period. PET usage reflects the number of times a specific Patient Education Tool was documented as being used and percentages are baes on tot PET usage.

Qualitative Staff Results

Qualitative data were collected from staff (*N*=9) through open-ended survey responses, feedback during initial training sessions, ongoing monthly support meetings, and post-implementation focus groups. These data provided in-depth insights into staff experiences with the C3 program, its perceived strengths and weaknesses, barriers and facilitators to implementation, and emergent adaptations.

Staff Perceptions from Surveys. Open-ended survey responses collected at post-training and the 3-month follow-up revealed several key themes regarding the C3 program and training. Staff identified several perceived strengths. A prominent strength was providing practical tools and structure, with one staff member noting, *"The M/V screener was useful to pinpoint the exact area of the HAPA model that needed addressed. Before it was sometimes difficult to pinpoint how exactly to help patient's get exercising"* (RS2, Post). Another participant found, *"The handouts were a useful tool to start conversations... [they] gave the discussion structure and a physical reminder when they were at home"* (OS5, FU). Staff also appreciated the C3 program facilitating a broader, patient-centered perspective. One commented on the usefulness of *"changing the reasons for exercising that patients can see a benefit such as improved mood, cognitive ability etc. - not just focusing on the health benefit"* (RS3, Post). Finally, enabling peer support and collaboration through the monthly check-in meetings was valued: "It was very useful to be able to meet up with the other team and bounce ideas off of each other to see what is working and what isn't" (OS1, FU), with another stating the check-ins provided a "'push' after every meeting" (RS1, FU).

Despite these strengths, surveys also highlighted significant barriers and recommendations for improvement. The most frequently cited concern was the overwhelming complexity and a need for simplification. As one staff member expressed, *"Simplify, keep it somewhat basic, material for patients needs to be at a 5th grade reading level... I think overall the information and verbiage is going to be a little too complex/intimidating"* (RS1, Post). This sentiment was echoed with calls to *"streamline as much paperwork as possible so it's less overwhelming to staff and patients"* (OS5, Post) and for *"Continued work on simpler language and shorter documents"* (OS5, FU). Practical barriers to implementation were also prominent, with the *"biggest barrier is time allowed for education due to high volume/acuity of patients"* (OS5, Post). This time constraint made using all C3 tools challenging: *"The M/V tool, using the HAPA approach and then the designated PET's. I could see these as useful tools but unfortunately, we simply do not have the time"* (OS1, FU). Additionally, patient resistance to *"take home - homework"* (OS1, FU) was noted. Finally, staff suggested refining the training and adaptation approach, with one participant feeling *"there was too much emphasis on the model in the beginning which was a little confusing"* (OS3, FU). Others found the iterative changes during development difficult to keep up with and suggested it *"would have been great for research staff* *[to] be on site more often to assess how the facility does current education and help with how to best run the research program"* (OS1, FU).

Table 4.5: Key Themes from Staff Qualitative Surveys on C3 Training and Implementation

Main Theme & Sub-theme	**Illustrative Quotes**
Perceived Strengths of the C3 Program and Training	
1. Providing Practical Tools and Structure	"The M/V screener was useful to pinpoint the exact area of the Hapa model that needed addressed. Before it was sometimes difficult to pinpoint how exactly to help patient's get exercising." (OS2, Post) "The handouts were a useful tool to start conversations... [they] gave the discussion structure and a physical reminder when they were at home. The PET was a helpful resource for patients who had no idea where to start/add exercise." (OS5, FU)
2. Facilitating a Broader, Patient-Centered Perspective	"When we discussed changing the reasons for exercising that patients can see a benefit such as improved mood, cognitive ability etc. - not just focusing on the health benefit." (RS3, Post) "[Useful aspect was the] holistic approach." (OS4, FU)
3. Enabling Peer Support and Collaboration	"It was very useful to be able to meet up with the other team and bounce ideas off of each other to see what is working and what isn't." (OS1, FU) "[The check-ins gave us a] 'push' after every meeting." (RS1, FU)
Barriers and Recommendations for Improvement	
1. Overwhelming Complexity and a Need for Simplification	"Simplify, keep it somewhat basic, material for patients needs to be at a 5th grade reading level... I think overall the information and verbiage is going to be a little too complex/intimidating." (RS1, Post)

	"Just to stream line as much paperwork as possible so it's less overwhelming to staff and patients. Simplify as much as possible." (OS5, Post) "Continued work on simpler language and shorter documents." (OS5, FU)
2. Practical Barriers to Implementation	"Biggest barrier is time allowed for education due to high volume/acuity of patients. I want to see how the project goes with the changes. Curious to see how more group education/discussion works with time restraints." (OS5, Post) "The M/V tool, using the HAPA approach and then the designated PET's. I could see these as useful tools but unfortunately, we simply do not have the time." (OS1, FU) "Pt's do not like take home - homework." (OS1, FU)
3. Refining the Training and Adaptation Approach	"I felt that there was too much emphasis on the model in the beginning which was a little confusing." (OS3, FU) "I understand we were helping in the development but there were so many changes and processes we were unable to keep up." (OS1, FU) "It would have been great for research staff [to] be on site more often to assess how the facility does current education and help with how to best run the research program." (OS1, FU)

Note. Themes derived from inductive thematic analysis of open-ended survey responses from staff ($N = 9$) at Post-training and 3-Month Follow-Up (FU). Quotes are cited with participant ID and time point. *Illustrative quotes for participant M3 at FU were generated based on prevailing themes from the on-site to provide a representative example.*

Evolution of Feedback and Program Adaptation from Training and Support Meetings. The iterative feedback process during the initial 4-week staff training and subsequent monthly support meetings revealed an evolution in staff input and led to program adaptations (see Table 5).

Phase 1 (Initial Questions & Clarifications) included staff input predominantly focused on logistical and program mechanics. For example, staff sought clarity on patient enrollment criteria (e.g., handling different patient schedules like 18-session vs. 36-session) and the availability of pre-made patient materials (e.g., PEPs), which constituted 88% of discussion items in this phase. They also had questions focused on how to use the M/V Screener, guidance on topics for group sessions, and how to apply the HAPA model in practice (75% of items).

In phase 2 (Staff-Generated Tips for Implementation), as staff began using C3, they shared practical, patient-centered strategies. Key tips included increasing patient self-efficacy by recommending short-term, achievable goals, using HR/BP monitoring to build safety and confidence, and having patients track progress in journals (68% of items in this phase). Staff also emphasized reframing PA and planning, such as breaking PA into smaller, manageable chunks and reframing exercise as a tool for stress relief rather than just a clinical task (58% of items). Addressing patient-specific needs, like providing home exercise options for patients lacking motivation to attend the gym, was also a common tip (58% of items).

Phase 3 (Resulting Program Adaptations) reflected collaborative solutions developed to address emergent challenges. Adaptations discussed and implemented included creating a simplified staff education tracker to reduce documentation burden, making use of the M/V Screener optional and based on clinical judgment rather than a strict requirement, and using incentives to encourage patient PET completion (67% of items in this phase). To further facilitate implementation and reduce burden, solutions involved allowing staff to export and reattach existing patient records instead of using separate tracking forms and creating a staff schedule to rotate the primary educator role to prevent fatigue (17% of items).

Table 4.6: Key Themes and Adaptations Emerging from Staff Training and Support Meetings

Phase, Core Theme, and Frequency	**Summary of Staff Input and Illustrative Examples**
Phase 1: Initial Questions & Clarifications (Total discussion items = 8)	***(Staff sought clarity on logistics and program mechanics during initial training)***
Logistical & Patient Questions (n = 7, 88%)	Staff asked about patient enrollment criteria, handling different patient schedules (e.g., 18-session vs. 36-session), and the availability of pre-made patient materials (e.g., PEPs).
Patient Edu. & Group Process (n = 6, 75%)	Questions focused on how to use the M/V Screener, guidance on topics for group sessions, and how to apply the HAPA model in practice.
Phase 2: Staff-Generated Tips for Implementation (Total discussion items = 19)	***(During implementation, staff shared practical, patient-centered strategies)***
Increasing Patient Self-Efficacy (n = 13, 68%)	Recommended focusing on short-term, achievable goals; using HR/BP monitoring to build safety and confidence; and having patients track progress in journals to visualize improvements.
Reframing Physical Activity & Planning (n = 11, 58%)	Suggested breaking PA into smaller, manageable chunks throughout the day; encouraging *any* movement (e.g., sit-to-stands during commercials); and reframing exercise as a tool for stress relief rather than just a clinical task.
Addressing Patient-Specific Needs (n = 11, 58%)	Included providing home exercise options for days when patients lack motivation to attend the gym and focusing on encouragement for patients who feel overwhelmed.
Phase 3: Resulting Program Adaptations (Total discussion items = 6)	***(Collaborative solutions were developed to address emergent challenges)***
Streamlining Staff Procedures & Tools (n = 4, 67%)	Adaptations included creating a simplified staff education tracker (reducing documentation burden); making the use of the M/V Screener optional and based on clinical judgment rather than a requirement; and using incentives to encourage patient PET completion.
Facilitating Implementation & Reducing Burden (n = 1, 17%)	Solutions involved allowing staff to export and redact existing patient records instead of using separate tracking forms and creating a staff schedule to rotate the primary educator role to prevent fatigue.

Note. Themes were derived from coded field notes and transcriptions from the 4-week staff training and subsequent monthly support meetings ($N = 9$). The process is organized chronologically into three phases reflecting the evolution of feedback. Frequencies represent the proportion of discussion items within each phase that pertained to a specific sub-theme, confirming the focus of conversation at different project stages.

Staff Self-Efficacy and Outcome Expectations from Focus Groups. Post-implementation focus groups (N=9) were analyzed deductively using Self-Efficacy Theory to explore staff confidence in C3 delivery (self-efficacy expectations) and their anticipated results of C3 (outcome expectations) (see Table 4.7).

Regarding Self-Efficacy Expectations (Confidence in C3 Delivery), three main themes emerged. Firstly, staff reported Mastery Experience, gaining confidence from past successes and hands-on application of C3 components, particularly when expert guidance was provided: *"When you brought in some of the topic leaders, I think that was incredibly helpful... that was definitely a big confidence booster"* (OS1, On-Site FG). Secondly, staff described their Physiological & Emotional State, noting hesitancy and feeling overwhelmed due to information overload and the perceived complexity of C3. One participant stated, *"I think the hardest part... was just cramming so much in the little time. Some of the terminology that you used was really confusing to me"* (RS1, Remote Site FG), and another felt, *"From the webinars I listened to, it was too much information, too repetitive, and needs to be simple"* (RS3, Remote Site FG). Thirdly, there was a theme of Vicarious Experience & Verbal Persuasion, reflecting a desire for mentorship and proven models: *"Would it feel better if you had a program expert or mentor...? Yes, having one person dedicated to this would be good"* (RS3, Remote Site FG). Another staff member highlighted the impact of researcher encouragement but also the reality of implementation: *"It's one thing to hear from a researcher that like, 'oh, this is going to be great.' It's another thing to hear from someone that's like, 'yeah, I actually tried this. It was tough, but there were some benefits, right?'"* (OS1, On-Site FG).

Concerning Outcome Expectations (Anticipated Results of C3), staff expressed both positive and negative expectations. On the positive side, they believed C3 tools would facilitate deeper, more productive patient conversations: *"I thought that simple question got that patient thinking and it was their words and their thoughts, not our words and our thoughts"* (RS1, Remote Site FG). Staff also believed the C3 program could genuinely improve patient outcomes: *"Success for me is like one patient... that goes from 'I don't like exercise' or 'I'm not exercising'... to like when they're done... and they have a plan or they continue into phase three and they're excited about exercise. Like that's success for me"* (OS1, On-Site FG). However, there were also negative concerns that program demands could increase staff burden and patient resistance: *"It felt some of it was just a little repetitive for the patients, like, and some of the PETs, they're like, 'well, I already answered that.' And I had... a hard time, like we didn't get the PETs back"* (RS1, Remote Site FG). Another staff member noted, *"Bringing it from the research perspective to actual practice with patients was what was challenging for us"* (OS2, On-Site FG). Finally, an adaptation expectation emerged: staff believed that digitizing and simplifying C3 would overcome barriers, with suggestions like, *"I think I would develop it on an iPad and have it as an app. And as the patient takes their motivational screeners, it automatically generates the PETs... that would be so much easier"* (RS1, Stie A, FG).

Table 4.7: Focus Groups-Staff Self-Efficacy and Outcome Expectations Regarding C3 Implementation

Theoretical Construct & Emergent Theme	Illustrative Quotes
Self-Efficacy Expectations (Confidence in C3 Delivery)	
1. Mastery Experience: Confidence from Past Success and Hands-on Application	"When you brought in some of the topic leaders, I think that was incredibly helpful... that was definitely a big confidence booster." (OS1, FG) "It was nice to at least have that... this guy really thinks pretty good of himself. And it kind of helps in the delivery of some things, I think." (RS2, FG)

2. Physiological & Emotional State: Hesitancy Due to Information Overload and Complexity	"I think the hardest part... was just cramming so much in the little time. Some of the terminology that you used was really confusing to me." (RS1, FG) "From the webinars I listened to, it was too much information, too repetitive, and needs to be simple... That is what we are taught when we market anything new to the community." (RS3, FG)
3. Vicarious Experience & Verbal Persuasion: Desire for Mentorship and Proven Models	"Would it feel better if you had a program expert or mentor...? Yes, having one person dedicated to this would be good." (RS3, FG) "It's one thing to hear from a researcher that like, 'oh, this is going to be great.' It's another thing to hear from someone that's like, 'yeah, I actually tried this. It was tough, but there were some benefits, right?'" (OS1, FG)
Outcome Expectations (Anticipated Results of C3)	
1. Positive: C3 Tools Would Facilitate Deeper, More Productive Patient Conversations	"I thought that simple question got that patient thinking and it was their words and their thoughts, not our words and our thoughts." (RS1, FG) "They were really able to hone down why they weren't physically active, you know, and it was a whole conversation probably that we wouldn't have had without that." (RS1, FG)
2. Positive: Believed the C3 Program Could Genuinely Improve Patient Outcomes	"Success for me is like one patient... that goes from 'I don't like exercise' or 'I'm not exercising'... to like when they're done... and they have a plan or they continue into phase three and they're excited about exercise. Like that's success for me." (OS1, FG)
3. Negative: Concerns that Program Demands Could Increase Staff Burden and Patient Resistance	"It felt some of it was just a little repetitive for the patients, like, and some of the PETs, they're like, 'well, I already answered that.' And I had... a hard time, like we didn't get the PETs back." (RS1, FG) "Bringing it from the research perspective to actual practice with patients was what was challenging for us." (OS2, MHK FG)
4. Adaptation Expectation: Digitizing and Simplifying C3 Would Overcome Barriers	"I think I would develop it on an iPad and have it as an app. And as the patient takes us motivational screeners, it automatically generates the PETs... that would be so much easier." (RS1, FG) "I think you would probably have to go a little bit more tech based, you know, with questionnaires and things... have that be sent back to the staff. So it's already done." (OS1, FG)

Note. Themes were derived from deductive thematic analysis of post-implementation staff focus groups ($N = 9$), guided by Self-Efficacy Theory. Quotes are cited with the participant ID and focus group (FG) site. To create a comprehensive table, illustrative quotes for participants with missing data were crafted to be representative of the core ideas expressed by their site-based colleagues.

4.5 DISCUSSION

This pilot study developed and evaluated the implementation of the Cardio Commitment Course (C3), a novel, theory-based patient education program, from the crucial perspective of CR staff. The findings present a nuanced and telling narrative of promise versus practice. While the C3 program was deemed acceptable in principle and its training demonstrated the potential to significantly enhance staff confidence and educational behaviors, its real-world implementation was met with substantial challenges related to feasibility and fidelity. These findings align with the broader implementation science literature and provide a clear, actionable roadmap for refining the C3 program for future, larger-scale trials (Damschroder et al., 2009; Chambers et al., 2013).

Interpretation of Findings

The central conflict of this study lies in the gap between the program's perceived value and its practical feasibility. The qualitative data revealed that staff saw the C3 program's key components as significant facilitators. They valued the structured, theory-based materials for providing a concrete framework for patient conversations and appreciated the patient-centered focus of the HAPA model. This aligns with research suggesting that healthcare professionals are more likely to adopt new practices when they are supported by clear, actionable tools (Damschroder et al., 2009). The opportunity for peer support was also a key facilitator, reinforcing the importance of collaborative learning environments when introducing new clinical protocols.

However, these strengths were consistently overshadowed by two dominant barriers: the program's perceived complexity and the significant time constraints of a real-world CR setting. These challenges are not unique to this study; they are well-documented as primary obstacles to implementing and sustaining new interventions in cardiac rehabilitation (Ghisi et al., 2014; Daw et al., 2021). The staff's struggle to integrate all C3 components into their demanding workflows perfectly illustrates the intention-behavior gap—the difficulty in translating knowledge into consistent practice (Graham et al., 2006). Notably, despite the different support models, implementation fidelity for the most novel C3 components was comparable between the two sites. For example, adherence to the target of three one-on-one sessions was 22% at the Remote Site and 18% at the On-Site location, while the use of the PETs accounted for 8% and 4% of educational contacts, respectively. This suggests that the primary barriers to implementing these C3 tools—such as time constraints and program complexity—were likely universal and not overcome by initial on-site training.

One of the most telling findings regarding implementation fidelity was the stark difference in group session delivery, with the remote site conducting 41 sessions compared to just one at the on-site location. This discrepancy strongly suggests that the implementation support model itself influenced fidelity. Paradoxically, the remote staff, who lacked in-person contact with the research team, may have placed a higher value on the group sessions as a crucial forum for peer learning and collaborative problem-solving. For them, the group format was a primary mechanism for support, whereas the on-site staff, who received initial in-person training, may have viewed it as an additional task outside of their established, individual-focused workflow. This finding underscores a central theme of implementation science: the success of an intervention component is determined not just by its theoretical value, but by how well it meets the perceived needs and integrates into the practical context of the providers.

Importantly, these quantitative outcomes gain context from the qualitative data. Staff at the Remote Site explicitly requested more on-site support, indicating that the lack of in-person contact was perceived as a significant challenge, even if it did not dramatically impact the specific quantitative outcomes in this pilot. This discrepancy itself is a key finding, suggesting that while remote and on-site support may yield comparable implementation *outcomes* for specific tools, the staff *experience* and perceived support may differ in critical ways that could affect long-term sustainment. This challenge may have been amplified at the RS, where the lack of any in-person interaction could have made the complex program feel more abstract and difficult to troubleshoot in real-time. This possibility is supported by qualitative feedback from staff who expressed that it *"would have been great for research staff [to] be on site more often to assess how the facility does current education and help with how to best run the research program"*. The strong qualitative theme calling for simplified and digitized tools underscores a critical lesson for dissemination: new programs, no matter how theoretically sound, must be highly practical and seamlessly integrated into existing workflows to achieve sustained adoption (Aarons et al., 2011).

These feasibility challenges directly explain the variability observed in implementation fidelity. The quantitative data revealed a classic 'voltage drop,' a concept where the core philosophy of an intervention is adopted but the specific, high-fidelity procedures are not (Chambers et al., 2013). For instance, while staff reported significant post-training increases in their confidence and general behaviors related to goal setting, the education logs showed that the specific C3 tools designed to facilitate this (i.e., the PETs) were used in only 6% of educational contacts. This suggests that while staff embraced the broader C3 principles, they often reverted to their established, less-structured methods when faced with practical constraints.

The study's findings are powerfully illuminated by Bandura's (1977, 1986) Self-Efficacy Theory, which provides a framework for understanding *why* the implementation hurdles occurred. The initial training successfully boosted confidence in specific tasks, providing a measure of *mastery experience*. However, the qualitative data revealed this was counteracted by negative *physiological and emotional states*—namely, staff feeling overwhelmed by information overload. Furthermore, the expressed desire for a program expert or mentor highlights a critical, unmet need for *vicarious experiences* (seeing a peer successfully model the behavior) and ongoing *verbal persuasion* to bolster confidence. Interventions that fail to build and sustain staff self-efficacy are unlikely to be implemented effectively (Lewis, 2012; Weiner et al., 2009). Therefore, a key takeaway is that future iterations of the C3 training must move beyond simple knowledge transfer and actively incorporate strategies known to enhance self-efficacy, such as ongoing coaching, audit and feedback, providing vicarious/mastery experiences, and further tailoring of materials to the local context (Powell et al., 2015).

Limitations

This study possesses several limitations that should be considered when interpreting its findings. First, the primary focus on staff feasibility, acceptability, and implementation, while crucial, means that conclusions regarding patient-level outcomes (PA, HAPA constructs, wellbeing) were not explored due to unforeseen challenges in patient recruitment and data collection. Future studies should include both patient and staff level outcomes. Secondly, the recruitment of staff and patients from only two cardiac rehabilitation sites in a specific geographic region may limit the generalizability of the findings to other CR settings with different patient populations, staffing models, or resource availability. The CR staff who volunteered to participate may have been more motivated or open to new educational approaches than non-participating staff, potentially introducing a selection bias. Furthermore, the use of two different implementation support models (one fully remote, one with initial on-site training) makes it difficult to disentangle the program effects from the support effects and limits the generalizability of the findings to any single training modality.

Furthermore, while the mixed-methods design provides rich data, the qualitative findings from staff, particularly those related to program adaptation during implementation, are specific to the context of these participating sites and the iterative process employed. The reliance on self-report measures for staff acceptability and feasibility may be subject to social desirability or recall bias. Finally, the 14-week intervention period for C3, while aligned with typical phase 2 CR duration, may not be sufficient to observe long-term sustainment of implementation practices by staff or lasting changes in patient behaviors.

Future Directions

The findings from this study will provide a strong foundation for several future research directions. Critically, before proceeding to a large-scale trial, an essential intermediate step is to adapt the C3 program based on the specific staff feedback gathered in this study. For example, this will involve simplifying the language of patient materials to a lower reading level, streamlining the M/V screener to reduce staff documentation time, and exploring the development of a tablet-based application—a direct suggestion from staff—which could automate the screening process and the delivery of tailored educational materials. Once a revised, more feasible version of the C3 program is established, the next logical step is to conduct a larger, multi-center randomized controlled trial (RCT). Such a trial would need to be adequately powered to rigorously evaluate the effectiveness of the C3 program on patient PA, HAPA-related psychosocial outcomes, and wellbeing, compared to standard CR care. The RCT should also systematically compare the effectiveness and costs of remote versus on-site training models to determine the most efficient way to scale up the C3 program. Given the data collection challenges identified in this pilot, a future RCT must distinguish between the minimal data needed for clinical delivery and the more extensive data required for research evaluation. To ensure the validity of the trial while minimizing the burden on CR staff, the collection of research-specific patient outcome measures should be facilitated by dedicated research support. This approach would allow for a rigorous evaluation of the C3 program's effectiveness, while still modeling a feasible level of data collection for staff in a real-world, post-study implementation. To directly address staff's call for support, future work will incorporate ongoing mentorship from a program expert, likely delivered through a hybrid model. This could involve an initial on-site or live-remote launch to establish rapport and provide hands-on training, followed by a suite of scalable, remote support options. For example, a library of video-based exemplars could provide vicarious experiences by modeling how to conduct a one-on-one session or use a specific PET with a patient. These could be supplemented with live, remote "case conference" or "office hours" sessions, allowing staff to engage in collaborative problem-solving and receive guided feedback, thereby fostering mastery experiences.

Future research should also explore strategies for scaling up the dissemination and implementation of the C3 program, should it prove effective. This could involve developing a comprehensive implementation toolkit and training package for CR programs nationwide, considering different types of CR settings (e.g., rural, urban, hospital-based, community-based). Investigating cost-effectiveness of the C3 program compared to usual care would also be a valuable contribution. Furthermore, exploring adaptations of the C3 program for diverse patient populations within CR, such as those with specific comorbidities, varying literacy levels, or different cultural backgrounds, could enhance its reach and impact. Research examining the specific components of the C3 training that are most critical for successful staff adoption and fidelity would also inform more efficient and targeted training approaches in the future. Finally, longitudinal studies tracking staff implementation over extended periods could identify factors that support or hinder the sustainment of theory-based educational practices in real-world CR settings.

Conclusion

This pilot study of the Cardio Commitment Course (C3) provides a critical lesson in the translation of theory to practice. The findings reveal a fundamental tension: while cardiac rehab staff valued the program's structured, theory-based tools and reported increased confidence in their educational abilities, the program's perceived complexity and the time constraints of the clinical environment proved to be significant barriers to high-fidelity implementation. The primary take-home message is that for interventions to be successful and sustainable in real-world healthcare settings, practical feasibility cannot be a secondary consideration; it must be a primary design principle. This study underscores that the path to improving patient outcomes is not paved with theoretical elegance alone, but with the thoughtful simplification and integration of evidence-based principles into the realities of clinical workflow. Simplicity, therefore, is not a compromise on theory, but the essential bridge to its successful application.

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Chapter 5 - General Discussion

5.1 Summary and Synthesis of Findings

This dissertation sought to explore the challenges in creating lasting change in sedentary populations through physical activity (PA) interventions. Through a multi-study, mixed-methods approach spanning literature, a worksite, and a clinical setting, a powerful, unifying theme emerged: the persistent tension between theoretical rigor and practical feasibility. The findings from these three distinct papers collectively argue that for both employee participants and clinical providers, the success of an intervention is governed less by its novelty or theoretical complexity and more by its perceived benefits, simplicity, adaptability, and ease of integration into a busy life.

The systematic review in **Chapter 2** set the stage by revealing that while many worksite interventions exist, few comprehensively measure the occupational wellbeing outcomes that are critical for long-term motivation. It found that all 8 included studies reported positive changes in PA/sedentary behavior and occupational wellbeing. Importantly, the studies that were most effective—demonstrating the broadest positive effects—were multi-component interventions that successfully integrated behavioral theory and education with practical tools like exercise equipment. This established that theory is not a barrier, but rather a key ingredient when combined with feasible application.

The empirical study in **Chapter 3**, which directly addressed this feasibility gap, found that a simple, familiar walking break reminder (WR) program was just as effective at objectively reducing sedentary time as a more complex Radio Taiso program (RT). Crucially, the chi squared analysis revealed the simple intervention was embraced with significantly higher fidelity. This difference was linked to intrinsic rewards, as the qualitative analysis affirmed that the WR group reported substantially more enjoyment and positive affect compared to the RT group. This provides direct evidence that the success of an intervention hinges not only on its simplicity but also on its cultural familiarity and potential for social support. The culturally novel RT routine may have needed more significant adaptation and structured social support to see the same success as the walking intervention, which was already an easily adoptable and socially acceptable activity. This highlights that when faced with a choice, users gravitate toward the path of least resistance—which includes both low physical *and* social barriers—allowing for a more positive and repeatable experience (Ryan & Deci, 2017).

Finally, the findings from **Chapter 4** mirrored this theme perfectly, but from the provider's perspective. While cardiac rehab staff found the theory-based "Cardio Commitment Course" to be valuable, they struggled with its perceived complexity and the time constraints of their clinical environment. This led to low-fidelity use of the program's specific tools, echoing the adherence patterns seen in the RT group. The CR staff, like the university employees, reverted to more familiar, less burdensome methods when under pressure. This demonstrates that even for trained professionals, the perceived burden of an intervention can easily outweigh its potential benefits, making simplicity and feasibility the true drivers of engagement and success (Damschroder et al., 2009).

5.2 Implications for Practice and Research

The synthesized findings of this dissertation have significant implications for both the design of future worksite/clinical wellness programs and the direction of future implementation science research.

A key implication of this work is not to abandon theory in favor of simplicity, but to recognize that the most effective interventions use behavioral theory to inform the design of simple, low-barrier applications. For practitioners, this means using theoretical constructs as a blueprint to build the simplest, most potent intervention that fits the real-world context. For example, the walking break program in Chapter 3 was successful not merely because it was simple, but because its simplicity allowed for the cultivation of intrinsic rewards like enjoyment and competence—core tenets of Self-Determination Theory (Ryan & Deci, 2017). Conversely, the C3 study in Chapter 4 struggled not because its HAPA-based theory was flawed, but because its application was perceived as too complex, preventing staff from using the tools with fidelity. Therefore, the most critical takeaway is the necessity of co-designing interventions with end-users to ensure that the theoretical mechanisms are delivered in a way that is not just evidence-based, but also feasible and minimally burdensome (Slattery et al., 2020).

For the end user, such as patients or employees, all three studies highlight the importance of focusing on wellbeing of employees, patients, and staff as these outcomes are more likely to lead to long-term adherence/implementation of interventions/behaviors. The higher adherence in the walking group, explicitly linked to participants' greater enjoyment, provides clear evidence for this connection. The CR staff who demonstrated better education session fidelity worked at the site that reported the most perceived benefits during the focus groups. When participants enjoy an activity, they tend to do it more consistently. Therefore, interventions should be designed to maximize opportunities for positive experiences like enjoyment, improved energy, and a sense of competence, as these are the short-term values that sustain long-term behavior change (Segar, 2015).

For researchers, this dissertation underscores a critical shift, moving beyond mere efficacy to understand the nuances of intervention success. It is imperative for future studies to delve into the mechanisms of implementation, investigating how factors like enjoyment, self-efficacy, social support, and cultural context influence adherence to various interventions. A significant strength of the C3 study was its iterative adaptation process, highlighting the value of co-designing interventions from the beginning with both target participants and delivery providers to ensure practical applicability (Slattery et al., 2020). The logical progression of this research is a large-scale, multi-center randomized controlled trial. Such a trial should assess a simplified, co-designed, and theory-based intervention against a straightforward active control group. This future research should measure objective patient PA, validated psychosocial outcomes, and detailed implementation metrics over an extended follow-up period of six to twelve months to gain a comprehensive understanding of long-term effectiveness.

5.3 Strengths and Limitations

The primary strength of this dissertation is its multi-faceted, mixed-methods approach, which combines findings from a systematic review and two distinct empirical studies to create a comprehensive picture. The focus on implementation from both the participant and provider perspectives provide a much-needed, nuanced view of gaps in literature.

The primary limitation, common to pilot research, is the small sample size of the two empirical studies. This limits the generalizability of the findings and the statistical power to detect smaller effects. While attrition in the Walking vs. RT study did not appear to be systematically biased, future studies need to explore strategies to mitigate the significant levels of attrition often observed in behavioral interventions. Alternatively, the lack of financial incentives in these pilot studies can be viewed as a conceptual strength. While this may have contributed to higher attrition, it provides a more realistic assessment of how these interventions would perform in a real-world setting, where participation hinges on intrinsic motivation rather than external rewards. The observed drop-out rate is therefore a key finding, highlighting the significant challenge of sustained engagement. Furthermore, both empirical studies were conducted in specific settings (a university and two CR clinics) in one geographic region, which may not be representative of all workplaces or clinical settings. Finally, the study completed in chapter three did not systematically measure the physical or social environments in which these interventions were performed, which, as noted, are plausible mechanisms that could help explain the observed differences in enjoyment and adherence between the groups.

5.4 Concluding Remarks

This body of work demonstrates that while increasing PA is a critical public health goal, the path to achieving it is paved with practical, human-centered challenges. Simply designing a theoretically sound or novel intervention is insufficient. The consistent theme across all three papers is that the most successful interventions are likely to be those that are not just evidence-based, but are simple to understand, easy to adopt, and flexible enough to be integrated into the complex realities of daily work and clinical practice. For both participants and providers, the perceived burden of an intervention may easily outweigh the potential benefits. To bridge the gap between theory and implementation, and to help people find their own sustainable reasons to be active, we must first and foremost design for feasibility. Simplicity is not a compromise; it is the cornerstone of success.

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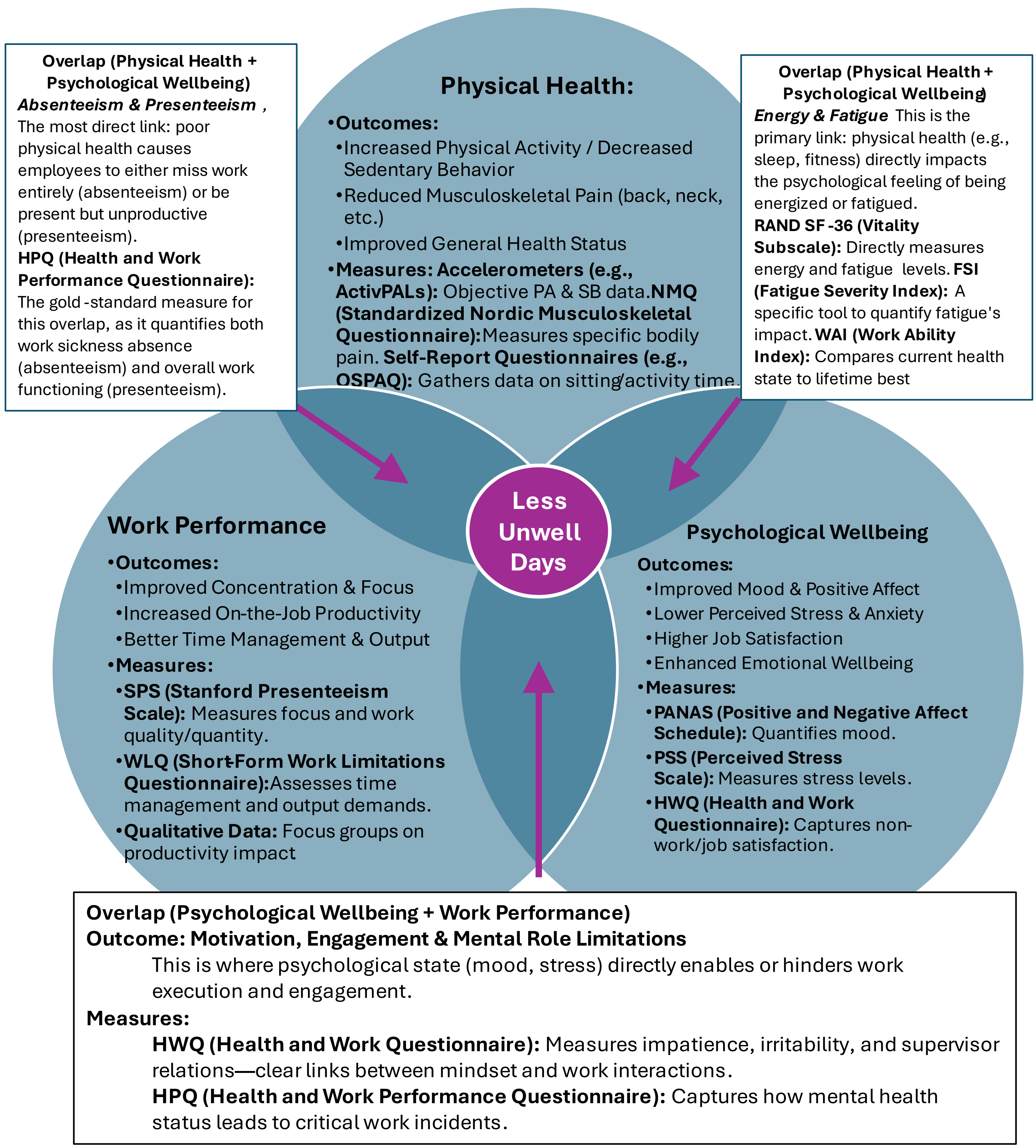
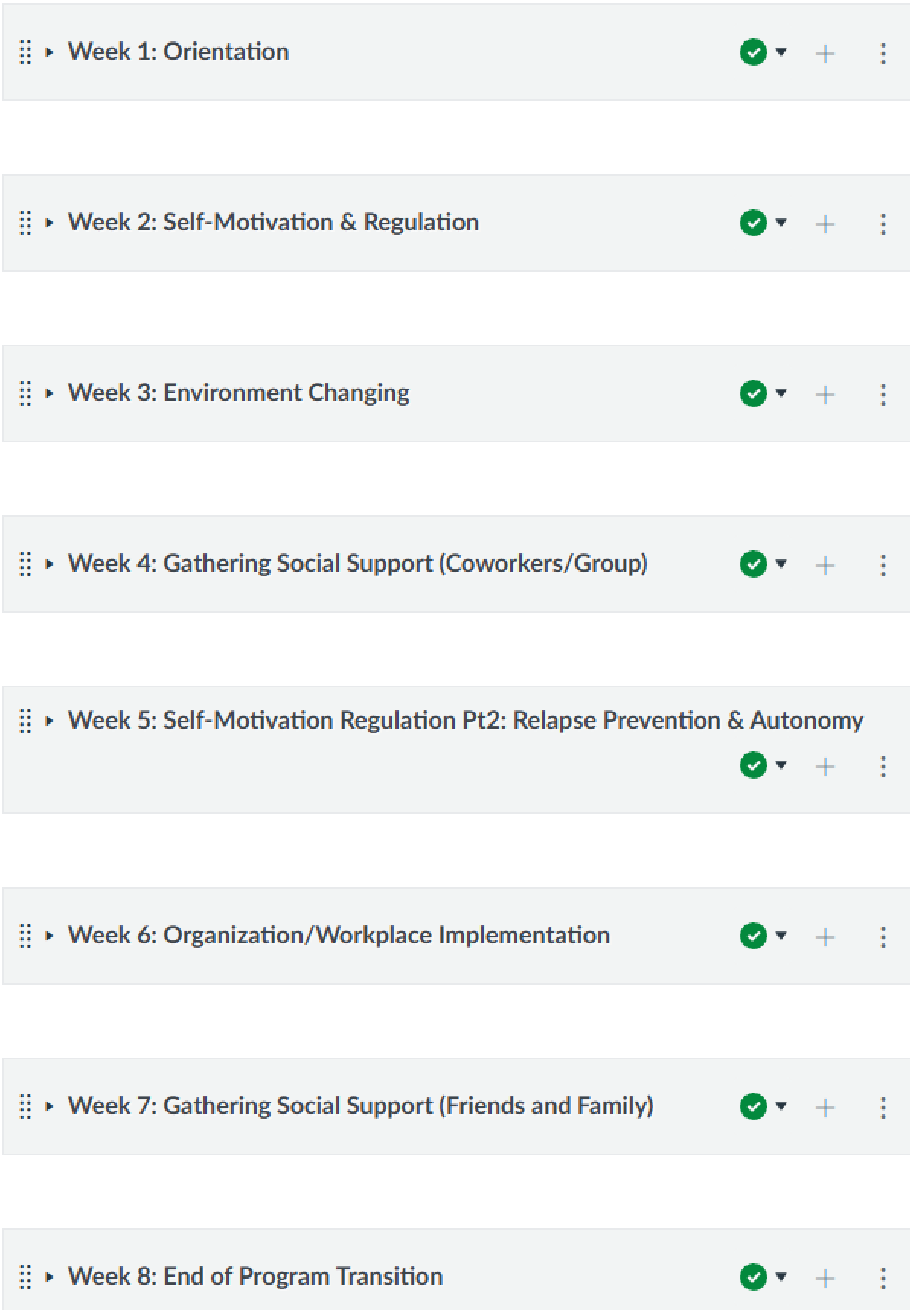
Appendix A - Occupational Wellbeing Concepts/Measures

Appendix Figure A.1: The Occupational Wellbeing and Overlap of its Core Concepts



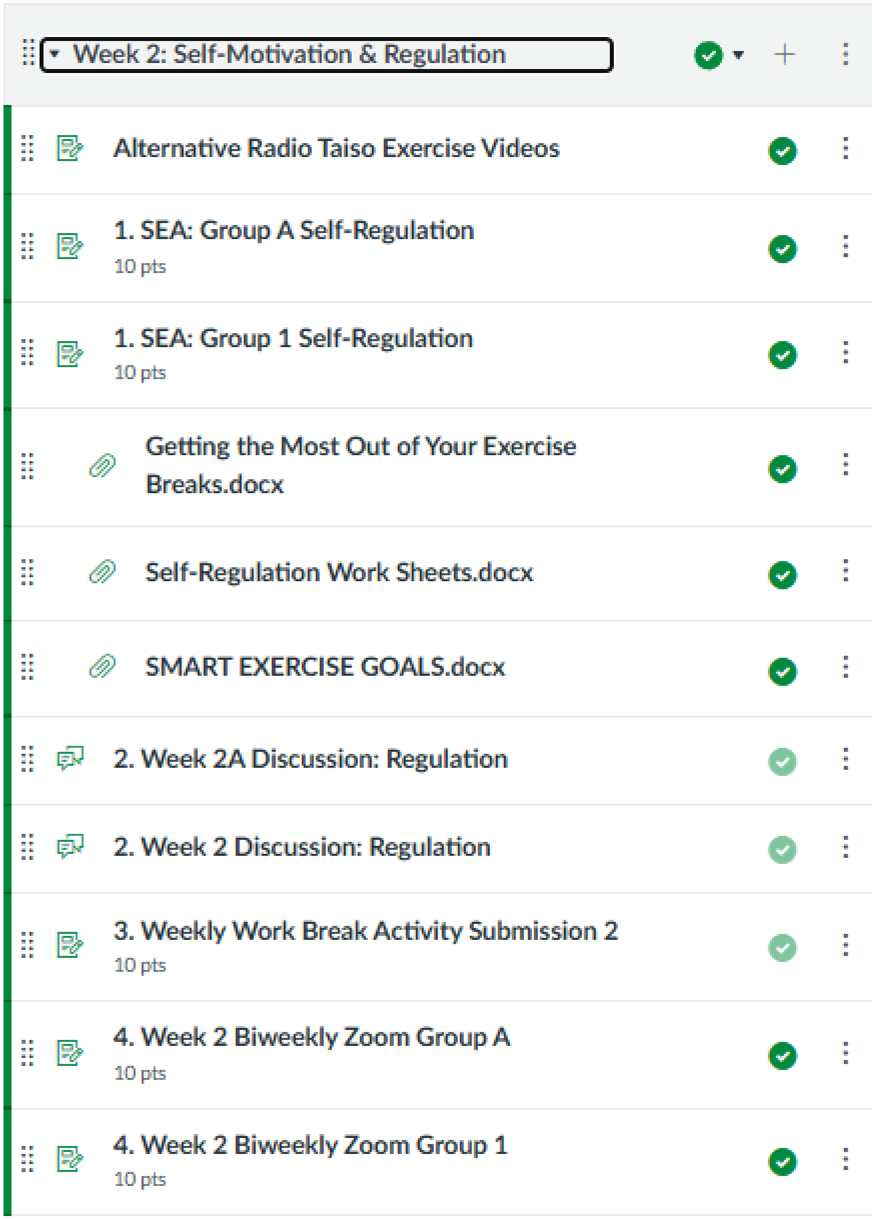
Appendix B - SEM Based Exercise Intervention Content for Walking and Radio Tiso Groups

Appendix Figure B.1: Course topics by week.



Appendix Figure B. 2: Expanded Course Section

Not all assignments went to every group. Group A was walking and Group 1 was RT.



Appendix Figure B. 3: Short Education Assignment Example

1. SEA: Group 1 Self-Regulation

Published | Assign To | Edit

SEA #2: Changing Break Behavior

Benefits of Exercise Breaks at Work

It is important to fully understand the benefits of taking exercise breaks to feel confident giving yourself permission for the break. This will help you better evaluate the pros and cons of exercise breaks. Here is an op-ed I wrote that might convince you that all work breaks are not considered equal.

Please read this (Getting Most out of Exercise breaks) (Required)

Benefits of Walking

Additionally, walking is known to host several benefits:

- Maintain a healthy weight and lose body fat
- Prevent or manage various conditions, including heart disease, stroke, high blood pressure, cancer, and type 2 diabetes
- Improve cardiovascular fitness
- Strengthen your bones and muscles
- Improve muscle endurance
- Increase energy levels
- Improve your mood, cognition, memory, and sleep
- Improve your balance and coordination
- Strengthen immune system
- Reduce stress and tension

Link if you would like to read more (not required) (https://www.mayoclinic.org/healthy-lifestyle/fitness/in-depth/walking/art-20046261)

Behavior Change

For this week, please fill out the 4 behavior change techniques in this document. You can print the document and write responses, or you can type them if you like. Please submit a picture of or the completed document in this week's SEA Quiz. Please consider the lessons you learned from the above articles while you complete your worksheets.

(Behavior Change Work Sheets) (Submit this completed one)

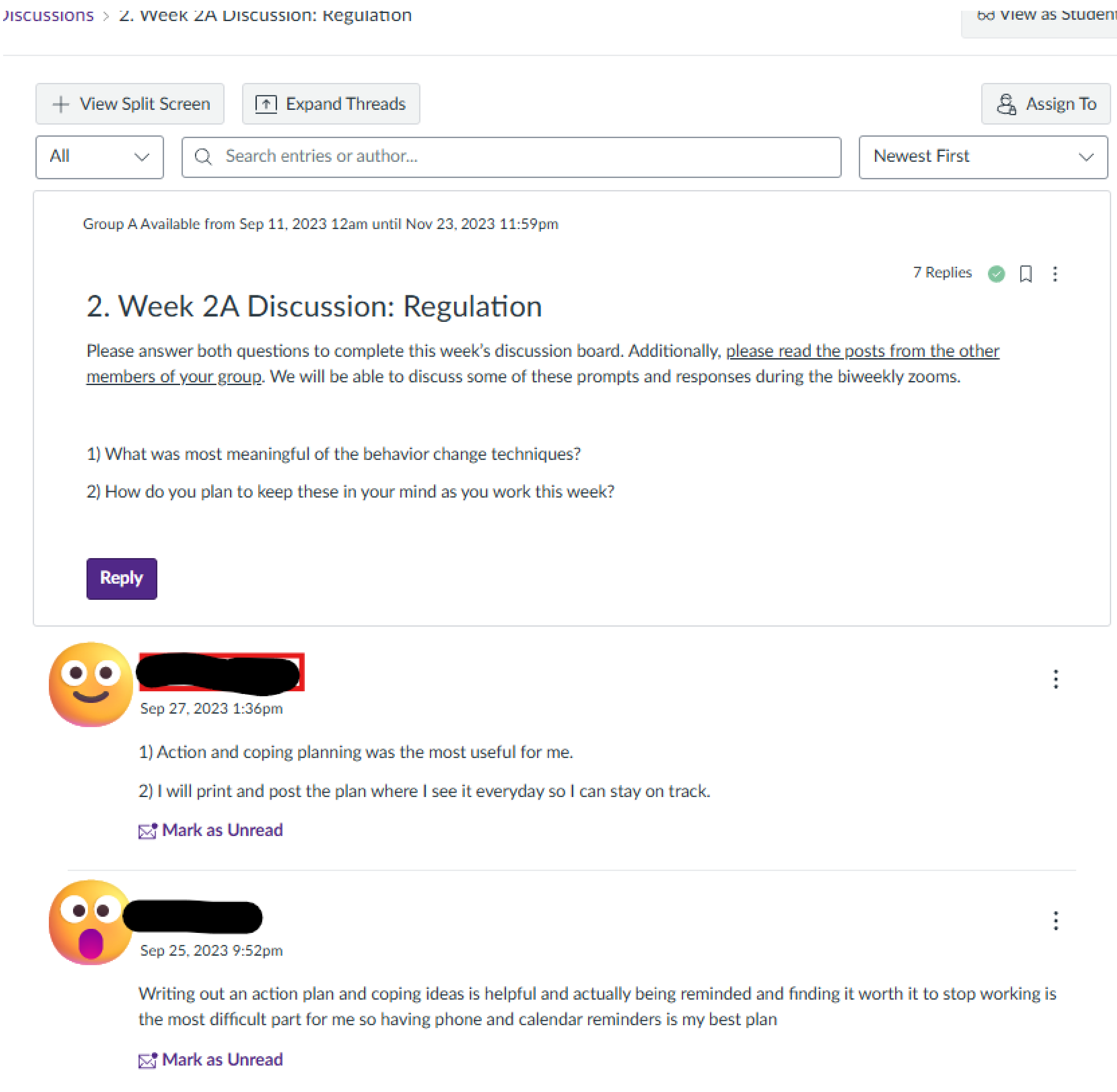
SMART EXERCISE GOALS.docx (Use this to complete the SMART Goals section of the Behavior Change Work Sheets Document)

SEA Quiz Link

Please follow the link and complete the quiz to receive 10 points for completing the SEA.

https://kstate.qualtrics.com/jfe/form/SV_3O5WmX8evQi2BCK

Appendix Figure B. 4: Discussion Board Example



Appendix Figure B. 5: Active Break Log Template

Name/Date:							
Monday	**Tuesday**	**Wednesay**	**Thursday**	**Friday**	**Saturday**	**Sunday**	TOTALS
Number of active minutes from each break	Number of active minutes from each break	Number of active minutes from each break	Nu[illegible] minutes from each break	Number of active minutes from each break	Number of active minutes from each break	Number of active minutes from each break	
1)	1)	1)	1)	1)	1)	1)	
2)	2)	2)	2)	2)	2)	2)	
3)	3)	3)	3)	3)	3)	3)	
This day's total number of Minutes from exercise breaks	This day's total number of Minutes from exercise breaks	This day's total number of Minutes from exercise breaks	This day's total number of Minutes from exercise breaks	This day's total number of Minutes from exercise breaks	This day's total number of Minutes from exercise breaks	This day's total number of Minutes from exercise breaks	**Total minutes of activity from work exercise breaks this week:**
Please describe how you felt this week at work and if or how exercise breaks impacted your work performance or health.							
***If you had to skip an exercise break please put 0 on that line. * Put DNW for Did Not Work on days off.**							

Appendix C - The Cardiac Commitment Course (C3)

Appendix Figure C.1: Staff Manual.

https://drive.google.com/file/d/1rUWshccTrkxmqwqB2DuwZAHztotlCs97/view?usp=sharing

Appendix Figure C.2: Motivational-Volitional Screener.

KANSAS STATE UNIVERSITY
Department of Kinesiology

Motivational-Volitional Screener

CARDIAC REHABILITATION
Take Your Recovery To Heart

STAFF ONLY:
1-on-1 Session #_____
p.t. ID _____ Staff ID_____

1. Please rate your past exercise experiences thus far (including CR).

Terrible 1	2	3	4	5	6	7	8	9	10	Fantastic

MOTIVATION

Please answer the following on a 0-5 scale with 0 = none, 1= nearly none, and 5 = fully or as much as possible.

TSE	
2. How **confident** are you that you can exercise the amount recommended by your CR team?	0 1 2 3 4 5
3. How **confident** are you that you can overcome barriers (e.g., bad weather, lack of time) to exercise regularly?	0 1 2 3 4 5
4. How **prepared** do you feel to find an independent exercise type, schedule, and motivation?	0 1 2 3 4 5
OE	
5. How much do you **believe** exercise will make you feel better physically?	0 1 2 3 4 5
6. How much do you **believe** exercise will make your mood or mentality better in general?	0 1 2 3 4 5
7. How much do you **believe** exercise will help with your heart health?	0 1 2 3 4 5
RP	
8. How **likely** do you think you are to experience health problems if you do not engage in regular physical exercise?	0 1 2 3 4 5
9. How **serious** do you believe the health consequences would be if you continued a sedentary lifestyle?	0 1 2 3 4 5
10. How **beneficial** do you believe regular physical exercise is for your overall health?	0 1 2 3 4 5
I	
11. I **intend** to engage in regular exercise after Cardiac Rehab.	0 1 2 3 4 5
12. **I intend** to attend CR and exercise as prescribed by the CR Staff.	0 1 2 3 4 5
13. **I intend** to build and implement my own exercise program as I transition out of CR.	0 1 2 3 4 5
MSE	
14. How **confident** are you that you can maintain your exercise routine for the next month, even if you have to push yourself?	0 1 2 3 4 5
15. How **confident** are you that you can continue to exercise regularly even when you feel tired or stressed?	0 1 2 3 4 5
16. How **confident** are you that you can stick to your exercise schedule even if you have a lot of other things to do?	0 1 2 3 4 5

KANSAS STATE UNIVERSITY Department of Kinesiology

Motivational-Volitional Screener

CARDIAC REHABILITATION Take Your Recovery To Heart

VOLITION

Please answer the following on a 0-5 scale with 0 = none, 1= nearly none, and 5 = fully or as much as possible.

AP	
17. I **have planned** where/when I will exercise on specific days of the week.	0 1 2 3 4 5
18. I **have planned** what equipment or resources I would need to exercise this week.	0 1 2 3 4 5
19. I **have planned** what type of exercise I will do and with whom I will do it.	0 1 2 3 4 5
CP	
20. I **have planned** how to overcome obstacles that might prevent me from exercising.	0 1 2 3 4 5
21. I **can plan** for what I will do when I need to make changes to my exercise routine (could be due to changes in my exercise needs, travel, time commitments, holidays, etc.).	0 1 2 3 4 5
22. I **have planned** alternative activities to ensure I stay active when my usual exercise plans fall through.	0 1 2 3 4 5
RSE	
23 After a setback or interruption, **how confident** are you that you can resume your exercise routine even if you are feeling tired?	0 1 2 3 4 5
24. **How confident** are you that you can continue your exercise routine even as your schedule changes?	0 1 2 3 4 5
25. After a period of inactivity, **how confident** are you that you have the skills and tools needed to get back to regular exercise?	0 1 2 3 4 5
AC	
26. I **am currently** engaged in regular exercise outside of Cardiac Rehab.	0 1 2 3 4 5
27. **I am currently** exercising and have been able to adapt based on my life barriers.	0 1 2 3 4 5
28. **I am currently** executing and refining my own exercise program as I transition out of CR.	0 1 2 3 4 5
A	
29. How many days of the week are you exercising (please put 0 to 7 days)? 0 1 2 3 4 5 6 7	

FOR STAFF

NOTES:

Appendix Figure C.3: Patient Education Packet and Patient Education Tools (PEP/PETs).

Personalized Exercise Regulation For:

Write Name Here: ______________________________

This packet is for you and there are no right or wrong answers!

You may need to focus on a specific area so do not feel you HAVE to complete the whole packet.

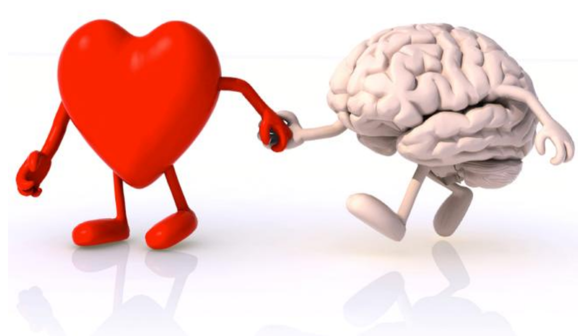
KANSAS STATE UNIVERSITY

We worked hard with CR staff and researchers at KSU to create this packet.

Its purpose is to help you achieve lasting exercise behavior!

Please fill out your packet with answers that are meaningful to **YOU**. The staff will review it, but this is for **YOU** to take Ownership of **YOUR** Exercise!

Please do one at a time and take your time to think/reflect when necessary!

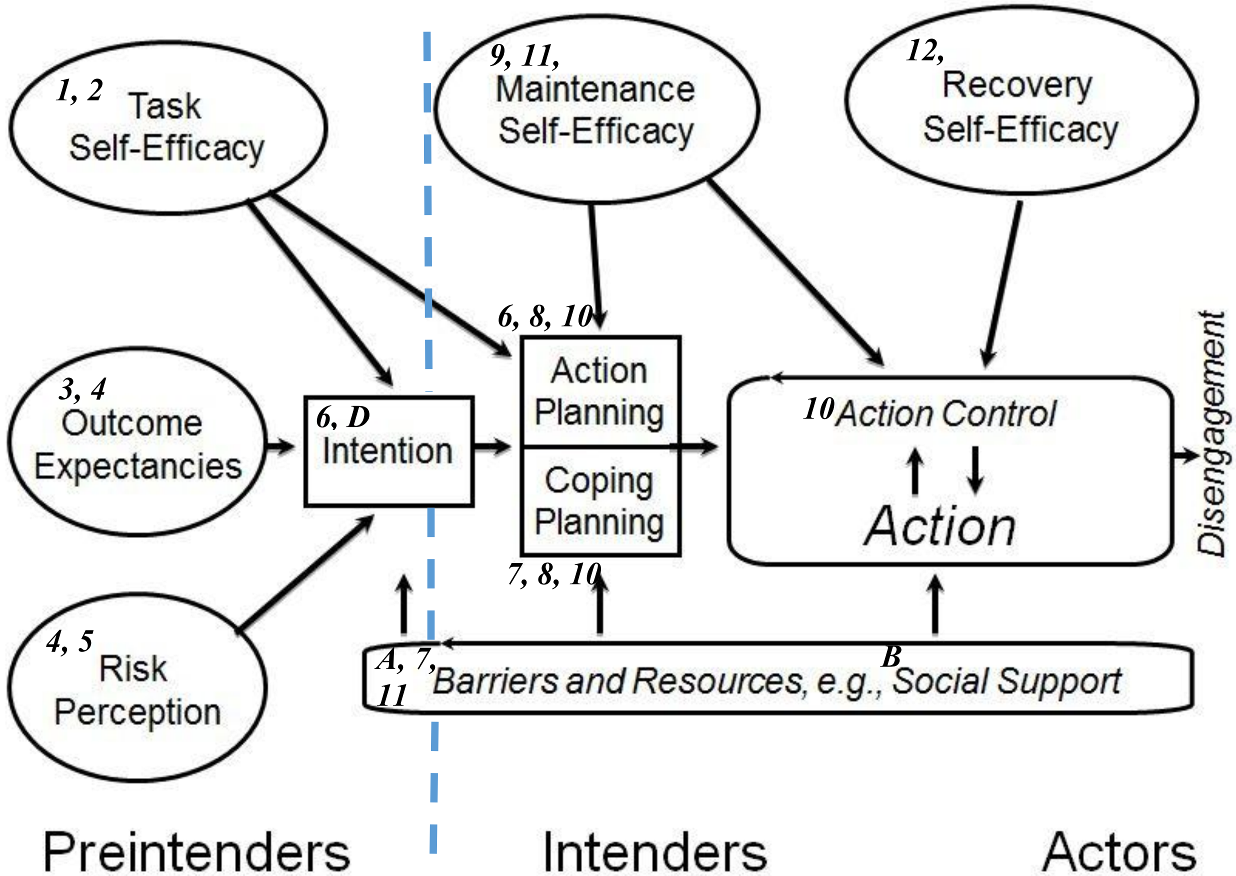


PAGE IS OPTIONAL & FOR STAFF

Checklist

Class	Date	Initials	Class	Date	Initials
One on One #1			Group #1		
One on One #2			Group #2		
One on One #3			Group #3		

The Health Action Process Approach (HAPA) is the diagram below and the foundation of the education to enhance your success!



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Part 1: MOTIVATORS

1) Choosing the Right Activity (Task-Self Efficacy)

In the table below, think about the different types of physical activity you might engage in. Only include activities in the table that you have tried or would consider trying (avoid listing any activities you already know you dread). Try to come up with at least 5 different activities, and include activities you know you prefer, as well as some new and exciting modes of activity you'd be willing to try.

Type of activity	How confident are you in your ability to engage in this type of activity? (1-10)	Where would you do this activity? How convenient is this location? (1-10)	How could you incorporate family or friends in this activity?	How could you make this activity more interesting or enjoyable? (e.g., add music, etc.)

WHAT COULD MAKE YOU MORE CONFIDENT IN YOUR ABILITY TO DO ACTIVITY?

2) Redefining Exercise (Task Self-Efficacy)

Make a list of 5 ways you could fit small bits of physical activity into your day, or combine physical activity with things you already have to do. Think of activities that only take a few minutes and would be convenient to fit into your current schedule. Here are a few examples:

- Walk around the block (or the yard, or the office) while talking on the phone
- Use a restroom that requires you to climb up 2 or 3 flights of stairs at work
- Walk or bike to run nearby errands
- Plan family outings that get everyone moving (biking, swimming, hiking, etc.)
- Do jumping jacks during commercial breaks while watching TV

What would you put on YOUR list?

1.

2.

3.

4.

5.

3) Exercise Beliefs (Outcome Expectancies)

From 0 to 5 How much do you agree **exercise will**…

1. Make me feel better physically	
2. Make my mood better in general	
3. Help me feel less tired	
4. Make my muscles stronger	
5. Is an activity I enjoy doing	
6. Give me a sense of personal accomplishment	
7. Make me more alert mentally	
8. Improve my endurance in performing my daily activities	
9. Help to strengthen my bones	

If any of these were **not a 5/5**, why do you feel that way?

4) Decisional Balance (Outcome Expectancies+Risk Perception)

When deciding whether to make a behavior change, it's helpful to consider the pros and cons of continuing your current behavior vs. making a change.

	Current behavior: ________________	Behavior change: ______________________
Benefits		
Costs		

After completing the chart, answer the following questions:

1) Why do I want to change my behavior and become more active?

2) What are the most important reasons for changing your behavior?

5) Risk Perception

What am I risking by being more active?

What am I risking being not as active?

What do I care about that makes these risks feel important?

Do I want to continue risking not being active? Why?

6) SMART Goals (Intention)

This week, set 1 or 2 goals related to physical activity. As you set your goals, remember these important principles:

- Set goals that are **SPECIFIC** and **MEASURABLE**
- Set short-term goals that are **REALISTIC** for you to accomplish this week
- Set **ACTION-ORIENTED** goals that focus on the behaviors you will do
- Set goals that you personally value and want to accomplish

Goal #1:

Goal #2:

Part 2: ACTORS

7) Coping Planning (Also Barriers)

List 2 of the biggest barriers that tend to interfere with your physical activity behavior. For each barrier, identify 2 potential solutions, and weigh the pros and cons of each proposed solution using the table below.

Barrier	Potential solution	Pros	Cons
1.	1.		
	2.		
2.	1.		
	2.		

8) Action and Coping Planning

This worksheet is designed for you to plan ahead for how you'll accomplish your goals. Start by identifying the activity in which you'd like to engage, then establish an action plan that specifies exactly when and where you'll do the activity. Then, consider the potential barriers that are most likely to interfere with you reaching your goal, and the strategies you can have in place for overcoming the barrier.

Goal (type of physical activity)	**WHEN and WHERE will you do this activity?**	**A barrier I will likely encounter is…**	**The strategy I will use to overcome this barrier is…**
1.			
2.			

9) Self-Monitoring (Maintenance Self-Efficacy/Action control)
Use the log below to track your activities for the next two weeks.

Type of activity	When and where did you do the activity? How easy was it to fit it in? (1-10)	How did you feel after you had engaged in the activity?	How much did you enjoy this activity? (1-10)	How likely are you to engage in this activity again? (1-10)

10) Reducing Cross-Behavioral Conflict (Coping, Action Planning, and Action Control)

Sometimes, there are other leisure activities we'd rather choose over physical activity when we have free time. Think of two other leisure activities that take up a significant amount of your time. Now, think about ways you could potentially make those activities

LESS appealing or accessible, while also making physical activity MORE appealing and accessible.

Other Leisure Activity	**Strategy for reducing ease of access**	**Strategy for combining or replacing with physical activity**	**Type of physical activity I will engage in**
Watching TV	*I won't turn on the TV until I've gone for a walk after dinner*	*I will walk on the treadmill while I watch my show*	*Go for a walk with the neighbor*

11) Revisiting Goals and Barriers (Maintenance Self-Efficacy)

Now that you've had some time to experiment with different physical activity goals, it's time to reflect on what's working well and what's not. First, think of 1 or 2 times when you've been successful in meeting your goals. What strategies were effective in helping you meet your goals? What immediate benefits did you notice?

My Success:	Strategies that helped me succeed:	When I was active, I noticed these benefits:

Now, think about 1 or 2 times when barriers interfered with meeting your goals. These are not "failures," but experiences from which we can learn and plan better the next time. By continuing to experiment with a variety of strategies for overcoming barriers, you will ultimately find a plan that works best for you.

My plan was:	Challenges I encountered were:	Things I will do differently next time:

My revised goals for the next 2-3 weeks:

1.

2.

12) Relapse Prevention (Recovery Self Efficacy)

The first step in preventing relapse is to identify and plan for high-risk situations you might encounter. These can be either internal or external barriers that will interfere with your physical activity plans. Once you've identified the situation, write down your plan for coping with the challenge.

High-risk situation	My plan:

When you encounter internal barriers (i.e., that "I need a break" feeling), it's important to focus on activities you enjoy, so that being active doesn't feel like another chore you have to do.

Activities I enjoy (that feel like a “gift” rather than a “chore”) are:

1.

2.

3.

4.

If you have a bad day or bad week, it’s important to remember lapses are normal, and having a short period of missed activity does not erase all of your progress. After a lapse, it is important to think about all the progress you’ve made already and remember this really is a lifelong change. There will be bad weeks along the way, but as long as you get back on track and keep the big picture in mind, you’ll be just fine!

To help you stay on track, answer the following questions:

What two steps can I take to get back on track immediately after a lapse?

What positive thoughts will I use to help me get back on track?

How will I reward myself once I get back on track?

Part A: BARRIERS and RESOURCES

A) Changing Your Physical Activity Environment (Barriers+Resources)

Think about two small changes you can make that would modify your immediate environment in such a way that you're prompting yourself to be active. Ideally, these small changes will also make it EASIER for you to do the behavior.

What will I change	How will this change make it easier for me to accomplish my goal?
Bring my exercise clothes to work and change before I leave the office	*It will put me in the mindset of exercising after work and keep me from getting caught up in other tasks when I get home*

B) Social Support (Group/Social Support)

Obtaining social support from others can help us meet our physical activity goals. But, others won't know what they can do to help unless you ASK! Below, identify two people who could support you in meeting your physical activity goals, then identify what they can do to help you. Be specific! Rather than saying you can ask your spouse to help out around the house more, specify WHAT he/she can do, and WHEN you would ask him/her to do it to help you carve out time to be active.

WHO I will ask	HOW I will ask him/her to support me
My husband	*I will ask him to get the kids ready for school on Tuesday and Thursday mornings so I can go to the gym before work*

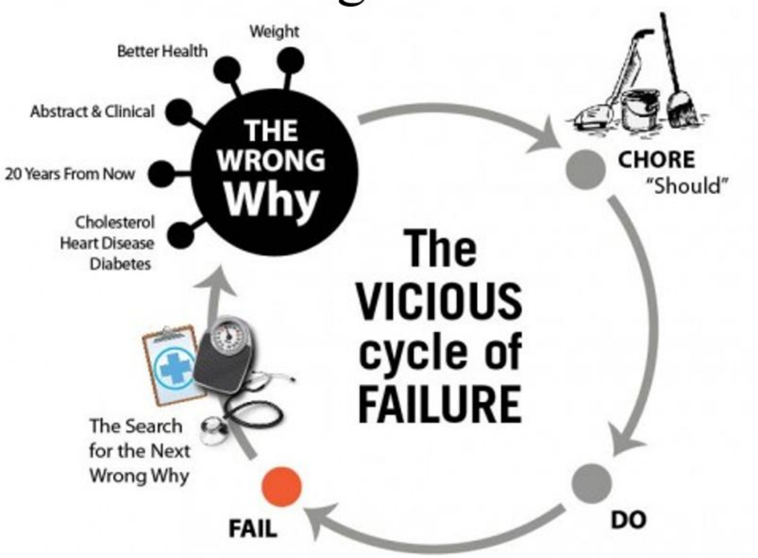
C) Exercise Journal (Resources, Action, and Maintenance/Recovery Self-Efficacy)

Research shows that journaling can be an effective tool for maintaining exercise behaviors. Those who add entries (big or small) to an exercise journal are much more likely to keep exercising and get more out of it (enjoyment, satisfaction, frequency etc.). Please consider reflecting after each of your exercise sessions with the following factors (may need a spiral notebook).

- How did I feel before exercise… How did I feel after?
- What was successful in my planning to exercise?
- What did I enjoy most about my exercise?
- What is something memorable that occurred during exercise?
- Did I think about any meaningful thoughts during exercise?
  - Motivation like family, friends, or goals
  - Problem solving like ways to improve your life or solutions to complex issues
  - Feelings/thoughts of thankfulness or strong emotion
- What have I modified to enhance my exercise experience or likelihood I will exercise
- What did I experience in this exercise session that makes me excited to exercise again?
- What Resources or Barriers did I face Before, During, or After Exercise
- How has exercise been affecting other areas of life?
  - Work, Social, family, or key life roles
- Who did I exercise with and how did it impact my…
  - Mood, effort, willingness to be active, Enjoyment
- What are future goals that exercise can help with?
- What are future exercise goals to help meet future life goals?

D) Finding Right Whys (Intention)

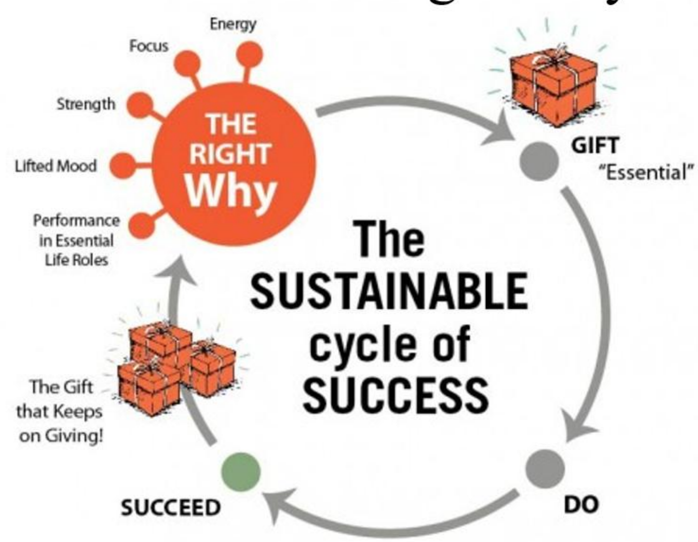
Some wrong motivations



List some of your wrong whys below:

Segar

Let's find the Right Whys!



List some of your right whys below:

Appendix Figure C.4: Staff Education Tracking Log.

How to measure the # of education sessions of CR staff

Currently, I have 2 documents (one for patient participants in the study and one for patient nonparticipants in the study). Our goal is to measure feasibility and adherence to the new education program in the next 14 weeks. The staff use daily schedule documents and treatment plans (ITPs). Ideally, we can reduce the amount of redundant writing in two places. One avenue could be using the daily schedule by modifying it to get the education tracking and attendance all in one place. Here's a modified daily tracking sheet with columns for education: **(Examples Below)**

Sess. #	**pt. ID**	**Education Type**	**PET #(s)**	**Concepts Discussed**	**Edu. Notes (Optional)** ***OR*** *Number of pts. in Group Session*
13	H9P	Impromptu	1	Task Self Efficacy, and Nutrition	
35	H4	1 on 1	12, C	Recovery Self-Efficacy	Pt thought of ways to prevent relapse
10	M11P	Group		Barriers, Social Support	they made a plan and used the PET
8	M3	Imp.		Smoking	and said they felt more confident
2	H9P	Imp.	11	Task Self Efficacy	Pt. needed additional resource

Explanation:

- **Sess#:** The number of sessions that the CR pt. is into their treatment.
- **Pt Study ID:** The unique identifier for the patient in the study. (H2/M2=Par 2, 2=Nonparticipant 2, ADD 'P' for Pulmonary) Example M13P = MHK pt. in the study #13. 6P would be a pulmonary pt.
  - Assign every patient and participant a # before the 1st week of recording education.
- **Education Type:** Indicates whether the session was 1 on 1, group session, or impromptu.
- **Concepts Discussed:** Key concepts or topics covered in the session.
  - HAPA concepts *OR* if it is additional like Nutrition, Smoking, Diabetes, Anatomy/Physiology.
  - For Group Sessions please include the number of patient (peer) group members.
- **PET #:** The number or letter that matches with PET the patient during or in between sessions.
  - Can have multiple in one line. Can also be when they completed an additional PET and they showed you during an impromptu discussion.
- **Edu Notes:** Any extra notes related to the education session you want the research team to know.
  - Include things you may include in session report or ITP (more likely ITP)

Sess. #	**pt. ID**	**Education Type**	**PET #**	**Concepts Discussed**	**Edu. Notes (Optional)** ***OR*** *Number of pts. in Group Session*
	[ID]	up			[Concepts]

With questions about how to use this document please email the research team. Additionally, these logs will be due at the end of each week. Thank you