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Abstract

Title of Dissertation: Participation and Effectiveness of Worksite Health Promotion Program

Myeunghee Han, Doctor of Philosophy, 2019

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Background: Worksite Health Promotion Programs (WHPPs) are limited by low participation and engagement. However, little is known about what factors influence participation and the relationship between participation and changes in body weight and composition. Mobile health technology (mHealth) may facilitate participation and engagement in WHPPs as mhealth is not limited by time or location, which are known barriers to participation and engagement. Yet, few studies have examined the use and effectiveness of WHPPs using mHealth interventions that aimed to change body weight and composition.

Purpose: To explore the features and effectiveness of WHPPs in previous studies that used mHealth interventions. To identify factors influencing participation and engagement in a WHPP and the relationship between participation and changes in body weight and composition.

Methods: A systematic literature review was conducted to explore features of WHPPs using mHealth that aimed to change body weight and composition. A secondary data analysis was conducted using data obtained from participants in the intervention group of

a WHPP to identify: 1) factors that influence participation and engagement and 2) the relationship between participation and body weight and composition changes.

Results: From the systematic review, 10 out of 12 WHPP studies using mHealth significantly improved body weight and composition. The most commonly used mHealth interventions were providing information, goal setting, and data entry. Based on the secondary data analysis, low levels of stress, anxiety, or high job satisfaction were significantly related to high participation in a WHPP. Significant relationships between participation and body weight and composition changes were not found due to a small sample size. However, this study found that those who reduced five pounds of body weight at six months among overweight or obese participants showed high participation in physical activity and/or diet components of a WHPP.

Conclusions: WHPPs using mHealth can significantly improve body weight and composition. Employees' psychological factors should be considered to increase participation in WHPPs. Further studies with larger sample size are needed to identify the relationship between participation and changes in body weight or body composition.

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Participation and Effectiveness of Worksite Health Promotion Program

by
Myeunghee Han

Dissertation submitted to the Faculty of the Graduate School of the
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INTRODUCTION

Overview, Problem Statement and Significance

1.1 Overview

In the United States, over 159 million workers make up the labor force and they spend one-third of the day, five days a week at the workplace.[1] For the working population, one-third of adults are obese.[2] Healthcare workers also show a high prevalence of overweight or obesity.[3] Researchers who surveyed workers in four healthcare settings found 78% of respondents were overweight or obese.[4] Obesity is one of the most prevalent chronic conditions with enormous impact on worksites. Many negative results related to obesity have been reported. The annual business cost of obesity-related absenteeism and productivity loss is about $73billion dollars.[5,6] Additionally, an estimated average medical expenditures related to obesity in the U.S. is $147 billion.[7,8] Consequently, worksites focus on the prevention, screening, and management of prevalent chronic conditions including obesity and obesity-related diseases, such as diabetes, heart disease, and cancer.[9] Part of the solution is to implement health promotion programs that improve multiple health related behaviors including physical activity and dietary intake.[10]

For these reasons, companies increasingly offer worksite health promotion programs (WHPPs) providing regular exercise, healthy nutrition, and stress management interventions that encourage employees to reduce health problems and subsequent outcomes.[11] Currently, mHealth has been recognized as a promising platform to increase interest, motivation, and participation in WHPPs. Because it can be easily programmed to meet the demands of the individual user, can benefit both employers and employees

through pervasive and permanent accessibility by reducing barriers, such as work time, work position, locations, and work schedule with minimal delivery cost.[12–16] According to Person et al[17] commonly reported barriers to participation were inconvenient locations, and time limitations.[18] Particularly, mHealth can be more appealing for employees with unhealthy habits or with chronic conditions as they offer the opportunity to stay anonymous.[19] Many studies reported that mHealth intervention shows significant effectiveness on health-related behaviors and outcomes, such as weight reduction[20–22] and improvement in physical activity,[23–25] dietary intake,[23,26,27] sleep quality,[23,28] and mental health.[29–31]

WHPPs can provide advantages for both employees and employers. Employers have the benefits of reducing health care costs and absenteeism and improving productivity and employee morale. In addition, workers get the benefit from enhanced health behaviors and health status and prevention risks for disease. Therefore, employers who provide WHPPs expect high participation to achieve maximize effectiveness of the program, however, participation rates in WHPPs remain low and inconsistent.[11] Specifically, fitness programs have an average participation rate of 21%,[32] while weight control programs have only an average participation rate of 10%.[12] Additionally, different job types have different participation percentages in WHPPs. For example, prior research has shown participation percentage were: 29% for salary workers,[33] 34% for government employees,[34] and 25% for faculty employees.[35] Since the success of WHPPs is limited by low participation rates, factors that influence participation in WHPPs should be identified.[11] In addition, it is necessary to identify the relationship between participation in WHPPs and achievement of targeted health behaviors or outcomes.[36]

1.2 Problem Statement

Currently, using mHealth is widely adopted in health promotion programs and shows significant effectiveness in targeted health outcomes, such as weight management and improvement of physical activity or diet quality. However, there are insufficient previous studies that have explored WHPPs using mHealth that aimed to reduce body weight and composition. In addition, the importance of analyzing features of employees' participation in WHPPs and the impact of participation on achievement targeted health outcomes have been stressed, however, most studies do not collect, analyze, and report participation information. Therefore, little is known about the consistent factors that influence participation in WHPPs and the impact of participation on body compositon.[37,38] Table 1.1 shows the some factors related participation in WHPPs from previous studies.

Table 1.1. Factors Influencing Participation in Worksite Health Promotion Programs

Author, year	Sample	Program	Definition of participation	Participation Rate	Factors associated with high participation in WHPPs
Kolacz, 2015 [39]	Employees in a rural hospitals N=186	Rural Hospital's wellness program including physical activity and diet.	Voluntarily engagement in at least one of the Hospital's wellness program initiatives	29% (N=54)	1) Fixed shift 2) High motivation 3) Interest in components of program 4) No responsibility for children/elders 5) Program scheduled during non-work times
Rongen, 2014 [40]	Plastics manufacturer N=83	Multi-components program including physical activity, healthy nutrition, smoking cessation, and stress management	none	26% (N=22)	1) High social support 2) High self-efficacy 3) Poor self-perceived health status 4) High level of work position (supervisor) 5) Social support from their colleagues and supervisor
Franklin, 2006 [41]	Employees of an insurance company N=960	Daily E-mail messages with links self-monitoring on nutrition and physical activity	none	40% (N=388)	1) Male 2) White 3) Married 4) Older Age 5) Middle-high and High income ($30,000-$59,999 and >$59,000)
Thomas, 2006 [34]	Government employees N=3,500	Pedometer and e-mail support to increase physical activity	none	34% (N=1195)	1) Male 2) Older Age
McCarty, 2005 [42]	Employees of a health care system (n=6539)	Self-monitoring and weekly e-mail support increase physical activity and diet	none	17% (N=1129)	1) Male
Blake, 1996 [43]	Employees in businesses	Three exercise competitions	none	37% (N=6,495)	1) Male,

Table 1.1. Factors Influencing Participation in Worksite Health Promotion Programs (continued)

	participating in the Minnesota Heart Health Program Intervention (N=17,626)	between companies of daily exercises			2) Company size with employees over 500
Hooper, 1995[35]	University employees and spouses (N=338)	Self-monitoring to increase physical activity	none	30% (N=103)	1) Male 2) White 3) Married 4) Higher Education 5) Full-time employment
Baer, 1993[44]	Management level male employees with high cholesterol levels (N=70)	Individual instruction every 3 months group meetings and monthly telephone support to decrease cholesterol levels	none	47% (n=33)	1) Older age 2) Non-smoker 2) Higher body weight 3) Higher cholesterol levels 4) Higher Body composition of fat
Mavis, 1992[45]	University employees (N=110)	Program on exercise, weight control, stress management, and smoking cessation	none	25% (N=22)	1) Male 2) Married 3) Older Age 4) Higher education 5) Higher income (> $30,000)

1.3 Specific Aims

The purpose of this study is to examine previous studies to determine the use and effectiveness of WHPPs using mHealth on body weight and composition changes. In addition, this study investigates features of participation in a WHPP and identifies the factors influencing participation in a WHPP. The relationship between participation in a WHPP and changes body weight and composition are also examined. The specific aims of this study are as follow:

Aim 1. Identify the characteristics of WHPPs using mHealth and their impact on body weight and/or composition. Identify successful interventions using mHealth in WHPPs and participation percentages. To meet this aim, a systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines.

Aim 2. Explore the participation features of a WHPP. Explore differences of baseline characteristics between high and low participation groups using independent t-tests and chi-squared tests. Identify the factors influencing participation percentages using univariate and multiple linear regressions. In addition, assess time to stop engaging in a WHPP for the first three months (90 days) using Kaplan-Meier plots and log-rank tests. The concept of aim 2 is presented in the Figure 1.1.

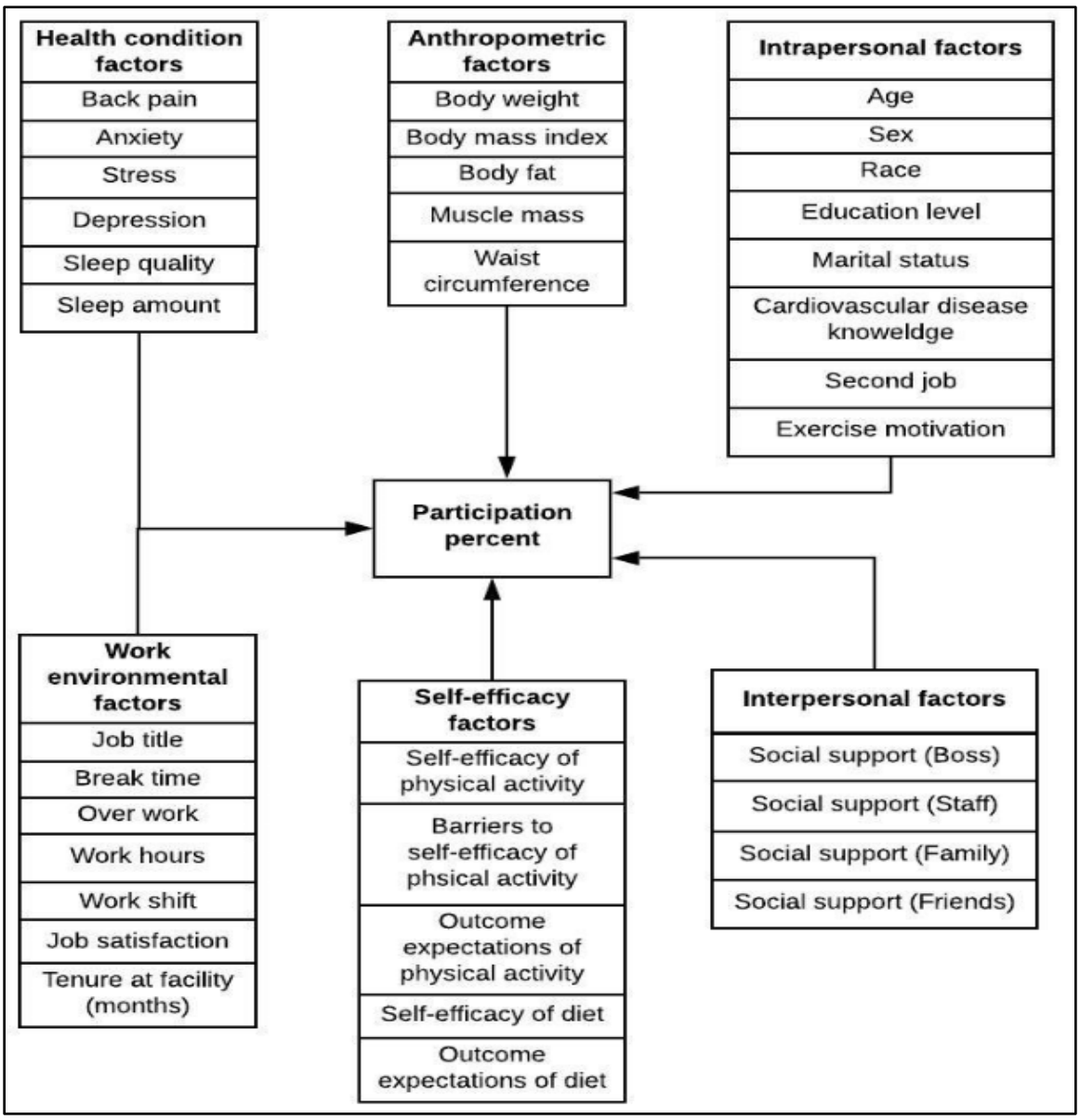

Figure 1.1. Conceptual model of Aim 2

Aim 3. Evaluate changes in the first six months of a WHPP in participation percent and body weight and composition. Explore the relationships between participation percentages of the WHHIP and changes in body weight and composition using univariate and multiple linear regressions. In addition, identify the participation differences of five-pound weight change groups using Mann-Whitney U-tests and Fisher's exact tests. The conceptual framework of aim 3 is shown in the Figure 1.2.

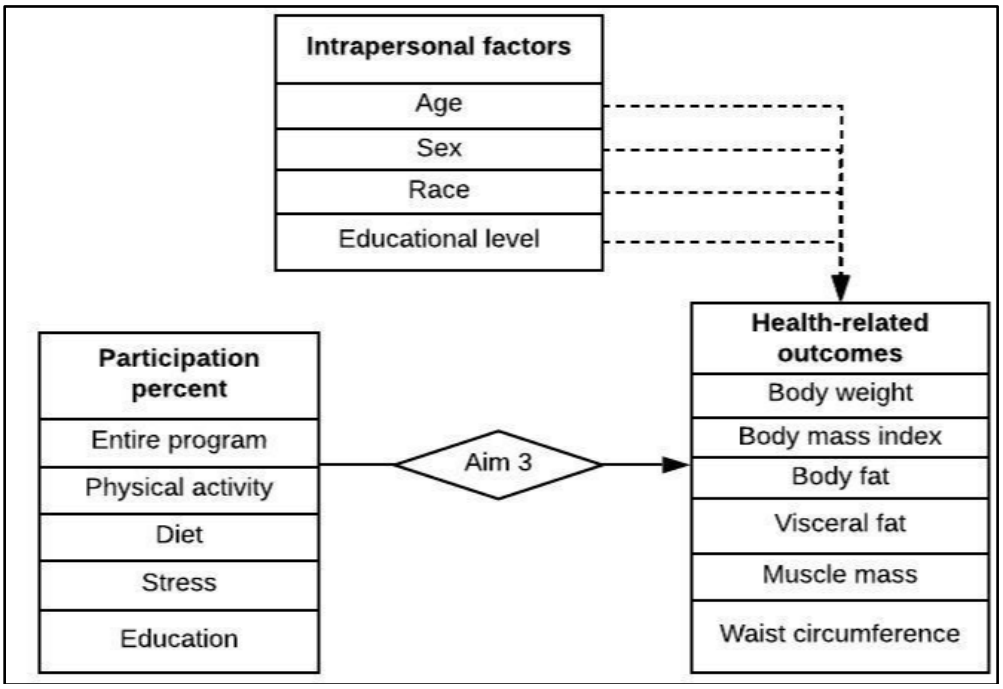

Figure 1.2. Conceptual model of Aim 3

This proposed study provides novel insights into understanding the features of participation and factors influencing participation in a WHPP. In addition, this study builds the evidence regarding the relationship between participation and success to achieve weight and composition loss. This study also provides information about effective mHealth interventions in WHPPs that influence in changes body weight and composition.

1.4 Background

1.4.1 Worksite Health Problems

In 2017, about 160 million (60.1%) people in the United States were employed and about 129.98 million people were employed full-time.[46,47] Since employees spend a considerable portion of their waking hours at the worksite, the worksite can become a potential detrimental setting for people's health status.[48] According to CDC (2017), obesity that is caused by physical inactivity and unhealthy diet is one of the serious

worksite health problems.[49] With less than optimally healthy employees, businesses suffer large productivity losses due to excessive absences from work (absenteeism) and reduced performance while at work (presenteeism).[50] Productivity losses from missed work due to ill employees cost employers $225.8 billion or $1,685 per employee, annually.[51] One of the biggest drivers of increasing healthcare costs of employees is chronic disease, with obesity being a key underlying cause.[52]

Obesity in Worksites

The number of people employed in sedentary industries has increased tremendously.[53] In addition, most worksites today are not only sedentary, but also provide easy access to high calorie foods and beverages.[54] Physical inactivity and poor diet has led to the rapid rise of obesity.[55] Since work-related stress has been related to unhealthy lifestyle behaviors, such as unhealthy diet and lack of exercise, higher stress levels result in obesity.[56] This has resulted in a modern workforce that has become a risk factor for obesity and the chronic diseases such as cardiovascular disease, diabetes, hypertension, metabolic syndrome, and osteoarthritis.[57–59]

Obesity, a modifiable condition, generates high costs associated with sick leave, injuries, disabilities, and health care claims in worksite.[60,61] Full-time workers who are overweight or obese and have other chronic health problems miss about 450 million more days of work each year than healthy workers.[62] The result is an estimated cost of more than $153 billion in lost productivity every year.[63,64] For employers, the cost of obesity entails higher medical claims expenses for obesity and its accompanying chronic conditions, increases in short- and long term disability expenses, increased absenteeism,

and lower productivity. Obese workers ages 18-65 incur medical spending that is 37 percent higher than spending for normal weight workers.[65]

1.4.2 Overweight or Obesity in Healthcare Settings

The international prevalence of overweight or obesity among nurses ranges between 54.5% and 79.1%.[66,67] In the U.S., researchers found considerable percentages (32%-78%) of healthcare workers were overweight and obese.[68,69] This percentage is higher than the national average (40%).[70] The factors influencing prevalence of obesity among this population include long work hours, high level of job-related stress, sleep deprivation, shift work (irregular work schedule), and poor dietary habits.[71,72] Obesity is a leading cause of work-related illness,[73] injury,[74] absenteeism,[75] and presenteeism.[76] Moreover, obesity has become a major risk factor for chronic diseases, including hypertension, diabetes, stroke, and cancer.[77] According to Orciari[78], obesity-related loss in productivity is estimated at $8.65 billion per year. Additionally, the estimated annual medical cost of obesity was $147 billion.[79] Overall, obesity incurs a considerable productivity loss, high medical costs, and disability.[78]

Obesity in healthcare workers affects not only their health but health of their patients.[80] Healthcare workers, including nurses, are role models and expected to educate and encourage patients to adopt positive health-related behaviors.[81] A systematic review found that patients seem to accept the advice provided by visibly healthy healthcare professionals compared to healthcare professionals who are overweight or obese.[82] For these reasons, healthcare workers should manage their weight and maintain a healthy weight. Therefore, the need for WHPPs has increased to address health and productivity of healthcare workers.[83] Applying WHPPs at healthcare settings provides health benefits

to employees. Moreover, WHPPs support the establishment of a healthy environment and create a culture of health.[84]

1.4.3 Worksite Health Promotion Programs (WHPPs)

The worksite presents a useful setting for introducing and maintaining health promotion programs for working adults.[85] Employers are taking on an important role in providing health promotion programs to their employees to prevent work-related health problems.[86] According to World Health Organization, worksites are perceived a worth of settings for health promotion.[87] WHPPs usually refer to programs, policies, benefits, environmental supports, and/or links to the surrounding community designed to meet the health and safety needs of all employees.[48] Currently, more than 51% of businesses with more than 50 employees operate some type of wellness program.[88]

1.4.4 Effectiveness of WHPPs

Studies have shown WHPPs can reduce direct and indirect healthcare costs related to employee absenteeism, loss in productivity, and health insurance costs.[89–93] A recent meta-analysis reported that costs and savings from WHPPs showed that absentee day costs fall by about $2.73 and medical costs fall about $ 3.27 for every dollar spent on such programs.[94] In addition, a review found that WHPPs supported an 28% reduction in sick leave absenteeism, 26% reduction in health costs, and 30% reduction in workers' compensation and disability management claims costs.[89] WHPPs have also shown the effectiveness of reducing body weight. Katz et al[95] and Anderson et al[96] reported that the participants in the WHPPs including diet and physical activity interventions showed moderate weight loss.

Therefore, WHPPs can provide benefits to both the individual and organizational level. For individuals, WHPPs have shown a positive impact on physical activity,[96–98] stress management,[101,102] and diet quality, which have all been shown to impact obesity.[96,101] For organizations, worksite health programs have the potential to impact areas, such as health care costs,[102] absenteeism,[12,103] productivity,[104] recruitment/retention,[105,106] and employee morale.[107]

However, low participation results in low-effectiveness of WHPPs.[40] There are many barriers that prevent employees' participation in WHPPs, such as inconvenient locations, time limitations, and uninteresting topics.[17] Currently, mHealth is recognized as a promising platform to overcome these barriers and support increased participation and effectiveness of WHPPs.[108,109]

1.4.5 Adoption of mHealth in WHPPs

In 2017, about 86% of the population were in possession of a mobile phone. Due to the abundance of devices and ease of access they subsequently allow, the utility of mHealth has never been more endemic.[110] Currently, smartphones are used by 95% of adults in worksites along with an increasing number of tablets and laptops.[111] Studies have found that 31% of mobile phone owners use them to access health information, 19% have also installed a mobile app that relates to a current medical condition or manage their health and well-being.[112] This means well-configured interventions integrated into mHealth can potentially provide 24/7 engagement with employees on health and wellness issues.[16]

Mobile engagement strategies for workforce health and wellness programs can deliver important and sustainable benefits to both employers and employees.[16] In

particular, mHealth applications (apps) can support users to self-monitor and motivate them to improve their lifestyle in the short-and long-term.[54] Additionally, mHealth has the potential to overcome adherence issues by minimizing the necessity of face-to-face interactions and thereby increase cost effectiveness through pervasive and permanent accessibility.[113] mHealth also can increase participation in WHPPs. Prior studies reported that mHealth integrated WHPPs can reach more employees and support to overcome of barriers that are work position, break time, and work schedule, which prevent participation in WHPPs.[114,115]

1.4.6 Factors Influencing Participation in WHPPs

According to previous studies, the average participation percent in WHPPs was 33%, ranging from 10% to 64%.[11,116] However, participation rates of healthcare workers in WHPPs were as low as 10-12%.[11] A systematic review reported general factors that influence participation in WHPPs. They found that those who were women, older, married or cohabiting, Caucasian or white, higher education level, or higher income level showed higher participation in WHPPs.[11] However, consistent health-related and work-related determinants that were related to participate in WHPPs were not found. Further, factors influencing participation vary based on type of program, type of workers, and worksite setting.[11] Since low participation in WHPPs greatly reduces the potential benefits of WHPPs, it is important to identify the factors that potentially facilitate or impede participation.[40] However, factors consistently influencing on participation of healthcare workers in WHPPs were not determined because it has not been studied sufficiently.

1.5 Theoretical Framework

1.5.1 Social Cognitive Theory

Social Cognitive Theory (SCT), illustrated in Figure 1.3 provides the motivational drivers of worksite wellness participation.[117] This theory is used to enhance motivation for behavior change. The SCT can be utilized to facilitate behavior changes within the intrapersonal and interpersonal area.[118] The core constructs of the SCT are self-efficacy and outcome expectations. Self- efficacy is an individual's ability to believe they can conduct the behavior.[117] It was suggested that those who have higher self-efficacy are more likely to initiate and maintain certain activity. Outcome expectations mean one believes if they engage in a behavior they will obtain a benefit.[119] Expected benefits (outcome expectations) and one's belief that he or she is capable of performing a behavior to get desired results (self-efficacy) influences participation in WHPPs.[120] Self-efficacy and outcome expectations are influenced by mastery experiences, vicarious experiences, social persuasion, and emotional/physiological states.[121] These main constructs have been extensively studied in multiple health behaviors, including physical activity, diet, and weight management.[122]

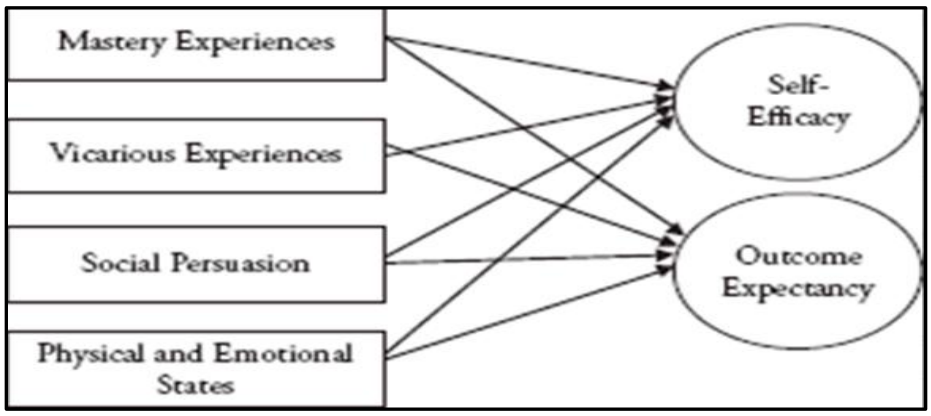

Figure 1.3. Social Cognitive Theory (SCT)

1.5.2 Social Ecological Model

Social Ecological Model (SEM), illustrated in Figure 1.4, provides a framework for understanding the facilitators and barriers to changes of health related behaviors.[123] This model not only considers the individual characteristics but also focuses on the social and physical environment which promote or prevent change of health-related behaviors.[124] A social ecological approach to understanding the impacts on health-related behaviors allows researchers to identify a variety of factors that foster the adoption and maintenance of health-related behaviors.[125]

The SEM consists of four constructs: intrapersonal, interpersonal, organization/environment, and policy. Intrapersonal factors include knowledge, awareness, attitudes, beliefs, and perceptions.[125] Interpersonal factors include social support systems, social networks, and coworkers' interactions.[118] Organization/environment factors refer to physical work environment.[118] Community level is comprised by the factors that increase risk based on settings including schools, worksites, and neighborhoods.[125] Policy level is shaped by local, state, and federal laws.[126] Taking into account all these factors of each level will assist in assessing the factors influencing participation in WHPPs.

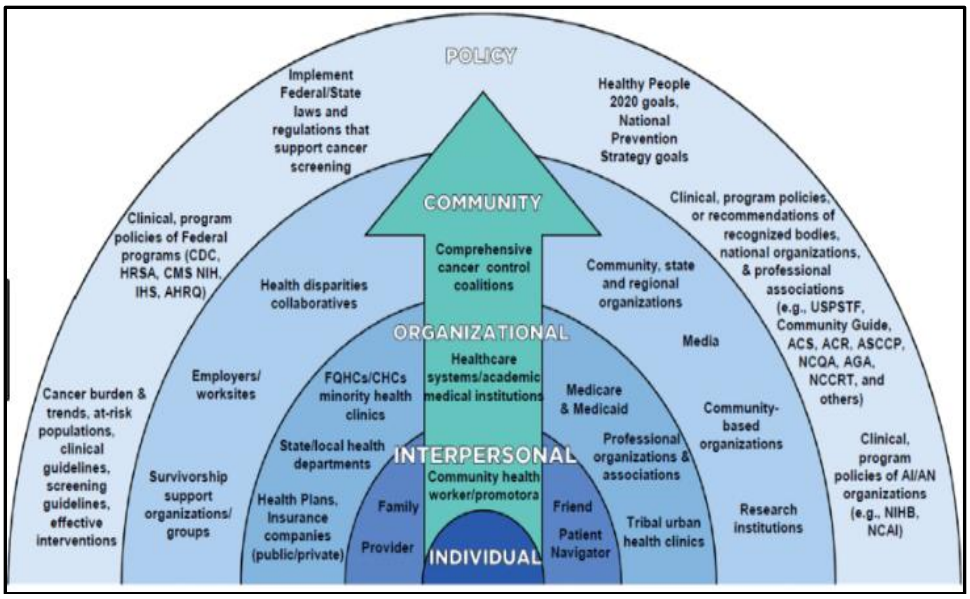

Figure 1.4. Social Ecological Model (SEM)

1.6 Conceptual Framework

The conceptual framework was developed based on core constructs of SCT and SEM (see Figure 1.5). This study used intra-personal factors (SCT and SEM), anthropometric factors (SCT and SEM), health condition factors (SCT and SEM), work environmental factors (SEM), self-efficacy factors (SCT), and interpersonal factors (SCT and SEM) to explain about participation in the WHHIP.

Intrapersonal factors included individual characteristics that are age, sex, race, education level, cardiovascular disease knowledge, presence of second job, and exercise motivation. Anthropometric factors (baseline body weight, BMI, body fat, muscle mass, and waist circumference) and health condition factors (back pain, anxiety, stress, depression, and sleep quality and amount) also included in the conceptual model. The work-related characteristics that are job title, break time, overwork, work hours, shift work, job satisfaction, and tenure at facility are included in the work environmental factors. Since the WHIPP provided physical activity and diet interventions, self-efficacy

and outcome expectations of physical activity and diet are included in the conceptual model as self-efficacy factors. Social support systems also have an important role in participation in WHPPs; therefore, this conceptual model involved interpersonal factors that are social support from family, friends, staff, and bosses.

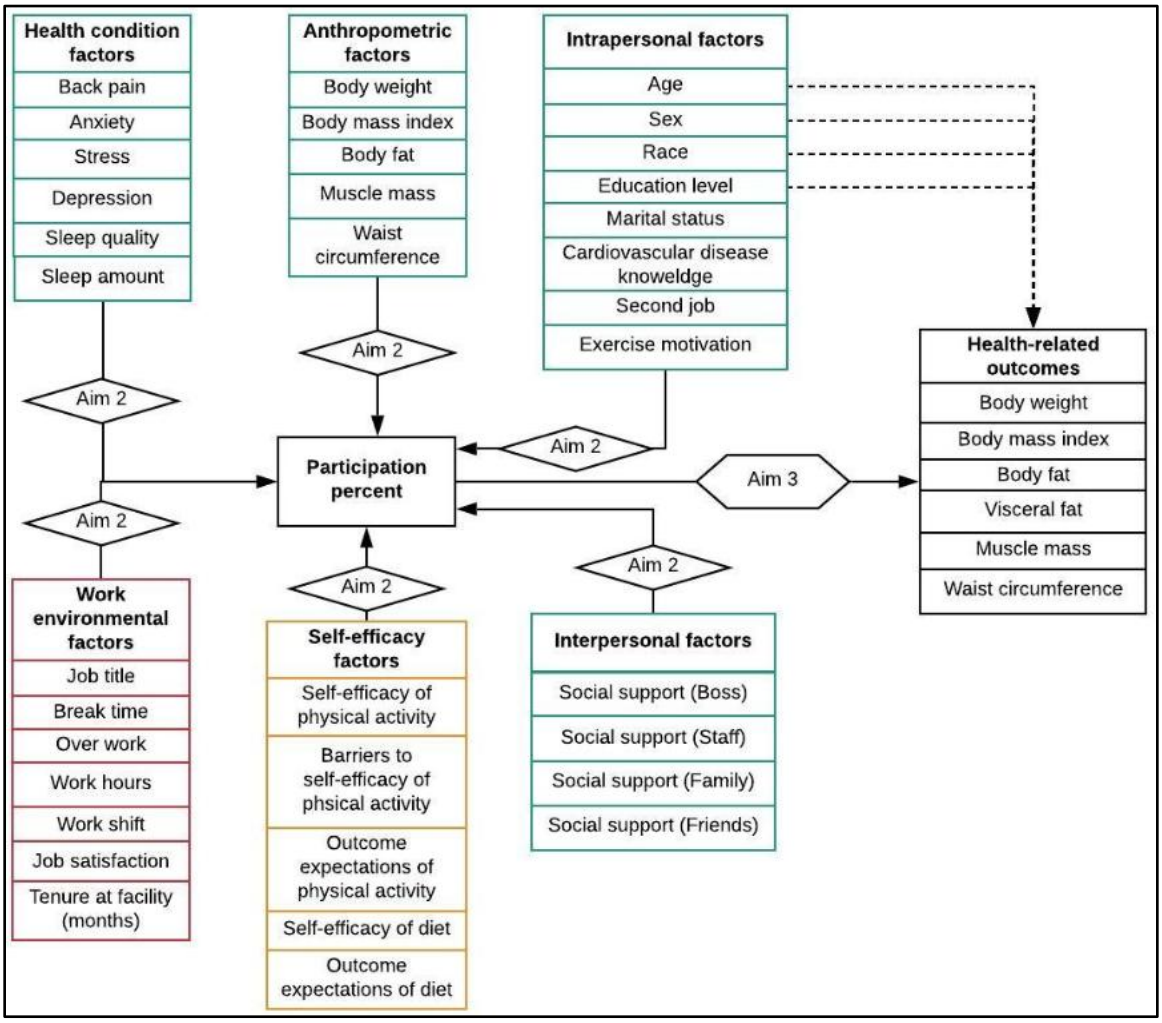

Figure 1.5. Conceptual Framework

* Red: constructs from SEM
* Yellow: constructs from SCT
* Green: Overlapping constructs of SEM and SCT

The specific description of each group of factors in the conceptual framework as below:

Intrapersonal factors

Prior reports show women, older employees, individual with high educational level and high motivation appear more likely to participate in WHPPs.[11,36,86,107,127,128] Similarly, Groeneveld et al[129] reported the employees who had lack of motivation were more likely not to participation in WHPPs. However, there are studies that reported the findings contrary to these results. There are studies that reported younger employees were more likely to be participants.[36,130,131] A study on determinants of sustained participation reported that particularly individuals with a lower education level were more likely to sustain participation inWHPPs.[40,130]

Self-efficacy factors

Self-efficacy influences the effort people put forth to change health risk behaviors and persistence to continue striving despite barriers that may undermine motivation.[132] Rongen et al[40] reported that employees with positive intention and high self-efficacy were more likely to participate in health promotion programs. Amlani and Munir[4] found that employees who had high outcome expectations were more likely to participate in WHPPs. Meilenz et al[119] reported that people who had high self-efficacy and outcome expectations of physical activity more actively participated in the physical activity program.

Anthropometric factors and health condition factors

Previous studies found that those who had low obesity risk such as lower body weight, fat, and waist circumference and higher muscle participated more frequently in WHPPs.[38,133] In addition, those who have healthier lifestyle and better health conditions were more likely to participate in the WHPPs.[11,39,40,134] However, contradictory results have also been reported. A study found that participants with poor self-perceived health

status were more likely to participate in the multi-component program that includes physical activity and diet interventions.[129] Another study found that those who were obese or had hypertension risk showed higher participation rates in the physical activity program.[130] In addition, a study reported people who had higher cholesterol levels are more likely to participate in nutrition programs.[44]

Work environmental factors

There are some work-environmental factors influencing participation in WHPPs. Employees who were salaried, employed in full-time or white collar positions, or had administrative jobs appeared to participate in WHPPs at higher rates.[108,135] A lower participation level was found for those with shift work.[17,136] Additionally, WHPPs offered during leisure time was associated with lower participation.[137]

Inter-personal factors

Many studies have found a link between social support and increased engagement in health promoting behaviors, such as dietary habits and physical activity.[125,138] For the worksite setting, it was found that employees who had a high level of social support from bosses, staff, friends, and family for participating in WHPPs, also had high participation rate.[40] Zunker et al[139] reported that social support was a major motivator for maintaining participation in WHPPs. Serxner, Anderson, and Gold[105] also found that social support is one of the key factors that directly influenced participation of employees in WHPPs.

1.7 Significance

Through a comprehensive literature review, a variety of types of mHealth interventions and their effectiveness in reducing body weight and composition were introduced. This information will be useful for developers or employers who want to

develop and apply weight management WHPPs that are not limited by time and locations. This study identified factors that influence participation in a WHPP. Considering these factors when developing a program for healthcare workers will result in effective programs that achieve high participation rates. In addition, this study reports the relationship between participation levels and changes in body weight and composition. This information provides insight into the importance of high participation in achievement of targeted health outcomes, such as body weight and composition changes. Therefore, results of this study remind researchers, developers, and employers who are interested in developing and implementing WHPPs that they should consider including a variety of strategies to achieve high participation rates for success of WHPPs.

1.8 Methods

The three-manuscript dissertation option is chosen to address the proposed researched project. The first manuscript is a systematic review for aim 1. Two manuscripts use data from a WHHP to address research aims two and three. The following is a brief overview of the methods used in the systematic review and secondary data analysis.

1.8.1 Systematic Review

A comprehensive bibliographic search was conducted to identify peer-reviewed articles published from January 1, 2010 to June 1, 2018. After eligible articles were identified the following information was extracted and analyzed: authors, year of publication research, setting, intervention duration, type of research design, sample size, intervention protocol and tools, measurements of dependent variable, targeted outcomes, body composition results with significance levels, participation definition and rates,

design strengths, and design limitation. Risk of bias for included RCTs was evaluated using Cochrane Risk of Bias Assessment tool and non-Randomized Controlled Trials (non-RCTs) were appraised using Risk of Bias Assessment tool for Non-randomized Studies (RoBANS).

1.8.2 Secondary data analysis

The data source for the secondary analysis is the Worksite Heart Health Improvement Project (WHHIP). The WHHIP was a clustered randomized controlled trial that was conducted in four long-term care facilities within one east coast state in the United States.[23] Participants were randomly assigned to an education only or intervention group that received exercise, nutrition, stress management, and education interventions, during paid work time. An exercise coach trained in diet and stress management counseling provided the intervention to staff and encouraged them to engage in healthy eating, exercise, and stress reduction skills for nine months. The WHHIP was approved by an Institutional Review Board (IRB) and all participants provided consent.

This dissertation study uses participation data from baseline to three months for aim 2 (n=46) and from baseline to six months for aim 3 (n=30). Independent t-tests and Chi-squared tests were used to explore the differences of baseline characteristics between high and low participation groups. Relationships between factors in the domains of work-environment, health, self-efficacy, anthropometric, intrapersonal and interpersonal with session participation were examined using univariate analysis and multiple linear regression. In addition, program engagement was explored using Kaplan-Meier plots and log rank tests. Non-parametric methods (Mann-Whitney U and Wilcoxson Sign-tests) and

linear regression models were used to study the effects of participation levels on changes of body weight and/or body composition.

1.8.3 Sample Size and Power Consideration

The sample size was calculated using G-power 3.0.10 software.[140] For the analysis of aim 2, sample size estimated using $\alpha = 0.05$, power $(1-\beta) = 0.60$, and effect size $f = 0.15$ (medium effect size) given multiple regression with two predictors. Based on the aforementioned assumptions, calculated sample size was 45. For the analysis of aim 3, sample size was calculated assuming $\alpha = 0.05$, power $(1-\beta) = 0.60$, and effect size $f = 0.35$ (large effect size) given multiple regression with five predictors. An estimated sample size was 31 for aim 3. This preliminary secondary data analysis used complete data from 46 and 30 participants for aim 2 and 3, respectively.

1.9 Introduction of the three Manuscripts

The dissertation includes three manuscripts. The background, methodology, and analysis approach of each of these will be described in detail in their own chapters. The first manuscript titled "Characteristics and effects of worksites health promotion programs using mobile technology interventions that aimed to change body weight or composition**:** a systematic review" is presented in Chapter 2. The second manuscript titled "Factors influencing participation in the Worksite Heart Health Improvement Project" focuses on identifying the factors that influenced participation in the WHHIP (chapter 3). The last manuscript titled "Relationships between participation percentages of a worksite health promotion program and changes in body weight and composition for six months" explores the relationships between participation percent of the WHHIP and changes of body weight and composition (Chapter 4).

2.0 Summary

This chapter presented an overview of the scope and gaps in the literature were identified to support the background of the aims, and the source of the data used in this dissertation was also described. The details of the three manuscripts, which were briefly introduced above, will be described in the subsequent three chapters.

CHAPTER 2

CHARACTERISTICS AND EFFECTS OF WORKSITES HEALTH PROMOTION PROGRAMS USING MOBILE TECHNOLOGY INTERVENTIONS THAT AIMED TO CHANGE BODY WEIGHT OR COMPOSITION: A SYSTEMATIC REVIEW

Abstract

Background: Worksite Health Promotion Programs (WHPPs) are designed to improve health-related behaviors and outcomes among employees. However, little is known about the mobile technology adoption in WHPPs and its effectiveness in changing body weight or body composition.

Objective: The purpose of this study was to explore the characteristics and effects of WHPPs using mobile technology interventions that aimed to change body weight or body composition.

Methods: A systematic search of articles on WHPPs using mobile technology interventions that aimed to change body weight or body composition published in peer-revieweed journals between January, 2010 and June, 2018 was conducted. Five different databases were used to search the literature. The Cochrane Risk of Bias Assessment tool and Risk of Bias Assessment tool for Non-randomized Studies were used to assess risk of bias.

Results: A total of 12 articles were included in this review and only four studies among them were RCTs. Three studies implemented WHPPs that used only mobile technology interventions to change body weight or body composition. The most commonly used mobile-based interventions were providing information, goal setting, and data entry. Ten

studies showed statistically significant impact on reduction in body weight, BMI, waist circumference, or body fat. Regarding the quality assessment, all studies had risk of bias. For the selection bias, reporting bias, performance, detection bias, and attrition bias, 58.33%, 83.33%, 58.33%, 75%, and 58.33% of studies showed the low risk of bias, respectively.

Conclusions: WHPPs using mobile technology interventions targetting body weight or body composition changes have been applied in various worksite settings and have shown statistically significant impacts on reudction of body weight, BMI, waist circumferecne, or body fat.

Introduction

In the United States, 61% of Americans were employed with about 128.57 million people considered as full time employees in 2018.[141] On average, full-time workers spend a substantial amount of their time at worksites, more than one-third of their day, five days per week.[142] There is no doubt that worksites environment has a significant impact on workers' health and well-being because workers spend considerable time at worksites.[143] Currently, the rapid increase in prevalence of chronic diseases and expenditures-related chronic diseases in worksites, employers have become increasingly aware of the importance of workers' health and the need to establish healthy worksites.[79] Since worksites are concentration of individuals by time and place, worksites are considered ideal place for health promotion programs.[144]

Among many factors that related to prevalence of chronic disease, over weight and obesity are major contributors.[145] A previous report found that workers in the U.S. gain weight every year.[12] The unhealthy work environment that surrounds workers' make

it extremely difficult to lose weight.[146] To be specific, worksites often offer easy access to unhealthy foods in vending machine and limited access to healthier food options, such as fruits and vegetables.[147] In addition, the decline in work-related physical activity is related to growth of obesity at worksites.[148]

Obese workers have adverse occupational consequences such as work absence, impairment, and workplace injury.[149] Workers who are overweight/obesity and have chronic health problems miss about 450 million more days of work than healthy workers do in an every year.[150] An estimated cost of this result is more than $153 billion in lost productivity yearly.[49] In addition, obesity-related medical expenditures, absenteeism (habitual absence of work), and reduced productivity of full-time employees is estimated to cost over $73 billion annually.[151] However, it was reported that as the body weight, blood pressure, and cholesterol levels decreased by 1% each year, the medical costs are reduced by about $100 per year.[152]

In order to support reducing body weight and improve well-being of employees, many employers adopt a worksite health promotion program (WHPP).[153] Previous studies showed positive effectiveness of WHPPs on reduction of body weight,[154–156] body mass index (BMI),[155–158] body fat,[156] and waist circumference.[157] However, not every WHPP showed positive outcomes. Some studies found non-significant changes in bodyweight,[159,160] BMI,[159–163] body fat,[161] and waist circumference.[161] In addition, a previous study reported that it is difficult to achieve and maintain a healthy body weight among employees by using WHPPs.[164] Another study also summarized that WHPPs have shown effectiveness in reducing blood pressure, glucose level, and cholesterol level, however, less effective at weight loss.[12]

These contradictory outcomes of WHPPs might be caused by many barriers and challenges, such as shift work, high job demands, inflexible work schedules, motivational issues, time limitations, and inconvenient locations.[36,79,142,165] These factors prevent employees from participating in the program and reduce effectiveness of WHPPs. The most commonly reported barriers to participation in WHPPs include inconvenient locations, scheduling, and time limitations.[17,36] To overcome these barriers and challenges, new platforms of WHPPs that are not limited by location and time are urgently needed. Currently, mobile technology has been recognized as a promising tool to overcome these problems.[166] Mobile devices, such as tablet PCs or smartphones, have been widely known that they are useful to provide preventive healthcare services, treatment support, disease monitoring, and chronic disease management.[167] Additionally, use of mobile technology has increased popularity in recent years as a tool to facilitate and sustain changes in body weight and composition.[168] Various prior studies showed the positive impact on reduction of body weight or body composition by using mobile technology.[169–173] However, little is known about their use and effectiveness in WHPPs. To build the comprehensive evidence of use and effectiveness of WHPPs using mHealth to change body weight and composition, this systematic review was conducted. This systematic review summarized the features and effectiveness of worksite health promotion studies that used mobile-technology as an intervention. In addition, the quality of the included studies was evaluated in this review.

Methods

Search Strategy

Before conducting the study, a university librarian, who is an expert in the field of systematic reviews, was consulted to identify the accurate search terms and databases. To search the relevant articles, search terms were categorized according to subjects, settings, interventions, and outcomes. Table 2.1 shows the detailed description of search terms. The following databases were searched: PubMed, Excerpta Medica dataBASE (Embase), Business Source Primier, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Cochrane.

Table 2.1. Summary of Search Terms

Subjects/Setting (OR)		Interventions (OR)		Outcomes (OR)
Employee Workplace Worksite Job Wellness program work place	**AND**	Mobile app Mobile apps Mobile application Mobile device Mobile technology Mobile health mHealth eHealth Smartphone Cell phone Mobile phone Text message	**AND**	Body weight weight BMI body mass index body composition body fat muscle Body Constitution Body Fat Distribution

Study Selection

The process of study selection is shown in Figure 2.1. Articles were included if they met the following criteria: 1) English-language publication, 2) Published in a peer-reviewed journal, 3) Published between January 1, 2010 to June 1, 2018, 4) Included at least one of the targeted outcomes (body weight, BMI, waist circumference, and/or body

composition), 5) Used a mobile technology intervention, 6) Were conducted in a worksite setting, 7) Full-text was available (Exclude those that only have abstracts), and 8) Were experimental or quasi-experimental studies.

The total number of articles identified at the first step of searching was 127: PubMed (n=34), Embase (n=39), Business Source Premier (n=17), CINAHL (n=11), and Cochrane (n=26). This review followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guideline to select the articles. Two researchers (Dr. KD and MH) independently scanned titles and abstracts to select the studies that met the inclusion criteria. Disagreements were resolved through discussions until reaching agreement. Finally, 12 articles were identified after screening duplicates, title, abstract, and full-text.

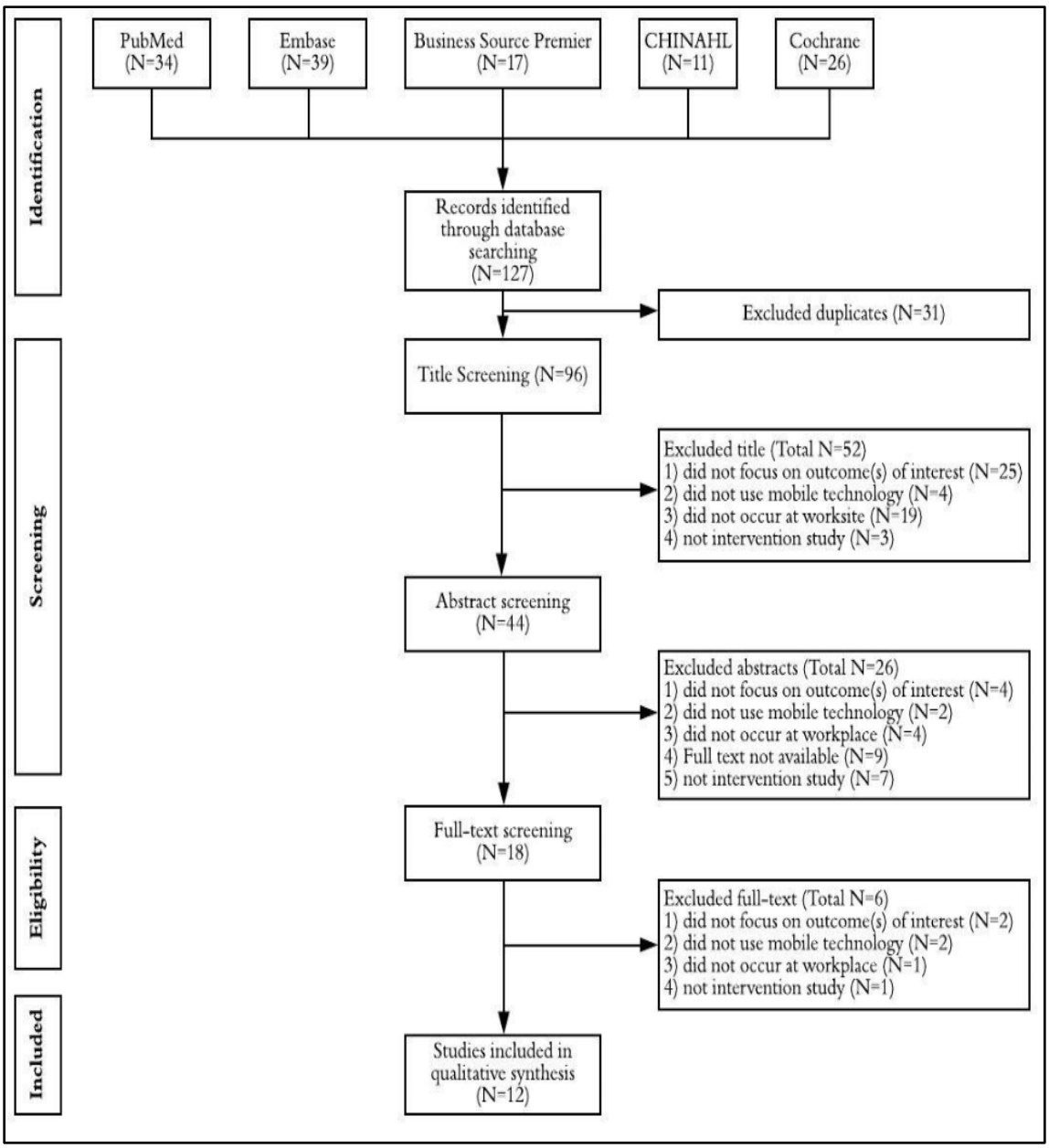

Figure 2.1. Flow Chart of Studies Selected

Data Collection and Analyses

The following information was extracted from the 12 eligible publications: 1) Authors, 2) Locations, 3) Years of publication research, 4) Study designs, 5) Study durations, 6) Characteristics of participants, 7) Sample sizes, 8) Attrition rates, 9) Target outcomes, 10) Intervention tools, 11) Control tools, 12) Intervention(s) contents , 13) Health-related behaviors, 14) Outcome measures, 15) Findings, 16) Strengths, 17)

Limitations, 18) Definitions and rates of participation (if reported), and 19) Theoretical frameworks (if used). Components of the intervention for each study were divided into two categories: mobile or non-mobile. Mobile was defined as Studies with attrition percent under 20, 20 to 40, and over 41 were considered as having low, moderate, and high attrition.[174] If studies did not report the attrition percent, they were presented as "Not Available (N/A)."

Quality Assessment and Risk of Bias within Studies

The quality of studies was critiqued using information provided in the publication. Randomized Controlled Trials (RCTs) were appraised using the Cochrane Risk of Bias Assessment tool.[175] This tool contains seven categories including: 1) Random Sequence generation, 2) Allocation concealment, 3) Blinding of participants, 4) Blinding of outcome assessment, 5) Incomplete outcome data, 6) Selective reporting, and 7) Other bias. Each criteria was judged for low, unclear, or high risk of bias. Non-Randomized Controlled Trials (non-RCTs) were appraised using Risk of Bias Assessment tool for Non-randomized Studies (RoBANS).[176] This tool contains six domains including: 1) Selection of participants, 2) Confounding variables, 3) Measurement of intervention (exposure), 4) Blinding of outcome assessment, 5) Incomplete outcome data, and 6) Selective outcome reporting. A judgement of low, unclear, or high risk of bias was assigned to each category.

Results

Characteristics of Included Studies

All 12 included studies were conducted between 2015 and 2018. Among the studies, 42% of them were conducted in the United States.[22,177–180] Of the seven

remaining studies, six were also conducted in high-income countries: three in Netherlands,[181–183] two in South Korea,[24,184] and one in Denmark.[185] For the study designs, included studies were classified as pre-post design studies,[22,24,187,188,191,1922,24,177,178,181,183] randomized controlled trials,[185,186] repeated measures design,[179] un-blinded randomized controlled trial,[184] multi-center cluster-randomized controlled trial,[182] and non-randomized design with matched control group.[180] Study duration ranged between 3 months and 12 months.

Characteristics of participants and attrition rates varied across the included studies. Participants were recruited from health care,[24,179,181,185] military, police, and health care,[181] food service,[177] and private and public sector organizations.[22,180,184,186] Two studies did not mention the specific type of company where they recruited participants.[178,183] Five studies conducted their WHPP among populations with specific health issues. Kim et al[184] and Kouwenhoven-Pasmooij et al[181] conducted studies with participants who had BMIs greater than 25kg/m^2. Senecal et al[178] conducted a study with participants who had poorly controlled hypertension (SBP >140 mmHg or a DBP > 90mmHg) and previously diagnosed with hypertension and obesity. Kim et al[24] conducted a study with only male workers who had metabolic syndrome. In addition, Limaye et al[186] conducted a study with participants who had three or more health risk factors (family history of cardio-metabolic disease, overweight/obesity, high blood pressure, impaired fasting glucose, hyper-triglyceridaemia, high-LDL cholesterol, and/or low HDL cholesterol). Generally, intervention groups showed lower attrition rates than control groups. None of the included studies defined participation or reported participation rates. Detailed description of included studies is presented in Table B.1.

Targeted Health-related Behaviors

Targeted health-related behaviors of interventions are presented in Table 2. There were nine different health-related behaviors being targeted by the 12 included studies. These behaviors were: 1) Physical activity (n=12),[22,24,177–186] 2) Healthy diet (n=7),[22,24,178,182–184,186] 3) Smoking cessation (n=4),[178,182,183,185] 4) Alcohol consumption (n=3),[182–184] 5) Sleep quality (n=1),[183] 6) Stress management (n=2),[182,183] 7) Physical strength (n=1),[185] 8) Substance use (n=1),[186] and 9) Medication adherence (n=1).[178] Four studies only targeted one component-improving physical activity,[177,179–181] which was the most common targeted health behavior. Eight studies targeted more than two health-related behaviors.[22,24,178,182–186]

Table 2.2. Targeted Health-related Behaviors of various WHPP Interventions

First Author, Year	Targeted Health related Behaviors of Interventions									
	Physical Activity	Healthy diet	Smoking Cessation	Alcohol consumption	Sleep Quality	Stress Management	Physical Strengths	Substance Use	Medication Adherence
Aalbers, 2016,[183]	X	X	X	X	X	X			
Balk-Moller, 2017,[185]	X		X				X		
Buchholz, 2016,[177]	X								
Ganesan, 2016,[22]	X	X							
Kim, 2015,[184]	X	X		X					
Kouwenhoven-Pasmooij, 2017,[181]	X								
Kouwenhoven-Pasmooij, 2018,[182]	X	X	X	X		X			
Limave, 2017,[186]	X	X						X	
Senecal, 2018,[178]	X	X	X						X
Tucker, 2016,[179]	X								
Kim, 2015,[24]	X	X							
Wilson, 2017,[180]	X								

• **"X"**: behavior included in intervention

Theory of Interventions

Among the 12 studies, four studies implemented theory-based interventions. In the Aalbers et al[183] study, the intervention was developed based on Social Cognitive Theory, Trans-theoretical Model, Theory of Reasoned Action, and Theory of Planned Behavior. Buchholz et al[177] developed the intervention based on the Pender's Health Promotion Model. Tucker et al[179] used egocentric and geocentric models to develop their intervention. Kim et al[24] developed their intervention based on the constructs of Trans-theoretical Model (TTM). Eight studies did not report being guided by a theoretical framework.[22,178,180–182,184–186] Three[24,179,183] out of four studies that used theory-based interventions found statistically significant effectiveness on reducing body weight and/or composition.

Components of Interventions

All included studies used multi-component health programs. While this review included studies that had mobile component interventions, several studies also included non-mobile component interventions. Mobile-component interventions are presented in Table 2.3 and non-mobile component interventions are presented in Table 2.4. As seen in Table 2.3, the mobile interventions included goal setting,[24,178,180,181,183–186] reminders to engage in interventions using text message and/or calls,[24,177,178,181,183,184,186] text-message for personalized health coaching,[179,180] calls for individual counseling,[180] self-monitoring by data entry,[22,24,177,178,180,183,185] games,[181,183] feedback,[182,183,185] information,[22,178,180–186] assignments,[180,185] and counseling.[180,182] Table 2.4 provides an overview of the non-mobile interventions. These include goal setting (paper version),[177] group sessions,[181,184] accelerometer/pedometer,[22,24,177,179,181] team competition,[185] motivational interviewing to

improve exercise adherence,[181] education session (in-person),[24] and trainer for individual coaching sessions, monitoring participant progress,[180,182] and environmental options (treadmill, Wii™, video supplements).[179] The most common mobile-based and non-mobile based interventions were providing information (e.g. education, tips, tricks, and guidance) and accelerometer/pedometer, respectively. In short, most studies (9/12, 75%) had interventions that combined the mobile and non-mobile interventions.[22,24,177,179–182,184,185] Three studies used only mobile interventions.[178,183,186]

Table 2.3. Types of Mobile-based Interventions

First Author, Year	Intervention types : Mobile -based interventions									
	Goal Setting	Reminder	Text-Message	Calls	Data entry	Games	Feedback	Information	Assignments	Counseling
Aalbers, 2016,[183]	X	X		X	X	X	X	X		
Balk-Moller, 2017,[185]	X			X	X		X	X	X	
Buchholz, 2016,[177]		X		X	X					
Ganesan, 2016,[22]				X	X			X		
Kim, 2015,[184]	X	X						X		
Kouwenhoven-Kouwenhoven-Pasmooij, 2017,[181]	X	X				X		X		
Pasmooij, 2018,[182]							X	X		X
Limaye, 2017,[186]	X	X						X		
Senecal, 2018,[178]	X	X			X			X		
Tucker, 2016,[179]			X							
Kim, 2015,[24]	X	X		X						
Wilson, 2017,[180]	X		X	X	X			X	X	X

"X": mobile-based interventions used in each study

Table 2.4. Types of non- Mobile-based Interventions

First Author, Year	Intervention types: Non-mobile-based Interventions							
	Goal setting	Group sessions	Accelerometer / Pedometer	Team competition	Motivational interview	Education	Trainer	Environmental options (treadmill, Wii™, video)
Balk-Moller, 2017,[185]				X				
Buchholz, 2016,[177]	X		X					
Ganesan, 2016,[22]			X					
Kim, 2015,[184]		X						
Kouwenhoven-Pasmooij, 2017,[181]		X	X		X			
Kouwenhoven-Pasmooij, 2018,[182]							X	
Tucker, 2016,[179]			X					X
Kim, 2015,[24]			X			X		
Wilson, 2017,[180]							X	

"X": non-mobile based interventions used in each study

Effectiveness of Interventions in Targeted Health Outcomes

Targeted health-related outcomes and time points of outcomes assessments varied in all 12 included studies (Table 2.5). Ten studies that targeted body weight reduction showed a statistically significant weight loss ranging from 1-3 kg.[22,24,178–180,182–186] Three out of ten studies showed statistically significant reduction in body weight over time.[179,184,185] Five out of seven studies that aimed to reduce BMI found a statistically significant reduction of BMI.[178–180,182,183] Tucker et al reduced BMI significantly at three months (-0.4kg/m^2, $P < .01$) and six months (-0.6kg/m^2, $P < .01$)[179]. Whereas, Buchholz et al[177] did not achieve a statistically significant reduction of BMI at three months (-.21kg/m^2, $P = .142$). Kouwenhoven-Pasmooij et al[181] did not show a statistically significant reduction of BMI at six months (-1.87 kg/m^2, $P > .05$). Two out of four studies aimed to reduce body fat found a statistically significant reduction of body fat.[184,185] Kim et al[24] showed statistically significant reduction of body fat at one month (-1.11%, $P <.001$) and three months (-1.86%, $P <.01$), but not at six months (-0.56 %, $P =.11$). Four out of six studies[180,184–186] that looked at effectiveness in reducing waist circumference achieved a statistically significant reduction. None of the studies considered muscle mass change as an outcome.

Table 2.5. Effectiveness of Intervention in Targeted-Health Outcomes

Outcomes	First Author, Year	1 month (P)	3 months (P)	4/5 months (P)	6 months (P)	9 months (P)	12 months (P)
Body weight	Aalbers, 2016,[183]						-.08 kg, (P = .01)
	Balk-Moller, 2017,[185]			-1.54kg (P <.001)		-1.01 kg, (P = .03)	
	Ganesan, 2016,[22]		-1.45 kg, (P < .001)				
	Kim, 2015,[184]	-1.11 kg , (P < .001)	-1.86 kg, (P < .01)		-1.71 kg, (P < .01)		
	Kim, 2015,[24]			-2.43kg, (P = .02)			
	Kouwenhoven-Pasmooij, 2018,[182]						-3.12 kg, (P < .05)
	Limaye, 2017,[186]				-1.1 kg, (P < .001)		
	Senecal, 2018,[178]						-0.23 kg, (P = .014)
	Tucker, 2016,[179]		-2.2 kg, (P < .01)		-3.5 kg, (P < .01)		
	Wilson, 2017,[180]					-2.0 kg, (P < .05)	
BMI	Aalbers, 2016,[183]						-.03 kg/m^2, (P = .01)
	Buchholz, 2016,[177]	-.21kg/m^2, (P = .142)					
	Kouwenhoven-Pasmooij, 2017,[181]				-1.87 kg/m^2 (P > .05)		
	Kouwenhoven-Pasmooij, 2018,[182]						-0.69 kg/m^2, (P < .05)
	Senecal, 2018,[178]						-0.40 kg/m^2, (P = .003)
	Tucker, 2016,[179]	-0.4kg/m^2, (P < .01)			-0.6kg/m^2, (P < .01)		
	Wilson, 2017,[180]					-0.5 kg/m^2, (P < .001)	

Table 2.5. Effectiveness of Intervention in Targeted-Health Outcomes (continued)

Body fat percentage	Balk-Moller, 2017,[185]			-0.81%, (P = .03)		-.08%, (P = .03)
	Kim, 2015,[184]	-1.11%, (P <.001)	-1.86%, (P < .01)		-0.56%, (P = .11)	
	Kim, 2015,[24]			-1.13%, (P = .197)		
	Tucker, 2016,[179]		-0.3%, (P = .87)			
Waist Circumference	Balk-Moller, 2017,[185]					-1.8cm, (P =.007)
	Buchholz, 2016,[177]		1.32 cm, (P = .273)			
	Kim, 2015,[184]			-3.25 cm, (P = .037)		
	Kouwenhoven-Pasmooij, 2017,[181]				-5.6cm, (P > .05)	
	Limaye, 2017,[186]				-1.5cm , (P < .01)	
	Wilson, 2017,[180]					-1.0 cm, (P = 0.009)
Other indicators						
Visceral Fat Mass (cm)	Kim, 2015,[24]			-5.99cm, (P = .033)		
Overweight and obese participants	Limaye, 2017,[186]	104 (78.2%)				96 (72.2%), (P =.021)
Total fat mass (kg)	Tucker, 2016,[179]		-0.6 kg, (P = .21)		-0.7 kg, (P =.21)	
Total lean mass (kg)	Tucker, 2016,[179]		-0.1 kg, (P <.01)		-0.7 kg, (P <.01)	

Risk of Bias Assessment

This review conducted a risk of bias assessment of all 12 included studies. Risk of bias assessment provides an opportunity to evaluate the strength of the individual study.[187] All 12 studies had some kinds of risk of bias according to the Cochrane Risk of Bias Assessment Tool or RoBANS (Table 2.6). For the RCTs, the five bias domains that include random sequence generation (selection bias), allocation concealment (selection bias), selective reporting (reporting bias), other sources of bias (other bias), blinding of participants and personnel (performance bias), blinding of outcome assessment (detection bias), and incomplete outcome data (attrition bias) were rated as low, unclear, or high.[175] For the non-RCTs, six domains of RoBANS including the selection of participants, confounding variables, measurement of intervention (exposure), blinding of outcome assessment, incomplete outcome data, and selective outcome reporting were used to evaluate bias of included each study.

Table 2.6. Risk of Bias Assessment

Author, Year	Randomized Controlled Trials							
	Selection bias		Reporting bias	Performance bias	Detection bias	Attrition bias	Other bias
	Random sequence generation	Allocation Concealment	Selective reporting	Blinding (Participants and personnel)	Blinding (Outcome assessment)	Incomplete outcome data	Other sources of bias
Balk-Moller, 2017,[185a]	Low	Low	Low	High	Low	High	Low
Kim, 2015,[184b]	Low	Low	Low	High	Unclear	High	Low
Kouwenhoven-Pasmooij, 2018,[182c]	Unclear	High	Low	High	Low	Low	Low
Limaye, 2017,[186a]	Unclear	High	Low	High	Low	Low	Low

Author, Year	Non-Randomized Controlled Trials							
	Selection bias		Reporting bias	Performance bias	Detection bias	Attrition bias	Other bias
	Selection of participants	Confounding variables	Selective outcome reporting	Intervention (Exposure) measurement	Blinding of outcome assessment	Incomplete outcome data	Other sources of bias
Aalbers, 2016,[183]	Low	Unclear	Unclear	Low	Unclear	High	Low
Buchholz, 2016,[177]	Unclear	High	Low	High	Low	Low	Low
Ganesan, 2016,[22]	Low	Unclear	Unclear	Low	Low	High	Low
Kouwenhoven-Pasmooij, 2017,[181]	Low	Unclear	Low	Low	Low	Low	Low
Senecal, 2018,[178]	Unclear	Unclear	Low	Low	Low	High	Low
Tucker, 2016,[179]	Unclear	Unclear	Low	Low	Low	Low	Low
Kim, 2015,[24]	Unclear	Low	Low	Low	Unclear	Low	Low
Wilson, 2017,[180]	Unclear	Low	Low	Low	Low	Low	Low

a. Randomized controlled trial
b. Un-blinded, randomized controlled trial with a 1:1 match of the intervention group to the comparison group
c. Cluster-randomized controlled trial

For RCTs, the risk of bias for random sequence generation can be evaluated as low risk of bias when the investigators describe methods such as coin tossing, throwing dice, or using a computer random number generator for randomization clearly. Among the four RCTs of this review, Balk-Moller et al[185] and Kim et al[184] adequately provided the information of random sequence generation and allocation concealment. Balk-Moller et al[185] performed randomization using a simple paper draw by two of the study investigators. Each draw was monitored by an independent witness to observe that it was conducted in a fair and unbiased way. Kim et al[184] performed the random allocation using blocked randomization using a Web-based randomization tool. However, Limaye et al[186] and Kouwenhoven et al[182] did not provide sufficient detail of the randomization and allocation concealment methods. Therefore, these were evaluated as unclear and high risk of bias for the random sequence generation and allocation concealment, respectively.

With regard to selective outcome reporting bias and other bias, four RCTs[182,184–186] showed low risk. All RCTs applied accurate statistical analysis for their research questions and discussed limitations that might affect the results. Authors of RCTs reported all measures that were used for the study. RCTs showed a high risk of performance bias because they did not blind subjects and outcome assessments. There were no other kinds of biases reported beyond the five included domains.

If included studies showed an attrition rate below 20%, they were considered having as a low risk of attrition bias.[175] The study of Balk-Moller et al[185] showed high attrition bias with a percent of 65.2% at 16 weeks and 47.5% at 38 weeks. In Kim et al study[184], attrition was 37.8% at six months; specifically, attrition percent of intervention and control groups were the same, 38%. Two of the RCTs showed low risk in attrition

bias. The study of Limaye et al[186] had relatively low attrition bias with a percent of 21% of intervention group and 26% of control group at 12 months. Kouwenhoven-Psasmooij et al[182] had an overall low attrition percent of 1.4% at 12 months.

Eight non-RCT studies were evaluated using RoBANS. Three studies sufficiently explained the process and methods of participant selection.[22,181,183] However, the remaining five studies did not explicitly provide information on how participants were selected.[24,177–180] For the confounding variables criteria, two studies showed low level of risk of bias because authors mentioned major confounding variables.[24,180] However, five studies[22,178,179,181,183] and one study[177] showed unclear and high risk of bias on confounding variables, respectively, because they did not provide sufficient information about the confounding variables that should be considered during the design and analysis phases. With regard to bias of selective outcome reporting, insufficient information was presented in two studies.[22,183] These studies did not fully report the pre-defined primary outcomes in accordance with the previously defined standards, thus they were categorized as unclear in this criteria. Seven studies showed low risk in performance bias because they used data from reliable sources.[22,24,178–181,183] For the blinding of outcome assessment, two studies provided unclear information.[24,183] A total of five studies were at low risk for attrition bias (attrition < 20%).[24,177,179–181] Figure 2.2 provides an overall summary of the risk of bias evaluations of the 12 studies. Over 50% of studies show low risk for selection bias (58.3%), reporting bias (83.3%), performance bias (58.3%), detection bias (75.0%), and attrition bias (58.3%).

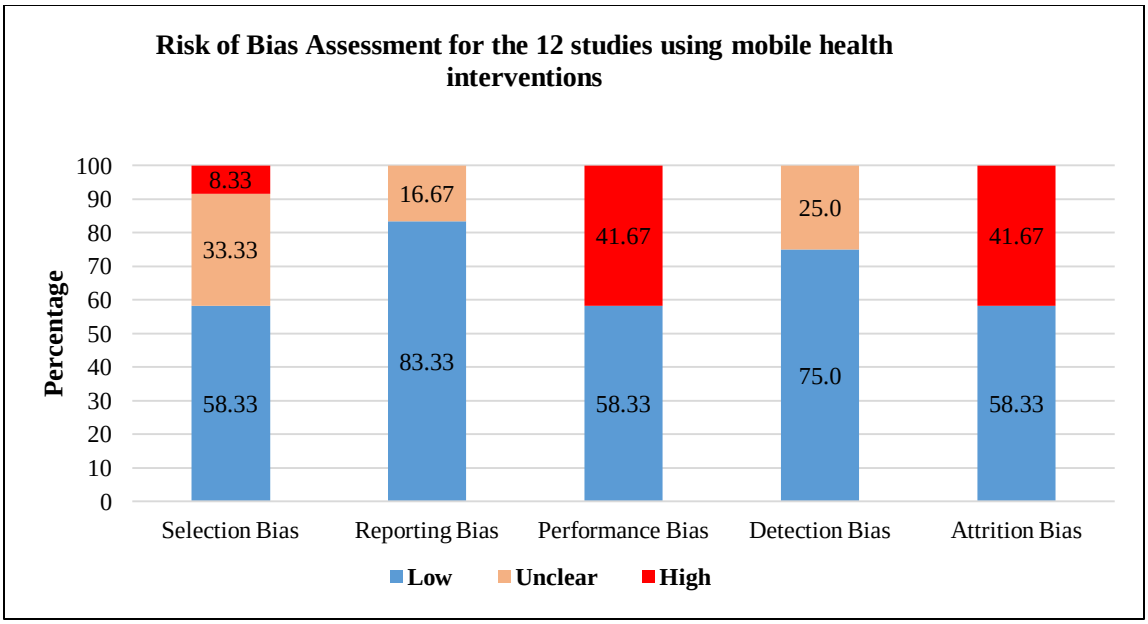

Figure 2.2. Risk of Bias Assessment for Twelve Studies Using a Mobile Health Intervention

Discussion

The findings from this systematic review indicated that 10 out of 12 included studies found that WHPPs using mHealth supported changes in body weight and composition in a variety of worksite settings. Nine studies applied WHPPs that combined mobile and non-mobile components and eight studies targeted changes of multiple health related behaviors and outcomes. Over 50% of included studies showed low risk for all bias domains. However, only four out of 12 studies were RCTs.

Participation

In this review, none of the included studies reported participation definition or participation rates. Recently, the importance of analyzing employees' participation and the impact of the WHPPs on health outcomes has been stressed because program effectiveness is heavily influenced by the participation rates.[110] Since participation data has important implications for generalizability of results, feasibility of interventions, and success of programs, future studies that implement WHPPs using mHealth interventions

that aim to change body weight or body composition should consider tracking, reporting, and evaluating participation in their programs.[38,188] In addition, it is necessary to compare whether the WHPPs using mHealth have high participation rates than those that do not use it.

Targeted Health-Related Behaviors

In this review, all included studies targeted an increase in physical activity. In addition, over 50% of studies aimed to change dietary intake. Among them, seven studies[22,24,178,182–184,186] aimed to change both physical activity and dietary intake. From a previous scoping review, physical activity and eating behavior changes were the most targeted health behaviors of mHealth interventions.[189] According to Irwin and Mayne[190], having both low diet quality and physical inactivity common and greatly increase the chance to get chronic diseases such as obesity, diabetes, cancer, and heart disease. In addition, a systematic review reported major chronic disease prevention strategies including improvement of physical activity and diet quality.[191] Therefore, using mHealth to serve both physical activity and diet interventions is considered a particularly promising efficient way to support improving employees' health.

While many WHPPs have targeted a single health-related behavior in prior studies, there have been a number of arguments in favor of targeting various health risk factors in a WHPP.[192] WHPPs that address multiple health-related behaviors might provide a greater opportunity to enhance participation of high-risk employees. According to Unger[193], success in changing more lifestyle behaviors also more increases one's confidence or self-efficacy to improve risk factors and overall healthful lifestyle. Consequently, targeting changes in multiple risk behaviors provides the potential of

increased health benefits, maximized health promotion, and reduced health care costs.[194] According to previous studies, mHealth interventions are promising to maximize initiation and maintenance of multiple health-related behavior changes.[195,196] The feasibility of mobile technology to change diet and activity behaviors simultaneously and efficiently has been demonstrated.[197]

Components and Effectiveness of WHPPs

This review found that common mobile-based components were providing information, data entry, and goal setting. Moreover, using accelerometer and/or pedometer was the most prevalent non-mobile based component. Even though, it was difficult to distinguish the effectiveness of each component on changes of health outcomes, studies that included components of providing information,[22,178,180–186] goal setting,[24,178,180,181,183–186] and data entry,[22,24,177,178,180,183,185] consistently showed a statistically significant impact on changes of targeted health outcomes.

These findings were similar with the previous studies. A prior meta-analysis found that providing tailored information via mobile health technology for changes of health related behaviors showed statistically significant changes in body weight and/or composition.[20] Information interacts with activation to improve self-efficacy and build skill mastery to facilitate sustained behavior changes.[198] A previous study found that frequent data entry (self-recording) and goal setting of weight, diet, and physical activity supported weight loss.[199] Goal-setting functions of mHealth support user-centered motivation and engagement in achieving one's goal.[70, 200] The data entry intervention supports self-monitoring. Self-monitoring with past data of behaviors is integrated into

their goals and activations to change future behaviors.[201] Additionally, self-monitoring includes cognitive and behavioral processes to facilitate goal achievement.[202]

This review did not isolate studies that implemented WHPPs using only mobile technology components that aimed to change body weight and composition since most of the included studies (9/12, 75%) used multi-component WHPPs that combined both mobile and non-mobile components. Although, it was difficult to isolate the effect of mobile-based components alone, this finding was consistent with suggestions of previous studies, which suggested that the most common approach to addressing employees' health issues is through a multi-component designed WHPPs,[203–205] as these combined components allow employees to obtain maximum health benefits from the same program[17].

Although a majority (10/12, 83.33%) of studies in this review showed statistically significant effectiveness of WHPPs using mobile technology interventions in changes of body weight and/or composition,[22,24,178–180,182–186] most studies (8/12, 66.67%) were not RCTs and did not apply solely mobile components.[22,24,177–180,183] Based on these results, using mHealth interventions in WHPPs seem a promising way to improve body weight or composition. However, more well-constructed WHPP RCTs that compare mHealth only (intervention arm) to non-mHealth only intervention (control arm) is needed to distinguish the effectiveness of mHealth interventions on chages in body weight and composition accurately. If using only mHealth interventions shows more effectiveness than control arm, future WHPPs that target population having time and location limitation to attend on-site WHPPs can apply only mHealth interventions to achieve body weight and composition reduction.

Risk of Bias Assessment

Since bias can cause false conclusions, we assessed the risk of bias of all included studies. In this study, around a half of included studies showed levels of "unclear" for the domains of selection and reporting bias. To reduce selection bias, methods they used to select participants should be clearly mentioned. In addition, pre-defined and purposed outcomes should be described as planned to minimize the reporting bias. For the performance, detection, and attrition bias domains, over 50% of studies showed low risk of bias. To reduce the performance bias, data for the study should be obtained from reliable sources. In addition, appropriate blinding of outcome assessments can reduce detection bias. Attrition bias can be reduced using retention strategies such as social support, adjustment of the program as needed, incentives, and/or appropriate imputation methods.[206]

Limitations

This study has some limitations that should be considered for further research. This study aimed to examine the effectiveness of WHPPs using mHealth interventions on changes of body weight and composition, however, most studies had a combination of mHealth and non-mHealth intervention components. Therefore, it was difficult to distinguish the effectiveness of mHealth interventions alone. Included studies of this review were conducted during different time periods. For this reason, the attrition rates might be influenced by the study periods. Therefore, the interpretation of attrition evaluation should consider the study period. This study was limited in that we were not able to do a meta-analysis to examine the pooled-effectiveness of the interventions due to a lack of consistency in the type of participants, settings, interventions and duration of

each study. Although we searched relevant articles using all related key terms, there might be other key terms that are relevant but were not included. Lastly, this review did not include articles that were published before year of 2010. It is possible that some relevant and high-quality articles published before 2010 were excluded.

Conclusion

The findings from this study provide some support for the use of mobile technology in WHPPs alone, or in combination with other interventions. Specifically, these interventions resulted in a reduction in body weight, BMI, body fat, and waist circumference. Future work should focus on testing the use of mHealth based interventions in RCTs with minimal bias with larger sample sizes are needed.

CHAPTER 3

FACTORS INFLUENCING PARTICIPATION IN THE WORKSITE HEART HEALTH IMPROVEMENT PROJECT

Clinical Significance

This paper highlights the importance of evaluating a diverse array of factors that influence participation in Worksite Health Promotion Programs (WHPPs). Work environmental, health and intrapersonal factors were shown to be more important in predicting what intervention components employees participated in than self-efficacy and interpersonal factors.

Abstract

Objective

This study explored the influence of an array of factors on participation and engagement in the first three months of the Worksite Heart Health Improvement Project (WHHIP).

Methods

Relationships between factors in the domains of work environment, health, self-efficacy, anthropometric, intrapersonal, and interpersonal with session participation and program engagement were explored in a sample of 46 long-term care employees randomly assigned to the intervention group.

Results

Employees with lower baseline stress levels had higher participation in particular subcomponents of the intervention (i.e., physical activity, stress management, and education) as well as in the entire program. Higher job satisfaction was related to

participation in the education component. Retention was lower among those working more than one job.

Conclusions

Strategies that can bolster participation should be considered when developing and applying worksite health promotion programs.

Background

Worksite Health Promotion Programs (WHPPs) are designed to support, identify, and address health and to encourage healthy lifestyles of workers.[207] According to the Kaiser Family Foundation's 2016 Employer Health Benefits Survey, 83% of large companies with over 200 employees offer a certain type of WHPPs to improve employees' health.[208] Employers often start WHPPs to improve work productivity and reduce medical costs by targeting lifestyle changes such as physical activity and dietary intake, as well as chronic disease management.[209] In keeping with this purpose, WHPPs have shown improvement of employees' health status by providing significant physiological, behavioral, and work-related benefits.[210] In particular, it is necessary to provide WHPPs to health care workers because they are a considerable part of the workforce in the U.S.[211] Additionally, prior studies showed health care providers are more likely to encourage healthy behaviors for their patients if they themselves engage in healthy behaviors.[212–214]

Success of WHPPs is severely limited by low participation.[36] According to previous studies, participation in WHPPs varies greatly.[11,215]A systematic review of 23 studies found participation percentage typically ranges anywhere between 10%-64% (median 33%) and varies according to program targets.[11] For example, fitness programs

have an average participation percentage of 21%, while weight loss programs have only 10%.[12] Participation percentage also varies widely by work area (10%-83%) and job type (17%-56%).[215] The average participation percent in WHPPs of healthcare workers (10%-12%) is often much lower than other types of workers.[11]

Since low participation results in low-effectiveness of WHPPs and it varies with type of worker and outcome, understanding participation is critical. Previous studies found that participation of employees in WHPPs heavily depended on demographic, health-related, and work-related factors.[11,216] Generally, those who were women, older, White, married, white-collar employees, full-time workers, non-shift workers, and had high education level were more likely to participate in WHPPs.[33,38,217,218] In addition, those who have a low obesity risk, low fitness/nutrition risk, and healthy lifestyle have been found to participate more frequently in WHPPs.[38,133] Some studies reported that employees with strong motivation to participate at baseline[40], high self-efficacy,[40] and high outcome expectations[219] were more likely to participate in WHPPs. However, some studies found the contradictory results that those who are in the categories of younger,[34,130] male,[35,220] Caucasian,[136] Black or Hispanic,[220,221] lower education,[130] higher health risks,[44] and shift work[136] were more likely to participate in WHPPs. To sum up, determining consistent factors related to participation in WHPPs is difficult.

In addition, most WHPPs have been provided employees who work regular schedules rather than workers with unpredictable and complex schedules, such as health care workers. Despite evidence that nurses and direct care workers are at high risk for cardio-vascular diseases, little is known about what factors are strongly related to participation of healthcare workers in WHPPs.[17,44,222] To fill these knowledge gaps, this

current study was conducted to examine features of participation and identify theory-driven factors that could influence participation in a WHPP. Guiding this study was a conceptual model (Figure 3.1) based on the Social Cognitive Theory (SCT) and Social Ecological Model (SEM) that emphasized the importance of comprehensive social context in the learning and adoption of new behaviors.[223,224] SCT has been applied broadly in health behaviors research to predict health behaviors and elicit behavior change. This theory consists of self-efficacy and outcome expectations, which are influenced by mastery experiences, vicarious experiences, social persuasion, and physical/emotional states.[117,225] SEM focuses attention on both individual and social environmental factors as targets for health promotion programs. This model proposes the importance of interventions directed at changing interpersonal, organizational, community, and public policy factors that support and maintain healthy behaviors.[226] These are the most widely-applied theoretical models of health behavior and identify the factors related to participation in health promotion programs.[227–229] The specific aims of this current study were: 1) to examine participation percent for the first three months of a WHPP, 2) to explore differences in baseline factors of low and high WHPP participants, 3) to identify factors related to participation, and 4) to identify differences in the length of engagement by baseline factors.

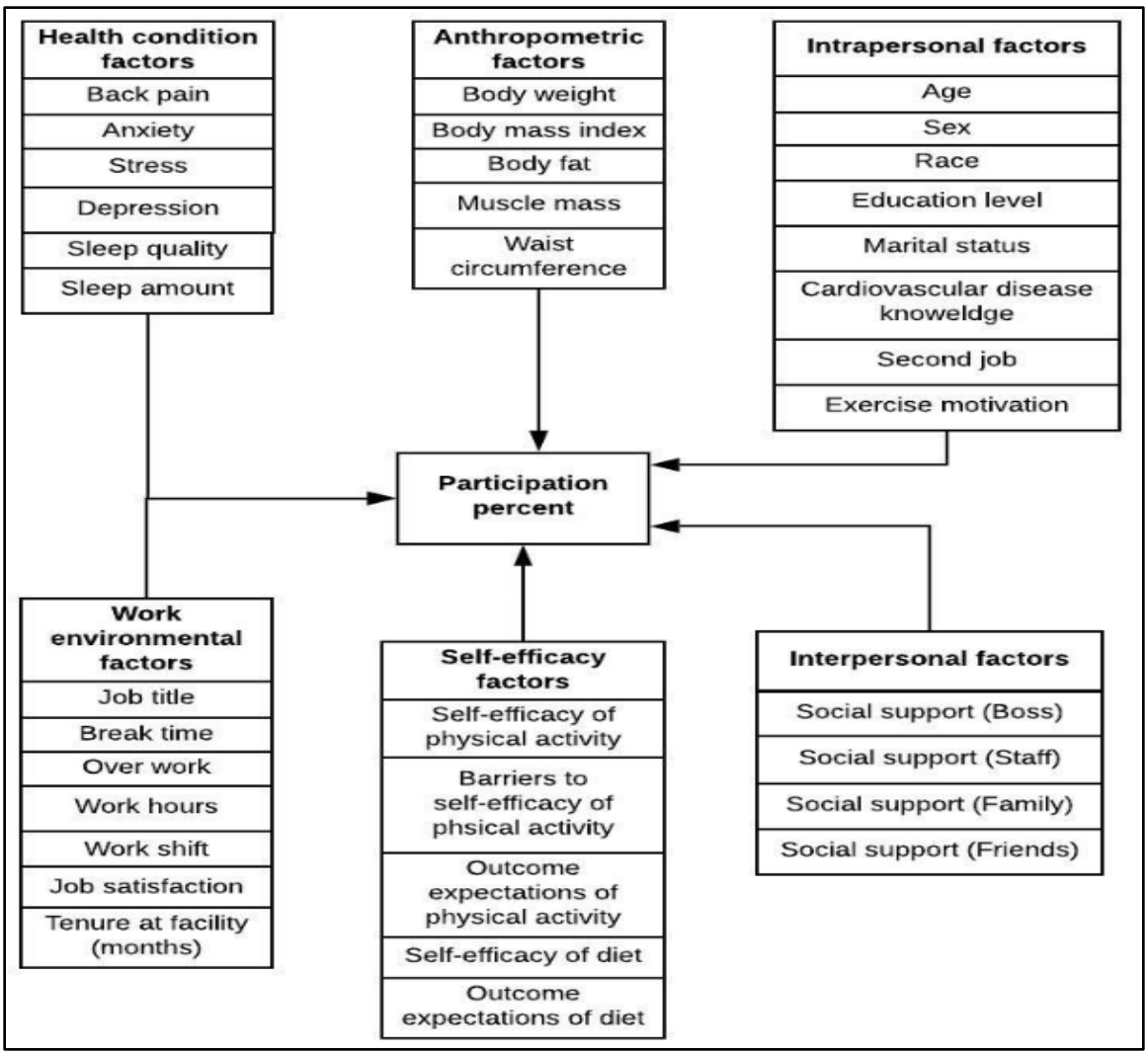

Figure 3.1. Conceptual Framework

Methods

Study Design and Data Source

This secondary analysis used data from the first three months of a clustered randomized controlled trial named Worksite Heart Health Improvement Project (WHHIP). The WHHIP targeted to reduce risk factors for heart disease by providing exercise, nutrition, stress management, and education interventions during paid work time and was conducted in four long-term care facilities within one east coast state in the United States.[118] Participants were randomly assigned to an education only or

intervention group. This initial project was approved by an Institutional Review Board (IRB) and all participants provided consent.

Study Sample

The intervention arm of the WHHIP is the focus of this secondary analysis. Out of the 341 potential participants across the four worksites, 146 attended a meet and greet to learn about the study. Screening excluded six employees who under 18 years of age (n=1), worked night shift (n=2), not employed by the facility (n=1), or pregnant (n=2). Among the 140 eligible, 98 consented to participate, of which 48 were randomly assigned to the intervention sites. Prior to the start of the intervention, two people from the intervention group dropped out. This current study uses data from the 46 employees who participated in the intervention group of the WHHIP.

Study Variables and Measurements

Measures of this study are described in Table 3.1.Trained research staff collected data. It took participants about 10 minutes to answer the 43 questions. The anthropometric data were assessed during participants' paid worktime and took approximately 10 minutes to collect.

Participation percent and the length of engagement were the outcomes of interest in this study. The WHHIP had several intervention components: physical activity, diet, stress, and education. The physical activity, diet, stress, and education participation percentages were calculated by dividing the number of days a participant attended each component by the total number of days the component was provided (53 days) and then multiplied by 100. The average participation percent of the entire program was calculated by summing the participation percent of each sub-component and dividing that total by 4.

In addition to operationalizing participation as a continuous variable, this study categorized participation as low and high. Participation percentages below the sample's average were categorized as low and participation percentages equal to or higher than the sample's average were categorized as high. The length of engagement was defined as the number of days in the first three months (90 days) that participants stayed involved in intervention activities before stop attending.

Table 3.1. Description of Study Measures

Concept (Units/Desired Direction)	Category	Measure(s)	Brief Description	Description of Psychometrics
Intra-personal Factors				
Age (years)				
Race	-White -Others		-White -Others: black, African-American, Asian, Native Hawaiian, other pacific islander, native America, and more than one race	
Sex	-Male -Female			
Marital Status	-Married -Non-married		-Married: married or cohabitating -Non-married : single, separated, or widowed	
Education Level	- Low - High		- Low: below high school -High: above high school	
Second Job	-No -Yes			
Exercise Motivation		3 items of ill – health avoidance, 3 items of positive health, 4 items of weight management were used among 51 item Exercise Motivation	This current study used the three subscales: ill-health avoidance, positive health, and weight management. [230]	-Reliability :Cronbach's α for ill-Health avoidance (α=0.901).[231] :Cronbach's α for positive health (α=0.877). [231] : Cronbach's α for weight management (α=0.914). [231]

Table 3.1. Description of Study Measures (continued)

		Index-2 (EMI-2) [230]		-Validity: Discriminative and construct validity.[232]
Health Condition Factors				
Back pain	-No -Yes	"How often in the past week, did you have back symptoms?"	-No: never or rarely -Yes: sometimes, often, or continuously	
Mood (Lower)		Short version of the Depression, Anxiety, Stress Scale (DASS-S) [233]		-Reliability: Cronbach's α for each subscale, 0.82 (anxiety), 0.88 (depression), and 0.90 (stress).[234] -Validity: Convergent and discriminant validity.[233]
Sleep Quality	-Bad -Good	Two questions from the Pittsburgh Sleep Quality Index.[235]	"During the past month, how would you rate your sleep quality overall?"	
Sleep Amount (hours)			"During the past month, how many hours of actual sleep did you get at night?"	
Anthropometric Factors				
Body Weight (pounds)		Standard scale		
BMI (kg/m^2) (lower)		The formula for BMI (kg/m^2) is weight in kilograms (kg) divided by height in meters squared (m^2).[236]		
Waist Circumference (inch)		Soft tape		
Body Fat (%) (lower)		OMRON HBF-514 full body Sensor Body Composition Monitor and Scale[237]	Eight-electrode BIA: measure body fat and muscle mass. BIA has been shown to produce body composition results that are highly correlated to	
Muscle Mass (%) (higher)				

Table 3.1. Description of Study Measures (continued)

			dual energy X-ray absorptiometry (DEXA) and magnetic resonance imaging [118,238]	
Work Environmental Factors				
Job title	-Nursing -Others		-Nursing -Others: housekeeper, dietary services, concierge, manager, and other	
Break time per day (minutes)				
Overtime work	-No -Yes			
Work Hours	- 8 - Others [10,12 or other]),		- 8 - Others: 10,12 or other	
Work Shift	-Day -Others		- Day - Others: evening or rotating shift	
Tenure at facility (months)				
Job satisfaction		16-item modified job attitude scale (JAS).[239]	-Measure the five domains of job satisfaction (pay, interaction/organizational factors, task requirements, job status, and autonomy) -Five-point Likert response scale	-Reliability: Cronbach's α >.70.[240] -Validity: Construct validity[240]
Self-efficacy Factors				
Self-efficacy of physical activity (0-800, higher)		8-item measure[241]	-Measure efficacy for participation in prescribed exercise regimens over incremental periods -Participants indicate their degree of confidence for each item on a 0-100% scale.	-Reliability: Cronbach's α =.98-.99.[241] -Validity: Construct validity [241]
Barriers to self-efficacy of physical activity (0-1,300)		13-item measure [242]	-Assess perceived ability to exercise when presented with barriers. -Participants indicate their degree of confidence for each item on a 0-100% scale.	-Reliability: Cronbach's α =.92-.94.[242] -Validity: Construct validity[242]

Table 3.1. Description of Study Measures (continued)

Outcome expectation of physical activity (13-65, higher)		13-item measure[232]	- Assess perceived positive and negative consequences of exercise - 5 point liker scale	-Reliability: Cronbach's α = .89.[232] -Validity: Criterion and construct validity.[232]
Self-efficacy of diet (0-20, higher)		20-item measure[243]	-Assess the health related diet that includes 5 subscales: resisting relapse, reducing calories, reducing salt, reducing fat, and behavior related to eating a healthy diet. -Yes or No format	-Reliability: Cronbach's α =.83[243] -Validity: Concurrent criterion and construct validity.[243]
Outcome expectations of diet (0-10, higher)		Single-item measure[244]	-Measure outcome expectations for heart healthy diet	
Interpersonal Factors				
Social support from friends (0-10, higher)		Ten-item subscales from modified Social Support for Exercise scale were used to assess each social support component.[245]	Assess social support for healthy behaviors from family, friends, staff, and boss.	-Reliability: Cronbach's α = 0.80.[245] -Validity: Construct and criterion-related validity.[245]
Social support from family (0-10, higher)				
Social support from staff (0-10, higher)				
Social support from boss (0-10, higher)				

Statistical Analysis

Appropriate descriptive analysis was conducted to describe the intra-personal factors, health condition factors, anthropometric factors, work environmental factors, self-efficacy factors, and interpersonal factors. The variable of cardiovascular disease knowledge had over 40% missing data; thus, it was excluded from the analysis. From the descriptive analysis, all continuous variables were normally distributed skewness between -3 and 3. The participation percent was examined using descriptive statistics that provided

the means and standard deviations. Independent samples t-tests and chi-squared tests were conducted to explore differences in baseline factors between low and high participation groups.

Multiple linear regression analyses were conducted to determine factors that influenced the participation percent of the WHHIP. Before running the multivariate regression analyses, the participation percent was regressed onto all possible variables that are presented in Figure 3.1, using univariate regression analyses. From the results of univariate regressions, only factors that showed significance value below or equal to .20 were included in the multiple linear regression models. The multiple linear regression models used backward elimination method to obtain the final parsimonious model. In the final model, factors that showed the significance value of below or equal to .05 remained. All final regression models were adjusted by age and gender. There was no violation of assumptions.

Kaplan-Meier (K-M) plots and log-rank tests were conducted to examine whether the lengths of engagement in the WHHIP differed by baseline factors. Continuous variables were categorized into two groups using mean for conducting the K-M plots and log-rank tests. Time was the number of days engaged in the WHHIP during the first three months. Those continuing to be engaged in the WHHIP at the end of three months were censored (contributed 90 days). Those who dropped out of the WHHIP contributed the number of days they were engaged until no longer attending intervention session. All statistical analyses were performed in SPSS 24.0.

Results

Baseline Factors of Study Sample and Differences of Baseline Factors between Low and High Participation Groups

Sample characteristics and baseline values are presented in Table 3.2. The mean age of the 46 participants was 37.6 years. Over half of the participants were female (79.2%), non-White (62.2%), un-married (63.6%), and/or had at least a high education (51.1%). Only a few of the factors were found to be related to participation. Those who were in the high participation group had statistically significant lower levels of baseline stress (P = .006) and anxiety (P = .025) than those who were in the low participation group. There were no statistically significant differences between low and high participation groups for any of the other baseline factors.

Table 3.2. Baseline Factors for the Overall Sample and by Low/High Participation Groups (WHHIP, n=46)

Category	Factor				Low Participation (n=25, 54.3%)	High Participation (n=21, 43.8%)	p-value
Interpersonal Factors		Number	%		Number (%)	Number (%)	
	Gender (Female)[a]	38	79.2		23 (92)	15 (75)	.214
	Race (White)[a]	17	37.8		12 (48)	5 (25)	.203
	Marital Status (Married)[a]	16	36.4		10 (40)	6 (31.6)	.796
	Education Level (high)[a]	23	51.1		15 (60)	8 (40)	.301
	Second Job (no)[a]	35	81.4		19 (82.6)	16 (80)	1.000
		Mean	SD	Range	Mean (SD)	Mean (SD)	
	Age (years)[a]	37.6	13.0	20-67	38.5 (11.9)	36.4 (14.6)	.600
	EMI-2- Ill health avoidance[a]	12.7	3.7	0-15	12.7 (3.7)	12.7 (3.9)	.943
	EMI-2- Positive health[a]	12.8	3.6	0-15	12.4 (3.8)	13.3 (3.5)	.441
	EMI-2- Weight Management[a]	15.1	5.9	0-20	15.1 (6.3)	15.1 (5.6)	.992

Table 3.2. Baseline Factors for the Overall Sample and by Low/High Participation Groups (WHHIP, *n*=46) (continued)

Health Condition Factors		Number	%		Number (%)	Number (%)	
	Back Pain (no) [a]	22	53.7		10 (47.6)	12 (60.0)	.630
	Sleep Quality (good) [a]	27	67.5		13 (61.9)	14 (73.7)	.648
		Mean	SD	Range	Mean (SD)	Mean (SD)	
	Stress level [a]	4.5	3.4	0-13	5.8 (3.0)	3.0 (3.2)	.006*
	Anxiety level [a]	2.8	2.9	0-10	3.7 (3.0)	1.8 (2.5)	.025*
	Depression level [a]	2.0	2.3	0-9	2.6 (2.3)	1.4 (2.2)	.084
	Sleep Amount (hours) [a]	6.4	1.0	3.5-8	6.4 (1.1)	6.4 (1.0)	.859
Anthropometric Factors		Mean	SD	Range	Mean (SD)	Mean (SD)	
	Body weight (lb)[a]	187.5	47.0	90.8-273.4	184.2 (51.9)	190.5 (42.9)	.660
	Body Mass Index (kg/m^2)[a]	31.3	7.3	16.6-48.4	30.6 (8.0)	31.9 (6.8)	.567
	Body Fat (%)[a]	40.1	9.6	20.3-57.5	40.3 (9.0)	39.6 (10.4)	.827
	Skeletal Muscle (%)[a]	26.7	4.7	18.8-38.6	26.2 (3.6)	27.4 (5.6)	.425
	Waist Circumference (inch)[a]	39.6	6.9	26-53	38.6 (7.5)	40.5 (6.4)	.369
Work Environmental Factors		Number	%		Number (%)	Number (%)	
	Job Title (nurse)[a]	17	35.4		10 (43.5)	7 (35.0)	.799
	Overtime work (yes)[a]	26	61.9		13 (59.1)	13 (65.0)	.940
	Work hour (8 hours)	29	70.7		13 (59.1)	16 (84.2)	.098
	Shift Work (day)	28	66.7		14 (63.6)	14 (70.0)	.913
		Mean	SD	Range	Mean (SD)	Mean (SD)	
	Break Time[a]	31.0	11.9	10-75	30.5 (13.8)	31.5 (9.7)	.782
	Job Satisfaction[a]	34.7	8.3	21-58	32.5 (7.2)	37.3 (7.2)	.067
	Tenure at facility (months) [a]	44.5	40.4	1-144	43.6 (41.2)	43.7 (40.6)	.993
Self-efficacy Factors		Mean	SD	Range	Mean (SD)	Mean (SD)	
	Self-efficacy of physical activity [a]	452.1	220.7	50-800	440.9 (196.7)	465.0 (250.1)	.730
	Barriers to self-efficacy of physical activity [a]	592.6	352.3	10-1300	556.5 (280.8)	636.3 (427.3)	.490
	Outcome expectation of physical activity[a]	46.2	8.5	26-61	46.7 (9.7)	46.7 (7.0)	.684
	Self-efficacy for diet[d]	13.7	4.2	0-20	14.4 (3.6)	12.9 (4.8)	.252

Table 3.2. Baseline Factors for the Overall Sample and by Low/High Participation Groups (WHHIP, *n*=46) (continued)

	Outcome expectation for diet[a]	8.0	2.6	0-10	7.8 (2.5)	8.2 (2.7)	.655
Inter-personal Factors		Mean	SD	Range	Mean (SD)	Mean (SD)	
	Social support (Friend)[a]	6.2	4.1	0-10	5.7 (4.5)	6.8 (3.7)	.402
	Social support (Family)[a]	6.4	4.1	0-10	6.0 (4.2)	6.9 (4.0)	.482
	Social support (Staff)[a]	4.2	3.9	0-10	3.8 (3.9)	4.6 (4.0)	.541
	Social support (Boss)[a]	3.8	3.7	0-10	3.4 (3.8)	4.2 (3.5)	.526

Note. a. Presence of Missing Values
Note. * Significant level at $P < .05$

Three-month Participation Percent for WHHIP

Participation percentage of the WHHIP for the first three months is presented in Figure 3.2. The average participation percentage of the entire program was 16.1% (SD 13.8). For each of the intervention component, the average participation percent was: physical activity 22.0% (SD 20.2), diet 6.9% (SD 6.7), stress 19.6% (SD 17.8), and education 15.7% (SD 12.2), Physical activity and diet components showed the highest and lowest participation percent, respectively.

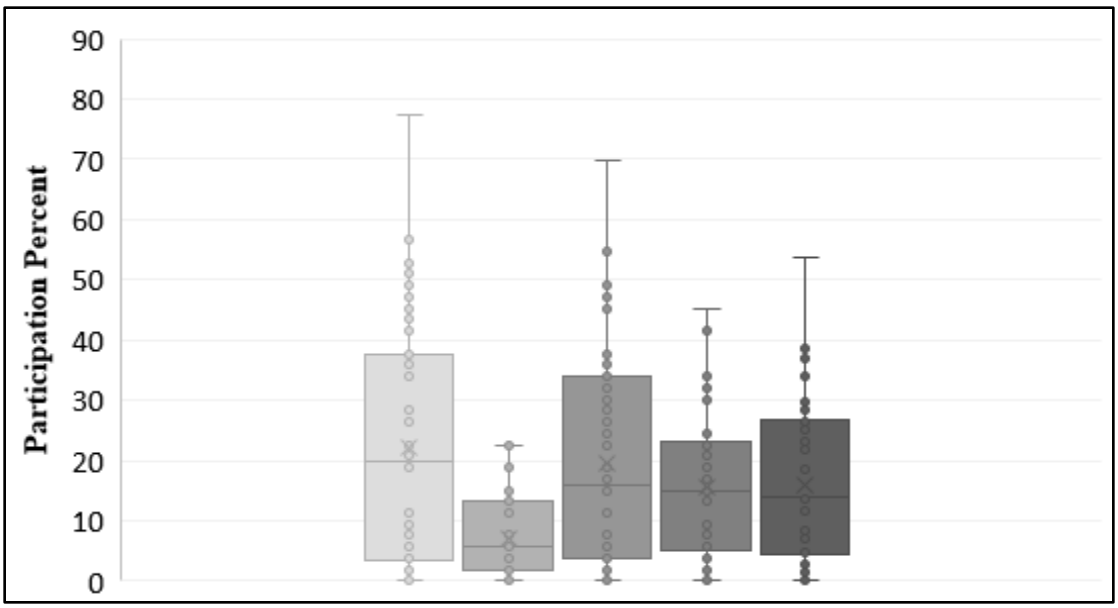

Figure 3.2. Average Three-month Participation Percent of the Entire Program and Each Component of the WHHIP

Differences of Sub-Component Participation Percent by Baseline Factors

Table 3.3 shows the differences of baseline factors between low and high participation groups of each component. Those who were in the high participation group of the physical activity (*P* = .021), the stress (*P* = .006), or the education (*P* = .041) components, reported statistically significant lower baseline stress levels than participants in the low participation group. In addition, those who were in the high physical activity component participation group had statistically significant lower anxiety levels (*P* = .050) than participants of low participation group. Participants who were in the high participation group of the physical activity (*P* = .052), diet (*P* = .020), or stress (*P* = .025) components reported statistically significant higher job satisfaction than participants in the low participation groups. Unlike our assumption, there were no statistically significant participation group differences for the majority of factors, especially interpersonal factors and self-efficacy factors (data not shown).

Table 3.3. Sub-Component and Difference of Baseline Factors between Low and High Participation Groups of Each Component (*n*=46)

Sub-Component	Category	Factor	Low Participation Group	High Participation Group	*t*	*P*-value
			M (SD)	M (SD)		
Physical activity	Health Condition Factors	Stress level	5.6 (3.0)	3.3 (3.4)	2.4	.021*
		Anxiety level	3.6 (3.1)	1.9 (2.5)	2.0	.050*
	Work Environmental Factors	Job satisfaction	32.3 (7.3)	37.3 (8.6)	-2.0	.052*
Diet	Work Environmental Factors	Job satisfaction	32.0 (7.1)	38.2 (8.6)	-2.5	.020*
Stress	Health Condition Factors	Stress level	5.8 (3.0)	3.0 (3.2)	2.9	.006*
		Job satisfaction	32.2 (3.0)	37.6 (2.5)	2.3	.025*
Education	Health Condition Factors	Stress level	5.5 (2.9)	3.4 (3.6)	2.1	.041*

Note. *Significant level at $P < .05$

Baseline Factors Influencing Participation Percentage

To examine the factors that influenced participation in the WHHIP, participation percent of the entire program and the individual component were used as continuous outcomes in regression models. The summary of factors influencing participation percent from multiple linear regression models is presented in Table 3.4. Based on the results of multiple linear regressions, stress level significantly contributed to predict average participation percent of the entire program (B = -1.34, t = -2.18, P = .035), the physical activity component participation percent (B = -2.17, t = -2.44, P = .019), and the stress component participation percent (B = -1.85, t = -2.35, P = .024) after controlling for age and gender. In addition, the variable of job satisfaction significantly contributed to predict

the education component participation percent after controlling for age and gender (B = .52, t = 2.38, *P* = .023).

Table 3.4. Multiple Regression Models of Factors Influencing Participation in the WHHIP

Outcome variable (Participation Percent)	Factors	B	SE	95% CI	β	t	*P*-value
Entire program	Stress level	-1.34	.61	-2.58, -.10	-.33	-2.18	.035*
Physical activity	Stress level	-2.17	.89	-3.96, -.37	-.36	-2.44	.019*
Stress	Stress level	-1.85	.79	-3.45, -.26	-.35	-2.35	.024*
Education	Job satisfaction	.52	.22	.08, .96	.35	2.38	.023*

Note. All models were adjusted by age and gender
Note. * Significant level at *P* < .05

Length of Engagement Differences by Baseline Factors

For the first three months of the WHHIP, there was more drop out (stopping engagement in WHHIP activities) among employees who had more than one job (Figure 3.3, log rank *P* = .023). On average, those with more than one job dropped out around two weeks sooner than those who had only one job. To be more specific, within the constraints of a 90 day period, the mean number of engagement days for participants who had two or more jobs was 65 days (95% CI: 44.86 - 85.71) as compared to the mean number of engagement days of 80 days (95% CI: 71.87 - 88.13) for those with only one job.

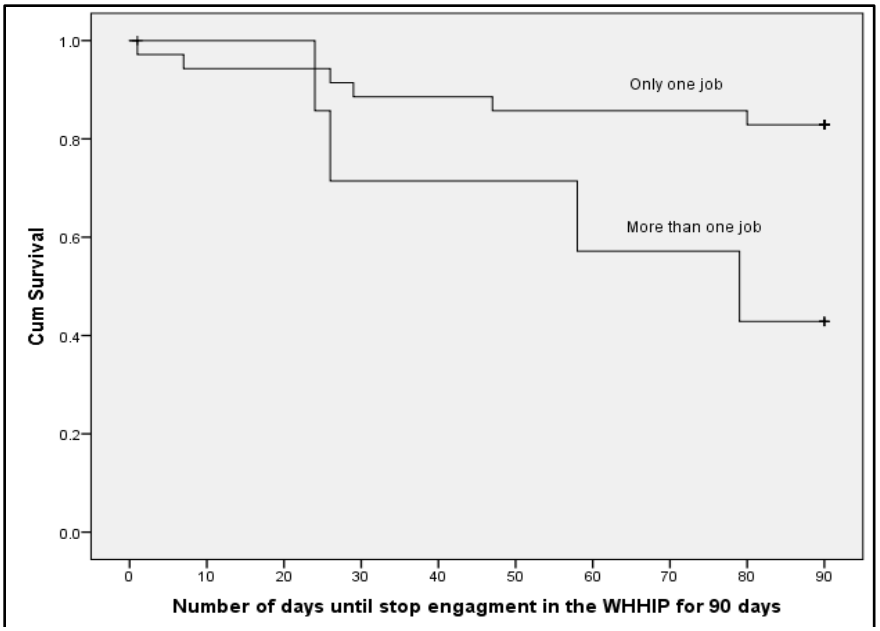

Figure 3.3. Difference WHHIP Engagement during the First Three Months (90 days) by the Presence of Second Job

Discussion

In the U.S., many worksites are offering comprehensive WHPPs to improve employees' health. However, in order for these WHPPs to have the anticipated impact on health, we need to find ways to increase participation. The current study was conducted to identify the factors that influenced participation in a physical activity, diet, and stress management WHPP among employees in long-term care settings. In addition, differences in baseline factors and lengths of engagement were explored.

Participation Percentage in the WHHIP

The average participation percentage for the first three months of the WHHIP was only 16%. These results are similar to those in a previous study.[11] As we know, it is impossible to achieve successful outcomes of WHPPs without participation from employees.[246] In order to increase participation in WHPPs, it is important to consider the needs, interests, and potential health risks of employees.[247,248] Additionally, convenient, affordable, and simple WHPPs are required to reach high participation.[249] It is also

essential to create a culture of wellness because employees should feel constant support and encouragement to make decisions for healthy living.[246,247] Therefore, future WHHPs should consider a variety of strategies that support an increase in participation.[248]

Differences in Baseline Factors between Low and High Participation Groups

This study hypothesized that there would be differences in baseline factors between low and high participation groups. From the results of this current study, participants who had low levels of stress, anxiety, or high level of job satisfaction were in the high participation groups of physical activity, diet, stress, and/or education component. These results are supported by previous studies that found stress was detrimental towards the effort of adopting and maintaining exercise behaviors.[250,251] For example, Stults-Kolehaminen and Sinha[250] reported that psychological stress predicts participants will engage in less physical activity and more sedentary behaviors. Similarly, a meta-analysis found that those who reported stress, depressive symptoms , negative affect, and anxiety participated in exercise at lower rates.[252] This current study also concluded that job satisfaction had a significant effect on participation in WHHIP. This finding is meaningful because previous studies have only focused on the effects of WHPPs on job satisfaction.[253–255]

We suggest implementing WHPPs that provide interventions that target both individual stress and job stress. This is supported by the SEM approach. Implementing a total worker health (TWH) approach that combines occupational safety and health programs designed to reduce job stress in conjunction with WHPPs designed to increase engagement in behaviors that reduce obesity is recommended.[256,257] The TWH is defined as practices, programs, and policies that incorporate protection from work-related safety

and health risks with promotion of injury and illness prevention efforts to improve workers' well-being.[258] This approach may support adherence to health behaviors that reduce obesity. Applying combined organizational level (i.e., supervisor training) and employee level interventions (i.e., education on stress coping techniques) to reduce stress may reduce obesity rates in worksites.

Factors Influencing Participation in the WHHIP

Our data suggest that participants with lower level of stress and/or higher level of job satisfaction at baseline showed higher participation in the WHHIP after controlling for age and gender. This is consistent with prior studies that found employees who experienced greater stress showed lower participation in health/wellness activities.[259–262] Similar to our findings, a prior study found that there was a positive relationship between job satisfaction and participation in WHPPs.[263]

The results of this current study are important in that it evaluated the relationship between a greater number of factors and participation in WHHPs based on a theoretical framework. The factors that were found in previous studies and the current study will play a pivotal role to develop effective WHPPs for health care workers by providing insights on factors for future researchers to target to increase participation and engagement. Healthcare workers face a variety of challenges on the job, such as high levels of stress, back pain, shift work, and long work hours.[264] This study suggests that stress, anxiety, or job satisfaction levels should be assessed constantly before and during the WHPPs. In addition, relaxation techniques such as meditation, yoga, tai chi or massage interventions can be combined with WHPPs to reduce stress and anxiety. This approach may be useful to increase participation of healthcare workers in WHPPs.

Length of Engagement Differences by Baseline Factors

This study hypothesized that there would be time differences to stop engaging in WHPPs based on baseline factors. Our findings provide preliminary evidence that participants who had a second job stopped engaging in the WHHIP sooner. This might have occurred due to employees with a second job might have mental exhaustion or musculoskeletal disorders that occurred as a result of being physically or psychologically burdened that in turn caused them to stop engaging in WHPPs sooner than their counterparts.[265]

While WHPPs bring many health benefits, they have suffered from low engagement rates.[12] A high level of engagement is an indicator of a successful program.[266] In addition, previous studies reported that sustained participant' engagement in a WHPP is important obtaining for positive results.[267,268] We recommend using incentives (e.g., gift card and T-shirts,[266,268] communication channels that allow participants to share the experience and outcomes with other empoyees,[266,268] personalized reminders,[268] and social support from co-workers, friends, family members (e.g., positive feedback and suggestions) to increase engagement in WHPPs.[268]

Application for Practice

According to Glasgow et al, most studies of WHPPs do not report participation data; however, among those that do, definitions of participation and participation percent vary dramatically.[38] To examine the participation accurately, an effort to define the meaning of participation is needed first. Although participation is a pivotal aspect of process evaluation, such participation evaluation is often ignored.[40] Since low

participation greatly diminishes the potential benefits of WHPPs, it is necessary to study the factors that potentially impede or facilitate participation.[11]

We suggest that WHPPs should combine strategies that support improving levels of stress, anxiety, or job satisfaction to increase participation rates of healthcare workers in WHPPs. Considering these suggestions fully, well-structured WHPPs will be developed to enhance employees' health and increase their participation and engagement in WHPPs.[269]

Strengths and Limitations

Previous studies have thus far primarily focused on examination of WHPPs' effectiveness on their targeted health-related behaviors and outcomes changes. However, the effectiveness of WHPPs might be influenced by participants' factors, participation, and engagement.[11] Therefore, the results of this study are meaningful to identifying the factors that influence participation of health care workers in WHPPs. Subjects of this study are health care workers who usually have shown low participation in WHPPs and had high risk of obesity and heart disease. The factors identified from this study can be used to guide future WHPPs for healthcare workers.

This study has several limitations. First, the findings of this study were limited by a small sample size that was conveniently selected from one state, which may have introduced bias and impact generalizability. Further, multiple testing increases risk of type 1 error. Second, participation was defined by days attended and did not account for participants attending multiple sessions. Some participants attended two or three sessions of physical activity or stress per day (on several occasions during the three-month intervention). Third, participation percent might be underestimated since it used number

of days the program was offered, not the number of days that participants' worked. Fourth, this study only considered short-term participation, and thus, did not allow us to examine the features of long-term participation and factors influencing long-term engagement. Fifth, this study used self-reported measures that are subject to response bias and social-desirability bias that can lead to false conclusions. Sixth, the drawback of log-rank is that it does not allow other explanatory variables to be taken into account.[270] Therefore, this study recommends conducting a Cox-regression with larger sample size to identify factors that influence the time to stop engaging in WHPPs. Further studies that account for these limitations are needed.

Conclusion

It is necessary to develop and apply WHPPs to improve employees' physical and psychological health. However, the effectiveness of WHPPs is influenced by participation; therefore, strategies that can bolster the participation should be considered when developing and applying WHPPs.[230] In addition, repeated studies are needed to identify the most important factors that influence the participation of health care workers in WHPPs.

CHAPTER 4

RELATIONSHIPS BETWEEN PARTICIPATION PERCENTAGES OF A WORKSITE HEALTH PROMOTION PROGRAM AND CHANGES IN BODY WEIGHT AND COMPOSITION FOR SIX MONTHS

Implications for Policy & Practice

- This study is important in that it addresses participation issues of healthcare workers who often have low levels of participation in WHPPs. It is necessary to evaluate unique occupational characteristics of healthcare workers, such as worktime, schedule, or job-related stress and reflect them in developing WHPPs to improve their participation.
- High participation in a WHPP leads to improve body weight and composition. In order to achieve changes in body weight and composition through using WHPPs, the factors that promote or inhibit the participation should be assessed and taken into consideration before and during implementing WHPPs on a regular basis.
- Participation patterns that include high participation in physical activity or diet intervention showed effectiveness in losing weight among overweight or obese healthcare workers. For effective weight loss, it is important to provide both physical activity and diet interventions and include strategies that increase participation in both interventions in future WHPPs.

Abstract

Purpose

The purpose was to examine the relationships between participation percentage of the Worksites Heart Health Improvement Project (WHHIP) and changes in body weight

and body composition.

Design

This study is a secondary data analysis

Setting

The WHHIP was conducted in four long-term care facilities within one east coast state in the United States.

Participants

The sample size was 30 that included 22 overweight or obese participants who are in the intervention group at six-month of the WHHIP.

Intervention

The WHHIP was conducted to reduce risk of heart disease by providing exercise, nutrition, stress management, and education interventions. Descriptive and multiple linear regression were used for analysis.

Measures

The six anthropometric outcome measures that are body weight, BMI, body fat, visceral fat, muscle mass, and waist circumference were available in the WHHIP. Independent variables included participation percentages of the WHHIP. Covariates were demographic characteristics including age, sex, race, and education level that related to the outcome variables.

Results

There were no significant relationships between participation percentages of WHHIP and changes in body weight and composition (n=30). Forty-one percent (n=9) among overweight or obese participants (n=22) achieved a five-pound weight reduction

at six months. Among overweight or obese participants, those who showed higher participation especially physical activity or diet component in the WHHIP lost more body weight than those who were not.

Conclusions

High participation in physical activity or diet interventions is a promising way to reduce five-pound body weight among overweight or obese healthcare workers. In order to identify the relationships between participation percentage and changes in body weight and composition, further research with larger sample size is needed.

Introduction

In 2017, 58.4% of the United States population aged 16 years or older was employed and spent more than one-third of their day, five days per week, at worksites.[271] Employed adults spend a considerable time of their lives at work, and the pressure and demands of work may affect their dietary intake and physical activity patterns, which may lead to overweight or obesity.[50,272] Obesity is a major health issue at worksites because of the economic impact, negative effects on work performance, other potentially serious risks, and complications.[273] Moreover, excess weight drastically increases a person's risk of developing a number of non-communicable diseases (NCDs), such as heart disease, stroke, diabetes, and cancers.[274] Workers who are overweight/obese and/or have other NCDs miss about 450 million more days of work each year than healthy workers.[275] Productivity losses from missed work cost employers $225.8 billion, or $1,685 per employee, annually.[48] Currently, workers in healthcare setting also showed higher obesity rates than average rate.[69]

For these reasons, employers provide worksites health promotion programs

(WHPPs) to address employees' health issues and reduce organizations' health-care costs. Healthcare workers have been prioritized to receive WHPPs due to having high health risks and spillover effects to their patients.[276,277] Healthcare workers face many challenges, such as high stress level, shift work, long work hours, and hostile work environments. These factors threaten their health engagement by preventing participation.[278] These factors also contributed to higher obesity rates among them.[69]

However, WHPPs suffer from low and inconsistent participation rates.[11,89,276,279] In particular, participation rates of healthcare workers are as low as 10-12%.[11] Previous studies reported that differences in participation levels may explain the large differences in effectiveness of WHPPs and success in targeted health outcomes.[11] However, little is known about the relationship between participation percentage of WHPPs at healthcare settings and changes in body weight and composition.[17]

Some WHPPs developed not for healthcare workers, showed a positive relationship between participation rate and changes in body weight and composition. To be specific, weight loss has been noted in studies with high participation in nutrition and exercise programs[280] and a weight loss program that use a diet and exercise diary.[281] Additional studies with a variety of workers identified the effectiveness of WHPPs on reduction of body weight,[282–285] body mass index (BMI),[284,286,287] body fat,[284] and waist circumference,[157] however, they did not consider effects of the participation levels. Prior studies found age,[288–291] race,[290] gender,[288–291] and education level[292] were also related to changes in body weight,[290] BMI,[289–291] body fat,[291] muscle mass,[289] and/or waist circumferences.[288,290]

As seen above, those who participated in WHPPs may be received a variety of

advantages, especially weight reduction. Prior research has demonstrated a five-pound weight reduction or more among overweight or obese adults as clinically significant.[293] The benefits included reduction of blood sugar, blood pressure, fat cells, inflammation, joint pain, liver fat, and intra-abdominal fat. In addition, a loss of five-pound can improve heart health, sleep quality, immunization, and mood.[293–298] However, five-pound weight loss through participating WHPPs is not easily achieved, thus we need to understand how to facilitate it.[164] In particular, less is known about the effectiveness of WHPPs on a five-pound reduction of body weight among overweight or obese healthcare workers. Therefore, this study focuses on identifying the relationship between participation in WHPPs and changes in body weight and composition. Moreover, this study explores the effectiveness of a WHPP on five-pound weight reduction among overweight or obese healthcare workers.

The specific aims of this study were to evaluate changes in the first six months of a WHPP in: 1) participation percent, 2) body weight and composition, and 3) examine the relationships between participation percentage and changes in body weight and composition after controlling for age, gender, race, and education level. In an additional analysis focused on those most likely to benefit from the WHPP (overweight or obese participants), we explore participation differences between those who achieved at least a five-pound weight reduction compared to those who did not.

Methods

Design

This study is a secondary data analysis using data that were obtained from participants of the Worksite Heart Health Improvement Project (WHHIP).[118] This project

was a clustered randomized controlled trial consisting of a nine-month intervention period and followed participants for 18 months. The purpose of the WHHIP was to test the efficacy of exercise, nutrition, stress management, and education interventions on reducing risk factors of heart disease among healthcare workers.[118] As described in the intervention protocol[118], the first six-month of the intervention were intensive and the remaining three-months were booster sessions to help with long-term adherence. It was conducted with 98 staff in four long-term care facilities within one east coast state in the U.S. Worksites were randomly assigned to the intervention group or to an education only group. The WHHIP was approved by an Institutional Review Board (IRB) and all participants provided consent.

Sample

The sample of this current study consisted of the 30 employees, from two sites, that were assigned to the intervention group and had completed six-month follow-up data. The initial study had 341 potential participants across the four worksites. From this population, 146 potential participants attended a meet and greet to learn about the study. Six were excluded because they were under 18 years of age (n=1), worked night shift (n=2), not employed by the facility (n=1), or pregnant (n=2). Among the 98 employees who provided written consent, 48 participants were randomly assigned to the intervention group. However, two people dropped out prior to the start of the intervention. Finally, this study used data from 30 participants at 6 months.

Measures

The outcome variables of interest were changes in body weight, BMI, body fat, muscle mass, visceral fat, and waist circumference, and participation patterns for the first

six months of the WHHIP. Changes in body weight, BMI, body fat, visceral fat, muscle mass, and waist circumference were calculated by subtracting the baseline value from the six months value. Body weight was measured with a standard scale.[118] BMI (kg/m^2) was calculated using the CDC's (2011) formula; the person's weight in kilograms (kg) is divided by their height in meters squared (m^2).[299] Body fat, visceral fat, and muscle mass were measured by the reliable and valid OMRON HBF-514 Full Body sensor.[238] Waist circumference was measured using a soft tape.[118]

The independent variables of interest were participation percentage of the entire program and the four sub-components: physical activity, diet, stress, and education. The participation percentages of physical activity, diet, stress, and education components were calculated by dividing the number of actual attending days in each component by the total number of days the component was provided for six months, and then multiplied by 100. The average participation percentage of the entire program was calculated by summing the participation percentage of each sub-component for six months and then divided by 4. Participants in each sub-component of the WHHIP (physical activity, diet, stress, and education) were categorized as having low or high participation based on the average participation percentage of each component. In addition, five-pound weight change groups among overweight or obese participants were also considered as an outcome variable in this study. The groups were categorized by the amount of weight change they experienced: those with a weight loss of five-pound or more versus those who did not have a five-pound reduction. The covariates were age (years), race (White or others [black or African-American, Asian, Native Hawaiian or other pacific islander,

native America, and more than one race]), gender (male or female), and education level (low [below high school] or high [above high school]).

Analysis

The data were analyzed with IBM SPSS Statistics version 24 for Windows (SPSS Inc., Chicago, IL, USA). Before conducting the data analysis, errors in coding, missing data, and normality were examined. Since this study used small sample size (n=30), this may cause type II error. To evaluate aim 1, appropriate descriptive statistics were conducted to explore baseline characteristics of participants and participation percentages for the entire program and all components. To evaluate aim 2, Wilcoxon Signed-Rank Tests were conducted to compare the interventions on changes in body weight and composition between baseline and six months.

To evaluate aim 3, multiple linear regressions were conducted. Before conducting multiple linear regressions, each outcome variable was regressed separately onto participation percentages of the entire program, the components of which are physical activity, diet, stress, and education and onto covariates (age, sex, race, and education level) using univariate regression analyses. From the results of univariate regressions, only factors that showed significant value below or equal to .20 were included in the multiple regression model. In order to determine the final regression model, backward elimination method was used. In the final model, factors that showed the significant value of below or equal to .05 remained.

For the exploratory analysis, Mann-Whitney U-tests and Fisher's exact tests compared the differences in participation percent and other demographic characteristics between the two weight change groups. The statistical significance for all tests was set at

p-values (two-sided) below or equal .05.

Results

Characteristics of Participants

The summary of baseline characteristics of participants is presented in Table 4.1. The majority of the participants were female, non-white, unmarried, and were not nurses (e.g., housekeeper, dietary services, concierge, manager, others). Ages varied from 22-67 years, with a median age of 44 (IQR=22). Based on BMI[299], over half of participants were obese.

Table 4.1. Demographic Characteristics of All Participants (*n*=30)

Characteristics	Category	N (%)	Median (IQR)	Mean (SD)	Range
Age (years)			44 (22.0)	41.4 (13.1)	22 - 67
Sex					
	Male	6 (20.0)			
	Female	24 (80.0)			
Race					
	White	11 (36.7)			
	Other	19 (63.3)			
Education Level					
	Low	14 (46.7)			
	High	16 (53.3)			
Marital Status [a]					
	Married	12 (40.0)			
	Non-married	17 (56.7)			
Occupational Status [a]					
	Nurse Job	9 (30.0)			
	Other	20 (66.7)			
Body weight (lb)[a]			182.4 (80.9)	196.1 (47.6)	118.4-273.4
BMI (kg/m^2)[a]			31.3 (12.1)	32.3 (7.7)	20.7-48.4
BMI (kg/m^2)[a]					
	Normal	6 (20.7)			
	Overweight	6 (20.7)			
	Obese	16 (58.6)			
Body Fat (%)[a]			43.8 (17.3)	41.0 (10.8)	20.3-57.5
Muscle Mass (%)[a]			24.8 (7.7)	26.2 (5.2)	18.8 -38.6
Visceral fat (cm)[a]			10.0 (5.0)	9.9 (4.2)	4.0-22.0
Waist circumference (inch)[a]			40.0 (12.0)	41.2 (7.2)	28.1-53.0

Note. [a]: presence of missing values

Changes in Participation Percentage for Six Months (*n*=30)

For the first six months, overall participation percentage of the WHHIP was under 20%. median participation percentages of the entire program and components of physical activity, diet, stress, and education was 14.9%, 19.4%, 8.4%, 16.8%, and 16.8%, respectively. The physical activity component and diet component showed the highest and lowest participation percentage for the first six months of the WHHIP, respectively.

Comparison of Changes in Body Weight and Composition between Baseline and Six-month

Follow-up anthropometric data on two people were missing thus this analysis used data from 28 participants. Very little body weight and composition changes occurred over the six month period. There was no statistically significant differences in body weight and composition between baseline and six months (Table 4.2).

Table 4.2. Difference of Body Weight and Composition between Baseline and Six months (*n*=28)

Variables	Wilcoxon Signed Rank Tests			
	Median		Z	P
	Baseline	6 months		
Body Weight (lb)	182.3	184.9	-1.1	.284
BMI (kg/m^2)	31.0	30.2	-1.1	.285
Body Fat (%)	43.7	43.2	-0.3	.733
Visceral Fat (%)	9.5	9.5	-1.1	.277
Muscle Mass (%)	25.1	25.1	-0.6	.516
Waist Circumference (inch)	40.1	41.1	-0.2	.866

Relationships between Participation Percentage of the WHHIP and Changes in Body Weight and Composition

Table 4.3 shows the results of relationship between participation percentages (entire program, physical activity, diet, stress, and education components) and changes in body weight and composition. Although these results are not statistically significant, those who had higher participation percentage in the entire program as well as in the

individual sub-intervention component showed more reduction in body weight, BMI, body fat, visceral fat, and waist circumference as well as increased muscle mass.

Table 4.3. Relationships between Participation Percentages and Changes in Body Weight and Composition (*n*=28)

Predictor Variables	Outcome Variables					
	Body weight	BMI	Body fat	Visceral fat	Muscle Mass	Waist Circumference
	B (sig.)	B (sig.)	B (sig.)	B (sig.)	B (sig.)	B (sig.)
Participation percent of the entire program	-.23 (P=.297)	-.04 (P=.313)	-.06 (P=.195)	-.01 (P=.414)	.03 (P=.177)	-.05 (P=.292)
Physical activity participation percent	-.16 (P=.229)	-.03 (P=.319)	-.07 (P=.127)	-.01 (P=.368)	.03 (p=.118)	-.05 (P=.214)
Diet participation percent	-.43 (P=.394)	-.07 (P=.420)	-.18 (P=.134)	-.05 (P=.238)	.09 (P=.105)	-.16 (P=.166)
Stress participation percent	-.21 (P=.228)	-.04 (p=.243)	-.06 (P=.167)	-.01 (P=.407)	.03 (p=.173)	-.05 (P=.259)
Education participation percent	-.20 (P=.402)	-.03 (P=.407)	-.04 (P=.514)	-.01 (P=.654)	.02 (p=.427)	-.02 (P=658)

Differences of Participation Percentage of the WHHIP between Five-Pound Weight Change Groups

Among 22 overweight or obese participants, nine (40.9%) participants achieved five-pound weight reduction at six months. There were no significant differences in baseline characteristics or participation percentages between the two groups (Table 4.4).

Table 4.4. Similarities of Weight Change Groups (Overweight or obese participants, *n*=22)

Variables	Category (n)	5 pound weight loss		*P*-value
		Yes (n=9, 40.9%)	No (n=13, 59.1%)	
		M (SD)	M (SD)	
Age		43.3 (12.0)	40.5 (15.9)	.601[a]
Sex N (%)	Male (N=5)	1 (11.1%)	4 (30.8%)	.360 ††
	Female (N=17)	8 (69.2%)	9 (69.2%)	
Race, N (%)	White (N=7)	2 (22.2%)	5 (38.5%)	.648 ††
	Other (N=15)	7 (77.8%)	8 (61.5%)	
Education, N (%)	Low (N=10)	6 (66.7%)	4 (30.8%)	.192 ††
	High (N=12)	3 (33.3%)	9 (69.2%)	
Participation Percent				
Entire program		19.2 (13.2)	16.6 (9.7)	.896[a]
Physical activity		25.8 (19.1)	22.0 (13.4)	.896[a]

Table 4.4. Similarities of Weight Change Groups (Overweight or obese participants, *n*=22) (continued)

Diet	9.3 (5.2)	8.1 (4.2)	.794 [a]
Stress	23.8 (17.3)	18.9 (11.9)	.601 [a]
Education	18.0 (11.9)	17.4 (10.2)	.948 [a]

Note. a: Results from Mann-Whitney U-test
††: Results from Fisher's exact tests.

Participation Patterns of Five-Pound Weight change Groups

Five patterns of participation across the sub-components were identified. The majority of the sample fell into two patterns of overall being low participants across all of the WHIPP components (pattern A, n=9, 40.9%) or being high participants in all the components (pattern E, n=10, 45.5%). Pattern B (high only for diet), Pattern C (high in diet and education) and pattern D (high in diet, education and stress) also emerged but there was only one participant in each of those patterns, respectively. While no statistical differences between five-pound weight change groups were detected (χ^2=3.2, p=.723), there were some encouraging trends.

Over half of the participants (n=5, 55.6%) in the five-pound weight reduction group showed high participation in all sub-components (pattern E), as compared to the 40% of those in the non-five weight reduction group. Those who (n=10) showed high participation in all components (pattern E) lost a median weight of 4.8lb (IQR=17.55), however, those who (n=9) showed low participation in all components (pattern A) gained 3.4lb (IQR=12.40), (p=.211). Those who had a pattern that included high participation in the physical activity or diet component (n=13) lost more than 6.4lb of body weight compared to those who did not (n=9). Participants who had a pattern that included a high participation in physical activity, diet, or stress component (n=10) lost more than 4.8lb of body weight compared to those who did not (n=12). Participants who had a pattern that

included high participation in stress or education component (n=11) lost more than 1.8lb of body weight compared to those who did not (n=11).

Discussion

This study targeted healthcare workers who usually show low participation in WHPPs to examine their participation in a WHPP and to explore effects of participation to change body weight and composition. Additionally, the most effective participation pattern on body weight reduction among overweight or obese participants was explored.

Changes in Participation Percent, Body Weight, and Composition

According to the results of this study, overall participation percentage dramatically decreased from baseline to six months. Based on results, median participation percentage of the entire program was around 15% for six months. This finding is similar to a systematic review reported that overall median participation percentage among healthcare workers in WHPPs was as low as 10-12%.[11] From this current study, the participation percentages of physical activity and diet were 19.4 and 8.4, respectively. Previous studies also found similar percentages around 21% for fitness programs[32] and 10% for weight control programs.[12] Since healthcare workers have unpredictable and complex schedules, participation in WHPPs might be lower than other workers who have regular work schedules.[118] Therefore, there is need for strategies that can increase the participation reflecting the occupational characteristics of healthcare workers.

This current study found that there were no notable changes in body weight and composition over the six months. This result was similar with a previous report. Aldana[91] evaluated dozens of WHPPs that aimed to reduce body weight and reported that it is

challenging to lose weight and maintain a healthy body weight through WHPPs because of a variety of demographic, cultural, and environmental factors. Likewise, a Research And Development (RAND) study reported that WHPPs are effective at reducing such health risks as blood pressure, glucose and cholesterol levels. However, they are not effective in supporting people losing weight.[32] Although the results of this current study were not significant, we found slight improvement in body weight and composition at six months compared to baseline. This suggests participating in WHPPs has a positive impact on changes in body weight and composition among healthcare workers.

Relationships between Participation Percentage and Changes in Body Weight and Composition

Based on the results of this underpowered study, there were not statistically significant relationships between participation in the WHHIP and changes in body weight and composition. Although it has been reported that low participation in WHPPs may greatly reduce the potential benefits of WHPPs, few studies existing studding factors that increase participation.[40] To build concrete evidence of the effect of participation levels in WHPPs on changes in body weight and composition accurately, further studies are needed that consider the participation levels as a predictor.

Participation Patterns and Body Weight Reduction

Although the results from this current study did not reach statistically significant levels, among overweight or obese participants who had higher participation percentage in the physical activity or diet component lost more weight than those who did not. For losing body weight among overweight or obese healthcare workers, we suggest combining physical activity and diet interventions and including additional strategies that encourage participation in both of these interventions in a WHPP. Due to a small sample

size, this result is not enough to conclude that the WHHIP is an effective program in losing five-pound weight for overweight or obese participants and what pattern is the most effective way to lose weight. Thus, further studies are needed to develop the most efficient WHPPs that considered effective pattern to losing weight among overweight or obese workers. This information will be useful to develop efficient WHPPs to reduce body weight with saving the money by only providing essential interventions.

Limitations

There are some limitations should be considered. Firstly, the statistical power is an issue with respect to small sample size, which may have led to a type II error. Further, subjects of this study were workers at healthcare settings in a variety of positions in two different facilities. For these reasons, the results of this study might not be generalizable. Next, this study did not consider all relevant factors for changes in body weight and composition. Lastly, the participation was defined based on authors' opinion, because there is no generalized definition. Therefore, it is necessary to establish a consistent definition of participation to measure it accurately.

Conclusion

High participation in a WHPP is an important factor to achieve improvement in body weight and composition. Although this study was unable to find a significant relationship between participation percentages and changes in body weight and composition, we found that high participation in physical activity or diet component seems a promising way to weight loss of overweight or obese healthcare workers.

CHAPTER 5

DISCUSSION, LIMITATION, CONCLUSION, FUTURE STEPS FOR NURSING, NEXT STEPS FOR RESEARCH, AND LESSON LEARNED

This chapter summarizes the major findings of the three manuscripts and consists of discussion, limitations, and conclusions of this dissertation project. Future steps for nursing, next steps for research, and lesson learned are also included in this chapter.

Discussion

This study provides evidence for diverse characteristics and effectiveness of WHPPs using mHealth interventions that aimed to change body weight and composition. In addition, features of participation in a WHPP (i.e., in the Worksite Heart Health Improvement Project, WHHIP) and significant factors driven by the SCT and the SEM that were related to participation of the WHHIP are introduced. This study highlights the importance of participation on changes in body weight and composition.

Major findings of the systematic review are categorized as: 1) targeted health behaviors, 2) types of interventions, 3) effectiveness of mHealth interventions, and 4) risk of bias. Based on the results of the systematic review, WHPPs targeted changes in nine different health-related behaviors including physical activity, diet, and/or stress management to reduce body weight or composition. All included studies targeted changes in physical activity and 7 out of 12 studies targeted changes in both physical activity and diet to reduce body weight or composition. In addition, two included studies targeted improving of physical activity, diet, and stress levels.

A lack of healthy food and physical activity is a major cause of obesity at worksites.[300–302] Job-related stress often leads to poor eating and physical inactivity,

which in turn may result in obesity.[303–305] For this reason, the importance of improvement in diet, physical activity, and stress level to achieve and maintain a healthy level of body weight and composition has been emphasized.[306–308] Prior WHPPs studies that did not use mHealth interventions, consistently comprised of interventions for increasing physical activity and diet quality.[96,302] Additionally, some WHPPs also targeted reducing stress level among employees.[99,309] This systematic review found that seven[22,24,177,179,182,184,262] and three [178,183,186] out of 12 studies used both mHealth and non-mHealth interventions and only mHeath interventions, respectively. Ten included studies showed significant effectiveness in reduction of body weight,[22,24,178–180,182–186] BMI,[178–180,182,183] body fat,[184,185] or waist circumference.[180,184–186] The most common mHealth and non-mHealth interventions were providing information and using a pedometer, respectively. Results from previous studies suggest mHeatlh is a useful approach for delivery of health-related information, including nutritional and exercise information that supports achieving and maintaining healthy weight, BMI, and waist circumference.[310–312] In addition, it was reported that those who received weight management information via mHealth interventions experienced significant changes in obesity-related health behaviors.[313,314]

The existing WHPPs tended to offer mHealth and non-mHealth interventions together rather than using mHealth interventions alone to achieve health-related outcomes. This approach may yield maximized effect by combining the advantages of both methods. However, three studies[178,183,186] that used only mHealth interventions also showed significant changes in body weight and/or composition. Although the number of studies is insufficient to conclude that using only mHealth interventions is enough to change

body weight and composition, this approach may be a promising as a standalone intervention or used to support weight loss after a face-to-face intervention.[315,316]

Based on results of this systematic review, we suggest utilizing mHealth interventions in future WHHPs that aim to change body weight and composition. However, further well-designed RCTs with minimal bias that have an intervention arm (mHealth intervention only) and control group (none or non-mHealth intervention) are needed. This will allow researchers to examine the effectiveness of mHealth interventions only in WHPPs and to know whether mHealth interventions have more effectiveness than do none or non-mHealth intervention. If the mHealth-only interventions show concrete positive impact on changes in body weight and composition, it will be useful to implement such interventions for workers who have time and location limitations that preclude attending on-site WHPPs.

Since effectiveness of WHPPs is limited by participation, this study tried to collect the data related to participation from each included study. We expected WHPPs using mHealth to have high participation percentages, because mHealth is not limited by time and location, which commonly prevents participation in WHPPs.[317–319] However, none of the studies included in the review provided participation data. Thus, we were unable to examine the levels of participation in WHPPs that used mHealth interventions in this review. For this reason, we recommend that researchers conducting WHPPs using mHealth interventions track and report on participation data. This will allow to do researchers examine whether mHealth interventions to lead to higher participation percentage than do other types of interventions in WHPPs that aim to achieve the same outcomes.

While we were unable to assess the participation levels of included studies in this review, the attrition rate of each study was examined. Attrition happens when participants drop out of a study.[320] We found seven out of 12 studies showed low attrition rates (below 20%). The attrition rates of the studies ranged from 0% to 53%. Prior reports found attrition rates of diet-focused WHPPs (mHealth and non-mHealth studies) ranged from 0% to 78%[101] and attritions rates for physical activity and diet WHPPs (mHealth and non-mHealth studies) ranged from 0% to 82%.[96] It is difficult to determine if WHPPs using mHealth interventions would lower attrition rates; however, preliminary evidence suggests mHealth intervention may reduce attrition. In addition, strategies that are already well known to decrease attrition rates, such as incentives, regular needs assessment, diverse intervention options, and communications with personalized and targeted message, also can be provided to reduce attrition rates in future studies.[105]

Since low participation results in ineffective programs, studies about what factors affect participation in WHPPs are needed. In addition, it is necessary to identify the relationships between participation and effectiveness of WHPPs. This dissertation project found low WHPP participation percentages of healthcare workers based on analysis using data from the WHHIP. To be specific, participation percentage of the entire program was as low as 16%. The physical activity (22%) and diet (6.9%) intervention components showed the highest and lowest participation percentages, respectively. These results are similar with previous studies with healthcare workers.[11,210]

Although it is widely known that participation in WHPPs is important to determine success of the programs, factors that influence participation are not well known. To fill this gap, this study also investigated the factors that significantly

influenced participation in the WHHIP. Low stress or anxiety level or high job satisfaction at baseline was significantly related to high participation percentage for the first three months of the WHHIP. Similar results have been seen in previous studies.[97,265] Also, high stress or anxiety levels can cause individuals to be less likely to engage in health behaviors such as physical activity[96] and healthy eating.[322–324] In order to increase participation in WHPPs, TWH approach, which is based on the constructs of SEM needs to be implemented. For example, companies can establish policies that provide workers more flexibility on their work schedules. In addition, education for reducing stressful working conditions can be provided to supervisors or managers. For workers, coping strategies should be offered for stress reduction.[258]

This dissertation project also investigated relationships between participation and changes in body weight and composition over the six-month period of the WHHIP. This study was unable to find significant relationships between them due to a small sample size. However, there are some promising relationships. Those who participated in physical activity, diet, stress, and education intervention components at higher rates showed slight improvements in body weight and composition. Although some previous studies were not conducted in worksite settings, they also found a positive relationship between participation and changes in body weight and composition.[325–327] In addition, prior research showed people who participated more frequently in physical activity programs showed larger reductions in body weight, BMI, and body fat.[328,329] Further, those who participated at higher rates in a 12-week weight management program that provided education and counseling sessions for dietary and behavioral modification lost more than 6kg compared to baseline.[330] Moreover, a previous study reported that those

who showed higher participation in individual counseling sessions for diet experienced successful weight loss.[331]

Based on these results, it can be concluded that higher participation in interventions that aim to reduce body weight and composition seems to have a positive result. Therefore, it is essential to increase the participation in WHPPs to obtain the maximum benefit of WHPPs. In order to get high participation, employers or developers should assess the needs of the target subjects in advance and fully reflect them to develop and apply WHPPs. Additionally, the characteristics of the profession should be considered. For example, considering WHPPs for nurses who have irregular work schedules, nurses may increase participate in WHPPs when the program is available 24 hours/7 days. Prior work has demonstrated that work environment and type of work in critical when planning WHPPs. As we know from our study, stress, anxiety, or job satisfaction has a significant impact on participation in WHPPs, so we should assess them on a regular basis and include a strategy to improve these factors in WHPPs.

Additionally, this current study found that the length of engagement in the WHHIP over three months was significantly influenced by presence of having two jobs. Those with more than one job stopped engaging in the WHHIP two weeks sooner than those who had only one job. Since less has been studied about the factors that influenced engaging in WHPPs, this result is not fully supported by existing evidence. However, we assumed that those who have two jobs might have considerable stress levels, musculoskeletal disorders, and mentally burdened. These conditions might influence to prevent participation and engagement in WHPPs. Therefore, psychosocial and work-

related aspects should be assessed continuously to increase participation and length of engagement in WHPPs.

Since WHPPs are only as effective as the proportion of employees who truly engage in the program, it is important to facilitate engagment.[332] According to a report from the CDC, WHPP engagement is defined as sustained participation in a WHPP.[333] There are some suggestions for improving employees' engagement level in WHPPs. Before implementing a WHPP, needs and interests of employees should be investigated using surveys or interviews with focus groups.[332] WHPPs that are available to be delivered in a variety of ways, such as telephone, e-mail, website, or text-messaging can increase employees' accessibility and encourage their continued engagement in WHPPs.[333] Providing programs with low cost to the employees also encourage a longer period of engagement.[334] Moreover, sharing success stories, useful resources, or encouragement messages through the communication channels is useful to increase engagement in WHPPs.[335] As we found from the systematic review, mHealth may be a promising platform to provide communication channels and deliver WHPPs in an easy way without time and location barriers to improve engagement.[336]

This study also made an effort to identify an effective participation pattern that will reduce at least five pounds of body weight among overweight or obese participants; however, a pattern was not found. Although the results were not significant, those who showed at least five-pound weight loss at six months participated in physical activity and diet components of the WHHIP at higher rates. In addition, among overweight or obese participants who had patterns that included high participation in physical activity or diet intervention showed more reduction in body weight compared to participants who had a

pattern that included low participation in physical activity or diet intervention. Similar results were also found in prior studies. For instance, other studies found that the best predictor of success in weight loss and maintenance among overweight or obese adults is their continued involvement in physical activity and diet programs.[337–340] Based on these findings, it is necessary to provide both physical activity and diet interventions in WHPPs to reduce body weight or composition of overweight or obese healthcare workers.

Even though the results of this current study did not reach statistical significance, this study played an exemplary role to address the relationships between participation percentages and changes in body weight and composition. In addition, this study endeavored to identify the most effective participation pattern for weight loss among overweight or obese participants. If such a pattern is found, WHPPs only need to provide interventions that duplicate this pattern. It can save the costs of providing many different interventions in WHPPs. Additionally, it will minimize requirements for employees to reduce weight or composition. However, strategies to increase participation rates should be applied as well to achieve this effective pattern.

Limitations

There are some limitations in this dissertation project that should be considered in any further research. First, this systematic review might not include all relevant studies due to use of limited search terms and databases. To build more concrete evidence, future studies should combine more diverse search terms and use additional databases to find more relevant literature. Since all included studies have different interventions, settings, populations and study periods, we were unable to conduct a meta-analysis to examine pooled-effectiveness, which future research should consider correcting.

Second, this study used a small sample size that was selected using convenience sampling from one state. Therefore, the results have lower statistical power and may cause a type 2 error.[341] In addition, the results from this study may have selection bias and limited generalizability of findings.[342] Third, this study only used data for three and six months for aim 2 and aim 3, respectively. These periods are relatively short to address participation and engagement in programs. In order to obtain richer findings, more studies with a larger sample size and longer duration are needed. Fourth, this study used self-reported data that may lead to a self-reporting bias, social desirability bias, and recall bias. This limitation can be minimized, when possible, by applying careful designed self-report measures or replacing self-report measures with observable measures. Fifth, we defined participation percentage based on our understanding; therefore, this definition might not be the same way to use in other studies. However, our definition might contribute to new perspective to define participation because there is no generalized definition of participation in research on WHPPs.

Conclusions

Using mHealth interventions in WHPPs may be a useful way to reduce body weight and composition. mHealth interventions have a capability can be adopted in a variety of worksites and are useful to change in diverse health-related behaviors and outcomes. Features of mHealth that are not limited by time and location may help to reach high participation in WHPPs. Based on the results of this study, employees' psychological, work-environmental, and health aspects should be considered to achieve high participation percentages in WHPPs.

From the analysis of this study, there are no significant relationships between participation percentages and changes in body weight and composition. However, we found participating in both physical activity and diet at high rates is promising as a way to reduce body weight and composition. We emphasize the need of further studies with larger sample size and longer duration to determine 1) significant factors that influence participation, 2) the relationship between participation and changes in health outcomes, and 3) useful participation pattern that most supports achieving expected health outcomes. This information will play a pivotal role to develop cost-effective and efficient WHPPs. In addition, we strongly recommend using of mHealth in WHPPs to increase likelihood of achieving goals of WHPPs.

Future Steps for Nursing

According to a report, 55 percent of 2,103 female nurses were obese.[343] Moreover, they reported high levels of job stress, irregular work hours, a lack of sleep, and low sleep quality as contributing factors of obesity. Nurses' overweight and obesity affect not only their health but the quality of patient care.[344] In addition, nurses who exhibit healthy diet and lifestyle practice may serve as role models and positively impact patients.[345] Therefore, nurses need to understand the importance of taking care of themselves before caring for patients.[346]

For nurses or health care providers, WHPPs that reduce high job-related stress and are readily available 24 hours a day are urgently needed to increase participation and effectiveness.[347] Based on our findings, we suggest using mHealth interventions that are not limited by time and locations to provide support when considering their irregular work schedule. mHealth is accessible 24 hours and can provide education sessions,

physical activity, and diet programs, simultaneously. This approach may their participation in WHPPs and improve effectiveness of WHPPs. In order to increase participation in WHPPs, continuous assessment of psychosocial aspects (e.g., stress, anxiety) and work-environment reforms are also needed. Since healthcare workers including nurses know best about the programs that are most needed and appropriate for them, they should be involved in the process of developing the WHPPs.

Next Steps for Research

There are several recommendations for future research. First, as shown by the literature review, using mHealth interventions in WHPPs seems a promising way to improve in body weight and composition; however, there is a lack of research in this area. To confirm the effectiveness of WHPPs using mHealth interventions in body weight and composition changes, we recommend conducting meta-analysis in the further research. Thus, repetitive RCTs with minimal bias that are conducted with the same interventions, populations, settings, and durations with this topic are needed. Second, studies that use the same definition of participation are needed to build the knowledge of participation in WHPPs. Third, larger and longer RCTs are needed to identify the relationships between participation in WHPPs using mHealth interventions and effectiveness to make changes in body weight and composition. Fourth, future research that aim to identify the effective participation pattern in WHPPs for reducing body weight and composition of healthcare workers is needed. This pattern may support participants to get benefits from WHPPs with the least waste of time and effort. Therefore, identifying the pattern is necessary in developing cost-effective and efficient WHPPs that provide essential interventions only.

Lessons Learned

mHealth interventions seem to be implemented successfully in WHPPs to achieve reduction of body weight and composition. However, mHealth interventions have often been utilized with non-mHealth interventions in WHPPs. This approach makes it difficult to identify the effectiveness of mHealth interventions alone; however, it can be assumed that this combined way seems to play a role of complementing the weaknesses of each other and reinforcing the effect of interventions. If we find benefits of interventions that only used mHealth interventions, WHPPs can be developed with only mHealth interventions for workers who have time and location limitations to attend on-site WHPPs. We found that using mHealth interventions in WHPPs may provide benefits for lower attrition rates. In addition, it was identified that combining mHealth interventions with other types of interventions in WHPPs yield booster benefits while complementing the weaknesses of each other.

Employees' psychosocial aspects, such as stress, anxiety, and job satisfaction, are important to determine their participation in WHPPs. Therefore, these factors should be assessed regularly before and during implementation of WHPPs to increase participation and effectiveness. In addition, providing incentives, communication channels, or tailored feedback as revealed in previous studies, will also play a positive role in increasing participation in WHPPs.

APPENDIX A

Combination of Search Terms

Best matches for (((employee*[tw] OR workplace[tw] OR worksite*[tw] OR job[tw] OR wellness program*[tw] OR “Workplace”[mesh])) AND (mobile app[tw] OR mobile apps[tw] OR mobile application*[tw] OR mobile device*[tw] OR mobile technolog*[tw] OR mobile health[tw] OR mhealth[tw] OR ehealth[tw] OR smartphone*[tw] OR cell phone*[tw] OR mobile phone*[tw] OR text messag*[tw] OR “Mobile Applications”[mesh] OR “Smartphone”[mesh] OR “Cell Phone”[mesh] OR “Text Messaging”[mesh])) AND ("Body weight" OR "weight" OR BMI[tw] OR body mass index[tw] OR body composition[tw] OR body fat[tw] OR muscle*[tw] OR “Body Mass Index”[tw] OR “Body Constitution”[mesh] OR “Body Fat Distribution”[mesh] OR “Muscles”[mesh]):

APPENDIX B
Characteristics of Included Studies

Appendix Table B.1. Characteristics of Included Studies (N=12)

N	First Author	Location/ Year	Study design/ Duration	Participants (Characteristics, N, age)	Attrition rate	Target Outcomes (Time to measure)
1	Aalbers, T,[183]	Netherlands/ 2016	Quasi experimental research design (Pre-post design) /12 months	- Employees of Dutch medium to large companies - N=2972 - Mean age: 51.8 (SD 12.9)	1. Goal setters: 50.99% 2. Non-goal setters: 53.71%	- Body weight (kg) (12 months) - BMI (kg/m^2) (12 months)
2	Balk-Moller, NC,[185]	Denmark /2017	Randomized Controlled Trial /38weeks	- 566 Employees from 20 different nursing homes in 6 municipalities. - Intervention (N=355) - Control (N=211) - Total 20 nursing homes (12 Intervention and 8 control)	1. 16 weeks : -Intervention group : 36.06% -Control group: 32.70% 2. 38 weeks : -Intervention group: 30.33% -Control group: 44.55%	- Body weight (16 & 38 weeks) - Body fat percentage (16 &38 weeks)
3	Buchholz,SW,[177]	United States /2016	Quasi-experimental research (Pre-post design) /3 months	- Participants in food service company site located in Chicago Illinois. -Total N=33	0%	-BMI (kg/m^2) (3 months)
4	Ganesan,AN,[22]	United States / 2016	Quasi-experimental research (Pre-post design) /100 days	- Participants of Stepathlon program were adult employees of private and public sector organizations located in Asia, Europe, Africa, North America, South America, Australia, and New Zealand. - Total N=62,219	47.0%	- Body weight (100 days)
5	Kim, JY,[184]	Republic of Korea /2015	Unblinded, randomized controlled trial with a 1:1: match of the intervention group to the comparison group /6 months	- Participants were recruited from 3 public institutions (Korea Gas Corporation, Korea District Heating Corporation, and	6-months -Total N=122 (37.76%) - Intervention group: N=63 (38.0%) - Control group: N= 59 (38.0%)	- Body weight (1, 3, and 6 months) - Percent body fat (1, 3, and 6 months)

Appendix Table B.1. Characteristics of Included Studies (N=12) (continued)

				Korea Expressway Corporation) - Total N=196		
6	Kouwenhoven-Pasmooij, TA,[181]	Netherlands /2017	Quasi-experimental research (Pre-post design) /23weeks	- Participants were employees of Erasmus MC, University of Medical Center in Rotterdam - Total N: 52 - Mean Age: 48.1 years	0.02%	- BMI (kg/m^2) (23 weeks)
7	Kouwenhoven-Psasmooi, TA,[182]	Netherlands /2018	Cluster-randomized controlled trial /12 months	- Participants were recruited from military (9 clusters), the police force (3 clusters), and an academic hospital (5 clusters) - Total N: 491 - Mean age: 50.8 years	12 months - Total: 1.43% - Limited intervention group: 1.84% - Extensive intervention group :1.09%	- Body weight (12 months) - BMI (kg/m^2) (12 months)
8	Limaye, T,[186]	India /2016	Randomized Controlled Trial /12 months	- Participants were recruited from information technology (IT) industry - Total N=265 - Mean age (36.2±8.0 years)	1. 3 months: -Intervention: 19% - Control: 27% 2. 6 months - Intervention: 28% - Control: 23% 3.9 months: - Intervention: 24% - Control : 34% 4. 12 months Intervention: 21% 3) Control: 26%	- Body weight (6 & 12 months)
9	Senecal, C,[178]	United States /2018	Quasi-experimental research (Pre-post design) /12 months	81 employers in 42 states encompassing 30,974 employees in a variety of occupations	Participants logged into the application at least once (1622/3300, 49%)	- BMI (kg/m^2) (12 months)
10	Tucker, S,[179]	United States /2016	Quasi-experimental research (Repeated measures design) /6months	- Participants from outpatient cancer chemotherapy infusion clinic	6 months -Early texting group :22.22% -Late texting group:7.14%	- Fat mass (3 & 6 months) - Lean mass (3 & 6 months)

Appendix Table B.1. Characteristics of Included Studies (N=12) (continued)

				and a medicine specially clinic at an academic medical center - Total N=42 - Mean age: Early texting group (43.0±12,4) and Delayed texting group (42.2±12.0)		- Percentage fat (3 & 6 months) - BMI (kg/m^2) (3 & 6 months) - Weight change (3 & 6 months)
11	Kim, CJ,[24]	Republic of Korea /2015	Quasi-experimental research (Pre-posttest parallel group design) /14 weeks	- Participants from a health care center at a large university hospital, South Korea. - Total N=61 - Mean age: 39.63 (SD 7.31)	14 weeks -BEST group :17.28% - Education group: 25%	- Body Weight (14 weeks) -Visceral Fat Mass (VFM) (14 weeks)
12	Wilson, MG,[180]	United States /2017	Quasi-experimental research (Non-randomized design with a matched group) /9 months	- Participants were recruited from Iron Mountain Inc. US based (if covered on Iron Mountains' health plans) - Total N=829 - Mean ages: no Report	1.16weeks :5.8% 2.12months :17.4%	- Body weight (9 months) - Body Mass Index (9 months)

Appendix Table B.1. Characteristics of Included Studies (N=12) (continued)

N	First Author	Intervention tool/ Intervention contents/ Control tool	Health behaviors	Findings	Strengths	Limitations
1	Aalbers, T,[183]	1. Intervention: Self-motivated eHealth intervention (Brain Aging Monitor; BAM; Internet-based tool for self-monitoring cognitive functioning	Increasing cognitive functioning	-Difference of body weight between baseline and 12 months : -0.62 kg (p=.03) -Difference of BMI between baseline and 12 months : -0.20 (p=.03)	1. Intervention can reach and support the participants who score sub-optimally. 2. Multimodal intervention 3. BAM uses a novel motivation for healthy living (e.g. self-monitoring of cognition with games).	1. High dropout rate of about 50% 2. Non-randomized study (selection bias) 3. Self-reported weight and BMI (outcome variables) 4. No participation

Appendix Table B.1. Characteristics of Included Studies (N=12) (continued)

		using applied games.) 2. Intervention Contents: - Set goal - Positive reinforcement - Practical tips and tricks - Short-term monitoring system - Reminder emails (weekly) 3. Control: N/A				information reported
2	Balk-Moller, NC,[185]	1. Intervention: SoSu life tool (web and app based tool) 2. Intervention Contents: - Self-reporting of diet and exercise - Personalized feedback, suggestions for activities and programs - Practical tips and tricks - Weekly assignment - Colleague challenges and team competition 3. Control: N/A	Self - monitoring for diet and exercise	-Difference of body weight, fat between Baseline and 16 weeks - Body weight: -1.54kg (P<.001) - Body fat percentage: -0.81% (p=.003) -Difference of body weight and fat between baseline and 38 weeks -Body weight : - 1.01 kg (p=.03) -Body fat percentage: -0.78% (p=.03)	Incorporating social feature contents	1. Short-term effects 2.did not consider mobile health literacy 3. No participation information reported 4. Difficult to distinguish the effectiveness of mobile components effectiveness alone due to using composite (mobile and non mobile) intervention
3	Buchholz,SW,[177]	1. Intervention: Text4Walking 2. Intervention Contents: -Text messaging to deliver physical activity text messages and to receive step	Physical activity - Daily steps - Intensity of their walking	- Difference of BMI between baseline and 3 months - Pre (baseline): 29.29 ,SD 6.43 -Post (12weeks): 29.08, SD 6.66, *p*=.142	1. Treatment fidelity assessed-increased steps 2. Individualized input into delivery of the text messages.	1. Non-randomized study (selection bias) 2. Small sample size 3. Two different physical activity monitors were used at baseline and follow up 4. No participation

Appendix Table B.1. Characteristics of Included Studies (N=12) (continued)

		counts from participants -Motivational calls (5-10 minutes on weeks 2,6, and 10) 3.Control group: N/A				information reported 5. Difficult to distinguish the effectiveness of mobile components effectiveness alone due to using composite (mobile and non mobile) intervention
4	Ganesan,AN,[22]	1.Intervention: Mobile health life-style program (Stepathlon) 2. Intervention Contents: - Step Counts - Enter daily using Pedometer activity. - Personalized tools for self-monitoring - Personalized logs of exercise, physical activity, and dietary intake - E-mails: information of physical activity and nutrition - Updated content with papers on nutrition and life-style - Online community 3. Control: N/A	1. Step count 2. Exercise days and exercise duration 3. Sitting duration	- Difference of body weight between baseline and 100 days after intervention: -1.45kg ($p<.0001$)	1. Use a large and highly heterogeneous participant population 2. Analysis of a large-scale multinational intervention. 3. Demonstration of the capacity for mHealth to provide an opportunity for low-cost development and innovation to occur in private sector of low and middle-income countries settings.	1. Short term follow up 2. Non-randomized study (selection bias) 3. Reliance on self-reported outcome measures 4. No participation information reported 5. Difficult to distinguish the effectiveness of mobile components effectiveness alone due to using composite (mobile and non mobile) intervention
5	Kim, JY,[184]	1. Intervention: text message based application 2.Intervention Contents:	1.Dietary intake 2. Physical activity	- Difference of body weight and body fat between baseline and 1 month (between 2 groups)	1. RCT 3. Attempt to use tailored text messages	1. Randomization within organization which have led to contamination

Appendix Table B.1. Characteristics of Included Studies (N=12) (continued)

		- Personally tailored to participants' lifestyles, eating pattern with behaviors, and metabolic risk factors - Motivation, nutritional tips, helpful recipes - Exercise tips - Goal setting and behavior change - Education and tips for nutrition - Exercise and get more active : 3 times/ week 3. Control: Not receiving automatic tailored text messages		-Body weight: -1.07kg (p=0.01) - Body fat: -1.09 (p=.16) - Difference of body weight and body fat between baseline and 3 months (between 2 groups) -Body weight: -0.18kg (p=.85) -Body fat: -0.19 (p=.80) - Difference of body weight and body fat between baseline and 6 months (between 2 groups) -Body weight : -0.15kg (p=.78) -Body fat: -0.28 (p=.60)		between 2 groups. 2. Only obese male participants 3. No participation information reported 4. Difficult to distinguish the effectiveness of mobile components effectiveness alone due to using composite (mobile and non mobile) intervention
6	Kouwenhoven-Pasmooij, TA,[181]	1. Intervention : A combination of eHealth and non-eHealth 2. Intervention Contents: - Non-eHealth: face to face individual session with physician and 5 group session - eHealth: 20-week movement web-based movement game using accelerometer. - Upload the accelerometer data into the web-based movement	Physical activity	- Difference of BMI between baseline and 23 weeks: -1.87kg/m^2 (p>.005)	1. Unique intervention combined eHealth and non-eHealth components 2. Targeting a high-risk population 3. Easily adapted to other target group	1. Small sample size 2. Non-randomized study (selection bias) 3. Only included physical activity 4. Short follow-up time 5. No participation information reported 6. Difficult to distinguish the effectiveness of mobile components effectiveness alone due to using composite (mobile and non mobile) intervention

Appendix Table B.1. Characteristics of Included Studies (N=12) (continued)

		game 3. Control: N/A				
7	Kouwenhoven-Psasmooi, TA,[182]	1. Intervention: "PerfectFit" 2. Intervention Contents: - A web-based Health Risk Assessment (HRA) - Tailored and personalized feedback based on the participants' risk profile. - Suggestions for health promotion activities available within each organization. - Electronic newsletter (information on the intervention) - E-mail: information on a healthy lifestyle (every 2 to 3months) - Seven individual coaching sessions (3 face to face and 4 by telephone) - More personalized suggestions for health promotion activities. - An additional motivational paragraph in the news paper. 3. Control: Received health risk	1. Education 2. Information 3. Suggestions	- Difference of body weight between two groups after 12 months : - 2.16 kg (p>.005) - Difference of BMI between two groups after 12 month: -0.81 (p>.005)	1. long-term follow-up 2. Multi-centered approach	1. Lacks a third arm that is non-intervention group 2. No participation information reported 3. Difficult to distinguish the effectiveness of mobile components effectiveness alone due to using composite (mobile and non mobile) intervention

Appendix Table B.1. Characteristics of Included Studies (N=12) (continued)

		assessment with advice				
8	Limaye, T,[186]	1. Intervention: virtual assistance-based lifestyle intervention 2. Intervention Contents: - Mobile phone and E-mail - Received information on lifestyle modification through mobile phone messages and e-mails for 1 year - Additional support through a website and Facebook page - Of a total of 150 mobile phone messages and 100 e-mails sent, one-tenth requested a reply. 3. Control: N/A	Provide information on lifestyle modification	- Difference of body weight between baseline and 6 months: - Intervention group: -1.1kg - control group :- 0.5kg ,p<.0001 - No significant weight reduction between two groups at 12 months.	1. Non-invasive nature of the intervention 2. Ease of administration of intervention	1. Only targeted the body weight change as an outcome variable 2. No participation information reported
9	Senecal, C,[178]	1. Intervention: Digital Health Intervention (a desktop and smartphone-based portal) 2. Intervention Contents: - Upload baseline data and additional data - Provide individualized care plans based on medical comorbidities	1. Educational materials 2. Concrete health improvement tasks while tracking and logging user data.	- Difference of BMI between two groups at 12 months - Users: -0.40 kg/m^2 - non-Users: -0.17 kg/m^2, p=.0429	This intervention can apply general population regardless of gender	1. No randomization (Selection bias) 2. No participation information reported 3. Intervention did not include physical activity tracking function

Appendix Table B.1. Characteristics of Included Studies (N=12) (continued)

		including health status information tasks, targets, and plans. 3. Control: N/A				
10	Tucker, S,[179]	1. - Intervention (1) : early texting (months 1-3) - Intervention (2): delayed texting group (months 4-6) 2.Intervention Contents: All participants were received combined intervention of - Non-exercise activity thermogenesis - Low intensity light purposeful with physical activity (PA) (workstation treadmill, WellMe in 3™ video clip, and stair climbing and walking meeting. 3..Control: N/A	1. Non-exercise activity thermogenesis 2. PA 3. Text message	-Difference of BMI, body fat, total fat mass, and total lean mass between baseline and 3 months (early texting group) -BMI: -0.4kg/m^2 (p=.01) -Body fat: -0.3% (p=.87) -Total fat mass: -0.6kg (p=.21) - Total lean mass: -0.1kg (p<.01) -Difference of BMI, body fat, total fat mass, and total lean mass between baseline and 6 months (early texting group) -BMI: -0.6kg/m^2 (p<.01) -Body fat: +0.2% -Total fat mass:-0.7kg (p=.21) -Total lean mass: -0.7kg (p<.01)	Menu intervention options allow for variety and individual preferences throughout the work day	1. Small sample size 2. Non-randomized study (selection bias) 2. No participation information reported 3. Difficult to distinguish the effectiveness of mobile components effectiveness alone due to using composite (mobile and non mobile) intervention
11	Kim, CJ,[24]	1. Intervention : Multi-component Web-based intervention 2. Intervention Contents: - Physical activity - Weight control - Personal counseling - Short mobile text message	Physical activity	-Difference of body weight of two groups between baseline and 14 weeks: - Best group: -2.23kg - Education group: -0.10kg, p=.019 -Difference of VFM of two groups between baseline and 14 weeks:	1.Developed tool is effective in reducing the levels of cardio-metabolic risk factors 2. Identification of decreased central obesity/abdominal fat mass was associated with reduced Cardio vascular disease risks.	1. Non-randomized pilot study 2. Small sample size 3. Recruitment from one single setting 4. Report on completers only may result in an overestimation of the intervention effect

Appendix Table B.1. Characteristics of Included Studies (N=12) (continued)

		-Received in-person education - Ten to thirty minutes of individual internet based online counseling (each week) - Download individual stage matched weekly goals and strategies - Submit weekly diaries - Provided short tailored text messages 3. Control: education group -Provided a booklet containing basic education advice on standard care -Monthly text messages about the standard care		- Best group: -5.99cm - Education group -1.91cm, p=.043		5. High attrition rate 6. No participation information reported 7. Difficult to distinguish the effectiveness of mobile components effectiveness alone due to using composite (mobile and non mobile) intervention
12	Wilson, MG,[180]	1. Intervention: Omada Health Program ® 2. Intervention Contents: - Small group support - Trained coach - Weekly behavior change curriculum - Various online tools, mobile tools, and wireless devices to track eating patterns, physical	1. Physical activity 2. Dietary in take	-31% of intervention group participants lost at least 5% of their starting body weight compared with 20% of controls (adjusting for age, sex, and baseline weight, p=.001) - 22% of intervention participants dropped one or more BMI category compared with 15% of matched controls (adjusting for	1. Large sample size 2. Intervention provided high flexibility (e.g.,no scheduling issues)	1. Non-randomized study (selection bias) 2. During study period, there was another wellness program 3. Study samples self selected into the digital health program 4. No participation information reported 5. Difficult to distinguish the effectiveness of mobile

Appendix Table B.1. Characteristics of Included Studies (N=12) (continued)

		activity, and body weight 3. Control: Trained coach		age, sex, and baseline BMI) (p=0.001)		components effectiveness alone due to using composite (mobile and non mobile) intervention

Appendix C
Summary of Measures

Appendix Table C.1. Measure for AIM 2

Variable	Score Range	Measurement scale	Description
Participation Percentage	0 %-100 %	Continuous	Actual attending days divided by the total number of program days
Participation Percentage		Categorical 0 (Ref): low 1 :High	1) Low participation rate group (0) : below average of participation rate 2) High participation rate group (1): same or high average of participation rate
Time (days)		Continuous	Time to stop engaging in the WHHIP

Appendix Table C.2. Outcome Measure for AIM 3

Variables	Measurement Scale	Coding	Description
Body weight (lb)	Continuous		Reading obtained using a Standard Scale
Body Mass Index (BMI)	Continuous		1) BMI was calculated using the CDC's (2011) formula: BMI=kg/ m^2 (where kg is a person's weight in kilograms and m^2 is their height in meters squared)
Body composition (Muscle/Fat)	Continuous	1. Ideal Body Muscle Mass 1) Male: 33% - 40% 2) Female: 24% -30% 2. Ideal Body Fat 1) Male: 11% - 14% 2) Female: 16% - 23% 3. Visceral fat: 0-12	1) OMRON HBF-514 Full Body Sensor, Body Composition Monitor and Scale 2) Eight-electrode BIA to measure body fat, skeletal muscle, and visceral fat. BIA has been shown to produce body composition results that are highly correlated dual energy X-ray absorptiometry (r=.88)[238]
Time	Continuous		Time to 5% reduction of original body weight (number of months)

Appendix Table C.3. Intrapersonal Factors

Variables	Measurement Scale	Coding	Description
Age	Continuous		Years
Race	Categorical	0 (Ref): White 1 : Others	**1) Categories:** White (0), Black or African-American(1), Asian(1), Native Hawaiian or Other pacific Islander (1), Native American (1), More than one race (1)
Gender	Categorical	0 (Ref): Male 1: Female	**1) Categories:** Male and Female
Marital Status	Categorical	0 (Ref): Married 1: Non-married	**1) Categories:** Married (0), Cohabitating (0), Single (1), Divorced (1), Separated (1), and, Widowed (1)
Educational Level	Categorical	0 (Ref): Low Education 1: High Education	**1) Categories:** No schooling (0), Elementary school (0), Some High school (0), High school Graduate(0), Trade School (0), Some college (1), College Graduate (1), Post-college (1)
Cardiovascular disease knowledge level	Continuous		**1) Design**: 6-item questionnaire **2) Scale:** 0-3 (higher score indicates higher receipt)
Second Job	Categorical	0 (Ref) :No 1: Yes	**1) Question:** "Do you have a second job?" **2) Answer:** 1) Yes 2) No
Exercise motivation:	Continuous	In this analysis, the subscales of ill health avoidance, positive health, and weight management will be used.[348]	**1) Design:** 51-item EMI-2 assesses 15 types of motivation that are stress management, revitalization, enjoyment, challenge, social recognition, affiliation, health pressures, ill-health avoidance, positive health, weight management, appearance, strength/endurance, and nimbleness. **2) Scale:** six-point Likert scale, ranging from 0 ("not at all true for me") to 5 ("very true for me"). Scores of each subscale are calculated by taking the mean of 3 or 4 appropriate items based on the scoring key by creator of EMI-2. **3) Validity and Reliability:** The factorial validity and invariance of factor structure across gender were tested using confirmatory factor analytic procedures. The EMI-2 has

Appendix Table C.3. Intrapersonal Factors (continued)

			found to discriminate between individuals at different stage in the stage of change for exercise.[230,231]

Appendix Table C.4. Health Condition Factors

Variables	Measurement Scale	Coding	Description and psychometric evidence
Back Pain	Categorical	0 (Ref) : No 1: Yes	**1) Question:** "How often in the past week, did you have back symptom? **2) Answer options:** Never(0), Rarely (0), Sometimes (1), Often or continuously (1),
Mood	Continuous	One composite score will be used in the analysis	**1) Design:** The short version of the Depression, Anxiety, Stress Scale (DASS-S) was used to measure the three scales of depression, anxiety, and stress over the past week. Each scale contains 7 items. This instrument comprises three domains; (1) the Depression subscale which measures hopelessness, low self-esteem, and low positive effect; (2) the Anxiety scale which measures autonomic arousal, muscle-skeletal symptoms, situational anxiety, and subjective experience of anxious arousal; and (3) the Stress scale which assesses tension, agitation, and negative affects.[349] **2) Scale:** Each item on a 4-point Likert scale, ranging from 0 (Did not apply to me at all) to 3 (Applied to me very much or most of the time).[350] Higher score means greater depression, anxiety, and stress level. **3) Validity and Reliability**: Appropriate reliability, with Cronbach's alpha values between 0.82 (Anxiety), 0.88 (Depression), 0.90, and 0.93 for the total scale.[351] This tool has shown good convergent and discriminant validity.[233]
Sleep Quality	Categorical	0 (Ref): Bad 1: Good	**1) Question:** Sleep quality over the past month, was assessed using an item: 1) "During the past month, how would you rate your sleep quality overall?" (Modified Pittsburgh Sleep Quality Index) **2) Scale:** 2_1) Sleep quality: very bad (0), fairly bad (0), fairly good (1), very good (1).
Sleep Amount	Continuous		**1) Question:** During the past month, how many hours of actual sleep did you get at

Appendix Table C.4. Health Condition Factors (continued)

			night?" (Modified Pittsburgh Sleep Quality Index) **2) Scale:** hours

Appendix Table C.5. Anthropometric Factors

Variables	Measurement Scale	Measures	Description of measures	Description and psychometric evidence
Body Weight (pounds)	Continuous	Standard scale		
BMI (kg/m^2) (lower)	Continuous	The formula for BMI (kg/m^2) is weight in kilograms (kg) divided by height in meters squared (m^2)[236]		
Waist Circumference (inch)	Continuous	Soft tape		
Body Fat (%) (lower)	Continuous	OMRON HBF-514 full body Sensor Body Composition Monitor and Scale[237]	Eight-electrode BIA to measure body fat and muscle mass	BIA has been shown to produce body composition results that are highly correlated to dual energy X-ray absorptiometry (DEXA) and magnetic resonance imaging [118,238]
Muscle Mass (%) (higher)	Continuous			

Appendix Table C.6. Work Environmental Factors

Variables	Measurement Scale	Coding	Description and psychometric evidence
Job Title	Categorical	0 (Ref: Other) 1 (Nursing)	-**Answer options:** Housekeeper (0), Dietary services (0), Concierge (0), Manager (0), Other (0), Research Assistant (1), Nurse (1)
Break Time	Continuous		Break time in a day (min)
Over Work	Categorical	0 (Ref) 1	-**Question:** Do you ever work longer than your scheduled shift at this facility? -**Answer options:** Never (0), Very rarely (0), Rarely (0), Occasionally (1), Frequently (1), Very frequently (1)

Appendix Table C.6. Work Environmental Factors (continued)

Work Hours	Categorical	0 (Ref) 1	-**Answer options:** 8 (0), 10 (1), 12 (1), other (1)
Work Shift	Categorical	0 (Ref) 1	-**Answer options:** Day (0), Evening (1), Rotating Shift (1)
Job Satisfaction	Continuous	0-64 (higher)	**1) Design:** Modified job attitude scale (JAS).[352] 16-item measure that covers five domains of job satisfaction (pay, interaction/organizational factors, task requirements, job status, and autonomy). In this analysis, the composite score will be used. **2) Scale:** Five-point Likert response scale ("strongly disagree to "strongly agree"). **3) Validity and Reliability:** Construct validity was demonstrated using a Rasch measurement model. Estimates of internal consistency were performed using Cronbach's alpha (>.70). This tool was demonstrated as a reliable and valid tool. [240]
Tenure at facility	Continuous		Number of months since started working at the particular facility.

Appendix Table C.7. Self-Efficacy Factors

Variables	Measurement Scale	Score Range	Description and psychometric evidence
Exercise self-efficacy	Continuous	0-800 (higher)	**1) Design:** 8-item scale designed to assess the respondents' efficacy for participation in prescribed exercise regimens over incremental periods. **2) Scale:** 0% (not at all confident) - 100% (always true) **3) Validity and Reliability:** Appropriate internal consistency and construct validity was demonstrated.[353]
Barriers self-efficacy	Continuous	0-1,300 (higher)	**1) Design:** 13-item scale measure that perceived ability to exercise when presented with barriers such as bad weather, lack of interest, schedule conflicts, etc. **2) Scale:** 0% (not at all confident) - 100% (highly confident) **3) Validity and Reliability:** Prior use provided evidence of internal consistency and construct validity with significant correlations with exercise.[354]

Appendix Table C.7. Self-Efficacy Factors (continued)

Outcome expectations for exercise	Continuous	13-65 (higher)	**1) Design:** 13-item assessed perceived positive and negative consequences of exercise. **2) Scale:** 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) **3) Validity and Reliability:** Appropriate internal consistency and validity with confirmatory factor analysis, Rasch analysis, and test criterion relationships from previous studies.[232,243,355]
Self-efficacy for health related diet	Continuous	0-20 (higher)	**1) Design:** 20-item includes five subscales: 1) resisting relapse, reducing calories, reducing salt, reducing fat, and behavior skills. **2) Scale:** Yes or No **3) Validity and Reliability:** internal consistency and validity of this tool was demonstrated.[243]
Outcome expectation for Diet	Continuous	0-10 (higher)	**1) Design:** the single-item diet outcome expectations measures outcome expectations for heart healthy diet. **2) Scale:** Higher value means higher outcome expectation **3) Validity and Reliability:** Demonstrated as a reliable and valid tool,[244] and has shown significant correlations with self-efficacy expectations and repeatability over time.[356]

Appendix Table C.8. Inter-personal Factors

Variable	Measurement Scale	Score Range	Description and psychometric evidence
Social Support (Boss)	Continuous	0-10	**1) Design:** 10-item dichotomous measure Social support for Exercise Scale was used to assess social support for health behaviors from family, friends, healthcare providers or supervisors. The measure was revised to include items particularly relevant to heart healthy behaviors, such as exercise, eating a heart friendly diet, and stress management, and support received from supervisors.[357] In
Social Support (Staff)			

Appendix Table C.8. Inter-personal Factors (continued)

Social Support (Family) Social Support (Friend)			this study, each subscale will be used, separately. **2) Scale:** Score ranged from 0 to 10. A total score is calculated to reflect overall social support for healthy behaviors from supervisors. The higher score indicates the stronger social support for healthy behaviors **3) Validity and Reliability**: Internal consistency and construct validity was demonstrated.[245]

Appendix D.

Multiple Regression Results

Appendix Table D.1. Multiple Regression Final Model_1

Outcome variable	Variables	Model 1		Model 2		Model 3	
Average participation percentage across of all programs		B	95% CI	B	95% CI	B	95% CI
	Age	.01	-.33, .35	.03	-.30, .36	-.01	-.32, .32
	Gender	-10.12	-22.10, 1.86	-9.84	-21.49, 1.82	-10.09	-21.48, 1.30
	Stress level	-.86	-2.34, .62	-.98	-2.38, .42	-1.34	-2.58, -.10
	Job satisfaction	.31	-.27, .90	.34	-.22, .91		
	Barriers self-efficacy of physical activity	.004	-.01, .02				

Appendix Table D.2. Multiple Regression Final Model_2

Outcome variable	Variables	Model 1		Model 2		Model 3		Model 4	
Physical activity component participation percentage		B	95% CI	B	95% CI	B	95% CI	B	95% CI
	Age	-.07	-.57, .44	-.05	-.54, .44	-.09	-.56, .38	-.05	-.51, .41
	Gender	-14.87	-32.50, 2.75	-14.63	-31.87, 2.61	-14.99	-31.64, 1.66	-14.28	-.2, .19
	Stress	-1.20	-4.13, 1.74	-1.43	-3.56, .71	-1.77	-3.69, .16	-2.17	-3.96, -.37
	Anxiety	-.38	-3.59, 2.84						
	Job satisfaction	.37	-.49, 1.23	.37	-47, 1.22				
	Barriers self-efficacy of physical activity	.01	-.01, .03	.01	-.01, .03	.01	-.01, .03		

Appendix Table D.3. Multiple Regression Final Model_3

Outcome variable	Variables	Model 1		Model 2		Model 3	
Diet component participation percentage		B	95% CI	B	95% CI	B	95% CI
	Age	-.02	-.18, .15	-.03	-.20, .13	-.02	-.18, .15
	Gender	-3.23	-8.81, 2.36	-3.09	-8.64, 2.64	-3.62	-9.26, 2.03
	Overtime work	3.66	-.66, 7.98	3.95	-.34, 8.23	3.54	-.81, 7.90
	Job satisfaction	.21	-.04, .45				
	Self-efficacy of diet	-.42	-.90, .07	-.41	-.89, .08		

Appendix Table D.4. Multiple Regression Final Model_4

Outcome variable	Variables	Model 1		Model 2		Model 3	
Stress component participation percentage		B	95% CI	B	95% CI	B	95% CI
	Age	.05	-.39, .49	.05	-.38, .49	-11.54	-26.19, 3.10
	Gender	-11.24	-26.72, 4.24	-11.32	-26.47, 3.83	-11.54	-26.19, 3.10
	Stress	-1.61	-4.14, .91	-1.54	-3.35, .28	-1.85	-3.45, -.26
	Anxiety	.13	-2.70, 2.95				
	Job satisfaction	.30	-.44, 1.05	.30	-.43, 1.04		

Appendix Table D.5. Multiple Regression Final Model_5

Outcome variable	Variables	Model 1		Model 2		Model 3	
Education component participation percentage		B	95% CI	B	95% CI	B	95% CI
	Age	.07	-.22, .36	.09	-.20, .37	.07	-.21, .35
	Gender	-9.21	-19.51, 1.08	-8.63	-18.68, 1.42	-9.42	-19.34, .50
	Stress	-.41	-1.65, .83				
	Work hour	-4.71	-12.92, 3.50	-5.52	-13.21, 2.81		
	Job satisfaction	.46	-.04, .95	.53	.08, .97	.52	.08, .96

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