UNDERSTANDING PATHWAYS TO WEIGHT LOSS AMONG EMPLOYEES AND ORGANIZATIONS ENROLLED IN THE WAY TO HEALTH WORKSITE-BASED WEIGHT LOSS STUDY

Jiang Li

A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Health Behavior in the Gillings School of Global Public Health.

Chapel Hill
2013

Approved by:

Laura Linnan

Susan Ennett

Kelly R. Evenson

Eric Finkelstein

Deborah Tate

ABSTRACT

JIANG LI: Understanding Pathways to Weight Loss among Employees and Organizations Enrolled in the WAY to Health Worksite-based Weight Loss Study
(Under the direction of Laura Linnan)

The focus of this dissertation is to understand how worksite-based multilevel weight loss interventions influence employees and worksites enrolled in the WAY to Health research study. Paper 1 uses the RE-AIM framework to evaluate the public health impact of the minimal-intensity worksite-based environmental change intervention called The Winner's Circle Dining Program (i.e., WC). In Paper 2, I conducted a theory-guided mediational analysis to examine motivations and self-efficacy as pathways in the relationship between the web-based weight loss program/cash incentives, healthy eating, physical activity and weight change among employees enrolled in the weight loss study.

Methods: A total of 1004 overweight employees from 17 community colleges in North Carolina were randomly assigned to one of three interventions: WC only, WC +Web-based Weight Loss Program (WC+WEB), or WC + Web-based Weight Loss Program + Incentives (WC+WPI). Descriptive statistics were summarized for RE-AIM measures-Reach, Adoption and Implementation of WC. To examine the Effectiveness, the interactions between WC and the individual level interventions as well as their main effects on changes in individual's weight (or healthy eating) were estimated using a 2-level hierarchical linear model. A structural equation model analysis was used to test the proposed mediators on the path to weight change for Paper 2.

Results: Paper 1 found that 62% of participants reported that they used the food services on campus thus were reachable by the WC. All campuses adopted at least one component of the WC to provide access and highlight healthy foods. Nine out of 17 community colleges (53%) placed WC stickers at cafeteria and/or vending machines over a 12-month period; 32.5% -48% of the employees reported that they purchased items with the WC logo. Moreover, placing WC stickers at the cafeteria or vending machines significantly enhanced the effects of the WPI on weight loss at the 12-month follow-up. Paper 2 revealed that the relationship between WC+WPI intervention and weight loss was mediated by autonomous motivation to participate in a weight loss program; as was the relationship between the WC+WPI intervention and total calories.

Conclusions: This dissertation provides insights on how to maximize the intervention effects on weight loss.

To my parents, Ming Li and Haicong Liang, husband Renlong Ge and my daughter Lily.

Your encouragement and support have helped make this achievement possible.

To my faculty mentors: Professors Linnan, Ennett, Evenson, Finkelstein and Tate.

And to all of my friends at the UNC-CH Gillings School of Global Public Health.

You have made my time in Chapel Hill memorable and worthwhile.

ACKNOWLEDGEMENT

I am fortunate to have had the opportunity to work with many talented scholars on my dissertation research. First, I am indebted to Dr. Laura Linnan, the Principal Investigator of the *WAY to Health* study and the chair of my dissertation committee. Her conceptual and methodological guidance helps me to conduct rigorous research that answers meaningful questions and has practical applications. Second, I would like to thank my committee members: Susan Ennett, Kelly Evenson, Eric Finkelstein, and Deborah Tate, for their thoughtful comments and critiques. Third, I must thank Carolyn Naseer, Project Manager of the WAY to Health study, for orienting me to the project and familiarizing me with data collection/scoring protocols, and Lori Stravers, for assisting with data collection.

Fourth, I would like to acknowledge the statistical assistance I received from Dr. Shrikant Bangdiwala from the Department of Biostatistics, and Christopher A Wiesen and Catherine Zimmer, from the Odum Institute, UNC-Chapel Hill.

Finally, I am indebted to the WAY to Health study research team and others at UNC Center for Health Promotion and Disease Prevention, for supporting my dissertation research and for encouraging my academic and professional development.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

1.1. Overview

Obesity, as a major public health problem in the United States, poses a huge burden of harm and cost to both individuals and the health care system. The latest prevalence and trends in obesity data from the National Health and Nutrition Examination Survey (NHANES), reported by Flegal et al., show that in 2009-2010, 68.8% of US adults were overweight and obese[1]. Annual U.S. medical costs attributable to obesity are estimated at $147 billion in 2010[2]. This dissertation work includes two papers focusing on the secondary data analysis to understand how worksite-based interventions can help the overweight and obese employees lose weight. The WAY (Worksite Activities for You) to Health Study was funded by the Centers for Disease Control and Prevention (#DP00010) as a three year, group-randomized intervention trial designed to test three different types of support for employee weight loss at both organizational and individual level: a minimal-intensity worksite-based environmental intervention which included point of purchase labeling for healthy foods, promotion of healthy food items, and increased access to healthier food options called the Winner's Circle Dining Program (i.e., "Winner's Circle", WC); and two promising employee level interventions (i.e., a web-based weight loss program (WEB) and a web-based weight loss program plus cash incentives (WPI) in a three group design: WC vs. WC+WEB vs. WC+WPI) (Table 1). Paper 1 uses the data from the WAY study to examine the public health impact of the WC, the environmental intervention; Paper 2 examines the pathways explaining the intervention effects of web-based weight loss program and cash incentives on individual's weight. The WAY project provides a unique opportunity to examine the mechanisms of multilevel weight loss interventions among a group of overweight and obese employees. The results presented in Paper 1 and 2 will help us gain a holistic, detailed and in-depth understanding of the nature of WAY interventions and how it works.

Table 1. Intervention Arms and Components of WAY to Health Study

Intervention Component	Intervention Arm		
	WC (N=375)	**WC+WEB (N=350)**	**WC+WPI (N=279)**
WC	X	X	X
Web-based Weight loss Program		X	X
Cash Incentives			X

1.2. Obesity as a major public health problem

Obesity has reached epidemic proportions in the United States. In the past 40 years, the percentage of adults age 20 to 74 who were overweight and obese increased from 45.3% in 1960-1962 to 68.8% in 2009-2010[1, 3]. The largest increases occurred in the 1990s[3]. Similar trends were observed among men and women. By 2020, 77.6% of adults are predicted to be overweight defined as body mass index (BMI) is greater than or equal to 25 kg/m^2 and 40.2% obese (BMI is greater than or equal to30 kg/m^2)[3]. Compared to normal weight individuals, the overweight/obese population has substantially increased mortality and morbidity of diabetes, high blood pressure, asthma and other diseases. Moreover, the obesity epidemic is associated with elevated health care costs and productivity losses due to illness, disability and premature mortality[3, 4]. The obesity epidemic represents a major public health problem. The Practical Guide Identification, Evaluation, and Treatment of Overweight and Obesity in Adults[5] recommends that overweight and obese individuals should be counseled about effective lifestyle changes to prevent any further weight gain. Population-based interventions are needed to stop the obesity epidemic and help individuals with weight management[6].

1.3. Worksite as an important setting for contextual study on obesity

At the midst of the rising health care cost attributed to obesity, increasing references have been made to worksite wellness as an important setting for health promotion[7]. We focus on the worksite-based weight loss interventions for several reasons. First, adults spend up to 60% of their waking hours at work[8], and it is possible to reach a significant proportion of US adults at work. Second, by intervening at the worksite and individual level, there is significant potential to improve individual employee weight[9]. Third, in aggregate, the cost of obesity among U.S. full-time employees is estimated to be $73.1 billion. This figure is roughly equivalent to the cost of hiring an additional 1.8 million workers per year at the average annual wages of U.S. workers of $42,000[2]. A healthy weight workforce may result in improved health for individuals and provide benefits to employers and society as a whole[10, 11]. Thus, an increasing number of worksite-based interventions attempted to improve the employee's healthy lifestyle and have showed favorable effects on weight loss[8, 11-15].

Based on a review of policy and environmental interventions[16], several approaches provide the strongest evidence for promoting physical activity and nutrition at worksite:

comprehensive worksite approaches, including education, employee and peer support for physical activity, incentives, and access to exercise facilities (N =5); the availability of nutritious foods (N = 33), point-of- purchase strategies (N = 29); and systematic officer reminders and training of physicians to provide nutritional counseling (N =4). The combined findings from 297 observational studies and 112 intervention studies suggest that availability and accessibility of healthy and less-healthy foods are important for nutrition behaviors and that worksites offer opportunities to improve the availability of healthy foods[17]. Matson-Koffman suggested that further research is needed to determine the long-term effectiveness of policy and environmental interventions with various populations and to identify the steps necessary to successfully implement these types of interventions[16]. Clearly, to develop the effective and sustainable worksite interventions, we need to focus in a practical way on which pathways explain weight change and what is required to address obesity in the workplace. If we understand mechanisms better, we can target interventions to influence those mechanisms and improve the likely effectiveness of the interventions.

A systematic review of worksite nutrition and physical activity interventions[12] suggested that more intensive modes of intervention appeared to have an increased program impact. For example, offering multi-component programs (i.e., program combining both individual and environmental interventions) appears more effective than individual or environmental intervention only, based on a recent review of the worksite health promotion programs that change the environment to increase healthy eating and PA[18]. However, few study examines the interaction between the environmental intervention and individual level intervention

1.4. Community colleges as worksites for addressing employee obesity

Worksite organizations in the United States vary in many ways including their size, workforce, management style, compensation system, and administrative infrastructure. They also vary in the extent to which they offer health insurance and/or benefits to their employees. Community colleges were the organizations chosen for conducting this worksite-based study. In the NC Community College System, there are 59 community colleges serving all 100 NC counties**.** It is the third largest community college system in the nation.

Using Finkelstein's Obesity Cost Calculator, we estimated that NC community colleges incur annual obesity-attributable costs of about $6 million or $457 per employee system-wide[19]. Based on formative research, Linnan et al learned that system and campus leadership were interested in adapting and implementing innovative and cost-effective interventions to address obesity[20]. Community college campuses represent a promising setting for promoting employee health because: a) community college systems are located in all US states and offer a built-in dissemination mechanism for effective health-related programming; b) wellness programming is consistent with a lifelong learning mission that community colleges espouse; c) there was both a supportive environment and infrastructure in the community colleges, as well as opportunities for intervening at multiple levels and disseminating these programs system-wide, if proven effective.

Moreover, in an extensive review of worksite obesity studies, we found no reports of the multilevel multi-component weight loss study or studies examining mechanisms of overweight or obesity within a university or community college system. Identifying organizational and individual-level intervention components that influence employee weight change using a cluster probability sample of employees at community colleges in North Carolina can help fill the important research gap.

1.5. Overview of WAY to Health Study

In the WAY to Health study, 17 community colleges were enrolled and randomly assigned to one of three intervention groups: Winners Circle Dining Program (WC) Only, WC + Web-based Weight Loss Program (WC+WEB), or WC + Web + Cash Incentives (WC+WPI) (Table 1). WC was offered as usual care in the WAY study. Thus, we did not expect any independent effects of WC on employee's diet and weight during the 12 months. WC was designed to identify and promote healthy food options, to educate consumers about the benefits of choosing healthy foods and to increase access to healthy foods in cafeteria and vending facilities. A 4-hour face-to-face training, two conference calls and one mini-training/booster session about how to adopt and implement the Winner's Circle were provided to campus representatives from all three intervention groups at a study kick-off event. Implementation of WC included placement of WC stickers on foods that met specific dietary criteria in vending machines or in the cafeteria and additional WC activity (e.g., the use of signs, posters, or pamphlets on the program, or specials or promotions). In Paper 1, we will first describe reach, adoption, and implementation of the WC using the RE-AIM constructs. Then, we will apply a hierarchical linear model to understand the effects of WC on the employee healthy eating and weight change over time, net of the effects of the individual level interventions (i.e., web-based program and cash incentives) as well as the interactions between the individual level interventions and WC implementation.

The web-based weight loss program (WEB) offered 52 weeks of nutrition, exercise, and weight loss tips, as well as interactive message boards and participant surveys to all enrolled, overweight employees. More details and the theoretical linkages for specific intervention components of the web-based intervention are summarized in section 2.2. Figures 1-5 are screen shots from the web-based intervention. The third intervention group WPI offered cash incentives for those who lost weight (compared to baseline weight) in addition to the WC and WEB (Table 2). In Paper 2, we will use the multilevel structural equation model to examine the pathways through which the WC+WEB and WC+WPI were delivered to employees and their potential influence on employee weight change.

Table 2. Cash Incentives for Weight Loss Payout Chart

Time	**Intervention Arm**		
	WC	**WC+WEB**	**WC+WPI**
3 Months	$5 for attending weigh in	$5 for attending weigh in	$5 for attending weigh in+ $5 for every 1% weight loss compared with baseline weight (Max 10% or $50 for weight loss per follow-up visit)
6 Months	$10 for attending weigh in	$10 for attending weigh in	$10 for attending weigh in+ $5 for every 1% weight loss compared with baseline weight (Max 10% or $50 for weight loss per follow-up visit)
12 Months	$20 for attending weigh in	$20 for attending weigh in	$20 for attending weigh in+ $5 for every 1% weight loss compared with baseline weight (Max 10% or $50 for weight loss per follow-up visit)

Note: The highest amount a participant could earn is $35 for WC and WC+WEB groups. The highest amount a participant could earn is $185 for WC+WPI group.

Figure 1. Screen shot of homepage

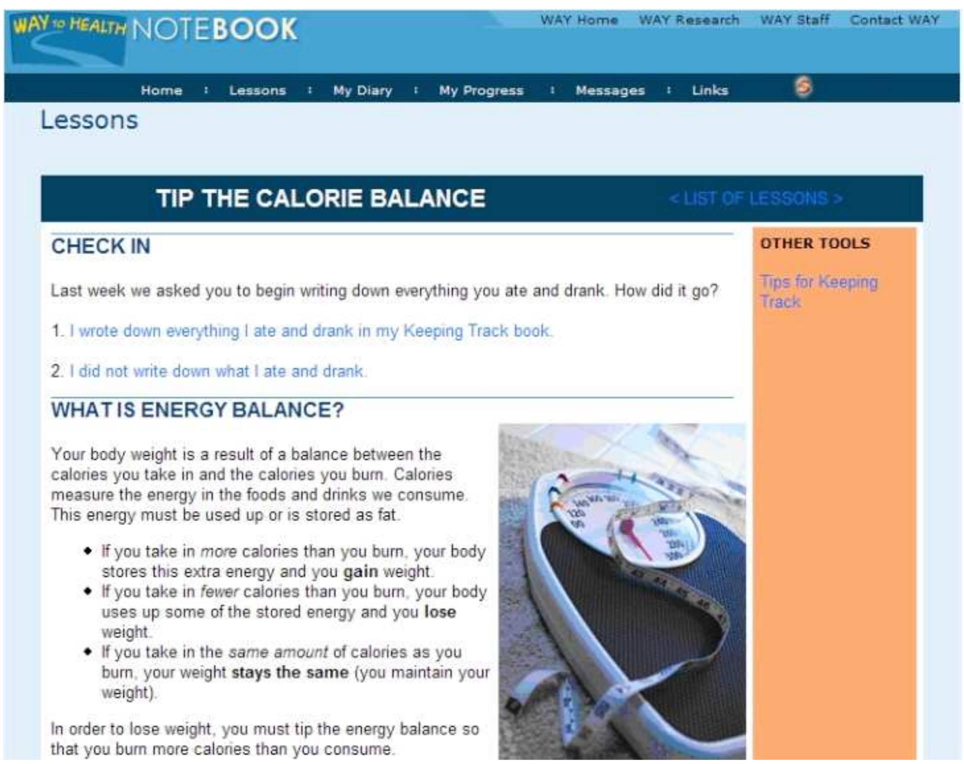


Figure 2. Screen shot of lessons

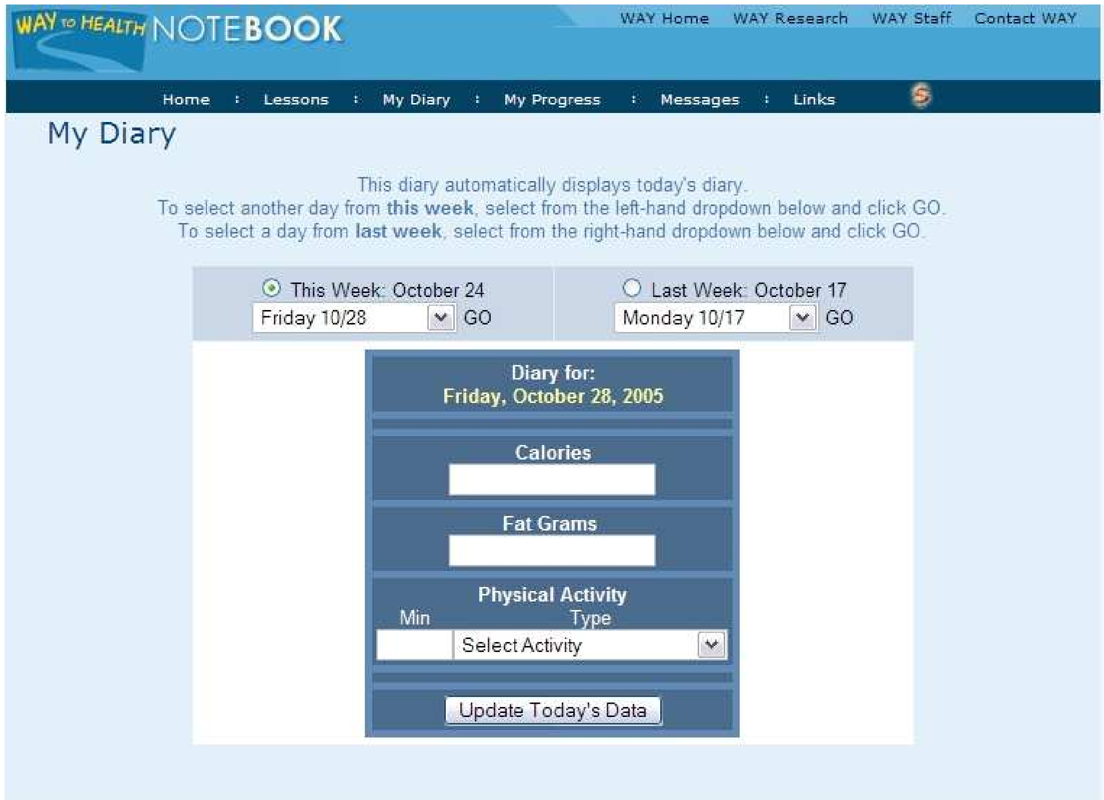


Figure 3. Screen shot of diary

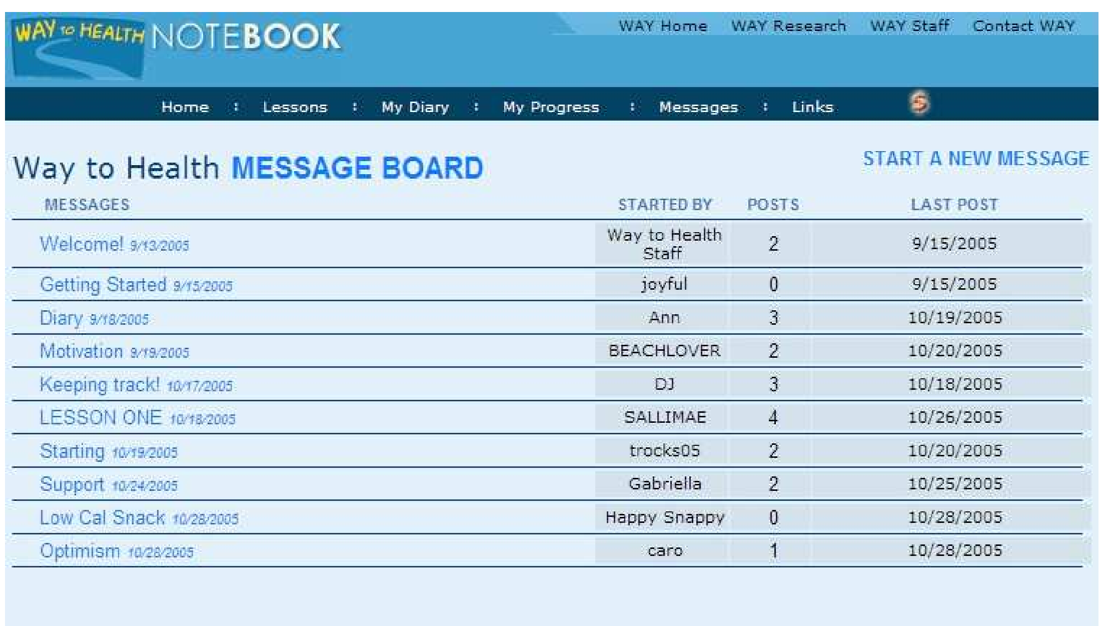


Figure 4. Screen shot of message board

Figure 5. Screen shot of links

1.6. Study Rationale

Multi-level/Complex Interventions

The worksite is a promising setting for health promotion activities targeting nutrition and physical activity (PA) to reduce body weight and body mass index (BMI) [8, 12, 13, 15]. Yet few rigorous evaluations of complex multi-level worksite-based weight loss interventions have been attempted, and there is little information on their mechanisms or long-term health outcomes[21]. "Complex interventions" are health service interventions that often assess multiple components within social contexts[22]. A complex intervention combines different components in a way that the effects of the whole intervention are more than the sum of its parts[22]. The WAY study has three intervention components (i.e., WC, WEB, and Cash Incentives). We hypothesized that the WEB and Cash Incentives would complement each other (e.g., cash incentives for weight loss alone is not adequate if we don't provide them help and support to lose weight through web-based weight loss program). Hence it will be easier to reach the intervention goal-help employees lose weight. Studies to thoroughly evaluate the multi-faceted components of the WAY interventions (WC, WEB & WPI) and examine the pathways of the intervention effects are needed.

1.6.1 Rationale for Paper 1

The recent and alarming increase in overweight/obesity are considered, in part, consequences of environmental influences on population behavior[16, 23-25] Organizational level interventions can promote a supportive environment for healthy eating (including programs and policies that increase access to high-fiber, low-fat and low-calorie foods and appropriate portion sizes), within defined areas, such as schools, worksites, or health care facilities. These types of interventions ensure that healthy choices can be made and may enable and/or support people who frequent those locations to adopt healthy eating behaviors[16].

The RE-AIM (reach, effectiveness, adoption, implementation, maintenance) health promotion evaluation framework has been used to evaluate the multi-faceted components of interventions[26]. The framework has previously been used in studies in weight management interventions[27-29]and worksite contexts[30-32]. The benefits of using the RE-AIM framework are that it enables complex settings based interventions, such as those in worksite settings, to be comprehensively evaluated. However, it has primarily been used in studies focused on changing individual behaviors until recently King et al. extended the RE-AIM to evaluate the effects of environmental change approaches[33]. Even fewer have used RE-AIM to evaluate the worksite-based environmental interventions on health eating or obesity. Given the importance of the built environment in promoting health, using RE-AIM to evaluate environmental approaches is logical[33]. The long-range goal of this study is to improve the evaluation of worksite-based environmental interventions through the use of the key constructs of the RE-AIM framework.

The results of two recent systematic reviews of the effectiveness of worksite nutrition and physical activity programs to promote healthy weight among employees show that most worksite intervention studies combine informational and behavioral skills strategies to influence diet and physical activity at the individual employee level; fewer studies modify the work environment (e.g., cafeteria, exercise facilities) to promote healthy choices or examine the relationship between environmental support and employee weight change[12, 34]. In a recent review of worksite-based health promotion programs with a diet-related outcome, a total of 16 studies were included[8]. Eight programs focused on employee education, and the remainder targeted change to the worksite environment, either alone or in combination with education. The findings of this review suggest that worksite health promotion programs are associated with moderate improvement in fruit, vegetable and total fat intake[8]. The authors reported that the quality of studies to date has frequently been sub-optimal and further, well-designed studies are needed in order to reliably determine effectiveness and cost-effectiveness. The authors also recommended that future programs to improve employee dietary habits should move beyond individual education and aim to intervene at multiple levels of the worksite environment. The WAY study used the WC as the usual care, which provides a unique opportunity to evaluate a worksite-based environmental intervention in a natural experiment.

Moreover, worksite-based environmental or policy interventions that promote physical activity and nutrition often have design and/or measurement limitations. For example, some studies do not adhere to either an experimental or quasi-experimental design with control groups[35, 36]; most studies rely solely on self-reported measures of health outcomes; and still other studies only provided information on implementation of the program (e.g., whether healthy food is available in the cafeteria) while lack outcomes documenting the amount of impact they have on individual behavior [16, 37]. Even fewer studies[38, 39]have utilized a multilevel analytical approach to distinguish the extent to which the success in employee's weight loss is due to an environmental change at work or due to individually –focused interventions. Such evaluations would be better done as a multilevel analysis of individual level behavior or weight change, in a multilevel model such as Hierarchical Linear Model (HLM) or Structural Equation Model which is designed to analyze variables from different levels simultaneously and properly includes the various dependencies[38, 40]. In order to assess the effectiveness of WC during the 12 months, we will use a HLM to partition the variance of the change in individual's weight (or eating habits) at a given time point (3, 6 or 12 months) into two parts: individual and organization, that way we can distinguish the extent to which the change in employee's weight (or eating habits) at certain follow-up assessment is due to an environmental change at work or due to individually –focused interventions. More research is needed to understand the processes by which organizational changes may influence employee dietary change, physical activity and (ultimately) weight loss. In addition, we need to identify intervention program components that contribute to these changes [41].

1.6.2 Rationale for Paper 2

Another important gap in the literature is the lack of the rigorous studies to test theories that link psychological factors (e.g., eating and physical activity self-efficacy, motivation) to both eating and physical activity behaviors[42], and ultimately, to weight loss outcomes [43]. Energy balance, which refers to the relation of the amount of utilizable energy taken into the body to what is employed for internal work, external work, and the growth and repair of tissues, depends on eating and Physical activity and is crucial to achieving and maintain a healthy body weight[12]. However, few studies have examined the mechanisms of weight loss intervention effects through both eating and Physical activity and related psychological factors simultaneously. Moreover, in a systematic review of interventions at the workplace to reduce the risks of CVD[14], the authors recommended that researchers summarizing the results of weight loss trials should also report lifestyle changes achieved in addition to body weight changes to gain better insight into the mechanisms that lead to desired intervention outcomes, such as weight loss. In the parent study of this dissertation-WAY to Health study, the WEB and WPI interventions of the demonstrated statistically significant effects (compared with WC alone) on participant's weight at the 12-month follow up as hypothesized. However, the difference in weight change between WEB and WPI interventions was not statistically significant. Yet the mechanisms through which the WEB and WPI interventions worked remains unclear. To fill this gap we will examine the psychological factors associated with both healthy eating and physical activity as pathways to help understand the relationship between the individual level interventions (WEB & WPI), behaviors (i.e., eating habits such as total calories, fat, fruit and vegetables intake, PA), and weight change.

Self-efficacy for selected eating behaviors and physical activity (i.e., an individual's confidence in his/her ability to overcome barriers to maintain healthy eating and Physical activity) are believed to be critically important for explaining healthy eating and Physical activity [44-46]. It has been suggested that psychological factors such as self-efficacy related to eating and physical activity result in weight change by changing eating and Physical activity [47]. In particular, Social Cognitive Theory [48] suggests that self-efficacy to lose weight can enhance the process of behavior change and maintenance. Based on this theoretical underpinning, the WAY to Health web-based weight loss program was designed to increase self-efficacy to adhere to weight control behavioral practices such as a standard calories-restricted diet of 1200 to 1500 kcal/d, increase physical activity over time to expend a minimum of 1050 kcal/week equivalent to approximately 30 minutes of walking per day and self-monitoring diet and exercise daily[49].

Furthermore, according to self-determination theory[50], motivation is a critical factor in supporting sustained exercise/healthy eating, which in turn is associated with important health outcomes. Accordingly, research on PA/eating motivation from the perspective of SDT has grown considerably in recent years[51-54] and can be applied to understand mechanisms of change in diet and physical activity interventions[50]. But previous reviews have been mostly narrative and theoretical[55]. Aiming to fill this research gap, this study uses empirical data to examine the relationships between motivation and healthy eating, physical activity and weight loss. SDT suggests that the lasting behavior change necessary for maintenance depends not on controlled motives (e.g., because other people insisted, or because you would feel guilty if you didn't) but rather on autonomous motives (e.g., because they personally value weight loss and its health benefits) (see more details in Chapter 2)[50]. Based on this theoretical underpinning, the WEB and WPI interventions are hypothesized to increase both autonomous and controlled motives but only autonomous motives are believed to lead to the positive behavioral change and weight loss.

1.7. Study Aims and Hypotheses

This dissertation involved a secondary analysis of longitudinal data (baseline, 3, 6 and 12 months) collected from 1004 overweight and obese employees from 17 community colleges in North Carolina that participated in the WAY study during 2005 and 2006. Using the group-randomized study design, the primary study aims for the original WAY study were to: a) use formative research to develop/adapt assessment protocols and interventions to address worksite-based weight loss and weight loss maintenance; b) test the independent and combined effects of the interventions (web-based weight loss program and cash incentives) on weight loss from baseline to 12 month follow-up (primary outcome) among participating employees. One thousands and four employees were enrolled from 17 community colleges at baseline and followed up at 3 months (retention rate=72%), 6 months (retention rate=70%) and 12 months (retention rate=70%) post-baseline. As hypothesized, WC+WPI participants lost significantly more weight than did participants in WC at all measurement points. WC+WEB participants lost significantly more weight than did participants in WC at all measurement points as well except at 12 months- the weight loss difference did not reach statistical significance[56]. Thus, two employee level interventions (i.e., WC+WEB and WC+WPI) resulted in greater mean weight losses than WC alone, although the effects of the organizational level intervention WC are unknown because the group-randomized controlled trial was not designed to test this.

In this dissertation, we have two study aims:

1.7.1. Aim 1: Describe the reach, adoption, and implementation of the WC across all campuses using mixed methods (e.g. environmental scans, campus contact and employee surveys) and determine the effectiveness of WC (extent to which implementation of WC explains change in healthy eating behaviors or weight change) among overweight/obese employees over time (i.e., baseline, 3, 6 and 12 months).

In Paper 1, the following research questions will be addressed (for RE-AIM key constructs Reach, Adoption and Implementation, descriptives are presented without statistical tests or hypotheses; for Effectiveness, a series of hypotheses are tested):

- How many and what percentage of employees could potentially be reached by the WC program?
- To what extent did the implementation of Winner's Circle moderate the effects of individual-level weight loss intervention and influence individual's healthy eating and weight change?
  - Hypothesis 1: The enrolled (overweight/obese) employee participants will make healthier food choices (i.e., lower fat intake, lower total Kcal/week, higher fruit/vegetable intake) in campuses with the placement of WC stickers compared to campuses without the placement of WC stickers at the 3, 6, and 12-month follow-up.
  - Hypothesis 2: The enrolled (overweight/obese) employee participants will lose more weight in campuses with the placement of WC stickers compared to campuses without the placement of WC stickers at the 3, 6, and 12-month follow-up.
  - Hypothesis 3: The effects of individual level interventions (WEB&WPI) will vary by the implementation of WC (i.e., the placement of WC stickers), such that the effects of individual level interventions on healthy eating will be stronger in campuses with the placement of WC stickers compared to campuses without the placement of WC stickers at the 3, 6, and 12-month follow-up.
  - Hypothesis 4: The effects of individual level interventions (WEB&WPI) will vary by the implementation of WC (i.e., the placement of WC stickers), such that the effects of individual level interventions on weight loss will be stronger in

campuses with the placement of WC stickers compared to campuses without the placement of WC stickers at the 3, 6, and 12-month follow-up.

- To what extent is the Winner's Circle program adopted and implemented at the organizational level including the presence of education and labelling, access to healthy food, technical assistance the worksite staff utilize, strategies they use to promote the Winner's Circle program among employees and barriers to implementing the Winner's Circle program?
- To what extent is the Winner's Circle program implemented at the individual level (e.g., awareness and satisfaction with the Winner's Circle program)?

Paper 1 Analytic Strategy: Four of five dimensions of the RE-AIM framework namely "Reach", "Effectiveness", "Adoption" and "Implementation" were used to evaluate the WC offered in the WAY to Health study. A 2-level Hierarchical Linear Model (HLM) allows us to test the main effects and interaction of WC implementation and individual level interventions on changes in individual's weight (or healthy eating) (see details in section 3.6).

1.7.2. Aim 2: Examine direct and indirect associations between the intervention groups (WC, WC+WEB and WC+WPI), motives, self-efficacy, healthy behaviors (i.e., eating, PA), and weight change.

- Hypothesis 1: The participants that received the individual-level WAY interventions had higher level of autonomous motives, controlled motives, physical activity self-efficacy and/or healthy eating self-efficacy than those who didn't at 3 months.
- Hypothesis 2: The participants with higher level of autonomous motives and/or physical activity self-efficacy at 3 months had higher level of physical activity (i.e. total physical activity MET-minutes/week) at 6 months.

- Hypothesis 3: The participants with higher level of autonomous motives and/or healthy eating self-efficacy at 3 months had healthier eating habits (i.e., total calories intake, fruit/vegetable consumption and proportion of calories intake from fat) at 6 months.
- Hypothesis 4: The participants with higher level of physical activity and/or healthier eating habits at 6 months achieved greater weight loss at 12 months.
- Hypothesis 5: The effects of WAY web-based weight loss intervention on weight change are mediated by autonomous motives, physical activity self-efficacy and/or healthy eating self-efficacy.

Paper 2 Analytic Strategy: A multilevel structural equation modeling (MSEM)[57] is used to test the hypotheses for Paper 2 that the effects of WAY web-based weight loss intervention on weight change are partially explained by healthy eating and physical activity self-efficacy, motivations to participate in a weight loss program, healthy eating and Physical activity (see details in section 3.6).

The conceptual model depicting hypothesized pathways to weight loss among employees and organizations enrolled in the WAY to Health study has been guided by theory (i.e., SCT, SDT, Social Ecological Framework) and results from previous weight loss literature (to be explained in Chapter 2). Figure 6 illustrates how WAY to Health interventions (WC, WC+WEB and WC+WPI) are hypothesized to influence employee health outcomes.

These interventions are consistent with influence on multiple levels of the social ecologic framework (SEF) (see details in section 2.1). The SEF is defined as a framework that considers the nature of people's interactions with their physical and sociocultural environments[58] as important influences on health and health behaviors. The WAY to Health interventions attempt to make changes at organizational and individual levels. As SEF suggests multiple levels of influence on human behaviors, it is important to overcome the barriers and/or enhance the facilitators of change that occur at each of these levels in order to maximize the effects of intervention. The organizational level intervention is the WC. As shown in the grey area in Figure 6, WC features a minimal-intensity environmental change program that included a 4-hour face-to-face training of worksite representatives, and voluntary participation in two conference calls, one mini-training/booster session and additional technical assistance (as requested) throughout the 12- month intervention period. The WC intervention was designed to increase access to healthy foods in cafeteria and vending facilities and use point-of-purchase labeling to identify healthy food options. These activities were designed to increase awareness among employees, create a supportive healthy eating environment and increase access to healthy food options. Changes produced at the organizational (worksite) level were believed to be able to influence employee eating behaviors (e.g. increase fruit and vegetable intake and decrease both total calories and total calories from fat) [14, 38, 59-61]. These changes in the physical environment at work were believed to help support individuals who might be trying to lose weight or maintain a healthy weight[62-64]. But the research team did not hypothesized that WC would lead to weight loss (e.g., in the power calculation, the WC only arm was not estimated to produce weight loss).

At the individual level (as shown in the white box), Tate's evidence-based web-based weight loss program[49, 65-68] was adapted for use in the workplace with and without cash incentives for weight loss(incentives were only given to participants who lost certain amount of weight in the WC+WPI arm). The individual level interventions were designed to increase motivation to participate in weight loss program, healthy eating and physical activity self-efficacy among participants. In turn, changes in motivation and self-efficacy are believed to influence positive change in employee healthy eating and PA, key target behaviors of the web-based weight loss program[69-71]. It is particularly important for us to test change in motivation or self-efficacy at 3 months lead to diet/PA change at 6 months then leads to weight change at 12 months to establish the temporality because otherwise we are not sure which one changes which one. For example, it could be improved diet increased one's self-confidence in maintaining healthy diet. Ultimately, healthy eating and improved physical activity are hypothesized to help overweight/obese employees enrolled in the WAY to Health weight loss study to lose weight[12]and has the potential to improve other employee health outcomes such as reduced risk of cardiovascular disease, improved mental health and mood[16]. Campus size, existence of an Employee Wellness Committee (EWC), gender, race, education, and income are examples of covariates at the organizational and employee levels. Chapter 2 provides more details on the rationale for each covariate and pathway/hypothesis of this study.

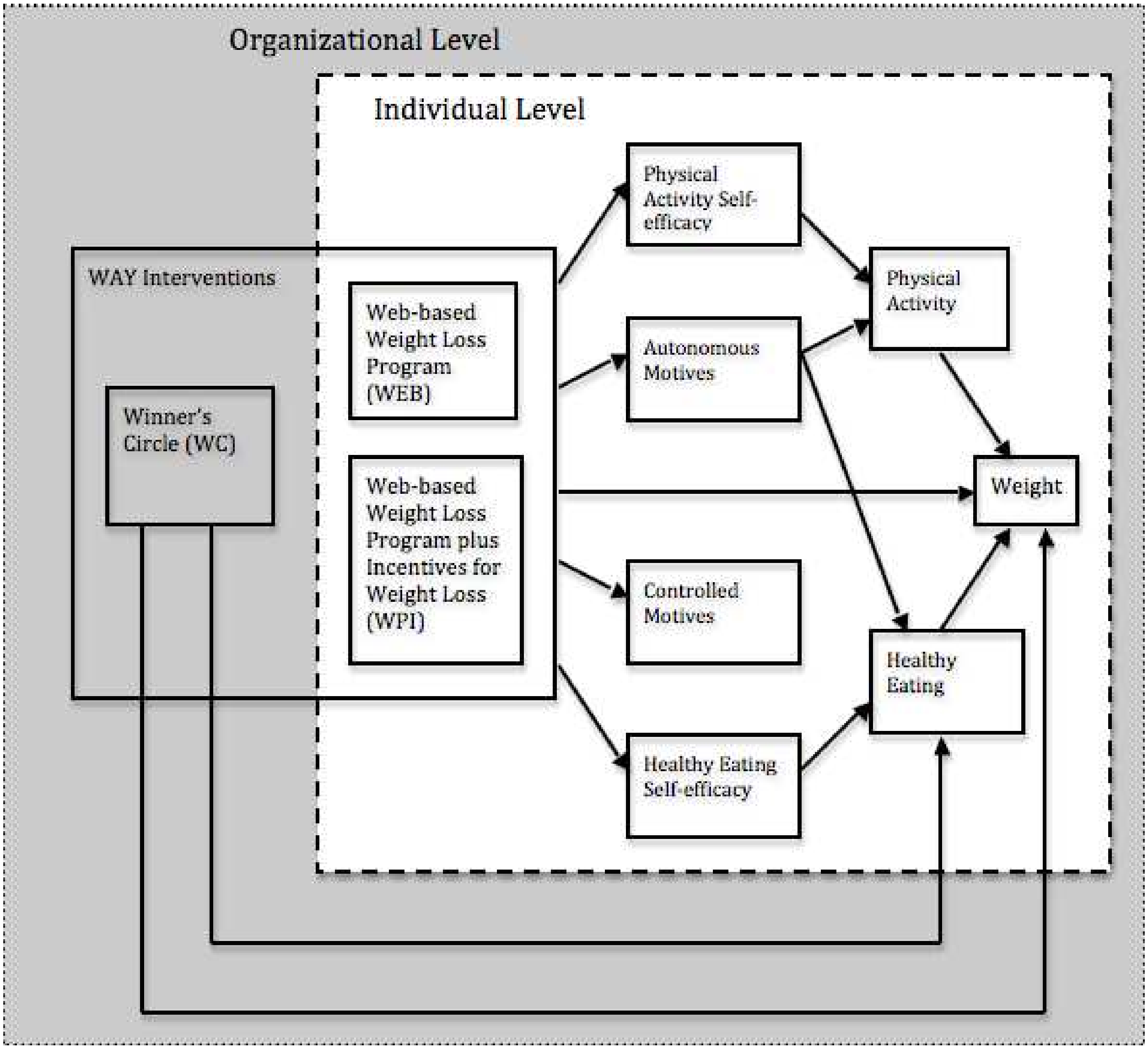


Figure 6. Conceptual Model and Hypothesized Pathways to Weight Change

1.8. Significance of the Study

1.8.1 Significance of Paper 1

A striking paucity in the worksite-based weight loss intervention literature is the role that the worksite environment plays in influencing employee health behaviors. For this reason, a comprehensive evaluation of the environmental change intervention (e.g. Winners Circle Dining Program) on individual employee eating behaviors and weight change using RE-AIM framework is warranted. This examination (Paper 1) is especially crucial when studying worksite-based health promotion programs with an environmental change component but is unable to use a Randomized Control Trial (RCT) to test the effectiveness of organizational change. Empirically testing the effects of the environmental change will allow us to understand whether the programs work and gain worksite policy and environmental supports to implement these programs for employee wellness. The WC was made available to all participating community colleges, including those who received WEB and WPI. The WC only arm served as the “usual care” arm of the study. Given the nature of the WC intervention, investigators did not expect WC to produce any effect on weight loss (primary outcome) in a 12-month period, however, it remains important to test the potential effects. This secondary data analysis will assess the reach, adoption, implementation and effectiveness of WC on both the primary (weight loss) and secondary (diet) outcomes using all available longitudinal data (baseline, 3, 6 and 12 months), mixed methods (e.g. environmental scans, campus contact and employee surveys) and multilevel models. RCTs are the most rigorous way to evaluate the effectiveness of intervention[72]. However, because of their multifaceted nature and dependence on social context (e.g., social norms, social environments, policies), complex interventions pose methodological challenges with regard to monitoring and assessing the effect of the intervention, especially when RCT is not an option[22]. For example, in our study, WC has been delivered to all 17 community colleges as a usual care intervention. The group-randomized controlled trial in the original WAY study was designed to test the effects of WEB and WPI rather than WC. The fact that all campuses have received WC creates a natural experiment with a nonrandomized design for evaluation of the WC. Although comprehensive evaluation plans for RCT are available to practitioners, frameworks for developing a comprehensive evaluation for interventions like WC with a nonrandomized design are less common[72]. Our work will add to the literature not only substantive knowledge of the environmental interventions but also an important methodological development to integrate longitudinal analysis (i.e., baseline, 3, 6 and 12 months follow-ups), process (e.g., implementation of WC at organizational level) and outcome data (i.e., employee healthy eating behaviors and weight change) to evaluate an environmental change intervention with nonrandomized design.

1.8.2 Significance of Paper 2

In Paper 2, not only we examined changes in motivations to participate in a weight loss program, physical activity and healthy eating self-efficacy attributable to the intervention, but also we determined the extent to which these changes predict the amount of physical activity and healthy eating that occurs, which is expected to lead to the primary health outcome of weight change. In the original WAY to Health proposal, investigators included an aim to explore mediators of weight loss following Baron and Kenny 4-step approach. While this was the best approach to understand mediators at the time the proposal was submitted (2003), there are now more advanced methodological approaches to mediation analysis that can establish the existence of complex causal relationships among these variables[73, 74]. As a result, this dissertation work will provide an independent and important contribution to our understanding the mechanisms of weight change with most advanced methodologies available.

CHAPTER 2: LITERATURE REVIEW AND THEORY

2.1. An Ecological Perspective

Environmental determinants of employee healthy lifestyles that curb the prevalence of obesity are drawing growing attention in the literature.[16, 37-39, 60, 75] The Social Ecological Framework (SEF) provides a helpful conceptual framework in which individual behavior such as obesity is believed to be influenced by factors at the intrapersonal, interpersonal, organizational, community/society and policy levels[58] (Table 3). Our work will examine the organizational level factor that provides supportive environment for healthy eating and weight loss among employees (i.e., WC) as well as the psychological and behavioral factors at the intrapersonal levels (i.e., motivation, self-efficacy, diet and PA) delivered via the WEB and WPI interventions.

Table 3. Social Ecological Framework of the Determinants of Employee Obesity

Level of Influence	Intervention Target	Variable of Interest
Intrapersonal	Employee	Psychological (self-care, body image, nutrition needs exercise requirements, motivations, intention, beliefs, self-efficacy, attitudes, knowledge of maintaining healthy weight); Biologic (health status, genetic predisposition); Behavioral (food choices or purchases, dietary intake, PA)
Interpersonal	Family, coworkers, friends	Social support; social networks; (family, coworkers, friends) communication patterns; peer/family influence; norms; membership in groups/departments and role; employee-supervisor relationship; management support
Organizational	Worksite	Social norms; environmental conditions (convenience and safety for exercise, access to affordable healthy food), participatory

Level of Influence	Intervention Target	Variable of Interest
		organizational strategies; incentives; management style; work design; corporate climate or culture; site-specific rules/policies
Community/society	Local, state, regional, national, international worksite and larger community	Relationships between/among national, international worksite and larger community related to economic, political, or social factors
Policy	Government laws or standards at local, state, national, and international levels	Legislative and/or regulatory approaches at local, state, national, and international levels (explicit or implicit; intentional or unintentional)

Note. Adapted from Linnan,L.A. (2001)[76]

Behavioral research in obesity has typically focused on identifying and modifying individual determinants[77]. This approach has been criticized because it places undue emphasis on the individual and fails to consider the context within which health behavior takes place[77]. Most worksite intervention studies attempted to influence employee's diet and physical activity by using informational and behavioral skills strategies, while fewer studies have attempted to improve the work environment or policies to promote healthy behaviors and help employees lose weight[12, 34, 38, 39]. For example, Anderson and his colleagues (2009) reviewed the literature on worksite health promotion programs that included strategies involving diet, PA, or both. Of 47 studies in the analysis, 32 studies (69%) had both informational and behavioral skills program components; among these, only four[78-81] included an environmental or policy component[12].

Table 4. Summary of the Worksite-based Weight Loss Studies with Informational, Behavioral Skills and Environmental/Policy Program Components

Study and country	N	Study Purpose	Study Design	Overweight (%) other risks (%)	Intervention Components	Intensity :1: 1 contact; 2: 2–5; 3: >5 (duration in week)	Pounds (mo f/u) Intervention Vs. Control	BMI (mo f/u) Intervention vs. Control	Attrition (%)
Muto (2001) [78]Japan	326	CVD risk reduction	RCTs with untreated comparison group	Overweight (65%) CVD risk (% not reported)	A seminar for 4 days at a hot springs resort to help participants reduce excessive weight, blood pressure, cholesterol; self-evaluation of the goals; comments or advice on the self-evaluation by the participant's supervisor and also by his spouse or family member.	2(4)	-3.75 (6mo); -3.31 (18mo)	-0.5(6mo); -0.5(18mo)	7
Jeffery (1993) [79]U.S.	32 sites (400–900 employees each site)	Weight loss	Group RCTs with untreated comparison group	Overweight (36%); CVD risk (% not reported)	Health education classes combined with a payroll-based incentive system.	3 (96)		-0.1 (24 mo)	Not reported
Abrams (1983) [81]U.S.	133	Weight loss (A) plus maintenance (B)	RCTs with different treatment arms (no untreated comparison)	Overweight (% not reported)	Organizational behavior modification techniques in addition to traditional small-group behavior-therapy procedures for weight control.	3(10)	Arm A -9, Arm B -3.3 (6 mo)		82

Study and country	N	Study Purpose	Study Design	Overweight (%) other risks (%)	Intervention Components	Intensity :1: 1 contact; 2: 2–5; 3: >5 (duration in week)	Pounds (mo f/u) Intervention Vs. Control	BMI (mo f/u) Intervention vs. Control	Attrition (%)
Erfurt (1991) [80] U.S.	4 sites (500–600 employees each site)	Health Promotion	Group RCTs with different treatment arms (no untreated control)	Overweight (30%) CVD risk (18 – 45%)	Site 1 offered screening only, with referral recommendations for those found to have CVD risks. Site 2 also provided health education information and classes. Site 3 added routine follow-up counseling and a menu of intervention types, and Site 4 added plant organization procedures to develop social support for both risk reduction and health improvement efforts within the plant.	2(144)	High risk group Site 1 +3.1 Site 2 +0.6 Site 3 -1.2 Site 4 -4.7 Overweight group Site 1 +4.2 Site 2 -2.4 Site 3 -5.0 Site 4 -6.4 (8 mo)		Not reported

Note. Adapted from Anderson et al. (2009) [12].

Even though these previous studies have made great contributions to worksite-based complex interventions for weight control, they suffered from limitations such as small sample size[78, 82], small number of participating worksites[80, 82], shorter duration[82], costly intervention[78] as well as worksite as the unit of analysis comparing the mean weight across worksites instead of individual's weight[79, 80]. Many of these studies were conducted at least a decade ago and used the statistical techniques (e.g., t-test, ANOVA) that fail to tease apart differences between individuals within worksites and differences in organizational characteristics between sites contribute to variance in individual's weight. None of them assessed the independent effects of organizational level intervention components net of the effects of the individual level interventions or the interaction between the organizational level and individual level interventions. Moreover, we are not aware of any studies that examined a minimal-intensity worksite dinning program like WC to increase awareness and access to healthy food options in cafeteria and vending facilities among community colleges. The Community Guide[83] indicated that because the majority of programs used behavioral, informational strategies plus environmental or policy component, it was difficult to contrast program components with respect to effectiveness. Questions remain about the effect on employee weight status related to reach, effectiveness, adoption, implementation and maintenance of environmental change (e.g., providing easy access to affordable, healthy foods, or modifying the physical environment to encourage physical activity). This study will fill this important research gap.

Secondly, new methodological developments in multilevel analysis and structural equation modeling enable us to tackled the comprehensive picture and simultaneously test whether weight loss interventions modify these individual determinants to influence diet and physical activity, and whether these influences affect individual's weight. To fill the gap of addressing multilevel influences on employee obesity conceptualized within the social ecological framework, the Social Cognitive Theory (SCT) [48]and classic economic theory were used to guide the development of the WAY interventions (WEB and WPI) that target determinants of employee obesity at both individual and organizational levels (see details in the following section 2.4). The SCT theory, which has been applied to a wide range of health behaviors including diet and PA[42, 44, 84-88], assumes reciprocal determinism in which individual and organizational level influences are dynamically linked and can help explain mechanisms of changes in PA, healthy eating and weight.

The "Law of Supply" states that as the benefit associated with supplying a product/service increases more of that product/service will be supplied[89]. Grounded in classic economic theory, financial incentives sewing to increase the benefits of weight loss/weight maintenance should produce greater weight loss. But according to the final results of WAY project, adding the financial incentives (WPI) didn't produce statistically significant differences in weight loss compared with weight loss produced by the web-based weight loss program (WEB). Financial incentives are widely used in health behavior interventions and are believed to be associated with increased motivations. However, some researchers believed that providing a financial incentive may undermine autonomous motivation for participating in a weight loss program and instead lead to increases in controlled motivation[90]. The autonomous motivation is found to be related to desirable behavioral outcomes according to SDT[50].On the other hand, to the best of our knowledge, no empirical evidence supports that the financial incentives would improve self-efficacy related to eating and/or PA. Therefore, we argue that the SCT and SDT theoretical perspective will be useful in explaining potential influence of Winner's Circle Dining program on employee obesity as well as the mediating effects of eating self-efficacy/PA self-efficacy on the relationship between WAY interventions and healthy eating/PA. A detailed description of the theoretical framework is provided in the conceptual model (Figure 6) and the following section 2.2 and 2.3.

2.2. Social Cognitive Theory

The WAY interventions are grounded in Social Cognitive Theory (Table 5). The SCT explains how people acquire and maintain certain behavioral patterns. The cognitive factors outcome expectations, self-efficacy, and intentions are important determinants of behavior according to SCT [48]. An overarching concept of SCT is reciprocal determinism, which states a constant interaction exists among the characteristics of a person, their behaviors, and their environment [48]. Weight control among employees is dependent on personal characteristics such as self-efficacy, and on external factors like healthy food availability. SCT encompasses individual, behavioral and environmental influences on weight loss and is therefore a fitting theory for investigation of worksite-based weight loss interventions. In the context of worksite weight loss intervention, outcome expectations can be operationalized as pros and cons of weight loss. Self-efficacy is often defined as the ability to resist eating in tempting situations or even in the face of difficult situations; and intentions are frequently framed in terms of self-regulation, motivation or readiness to lose weight[42, 91, 92]. Several studies have demonstrated that self-efficacy and self-control of weight loss affect their behavior[69-71]. Individuals who report they were relatively more motivated and more confident in their ability to lose weight are more likely to achieve behavioral change and weight loss[42].

According to the SCT, individuals gain information and cognitive skills from observational learning and are likely to remember and repeat the behaviors provided by a model -learning directly from observation of models -interpersonal imitation or media sources[93]. Therefore, Tate et al.[49, 66-68, 94]developed a Web-based Weight Loss Program (WEB) guided by the Social Cognitive Theory, which is a comprehensive, individually focused, theory-driven, self-directed weight loss program includes education, behavioral self-regulatory strategies, continuing contact, prompting, and access to social support. Table 4 describes different features of the WAY interventions that relates to aspects of the SCT. Tate (2011) found that the feasibility and efficacy of Internet treatment programs for overweight and obese people have been demonstrated in a series of randomized trials[94]. Initial studies examined various approaches to Internet behavioral treatment. Other studies have examined delivery of group behavioral counseling using Internet chat rooms, using the Internet for long-term maintenance of weight loss, and enhancing motivation in Internet programs. These interventions have produced weight loss of 4-7 kg over 6 months to 1 year when support via e-mail, automated messages, or chat rooms is provided.

Individual behavior is influenced by a variety of characteristics related to the individual, organization and environment such as social norms, convenience and safety for exercise, access to affordable healthy food, participatory organizational strategies, rules and policies. The SCT construct “environment” can be used to address the environmental change at the organizational level that facilitates weight loss, in our case, the WC. The WC activities related to SCT are also included in Table 5.

Table 5. Social Cognitive Theory Constructs Guiding the WAY to Health Intervention Components – Winners Circle, Web-based Program and Cash Incentives

Construct	**Definition**	**WAY Intervention Activities**	**WAY Intervention Component**
Environment	Factors physically external to a person	Increase availability and accessibility of healthy foods option at worksite; sustainable changes in foodservice	Winner's Circle; Cash Incentives
Behavioral Capacity	Knowledge and skill to perform a given behavior	Lessons with participatory activities including skill development for preparing fruits and vegetables; tailored, reinforced messages; repeated multimedia approach	Web-based program (lessons)
		Logo for point-of-purchase labeling to identify healthy food option and educate employees about the benefits of choosing healthy foods	Winner's Circle
Expectations	Anticipated outcomes of a behavior	Multiple, repeated messages; use of recognizable or relatable role models	Web-based program (lessons, message board)
		Regulated use of exterior incentives for weight loss	Incentives
		Logo for point-of-purchase labeling to identify healthy food option and educate employees about the benefits of choosing healthy foods	Winner's Circle
Expectancies	Values placed on a given outcome	Discussion on the message board of social impact; Use of recognizable or relatable role models; focused messages highlighting fruit and vegetable benefits and alleviating concerns regarding peer acceptance	Web-based program (lessons, message board)
		Logo for point-of-purchase labeling to identify healthy food option and educate employees about the benefits of choosing healthy foods	Winner's Circle
Self-Control	Self-regulation of a behavior	Goal-setting; monitoring using food diaries; feedback; Role-playing; Problem-solving activities	Web-based program (diary, lessons, dynamic Behavioral Focusing and Goal Setting activities, a graph or chart of weight change over time, downloadable self-monitoring form)

Construct	**Definition**	**WAY Intervention Activities**	**WAY Intervention Component**
		Logo for point-of-purchase labeling to identify healthy food option and educate employees about the benefits of choosing healthy foods	Winner's Circle
Observational Learning	Behavioral acquisition by observing outcomes of others'	Use of credible, recognizable or relatable role models; Participatory skill development activities	Web-based program (message board)
Emotional Coping Responses	Strategies used to manage emotional stimuli	Monitoring & feedback; Role-playing; Problem-solving activities	Web-based program (diary, dynamic Behavioral Focusing and Goal Setting activities, a graph or chart of weight change over time, downloadable self-monitoring form)
Reinforcement	Responses to behavior that will increase or decrease likelihood of behavior's occurrence	Monitoring & feedback; Encourage self-initiated rewards and incentives	Web-based program (diary, dynamic Behavioral Focusing and Goal Setting activities, a graph or chart of weight change over time, downloadable self-monitoring form)
		Regulated use of exterior incentives for weight loss	Incentives
Self-efficacy	Confidence in the ability to perform the behavior	Clear, targeted messages; Role-playing; Enhancing preparation skills; Use of recognizable or relatable role models; Approach behavior change in small steps to ensure success	Web-based program (lessons, diary, dynamic Behavioral Focusing and Goal Setting activities, a graph or chart of weight change over time, downloadable self-monitoring form, message board)

Note. Adapted from Glanz, et al (2002)[95]

2.3. Self-Determination Theory

SDT suggests that the lasting behavior change necessary for maintenance depends not on complying with demands for change but rather on accepting the regulation for change as one's own[50]. In other words, it requires internalizing values and regulation of relevant behaviors and then integrating them with one's sense of self so they can become the basis for autonomous regulation. Thus, according to the theory, successful weight loss and long-term maintenance would not result from dieting if the reasons for dieting were controlling[96]. Such controlling reasons indicate that the perceived locus of causality is external, that the individual has not personally endorsed the behaviors and developed a genuine willingness to do them. Instead, successful, maintained weight loss is theorized to result from people's dieting because they personally value weight loss and its health benefits[96]. People's behavior change will be maintained, the theory asserts, when the reasons for action are truly their own, when people are acting with autonomous motives[50]. Financial incentives are widely used in health behavior interventions. However, SDT posits that emphasizing financial incentives can have negative consequences if experienced as controlling. Feeling controlled into performing a behavior tends to reduce enjoyment and undermine maintenance after financial contingencies are removed (the undermining effect) [90]. In line with these proposed relationships, in this dissertation, we hypothesized that self-determined motivation would partially mediate the relationship between WAY interventions and healthy behaviors/weight.

2.4. Evaluating the Impact of Winner's Circle Using RE-AIM Framework

2.4.a. RE-AIM Framework

Worksite health promotion program evaluations typically focus on short-term individual behavior change with little attention to intervention implementation or maintenance[97]. However, complex interventions also require process and impact evaluations to understand participation of organizations and individuals, intervention implementation, and long-term effects on institutions or individuals[31].

The RE-AIM framework is useful for evaluating a program's overall public health impact. A central tenet is that the ultimate impact of an intervention is due to its combined effects on 5 evaluative dimensions[26, 98]: (1) reach, the percentage and representativeness of individuals participate in the intervention; (2) effectiveness, the impact of the intervention on targeted outcomes; (3) adoption, the representativeness of settings and intervention staff who agree to deliver a program; (4) implementation, the consistency and skill with which program components are delivered by intervention staff; and (5) maintenance, the extent to which individuals maintain behavior change and organizations sustain program delivery over time[26]. Researchers have used RE-AIM to evaluate health promotion programs in worksite[27, 30, 32], hospital[31, 99], school[100-102], and community settings[103] and have found that factors beyond efficacy can affect overall program impact. RE-AIM can also be used to compare across interventions[98]. One of its strengths is the validity and applicability of each domain across different research questions and settings. Specifically, to address the social and institutional context of eating and exercise behaviors related to weight control, the domains of RE-AIM help to thoroughly understand the public health impact of weight control interventions and are widely used in weight management programs[28, 29, 31, 104]. The RE-AIM framework has also been recommended for evaluation of environmental approaches and policy change to enhance population health[33, 105]. In this dissertation, we applied four dimensions of RE-AIM (Maintenance was not assessed due to the lack of the long-term data) to the evaluation of the worksite-based environmental intervention (i.e., Winner's Circle) through the application of RE-AIM framework.

2.4.b. Reach of Winner's Circle

Reach refers to participation rate within the population of interest, and characteristics of participants and nonparticipants[31]. The basic premise underlying workplace health promotion interventions may not bring into effect if the interventions do not reach the targeted populations. Employed adults spend approximately half of their waking hours at work, but the workplace may not be a major source of influence on weight status. Thus, even if changes in the worksite environment, such as improved food choices, are made, the proportion of the employee population affected by these changes should be in our consideration when evaluating the potential public health impact of such programs[106]. Because Winner's Circle Dining program is implemented at the worksite cafeteria and vending machines, the reach of Winner's Circle is determined by the proportion of the employee population who utilize the food services (i.e., cafeteria and vending machines) at the workplace. A further investigation on the reasons why some employees didn't utilize the food services at workplace as well as a comparison of characteristics of those who utilized the food services with those who didn't provides insights on increasing the employee's utilization of the food services at workplace to maximize the effects of Winner's Circle Dinning program.

2.4.c. Adoption and Implementation of Winner's Circle

Adoption operates at the systems level and refers to the community college acceptance of the intervention within the organization. Implementation refers to intervention integrity, or quality and consistency of intervention delivery.

A 4-hour face-to-face training session was provided to representatives from each campus (HR and/or food service personnel) at the study kick-off event, prior to randomization by project staff. The training agenda included a review of the history of WC ("The Winner's Circle Dining Program SM as a menu labeling and social marketing initiative developed by NC Prevention Partners (NCPP) that promotes healthy food in dining establishments."[107]; nutrition analysis activity to identify menu items that meet the Winner's Circle Health eating nutrition criteria; and developing an action plan consisted of 4 major steps: establishing a team, nutrition analysis, labeling and promotion. After the training, two conference calls and one mini-training/booster session were offered to all 17 campuses, regardless of intervention arm assignment. Additional technical assistance was available to campuses throughout the 12-month intervention period. See Section 3.3.a for more details on how WC program was implemented including training, follow-up calls and booster sessions.

Winner's Circle uses a logo (Figure 7) for point-of-purchase labeling to identify healthy food option in participating venues. Food items are placed into one of four categories: meals, single items/side dishes, snacks, and beverages. The participating cafeteria and vending facilities are encouraged to offer and label the food options that meet the WC program healthy eating nutrition criteria (Table 6). Food items that meet the criteria for each category receive Winner's Circle designation and are identified with a purple star and gold fork logo, which can be placed on menus, menu boards, directly on pre-packaged items, inside vending machines, or on lists attached to vending machines or display cases.

Participating campuses were encouraged to display promotional materials for the program, including descriptions of how an item qualifies for Winner's Circle. An important component of WC program was placement of WC stickers. Education/labeling and encouraging increased access to healthy food options were two factors the WC program targeted at the organizational level (see Section 3.5.a.4 for their measurement).

Figure 7. Winner's Circle logo and labeling

Table 6. WC Health Eating Nutrition Criteria[108]

i. Meals
1. Minimum of 2 servings of fruits/vegetables AND 2. Minimum of 1 serving of grains or beans OR 3. Minimum of 245 mg calcium AND 4. Maximum of 30% calories from fat AND 5. Max 1500 mg of sodium per meal
ii. Sides/single items
1. Minimum of 1 serving of grains or beans OR 2. Minimum of 1 serving of fruits/vegetables OR 3. Minimum of 245 mg of calcium AND 4. Must have max of 30% of calories from fat AND maximum of 1000 mg of sodium
iii. Beverages
1. Water/flavored water with less than 50 calories per 8 oz. serving OR 2. Skim/1% milk OR 3. At least 50% juice and <12 oz. serving OR 4. Sports drinks <100 calories and <12 oz serving OR 5. No added herbal supplements
iv. Snacks
1. Less than 30% fat AND 2. Less than 480 mg sodium AND 3. No more than 35% sugar weight OR 4. Dairy snacks: 4 oz servings must have at least 120 mg calcium, 6 oz servings at least 150 mg calcium, 8 oz at least 245 mg calcium

Notes: Winner's Circle Healthy Eating and Winner's Circle healthy Dining Programs are property of NC Prevention Partners. For more information on how to bring either program to your state, school, business or to have your foods qualified for the preferred list, go to www.winnerscirclehealthydining.com.

2.4.d. Effectiveness of Winner's Circle

Effectiveness measures pertain to the impact of the intervention strategies (i.e., WC) on impact and outcome objectives (e.g., healthy eating and weight loss). The worksite physical and social environment can influence individual employee food choices[39]. If worksites remove unhealthy foods/beverages and promote healthy foods/beverages at vending machines and cafeterias, employees will have less access to high-fat foods/sugary beverages while at work. Providing less access to these foods is likely to reduce consumption of these foods[8]. Worksite-based nutrition programs targeting vending machines or cafeterias[14, 38, 59-61] found generally positive dietary outcome, suggesting availability of healthy foods/beverage influences employee's diet[8]

However, the studies of the effects of environmental interventions on individual's weight do not always yield consistent results. In a multi-component group-randomized worksite environmental intervention trial by Linde et al. (2012) focused on weight gain prevention, environmental components focused on food availability and price, physical activity promotion, scale access, and media enhancements. A majority of intervention components were successfully implemented. However, there were no differences between sites in the key outcome of weight change over the two-year study period[106]. The results raised questions about whether environmental change at worksites is sufficient for weight gain prevention. Although evidence suggests that health promotion programs of all kinds in worksites are beneficial, it may be asking too much to expect such programs to have a specific effect on health outcomes like weight change. Recent reviews and commentaries on the idea that environmental changes are the key to rising obesity rates increasingly recognize that crude aspects of environment alone (e.g., proximity of unhealthy foods) are not universally associated with individual obesity[18]. This finding does not negate the premise that the environmental change plays an important role in individual obesity control. In consideration of a social ecological framework, interventions may need to consider simultaneous changes at multiple levels to promote change by combining environmental actions with more intensive individual dietary and physical activity counseling or incentivized individual approaches to worksite wellness, as changes to the workplace environment may be necessary but not sufficient to change obesity-related health behaviors of individuals[18, 106].

Based on these findings, we hypothesize that during the 12-month study, the enrolled (overweight/obese) employee participants at campuses with high levels of Winners Circle (WC) implementation will eat healthier and lose more weight than overweight/obese employee participants in the campuses with a lower level of WC implementation. I further hypothesize that the effects of individual level interventions (WEB&WPI) will vary by the implementation of WC (i.e., the placement of WC stickers), such that the effects of individual level interventions on healthy eating/weight will be stronger in campuses with the placement of WC stickers compared to campuses without the placement of WC stickers at the 3, 6, and 12-month follow-up.

2.4.e. Other Worksite Characteristics as Covariates

Other worksite characteristics such as worksite size, the presence of administrative supports for wellness and/or an Employee Wellness Committee (EWC) may also play a role in controlling and maintaining a healthy weight among employees by promoting a supportive environment and offering resources to employees. Results from a nationally representative, cross-sectional telephone survey of worksite health promotion programs showed that worksites with more than 750 employees consistently offered more programs, policies, and services than did smaller worksites[109]. Moreover, worksites with a wellness committee reported a greater number of worksite health promotion programs than did those without either of these administrative supports[109]. For example, the PACE project[38], a multilevel intervention to promote activity and changes in eating that included worksite-wide events implemented in partnership with EWCs which successfully achieved changes in the physical activity and nutrition information environments. If these types of resources are offered by worksites in the WAY to Health study, it might potentially confound the effects of WC on employee weight loss outcomes. Therefore, we will include key worksite characteristics (i.e., worksite size, the presence of administrative supports for wellness, an EWC in place, budget for HPP and availability of physical activity facilities on campus) as potential covariates to assess the impact of these variables on behaviors that contribute to healthy eating and weight change over time.

2.5. Increased Autonomous Motivation and Physical Activity/Eating Self-efficacy as Potential Mechanisms

2.5.a. Physical Activity and Healthy Eating

Both diet and physical activity are important in achieving and maintaining a healthy body weight[12]. On the simplest level, obesity can arise only when energy intake exceeds energy expenditure. Low rates of non-basal components of energy expenditure, including energy expended in physical activity and the thermagenic effect of food, are factors which influence weight[110].

Unhealthy dietary habits are associated with obesity (e.g., each daily serving of a sugar-sweetened beverage increases the odds of becoming obese by 1.6 times)[62]. The American Cancer Society recommends that individuals eat five or more servings of vegetables and fruits a day for cancer prevention[63]. A recent systematic review shows that higher levels of fruits and vegetables intake were weakly associated with weight loss among overweight or obese adults in multi-component experimental studies that promoted several behaviors to induce negative energy balance, including increased fruits and vegetables consumption[111]. However, there has been little improvement in consumption since the mid-1990s. In 2007, only about one forth US adults were eating the recommended servings of fruits and vegetables[64].

The American Cancer Society also recommends that adults engage in at least 30 minutes of moderate to vigorous physical activity, on 5 or more days of the week[63]. However, similar to trends in nutrition, there has been little change in leisure-time physical activity during the 1990s. About one-fourth of adults do not engage in any leisure-time physical activity[64]. Compelling evidence exists that increased physical activity reduces people's risk for obesity and improves their quality of life[16]. Also, high levels of exercise may be necessary for long-term maintenance of weight loss[112]. No consensus exists on the amount of physical activity that are necessary to maintain the weight loss. A systematic review of the association between physical activity and weight gain including observational studies and randomized, controlled trials concluded that an increase in energy expenditure from physical activity of approximately 1,500 to 2,000 kcal/week is associated with improved weight maintenance[113]. In particular, many unanswered questions exist about the association of physical activity and weight loss. One study noted that a complex relationship of food intake and body weight to the duration of exercise exists; low-duration exercise leads to slightly decreased food intake, whereas increased length of exercise is accompanied by an increased food intake and prevention of weight reduction[114, 115]. In short-term interventions, restriction of calories to 1,200/d has a more pronounced effect on weight loss than that of exercise alone [115]. However, an exercise program lasting 12 weeks and consisting of physical activity 5 day/week, with 30 minutes of walking/running, when added to the dietary restrictions, helped to consolidate weight loss achieved by a calorie-restrictive diet [115]. For males, exercise-related body weight loss and fat weight loss are minimal (2.7% and 5%, respectively), and similarly, in females, body weight and fat weight loss are 2.6% and 4%, respectively[47, 115].

Therefore, more investigation is needed to describe (1) the duel process of physical activity/diet to reduce body weight, and, (2) the impact of weight loss interventions on psychological factors, PA, diet and weight loss. Successful weight management relies on at least two health behaviors, eating and exercise. However, little is known about their interaction on a motivational and behavioral level. We will study an overweight employee population and interventions designed to change the worksite environment in community colleges. We will examine the association between WAY interventions and participants' physical activity and healthy eating as well as how they relate to participants' weight change simultaneously.

2.5.b. Self-efficacy Related to Physical Activity and Healthy Eating

As described in Lockwood (2010) the theoretical underpinnings of potential mediators must be clearly stated and supported by prior research. Also, to be able to empirically test them, the potential mediators have to be properly assessed. Self-efficacy related to PA, healthy eating and motivation to participate in the weight loss program are the only ones that meet these criteria given our data and intervention design. In the long-term, weight regain is a typical outcome of weight loss interventions[47]. Weight regain is related to complex interactions between physiologic and psychosocial factors[47], which suggests a potential mediational relationship between the intervention, psychosocial factors and weight. The most common theoretical framework of the theory-based intervention studies examining potential mediators in physical activity include SCT and TTM[44]. Mediators such as behavioral processes of change and self-efficacy related to physical activity have received the most consistent support for mediating the relationship between physical activity interventions and Physical activity[44]. Bandura (1997) specifically cited self-efficacy—one's faith in one's ability to maintain physical activity in the face of challenges and setbacks—as a key to success in regular exercise. Numerous studies have found self-efficacy to be physically active to be associated with physical activity (for a review, see[44, 116]. Moreover, self-efficacy related to physical activity may mediate treatment effects on physical activity[117]. Fewer studies have examined self-efficacy as a pathway to explain healthy eating behavior[73, 86, 118, 119]. Anderson-Bill et al (2011) found that improved self-efficacy increased F&V intake (beta(total) =. 20, P =. 01)[46, 120, 121]. A recent review of the in nutrition literature[73] reveals that a wide range of potential mediators are possible, such as self-efficacy related to healthy eating, expectancies for life improvement from thinness, attitudes, accessibility to healthy food options, internal and external cues for meal cessation. But few studies used adequate statistical methods to test potential mediators. Researchers typically selected potential mediators based on factors that the intervention was designed to influence. Consistent with SCT, the WAY web-based weight loss program was designed to increase self-efficacy related to healthy eating and PA. Therefore, the goal of this study is to test self-efficacy related to healthy eating and physical activity as potential mediators or pathways to explain the intervention effects.

2.5.c. Autonomous and Controlled Motivations

Motivation is a critical factor in supporting sustained exercise and healthy eating, which are also associated with important health outcomes including weight loss[55, 122-124]. SDT proposes that motivation is multidimensional and resides along a continuum of self-determination ranging from no motivation (i.e. when a person lacks the motivation to act) through controlled motivation (i.e. when a person acts in response to external cues) to autonomous motivation (i.e. when a person acts for the inherent pleasure derived from that particular activity)[125]. The distinction between autonomous and controlled motivation is useful and compliments a growing body of evidence supporting SDT as a framework for understanding motivational processes in physical activity and healthy eating contexts. A cross-sectional nationwide survey of middle-aged women showed that the relationships between autonomous motivation and BMI as well as controlled motivation and BMI were partially mediated by the specific food and eating habits[122]. Accordingly, research on exercise motivation from the perspective of self-determination theory (SDT) has grown considerably in recent years. A systematic review on physical activity and self-determination theory provides good evidence for the value of SDT in understanding exercise behavior, demonstrating the importance of autonomous motivations in fostering physical activity[55]. A study to test the relationships between constructs from the self-determination theory (autonomous and controlled motivation) and self-efficacy within a theoretically integrated model suggests that changes in autonomous and controlled motivations positively predicted changes in self-efficacy towards healthy eating[126]. In this dissertation, we examine the relationships among the WAY interventions, SDT constructs (autonomous/controlled motivation), behaviors (PA/healthy eating) and weight loss with the co-varying self-efficacy related to physical activity and healthy eating.

2.5.d. WAY interventions link to the theories

2.5.d.1.Theoretically Based Web-based Interventions Targeting Physical Activity and Healthy Eating Self-efficacy

In the past decade, an explosion of the art and science of Internet-based interventions has occurred. Tate and colleagues have demonstrated the efficacy and cost-effectiveness of Internet-based weight loss programs for overweight and obese people in a series of randomized trials[49, 65-68, 94]. Various approaches to Internet behavioral treatment for weight loss were tested. These interventions with support via e-mail, automated messages, or chat rooms have produced weight losses of 4-7 kg over 6 months to 1 year[94].The WAY web-based intervention was designed based on SCT to help participants increase physical activity and healthy eating self-efficacy and self-regulation. [84]. SCT suggests that interventions must help individuals develop a sense of self-efficacy in specific behaviors (such as being physically active and eating nutritiously), which promotes individuals' positive expectations for behavior change and their modification or differential use of self-regulatory skills (ie, planning, self-monitoring, problem solving, and setting self-standards, goals, and self-incentives)[46].

2.5.d.2 Cash Incentives Increase Autonomous and Controlled Motivations to Participate in Weight Loss Program

According to a recent review, empirical research has supported that providing financial rewards for losing weight motivates people to engage in behaviors that produce weight loss[127]. In a large retrospective cohort study conducted to observe the relationship between financial incentives and worksite-based behavior change program registration, completion, and risk improvement rates, companies that offered incentives had significantly higher health coaching completion rates than companies not offering an incentive (82.9% vs. 76.4%, respectively, p =.

017) but there was no significant association with registration (p =. 384) or risk improvement rates (p =. 242). The actual incentive values were not significantly associated with risk improvement rates either (p =. 240) [128]. Finkelstein et al. tested the effect of different levels of financial incentives on weight loss among overweight employees and revealed that modest financial incentives can be effective in motivating overweight employees to lose weight[129]. However, there is little evidence that financial incentives are effective in changing people's long-term behaviors. According to a systematic review of the impact of worksite wellness programs, only 2 of 23 studies that used financial incentives actually evaluated the impact of incentives and found increased wellness activities participation and decreased risk for high body weight[130]. Adopting new health behaviors is more likely to occur because of embracing autonomous motivation like feeling energized, feeling a sense of accomplishment from achieving a goal, being a good role model for children and friends, and being able to spend quality time with other people who are practicing healthy behaviors[55, 122, 123, 131]. In fact, financial incentives can actually reduce a person's underlying motivation to practice a healthy lifestyle, especially when financial incentives are withdrawn[90]. This happens because people sometimes shift their attribution for practicing the behavior from the intrinsic benefits to the extrinsic financial reward. In other words, they begin to think that they are practicing the behavior primarily because they are receiving the financial reward and losing awareness of the intrinsic rewards. On the other hand, it is important to point out that there is also little evidence to prove that financial incentives do not produce long-term behavior changes; existing studies have small sample sizes and insufficient ranges of incentive amounts to provide that proof[130, 132, 133].

In this dissertation, we hypothesize that the cash incentives will reinforce employee's motivations to participate in the weight loss program. In a study to test whether the offer or receipt of an incentive would lead individuals to show differential changes in autonomous and controlled motivation for remaining in the WAY study[133], the cross-sectional and longitudinal analyses demonstrated inconsistence evidence to support that the WC+WPI had greater influence on autonomous motivation for participating in a weight loss program than WC+WEB. This dissertation will use more advanced statistical methods and add new knowledge beyond the study by Crane et al. (2012) in the following ways: 1) to assess whether financial incentives increase participants' autonomous and controlled motivations for participating in a weight loss program in the short term (i.e., autonomous and controlled motivations at 3 months after the beginning of the interventions); 2) to assess the effect of financial incentives in combination with WEB (i.e., compared with the WC only group); 3) to include all three intervention arms which results in a larger sample.

2.6. Summary

In conclusion, this dissertation will focus on two studies: 1) the contextual study of the impact of environmental change on employees' weight over time was framed using principles of SEF, and guided by RE-AIM framework and the worksite intervention literature; 2) the mediational study of the relationships between the WAY web-based weight loss program, autonomous and controlled motivations, physical activity and eating SE, healthy behaviors (i.e., eating, PA) and weight change were informed by the SCT, SDT and empirical studies from effective weight loss interventions as well as reports about mediation in nutrition and Physical activity in the literature. Both studies will be guided by conceptual model designed to understand key mechanisms of change along the path to weight loss. The WAY to Health interventions (WC, WC+WEB and WC+WPI) were theory-guided. The conceptual model provides a visual representation of the hypothesized relationships between individual and organizational level (multi-level) interventions delivered as part of the WAY to Health research study and the mechanisms which potentially influence employee weight change over time.

CHAPTER 3: METHODS

3.1. Overview

This dissertation will include two papers. Paper 1 of this dissertation is designed to examine the public health impact of the WC and will use both individual level and organizational level data from WAY project with 1004 employees in 17 enrolled worksites (e.g. colleges from North Carolina Community College System) (NCCCS) for a longitudinal contextual study. Paper 2 is designed to examine the pathways explaining the intervention effects of WAY interventions on individual's weight and will only use employee level data collected at baseline, 3, 6 and 12 months.

In order to address the two specific aims at multiple levels of SEF, we will use RE-AIM measures including reach, adoption and implementation of WC at the organizational level as well as implementation and effectiveness of WC at the employee level. Simultaneously, employee's body weight, PA, healthy eating, motivation to participate in a weight loss program and self-efficacy related to PA/ healthy eating as well as the demographic information were collected at the individual level.

Data for Paper 1 were obtained using a mix of qualitative and quantitative data collection methods from 5 sources: campus environmental assessments, workforce information data, key stakeholder interviews, anthropometric measurements of employees and a 30-minute self-administered survey among 1004 overweight/obese employees age 18 or above from 17 community colleges at baseline, 3, 6 and 12 months (See section 3.4 for a description of each instrument). Data for Paper 2 were obtained using anthropometric measurements of employees and the 30-minute self-administered survey at baseline, 3, 6 and 12 months. In this chapter, we will describe the sample, setting, recruitment efforts that are shared by the two papers, followed by a detailed description of the methods for Paper 1&2, respectively.

3.2. Sample/Settings and Recruitment Procedures

3.2.a. Worksite Recruitment

In response to a letter and brief interest survey faxed to the president of each community college, 81% (48/59) of colleges initially expressed interested in participating in a research study addressing employee weight loss. They completed a brief survey to provide key information about the campus and its employees[21]. After funding and IRB approval were secured, each college president was approached again to assess current interest. Thirty-four (58%) remained interested and were eligible for enrollment. Of the 34 colleges interested and eligible to participate, 16 (based on campus and employee size) were selected and accepted the invitation to enroll; 18 were waitlisted. However, prior to campus baseline data collection (and before randomization), two colleges withdrew: one for reasons unrelated to the study and one because the campus contact decided that there was insufficient staff time available to meet the study requirements. To make sure the research team could recruit enough eligible (overweight) employees into the weight loss study and given that several college campuses wanted to participate but had small numbers of employees, they combined two smaller campuses and randomized them as a cluster. Thus, the research team maintained ability to recruit enough overweight employees into the study and maintained/enhanced the sample size at the college level (e.g. preserving power to detect expected weight losses). All participating campuses signed a Campus Study Agreement Form that outlined the stages of the research study and described the responsibilities of the campus administration, enrolled employees and research team. Moreover, a campus contact kickoff event was held to orient the participating campuses to the study, provide the WC training and seek their help in conducting the key stakeholder interviews and environmental scans, recruiting employees, etc.

The 17 enrolled colleges employed a total of 8252 full-time and part-time employees. Using national figures, we estimated that 64% of community college employees were overweight or obese (BMI > 25 kg/m2), thus 5364 met the weight-related inclusion criteria. 2293 employees (43% of assumed eligible employees) either came to an onsite event or completed online screening. Of these 2,293 individuals screened, 906 (39.5%) were ineligible to participate; the primary reasons were BMI of less than 25 kg/m^2, aged less than 18 years, and not employed by the community college (Figure 8). Among otherwise eligible employees who attended the onsite assessment, 354 (15%) required physician consent either due to a BMI > 42 or based on responses to the PAR-Q[134]. Of the 354 who required a medical consent, 249 employees (70.3%) returned the signed physician consent form and were enrolled in the study. Another 278 employees (12.1% of employees assessed) did not attend the onsite baseline measurements required to confirm eligibility (Figure 8). Total 1004 participants were enrolled in the WAY project at baseline.

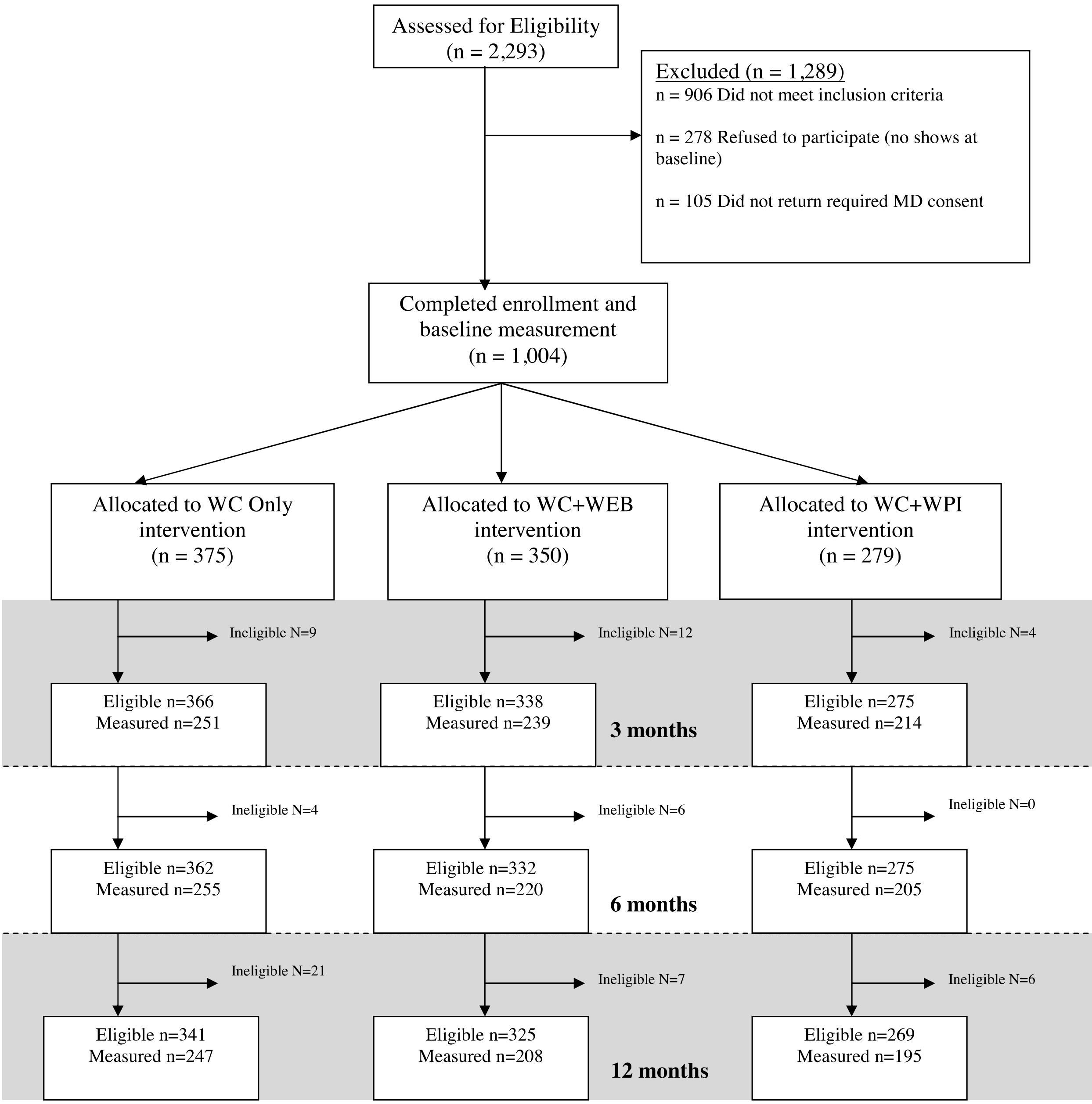


Figure 8. WAY to Health CONSORT Diagram: Participant level

3.2.b. Participant Recruitment

Participants were recruited through a variety of methods, including e-mail, flyers, posters, campus newsletter/newspaper articles, closed-caption television screen shots (where available), and links to the study website which were placed on campus websites. Eligibility criteria included being at least 18 years of age, working at a participating community college (either full or part-time) and having a body mass index (BMI) greater than $25kg/m^2$ Participants who were pregnant or lactating, had Type I diabetes, had recent weight loss of 20 lbs. or more, were currently taking weight loss medication, had either undergone or scheduled weight loss surgery, had experienced a malignancy requiring chemotherapy/radiation in the past 5 years, or who lacked Internet access either at home or at work were excluded. Physician consent was required of any participant who answered "yes" to any of those eligibility criteria items described above on the Physical Activity Readiness Questionnaire (PAR-Q)[134].

Participants were directed to the study website where screening questions were completed. Eligible participants viewed a copy of the study consent form, were asked to provide demographic information and completed a baseline survey, and were prompted to set an appointment during a three-day period when project staff would be on campus to complete enrollment. At the on-campus event, participants signed copies of the consent form and had their baseline height and weight measurements taken to verify eligibility with objective measurement. Additionally, participants who were enrolled in the State Health Plan were given the voluntary option of granting research staff access to their medical claims data. Interested employees who had not taken the online screener prior to the on-campus visit were accepted as "walk-ins" and underwent the same enrollment procedure, provided they met the eligibility criteria.

3.3. Intervention

After all baseline measures were collected, group randomization occurred when campuses (and all their enrolled employees) were assigned to one of three intervention groups: Winners Circle Dining Program (WC only), Web-based weight loss program plus WC (WEB+WC), Web-based weight loss program plus cash incentives plus WC (WPI+WC) (Table 1). Community colleges were the unit of randomization but individual enrolled employees were the unit of analysis.

3.3.a. WC (WC)

The WC intervention was designed to identify and promote (via labeling) healthy food options, to educate consumers about the benefits of choosing healthy foods and to increase access to healthy foods in cafeteria and vending facilities.

Each campus received multiple training opportunities for the WC. First, two Registered Dieticians from the NC Prevention Partners team offered a 4- hour workshop as part of the initial WAY to Health orientation session/kickoff event for all participating campuses. Campuses were invited to send two representatives to the initial campus contact kickoff event. It was suggested, but not required, that each campus include the study contact person (often the Human Resources/Benefits Director) as well as a food service operations person from the campus (either a campus employee and/or a food service vendor representative who serviced the campus). The Winner's Circle training session consisted of a brief overview of the history and purpose of the program, a review the criteria that food items had to meet in order to be labeled as "Winner's Circle" approved item, a tutorial on how to analyze food items to see if they met the Winner's Circle criteria, and discussions regarding potential Winner's Circle promotions. This interactive training session concluded by asking each campus to develop tailored marketing plans for the Winners Circle program.

In addition to the initial orientation/training session, trained project staff conducted two conference calls for participating campuses. One call reviewed the initial orientation materials with individuals who may not have attended the initial training session. The second call addressed onsite promotions and problem-solving for potential barriers. Additionally, trained project staff conducted a mini-training/booster session halfway through the project intervention period. Minutes of both conference calls and the mini-training were sent to all campuses, as well as a DVD recording of the initial training session. Project staff from WAY to Health and NC Prevention Partners were on call and available to provide technical assistance throughout the intervention period.

Campuses were encouraged to make use of all training opportunities but it was completely voluntary after the initial training. Thus, an assessment of the adoption and implementation of the WC intervention in 17 campuses became a "natural experiment" embedded within the larger WAY to Health study.

3.3.b. Web-Based Weight Loss Program (WEB)

Elements of website included lessons, diary, dynamic Behavioral, Focusing and Goal Setting activities, a graph or chart of weight change ove time, downloadable self-monitoring form and message board(Table 5). Upon completing the baseline measurement, employees in campuses randomized to the WEB or WPI interventions received the WEB intervention. Each enrolled employee was provided a guide book containing caloric information for commonly eaten foods (including popular restaurants) along with weekly calorie tracking booklets. Participants were not required to track their caloric intake but were encouraged to do so online.

3.3.c. Cash Incentive

In addition to Winner's Circle (WC) and the Web-based weight loss program (WEB), participants in the WPI+WC group received financial incentives for weight loss at each of the follow-up visits. Participants received $5 for each percent of baseline weight lost at each visit (3, 6, 12 months), thus rewarding both initial weight loss and maintenance of weight loss. Payouts at each time point were capped at 10% weight loss to encourage healthy weight loss patterns (e.g. not excessive, potentially harmful weight loss). The maximum total payout for weight loss over the course of the study was $150.

Participants in all three intervention groups also received a small cash stipend of $5, $10 and $20 for attending the 3-month, 6-month and 12-month follow-up visits, respectively, for completing study questionnaires. In addition, all participants who attended a follow-up weigh-in were included in a $100 prize drawing across all campuses. Participants received chances for the drawing by attending the follow-up visit; additional chances for the drawings were earned upon completion of the corresponding surveys at each follow-up event.

3.4. Data Collection Sources/Methods

3.4.a. Key Stakeholder Interviews

Prior to employee recruitment into the weight loss study, campus key stakeholders interviews with the President, Human Resource Director, Wellness Coordinator, Cafeteria and Vending Food Service Managers and Facilities Managers were conducted by trained research staff at all campuses. Structured interviews originally adapted from the Working Well Trial[135, 136].

3.4.b. Campus Environmental Scan

Trained staff also performed an environmental scan at each campus to make direct observation of food and physical activity-related programs, services and facilities. Specifically, food labeling, education and availability of healthy food options at cafeteria/snack bars (if applicable) and in snack and beverage vending machines at baseline, 3-months, 6-months and 12-months to monitor implementation of the WC program, described below in both text and table.

3.4.c. Campus Contact Survey

Questionnaires were distributed to all 17 campus contacts prior to the 3 (n = 17), 6 (n = 16), 9 (n = 14) and 12 month (n = 15) follow-up visits. Contacts were instructed to complete the questionnaires and either fax them back or hand them to research staff. These questionnaires were designed to collect process evaluation data regarding the implementation of the Winner's Circle.

3.4.d. Workforce Information Data

The workforce information data such as campus size were requested from each participating campus at the beginning of the study or from NCCCS records.

3.4.e. Employee Onsite Anthropometric Measurements /Questionnaires

At each assessment (baseline, 3, 6 and 12 months) weight was measured using standardized protocols. Height was measured at baseline only. The anthropometric measurements were conducted by a trained research assistant in a private room so that participant privacy was protected. The self-administrated questionnaires collected information on demographics, physical activity, healthy eating, motivations to participate in a weight loss program and self-efficacy for physical activity and specific eating behaviors and were administered onsite (baseline survey: either online or by paper; follow-up surveys: online) after the anthropometric measurements were taken. Mail or email reminders were sent to each enrolled employee 1 week and 1 day before the scheduled weigh-in measurement event.

3.5. Measures

Table 7. Measures and Data Collection Methods

Study	Type of Variable	Construct	Variable	SEF Level	Timing	Method	Instrument	Reference	Reliability
Paper 1: The impact of environmental change on employees' healthy eating and weight over time	RE-AIM Dimension-Reach	Reach of the Winner's Circle Dinning Program	Absolute number and proportion of employees who used the food service (i.e., cafeteria and/or vending machines) at the participating community colleges	Campus	Baseline, 12 mo	Questionnaire	Employee Survey	N/A	N/A
	RE-AIM Dimension-Adoption	Adoption of the Winner's Circle Dinning Program	Absolute number, proportion and characteristics of community colleges that implemented any component of the Winner's Circle over the 12 months of intervention	Campus	Baseline, 12 mo	Observation	Environmental Scan Forms	N/A	N/A
	RE-AIM Dimension-Implementation	Implementation of the Winner's Circle Dinning Program	Education & Labeling: the sum of the following 7 items (1=yes, 0 = no)	Campus	Baseline, 3, 6, 12 mo	Observation-tour	Environmental Scan Forms	Developed by the research team	The inter-rater reliability was 100%
			• Nutrition posters or signs? (Y/N)						
			• Labels or signs placed next to healthy food? (Y/N)						
			• Food items with easily visible nutrition information signs (fat grams, cals, etc.)? (Y/N)						
			• Nutrition information available for customers to take? (Y/N)						
			• Signs/prompts to choose low fat items? (Y/N)						
			• Signs/prompts to choose fruits and vegetables? (Y/N)						

Study	Type of Variable	Construct	Variable	SEF Level	Timing	Method	Instrument	Reference	Reliability
			• Low/reduced fat items labeled? (Y/N)						
			Access to Healthy Food: the sum of the following 10 items (1=yes, 0=no)	Campus	Baseline, 3, 6, 12 mo	Observation-tour	Environmental Scan Forms	Developed by the research team	The inter-rater reliability was 94%
			• Low-fat milk in the milk case? (Y/N)						
			• Low-fat yogurt? (Y/N)						
			• Low/reduced fat items on menu? (Y/N)						
			• High-fiber cereals displayed? (Y/N)						
			• Fruit available? (Y/N)						
			• Vegetables available? (Y/N)						
			• Frozen yogurt machine? (Y/N)						
			• Salad bar? (Y/N)						
			• Prepackaged salads? (Y/N)						
			• Special promotions featuring healthy food choices? (Y/N)						
	RE-AIM Dimension-Effectiveness	Implementation of WC	Placement of WC stickers	Campus	3, 6, 12 mo	Observation	Environmental Scan Forms	Developed by the research team	N/A
		Employee Weight	Weight	Employee	Baseline, 3, 6, 12 mo	Measured weight	N/A	N/A	N/A
		Employee Healthy Eating	Total calories	Employee	Baseline, 6, 12 mo	Questionnaire	Block Food Frequency Questionnaire	Block G, Hartman AM, Dresser CM, Carroll MD, Gannon J, Gardner L. A data-based approach to diet	0.74
			Fruits and vegetables	Employee	Baseline, 6, 12 mo	Questionnaire	Block Food Frequency		0.84

Study	Type of Variable	Construct	Variable	SEF Level	Timing	Method	Instrument	Reference	Reliability
							Questionnaire	questionnarie design and testing. Am J Epidemiol. 1986;124:453-469.	
			Total and saturated fat	Employee	Baseline, 6, 12 mo	Questionnaire	Block Food Frequency Questionnaire		0.72
			Eating Behaviors	Employee	Baseline, 6, 12 mo	Questionnaire	Eating Behavior Inventory	O'Neil PM, Currey HS, Hirsch AA, Malcolm RJ, Sexauer JD, Riddle FE, Taylor CI. Development and validation of the Eating Behavior Inventory. J Behav Assess 1979; 1: 123–132.	Split-half reliability=0.62; one month test-retest reliability =0.74
Paper 2: Pathways to explain weight loss program among community college employees	Independent Variable	WAY Intervention	Intervention arm(values=WC only, WEB +WC or WC+WPI)	Employee	Baseline, 12mo	Manipulated	N/A	N/A	N/A
	Dependent Variable	Employee Weight	Weight	Employee	Baseline, 3mo	Measured weight	N/A	N/A	N/A
	Mediators	Autonomous Motivation	Weight Loss Causality Orientations Scale (0-7 likert scale): Autonomous Regulation score	Employee	Baseline, 3mo	Questionnaire	Treatment Self-Regulation Questionnaire (TSRQ)	Rose, E.A., Markland, D., & Parfitt, G. The development and initial validation of the Exercise Causality Orientations Scale. Journal of Sports Sciences. 2001;19:445-462.	
		Controlled Motivation	Weight Loss Causality Orientations Scale (0-7 likert scale): Controlled Regulation Score	Employee	Baseline, 3mo	Questionnaire	Treatment Self-Regulation Questionnaire (TSRQ)	Rose, E.A., Markland, D., & Parfitt, G. The development and	

Study	Type of Variable	Construct	Variable	SEF Level	Timing	Method	Instrument	Reference	Reliability
								initial validation of the Exercise Causality Orientations Scale. Journal of Sports Sciences. 2001;19:445-462.	
		Physical Activity self-efficacy	Physical Activity self-efficacy (1-5 likert confidence, 5-item scale)	Employee	Baseline, 3mo	Questionnaire	Exercise self-efficacy	Marcus BH, Selby VC, Niaura RS, Rossi JS. Self-efficacy and the stages of exercise behavior change. Res Q Exer Sport. 63(1):60-66, 1992.	0.79
		Healthy Eating self-efficacy	Healthy Eating self-efficacy (0-9 likert confidence, 20-item scale)	Employee	Baseline, 3mo	Questionnaire	Weight Efficacy Lifestyle Questionnaire (WEL)	Clark MM, Abrams DB, Niaura RS, Eaton CA, Rossi JS. Self-efficacy in weight management. J Consult Clin Psychol 59:639-44, 1991.	0.9
		Physical Activity	Weekly Energy Expenditure	Employee	Baseline, 6mo	Questionnaire	Short IPAQ	Booth, M.L. (2000). Assessment of Physical Activity: An International Perspective. Research Quarterly for Exercise and Sport, 71 (2): s114-20	It exhibits moderate correlations with objectively assessed physical activity via pedometer or accelerometer data with criterion validity of a median ρ=0.30

Study	Type of Variable	Construct	Variable	SEF Level	Timing	Method	Instrument	Reference	Reliability
		Employee Healthy Eating	Total calories	Employee	Baseline, 6mo	Questionnaire	Block Food Frequency Questionnaire	Block G, Hartman AM, Dresser CM, Carroll MD, Gannon J, Gardner L. A data-based approach to diet questionnarie design and testing. Am J Epidemiol. 1986;124:453-469.	0.74
			Fruits and vegetables	Employee	Baseline, 6mo	Questionnaire	Block Food Frequency Questionnaire		0.84
			Total and saturated fat	Employee	**Timing**	Questionnaire	Block Food Frequency Questionnaire		0.72

3.5.a. Measures for Paper 1

In order to evaluate the public health impact of Winner's Circle, we used four of five dimensions of the RE-AIM framework namely "Reach", "Effectiveness", "Adoption" and "Implementation". Maintenance was not assessed in this study. The four dimensions are operationalized below.

3.5.a.1. Reach

Reach was defined as the absolute number and proportion of employees who used the food service (i.e., cafeteria and/or vending machines) at the participating community colleges. The characteristics of the employees who used the campus food service and the reasons why the employees did not used the cafeteria on campus were examined.

3.5.a.2. Effectiveness

Effectiveness of Winner's Circle program was addressed at the participants' level and defined as its main effect and interaction with the individual-level WAY interventions in the following behavioral and health outcomes: 1) change in healthy eating (i.e., total kilocalorie intake, fruit, vegetable and saturated fat consumption); 2) change in weight.

Implementation of WC was dichotomized as "placement of WC stickers" and "no WC stickers" to indicate the implementation of the key WC component-placement of Winners Circle stickers on vending machines or in the cafeteria.

Change in weight: the primary outcome for effectiveness was change in body weight from baseline to 12 months. We also report changes in body weight at 3 and 6 months compared to baseline weight. Weight was measured using a standardized protocol by trained staff with employees in casual street clothing, without shoes, on a calibrated electronic scale (Tanita BWB-800) and rounded to the nearest 2/10th of a pound.

Change in healthy eating: an additional outcome of interest was change in healthy eating (i.e., total Kcal, fruit, vegetable and fat consumption) from baseline to 12 months. Change in healthy eating at 6 months compared to baseline was also included. Total Kcal, fruit, vegetable and fat consumption were assessed onsite by Block Food Frequency questionnaire (version 1998)[137, 138]. This 110 food item questionnaire is designed to assess nutrient intake levels as well as specific foods and food groups (e.g., fruits, vegetables, meats) over extended periods. It takes 30-40 minutes to complete. The food list for this questionnaire was developed from the NHANES III dietary recall data. The nutrient database was developed from the USDA Nutrient Database for Standard Reference.

This questionnaire version requests that respondents estimate their daily, weekly, monthly, yearly, or rarely/ never consumption frequencies by indicating the exact number of times each food was eaten per day, per week, etc. Respondents were also asked to indicate whether their usual portion sizes were small, medium, or large compared with a standard. All completed questionnaires were checked by the study coordinator for accuracy and completeness. Daily intakes of energy and nutrients were estimated by multiplying frequency responses with the specified portion sizes and the nutrient values assigned to each food item in the nutrient database. The fruit and vegetable screener consists of ten items and is summarized as servings of fruits and vegetables per day. The fat screener consists of 17 items and assesses both fat and saturated fat. The percentage of total calories from saturated fat will be used in this study as one of the secondary outcomes[137]. The reliability coefficients for total calories, fruits and vegetables and total and saturated fat are 0.74, 0.84 and 0.72, respectively.

Other Potential Covariates include Employee **Demographic Characteristics** which includes employee job classification (faculty member vs. staff), gender, age, education, race/ethnicity, annual household income and number of years employed at the college, which were collected via employee questionnaires. **Campus Characteristics** include the campus size (number of employees) and existence of employee wellness committee (Y/N) were determined either via information provided by the NC Community College System and/or key stakeholder interviews (Table 8).

Table 8. Variables Associated with Worksite Characteristics

Worksite Characteristics	Question	Variable	Source
Administrative perceived importance to offer HPP to employees	How important do you think it is to offer health promotion programs to employees at this campus? Would you say it is not at all important, not very important, somewhat important, very important, or extremely important? [5-point Likert Scale]	P3BL	Baseline President Interview
Administrative perceived interest of faculty in participating in HPP	To what extent do you believe employees who are full-time faculty are interested in participating in health promotion programs on this campus: not at all, a little, to some extent, to a greater extent, or to a significant extent? [5-point Likert Scale]	P8BL	Baseline President Interview
Administrative perceived interest of staff in participating in HPP	To what extent do you believe employees who are full-time, staff are interested in participating in health promotion programs on this campus: not at all, a little, to some extent, to a greater extent, or to a significant extent? [5-point Likert Scale]	P7BL	Baseline President Interview
Number of Employees on Campus	Total Number of Full-time Employees	W3H1BL	Workforce Information Data
EWC in Place	Is there a wellness committee that exists on campus? [Yes/No]	W7ABL, HR13CBL	Baseline Wellness Coordinator and HR Interview
Budget for HPP	Is there currently a budget to support employee health promotion activities on this campus? [Yes/No]	BUDGET	Supplement Question for Wellness Coordinator
Availability of Physical Activity Facilities on Campus	Is this area(FITNESS FACILITY) present on campus?[Yes/No]	PAFacility	Environmental Scan Form

3.5.a.3. Adoption

Adoption was measured at the organizational level (campus) only and defined as the absolute number, proportion and characteristics of community colleges that implemented any component of the Winner's Circle over the 12 months of intervention. Moreover, the extent to which the community colleges participated in the WC training sessions, conference calls and booster session were documented.

3.5.a.4. Implementation

Implementation was addressed at both the campus level and the participants' level. Implementation at campus level was defined as the extent to which the community colleges successfully implemented the components of the Winner's Circle and was assessed by both the campus contact self-reported implementation and objective measures. Objective implementation was assessed using the Campus Environmental Scan data and rated on a four level scale by using the following criteria: "no WC stickers" indicated no placement of Winners Circle stickers on vending machines or in the cafeteria; "low" defined placement of Winners Circle stickers on vending machines or in the cafeteria; "medium" indicated stickers in the cafeteria and on vending machines or stickers in either the cafeteria or vending machines and at least one additional activity; and "high" indicated the use of stickers on vending machines, and in the cafeteria and one additional Winners Circle activity. Additional Winner's Circle activities included the use of signs, posters, or pamphlets on the program, specials or promotions.

Moreover, to quantify the level of implementation of Winner's Circle program two scales were created: 1) Education and Labeling; and 2) Access to Healthy Food. Education and Labeling assessed if various labeling or education materials were available using a 7-item scale. Access to Healthy Food accessed an employee's access to healthy food in cafeteria using a 10-

item scale (Table 7). In this study, we got an IRB approval to have two trained staff members perform an environmental scan simultaneously and independently to test the inter-rater reliability of the indices using a representative sample of 10-15 NC community colleges. The inter-rater reliability was 100% and 94% for Education and Labeling and Access to Healthy Food, respectively. We also examined whether the campus contacts reported the Winner's Circle program was in place ("Is the Winners Circle Dining Program in place on your campus at this time?" and which components were implemented ("What components of the Winners Circle Dining Program are in place in your campus cafeteria/vending at this time?"). In terms of utilization of technical assistance to implement the Winner's Circle program, results of the Campus Contact Survey items "To what extent has your campus used the Winners Circle Dining Program materials provided to you at the training?" and "Has your campus used any of the following help or technical assistance available to implement the Winners Circle Dining Program on your campus?" is reported. We will also discuss the campus contact's perceptions about the extent to which the Winner's Circle program helped employees lose weight, methods to promote the Winner's Circle Dining Program to employees on campus and barriers to implementation of the WC.

3.5.b. Measures for Paper 2

3.5.b.1. Dependent Variable

Weight

The participant's body weight at 12 months was the dependent variable controlling for his/her weight at baseline in the model. Weight was measured using a standardized protocol by trained staff with employees in casual street clothing, without shoes, on a calibrated electronic scale (Tanita BWB-800) and rounded to the nearest 2/10th of a pound.

3.5.b.2. Independent Variable

WC+WEB and WC+WPI Interventions

In Paper 2, we will explicitly test the impact of the web-based weight loss program with (WC+WPI) and without incentives (WC+WEB) by examining direct and indirect associations between the intervention groups (WC, WC+WEB and WC+WPI), motives, self-efficacy, healthy behaviors (i.e., eating, PA), and weight change.

3.5.b.3. Potential Mediators of Weight Change

Total Kcal, fruit, vegetable and fat consumption

Total kilocalorie intake, fruit, vegetable and saturated fat consumption at 6 months were assessed onsite by Block Food Frequency questionnaire (version 1998))[137, 138]. The details of this instrument and measures of total kilocalorie intake, fruit, vegetable and saturated fat consumption are described in Section 3.5.a.2. "Change in healthy eating".

Physical activity

The International Physical Activity Questionnaire-Short Form (IPAQ-Short) assessed physical activity at 6 months in which physical activity is measured by a 7 day recall. The total volume of physical activity is converted to Metabolic Equivalents (MET) min/week. Total MET min/week (i.e., the sum of the walking, moderate, and vigorous intensity activity MET-minutes/week scores) was used as a global measure of physical activity. This measure has demonstrated validity and reliability and performs similarly to the longer version of the questionnaire [139, 140]. It exhibits moderate correlations with objectively assessed physical activity via pedometer or accelerometer data with criterion validity of a median $\rho=0.30$[140-143] and produced repeatable data (Spearman's ρ clustered around 0.8) [140-143].

Autonomous and Controlled Motivations

Participants completed the Treatment Self-Regulation Questionnaire (TSRQ) as an indicator of their autonomous and controlled motives towards weight loss intervention participation at 3 months. Autonomous motives for remaining in the program and following the procedures of the program were assessed using three items; controlled motives were assessed by 7 items. Participants responded to each item on a scale of 1 (Not at all true) to 7 (Very true). An example of autonomous motives is “I feel like it's the best way to help myself”. An example of controlled motives is “Others would have been angry at me if I didn't”. Previous research using the TSRQ has reported internal consistency (Cronbach’s α) reliability estimates ranging from 0.67 to 0.87[52] and indicates that greater endorsement of autonomous motives measured by TSRQ scores predicts sustained weight change[96].

Health Eating Self-efficacy

Health eating self-efficacy at 3 months was assessed by the Weight Efficacy Life-Style Questionnaire (WEL) as part of the employee survey administered online or at the onsite assessment. Subjects were asked to rate their confidence about being able to successfully resist the desire to eat using a 10-point scale ranging from 0 (not confident) to 9 (yery confident). A principal components analysis revealed a five-component solution for the 20 items (4 per component) by two different methods of determining the number of components to retain (Velicer's, 1976, minimum average partial procedure and Horn's, 1965, parallel analysis method). The components are Negative Emotions, Availability, Social Pressure, Physical Discomfort, and Positive Activities. Scale scores were computed by summing the 4 items for each of the five scales. The Cronbach alpha coefficients of internal consistency ranged from. 90 for the Social Pressure scale to. 70 for the Positive Activities scale[144, 145].

Physical Activity Self-efficacy

Physical activity self-efficacy at 3 months was measured using a 5-item instrument on which participants indicated their confidence in being able to be physically active in a variety of situations[146]. This instrument uses a 5-point Likert scale ranging from 1 (not at all confident) to 5 (very confident). The Cronbach alpha coefficients of internal consistency reliability is 0.79[146].

3.6. Data Analysis

Before analyzing the data to achieve the specific aims, the following analyses were done for both aims. Frequency distributions were computed to describe the study sample. We used the baseline data to compare the characteristics of respondents who weighed in with those who did not weigh-in at the 12 months assessment by arm. The non-response analysis used generalized linear mixed models to determine if there was any significant difference between respondents and non-respondents by arm and whether the differential attrition is a threat to internal validity of the study. The statistical analyses for all analyses in this study accounted for the cluster random sampling design, with college as the unit of sampling, and employee nested within college as the unit of analysis. The hierarchical nature of the data enabled us to study the effectiveness of campus level Winner's Circle program net of the individual level interventions as well as to explore the mediation effects of several potential mediators to explain how the individual level interventions worked. The statistical techniques to be used to analyze data are detailed specifically under each Aim below.

3.6.a. Statistical Analysis for Paper 1

Descriptive statistics (percentages and means/standard deviations) were summarized for the worksite characteristic, participants' demographic and representativeness. Additionally, descriptive statistics were summarized for RE-AIM measures-Reach, Adoption and Implementation.

In order to examine the Effectiveness of WC, we fitted a 2-level Hierarchical Linear Model (HLM) for the change in each of the healthy eating variables as well as the change of body weight at each time point compared to baseline, which allows us to examine the interactions between placement of WC stickers and the web-based intervention and incentives as well as their main effects on changes in individual's weight (or healthy eating). The web-based intervention and incentives entered into the HLM as the individual-level factors and placement of WC stickers entered as the campus-level factor which influences both intercept and slope of the relationship between the individual-level intervention and change of weight (or healthy eating). Baseline body weight (or healthy eating), participant demographics (e.g., age, gender, race, education) and the worksite characteristics including number of full time employees, budget for health promotion programs, existence of an Employee Wellness Committees (EWC) and availability of physical activity facilities on campus were included as control variables in the HLMs. Multiple imputation was used to handle the missing data. Ten datasets were generated by assuming a monotone missing data pattern and imputing plausible values for the missing values via a Markov Chain Monte Carlo (MCMC) algorithm [147]. The combined parameter estimates from the separate analyses of 10 datasets were then used for hypothesis testing and inference. Age was group-mean centered and unit-level variables were grand mean centered to facilitate interpretation. Differences were considered statistically significant at $p < 0.05$.

The gross variance in weight (or healthy diet) change between individuals with campus-level context at certain time point was first estimated with a null, or unconditional model that contains only a random intercept. Then we incorporated the individual-level intervention variables (indicated as “Intervention” in the equations) and began with a linear model to look at the effects of the individual-level interventions on individual weight change over time controlling for the individual-level characteristics. The aforementioned two models were conducted for model building process and the results were not reported in this paper. Next, the main effects of individual-level interventions, individual-level characteristics, campus-level characteristics and placement of WC stickers (indicated as “WC” in the equations) were assessed in model a. In model b, an interaction term between placement of WC stickers and the individual-level interventions were then added to the model with estimations of random intercepts and slopes. The following are the final 2-level HLM. Intervention represents the individual level WAY interventions (i.e.,WEB, WPI), X_p represents a number of individual-level variables, Z_q represents a number of worksite characteristics variables:

Level 1: Difference in weight (or healthy diet) from baseline to certain timepoint $_{ij}$ =

$$\pi_{0j} + \pi_{1j} * Intervention_{ij} + \sum_{p=1}^{p} \pi_{pj} * X_{pij} + \varepsilon_{ij}$$

Level 2: $\pi_{0j} = \beta_{00} + \beta_{01} * WC_j ++ \sum_{q=1}^{q} \beta_{0q} * Z_{qj} + r_{0j}$

$$\pi_{1j} = \beta_{10} + \beta_{11} * WC_j + r_{1j}$$

$$\pi_{pj} = \beta_{p0}$$

After putting them together, we have

Difference in weight (or healthy diet) from baseline to certain timepoint $_{ij}$ =

$$\beta_{00} + \beta_{01} * WC_j + r_{0j} ++ + \sum_{q=1}^{q} \beta_{0q} * Z_{qj} + \sum_{p=1}^{p} \beta_{p0} * X_{pij} ++ r_{0j} + \varepsilon_{ij}$$

Level 1 residual distribution plots, residual by predictor plots and higher level random effect univariate/bivariate distribution plots, and random effect by predictor plots were examined as diagnostic analyses for the model fit. The key multilevel model assumptions will be evaluated through diagnostic analyses: Level 1 and Level 2 predictors are uncorrelated with Level 1 residuals and Level 2 random effects; the model is properly specified; Level 1 residuals are independent, homoscedastic and normally distributed with mean 0 and variance σ^2; Level 2 random effects are independent over Level 2 units, homoscedastic and multivariate normally distributed with mean 0 and covariance matrix T; Level 1 residuals are uncorrelated with Level 2 random effects and vice versa. Statistical analyses were performed using SAS Version 9.2.

3.6.b. Statistical Analysis for Paper 2

We used a recent innovation -the multilevel structural equation modeling (MSEM)[57], a synthesis of multilevel modeling and structural equation modeling to test a series of hypotheses for Paper 2 that the effects of WAY interventions on weight change are partially accounted for by motivations to participate in a weight loss program, healthy eating and physical activity self-efficacy and behaviors. The advantage of MSEM is that it can provide valid statistical inference when the units of observation form a hierarchy of nested clusters and some variables of interest are hypothetical constructs (i.e., latent variables) or measured by a set of items. In our study, we use a 20-item healthy eating self-efficacy scale and a 5-item physical activity self-efficacy scale to measure the healthy eating and physical activity self-efficacy (Figure 1). Treating the scale items as the multiple indicators of the latent variable, we can minimize the measurement error in the self-efficacy scales. By fitting one simultaneous model, all the parameters and standard errors are estimated conditional on the same effects being present in the model. Therefore, both theoretically and empirically, fitting a single MSEM model lends more efficient and elegant estimation of parameters or coefficients than regression[74]. A simulation study conducted by Iacobucci,D [148] documented that MSEM is more suitable than regression for all sample sizes. Given a large sample size for this analysis, MSEM is a tool well-suited for testing with clustered data, multiple mediator paths and causal chains longer than the traditional-all scenarios that are embedded in the Paper 2 hypotheses and will help us understand multiple mediator pathways and causal chains as depicted in the conceptual model.

Testing multilevel mediation within the standard multilevel modeling (MLM) paradigm has several limitations. First, the MLM approach may produce conflated estimates of between- and within-level components of indirect effects. We refer to effects of between-level components (variables) on other between-level components (variables) as “between effects”, and to effects of within-level components (variables) on other within-level components (variables) as “within effects”. MLM does not distinguish between effects from within effects, and instead report a single mean slope estimate that combines the two. Our study does not involve a between variable in the mediation. However, it’s possible that between components of level-1 variables (e.g., race) has an effect on between components of other level-1 variables (e.g., baseline weight) which causes between effects. At the same time, within components of level-1 variables (e.g., gender) has an effect on within components of other level-1 variables (e.g., PA) which causes within effects. The use of slopes that combine between and within effects can easily lead to indirect effects that are biased relative to their true values because the component paths may conflate effects that are relevant to mediation with effects that are not. Second, MLM approaches require a series of models for the mediation and are likely to be complicated both from a data management and model specification perspective[149]. Using the new advances in addressing multilevel mediation (e.g. a MSEM perspective), we can overcome these limitations of MLM mediation analysis. We will test the mediation in 1-1-1-1 design, in which the first “1” stands for the WAY interventions, the 2nd and 3rd “1” stands for the mediators (i.e., psychological factors and behaviors), the last “1” refers to the dependent variable weight. None of the variables of interest are at the campus level (“1” means they are all at the employee level) but the clustering nature of the data is accounted for in the model, by separating the individual-level mediators into within- and between-group components to yield a more thorough and less misleading understanding of indirect effects of the independent variable in hierarchical data. MSEM permits us to investigate the (1-1) and (1-1) linkages simultaneously, rather than in two steps as the conventional MLM framework requires. Using Mplus statistical software (version 6.0)[150], The MSEM estimated the path coefficients and the indirect effect of the individual level intervention for weight loss on the individual weight through the multiple mediators. The model fit will be assessed by Chi-square test for model fit and other fit indices (e.g., CFI, TLI, RMSEA) using Mplus 6.0[150].

3.7. Summary

The results of Paper 1&2 in this dissertation allowed us to move beyond simply establishing the effectiveness of the WAY interventions by also determining which aspects of WAY intervention are contributing to change. By using more rigorous, multilevel methods, we can establish the impact of the organizational change and the temporal sequence among psychological, behavioral and health outcome variables which will help describe healthy eating and PA, and for WAY interventions influencing those behaviors at the employee level, it provides insights for how future interventions may be modified and improved.

CHAPTER 4: EVALUATING A WORKSITE-BASED ENVIRONMENTAL CHANGE PROGRAM USING THE RE-AIM FRAMEWORK

4.1. Introduction

The worksite is a promising setting for health promotion activities targeting nutrition and physical activity (PA) to reduce body weight and body mass index (BMI)[8, 12, 13, 15]. The importance of the physical and social environment as factors in workers' health is widely recognized and have long been advocated as a basis for the investment in workplace environmental and policy change[12, 34]. According to a recent review of strategies on weight maintenance and prevention of weight gain among adults by the Agency for Healthcare Research and Quality (AHRQ), workplace interventions having both individual and environmental components was one of two interventions found to be effective with moderate strength of evidence[9]. Strategies for weight maintenance and prevention of weight gain are also beneficial to weight loss. According to the Practical Guide Identification, Evaluation, and Treatment of Overweight and Obesity in Adults[5], the goals of weight loss are to reduce body weight and maintain a lower body weight for the long term; the prevention of further weight gain is the minimum goal. After the first 6 months of weight loss treatment, the priority should be weight maintenance achieved through combined changes in diet, physical activity, and behavior transition. Epidemiological evidence suggests that worksite environmental and individual level interventions may have important effects on health, but understanding their complex interactions requires a multilevel analytic approach[151, 152]

The long-range goal of this study was to improve evaluation of the multilevel intervention programs that incorporate environmental and individual components guided by the RE-AIM (Reach, Effectiveness, Adoption, Implementation, Maintenance) evaluation framework designed by Glasgow et al[26]. Translating interventions proven to be efficacious to practice allows for a greater public health impact[153]. However, the efficacy-based research paradigm that dominates our current notions of science is limiting and not always the most appropriate standard to apply because the interventions proven to be efficacious are often delivered and tested in a very restrict scientific environment[154, 155]. The RE-AIM framework is compatible with systems-based and social-ecological thinking as well as community-based and public health interventions[97, 156, 157].

A unique contribution of this study is to test the interaction between the individual-level and environmental interventions. First, despite the multilevel worksite-based interventions were structured to target multiple levels of influence following a socioecological model, few studies have investigated the interactions between individual-level and environmental interventions[12, 38, 158]. What has not been adequately explored is the role played by the environmental change into which a given individual-level change is embedded and how it may affect individual-level change responses[159]. Secondly, the existing research provides inconclusive evidence for the effectiveness of environmental and policy changes alone to change employee dietary behaviors[160-163] whereas the multilevel interventions combining both individual level and environmental changes showed moderate evidence for the effectiveness of improving employee dietary[164-167]. Kahn-Marshall et al (2012) reviewed the worksite health promotion literature to investigate programs that are aimed to change the environment to increase healthy dietary intake and physical activity[18]. Limited evidence was found for the effectiveness of environmental and/or policy changes alone (n = 11 studies) to change employee behavior, but intervention studies (n=5) that provided individually focused health education and modified the dietary environment in workplaces such as food labeling, promotional materials, and enhanced availability and placement of healthy foods in cafeterias and vending machines showed modest improvements in employee self-reported consumption of fruits/vegetables and fat intake[18]. Therefore, the study of the interactions between environmental and individual-level interventions in workplace has clinical importance because it further explains why it's beneficial to combine both individual level and environmental changes; whereasthe environmental changes alone may or may not have a direct impact on individual's behaviors.

The WAY to Health study (referred to as "WAY") is a three-year, three-group randomized, controlled weight loss intervention trial. It was designed to test the effects of two individual-level interventions (i.e., the web-based program and cash incentives) and one environmental change intervention on weight change over 12 months among 1004 overweight and obese employees enrolled across 17 community colleges. This paper describes the evaluation of the minimal-intensity worksite-based environmental change intervention called The Winner's Circle Dining Program (WC) that served as the "usual care" arm of a 3-arm intervention trial. . To understand the reach, effectiveness, adoption and implementation of the WC in the real-world settings, we address the following research questions:

1. How many and what percentage of employees can be reached by the Winner's Circle program?

2. To what extent does the implementation of Winner's Circle moderate the effects of individual-level weight loss intervention and influence individual's healthy eating and weight change?

3. To what extent was the Winner's Circle program adopted and implemented at the organizational level?

4. To what extent is the Winner's Circle program implemented at the individual level (e.g., awareness and satisfaction with the Winner's Circle program)?

4.2. Methods

Study Design

17 community colleges were enrolled in the WAY to Health research study[21] and then were randomized into one of three arms: group 1 (WC only) served as control, group 2 (WC+WEB) received WC and a 52-lesson web-based weight loss program developed by Tate[49, 65-68]; group 3 (WC+WPI) received the WC and web-based weight loss program plus cash incentives based on weight loss. The RE-AIM framework was used to examine WC's overall public health impact because it addresses individual (employee)-level and organizational (worksite)-level factors along five dimensions: (1) reach, the percentage and representativeness of individuals who participate in the intervention; (2) effectiveness, the impact of the intervention on targeted outcomes; (3) adoption, the percentage and representativeness of settings and intervention staff who agree to deliver a program; (4) implementation, the consistency and skill with which program components are delivered by intervention staff; and (5) maintenance, the extent to which individuals maintain behavior change and organizations sustain program delivery over time[26]. As the usual care of the WAY to Health study, WC was offered to all 17 participating community colleges with the same access to training and resources, which provides a unique opportunity and a "natural experiment" for examining the reach, effectiveness, adoption and implementation of WC across all campuses enrolled in the study.

To test the effectiveness of WC, the WAY community colleges with no placement of Winners Circle stickers on vending machines or in the cafeteria were categorized as the "No WC stickers" group; other participating community colleges were grouped into the "WC stickers in place" group. We present the results from a quasi-experiment using a non-equivalent comparison group design with dependent pretest posttest samples that existed within the larger trial to help understand the effectiveness of Winner's Circle. The WAY study was approved by the Institutional Review Board at both the University of North Carolina at Chapel Hill and Research Triangle Institute (RTI).

Sample

A detailed description of WAY is available elsewhere[21, 56] The 17 participating community colleges comprised a total 8252 full-time and part-time employees, of which 1004 overweight and obese employees (12%) participated in the WAY project and completed the surveys and anthropometric measurements at baseline. Employee retention was 704(72%) at 3 months, 680(70%) at 6 months and 650(70%) at 12 months (see section 3.2, Figure 8. Consort Diagram). Only participants with self-reported use of campus food service in these community colleges (n=626) were included in the analysis of Effectiveness and Implementation at the participants' level (participants' awareness and satisfaction of WC).

Data Collection Instruments/Procedures

<u>Employee onsite anthropometric measurements /Questionnaires</u>

At each assessment event, employee height (baseline only) and weights were measured using standardized protocols by trained research staff at baseline, 3, 6 and 12 months. The self-administrated questionnaires collected information on demographics, use of campus food service, awareness and attitude toward Winner's Circle. Total kilocalorie intake, fruit, vegetable and saturated fat consumption were also assessed onsite by Block Food Frequency questionnaire (version 1998) at baseline, 6 and 12 months[137, 138].

Organizational-level measurements/Interviews

Prior to employee recruitment, campus key stakeholders interviews with the President, Human Resource Director, Wellness Coordinator, Cafeteria and Vending Food Service Managers and Facilities Managers were conducted by trained research staff by phone or in person at all campuses. The contextual variables such as administrative, staff and faculty members perceived importance of health promotion program for employees, number of full time employees, budget for health promotion programs, existence of an Employee Wellness Committees (EWC) and availability of physical activity facilities on campus were collected through the structured interviews originally adapted from the Working Well Trial[135, 168]. Campus contacts were interviewed at baseline, 3, 6 and 12 months. Items on this interview included whether the entire Winner's Circle program had been adopted, if individual elements of the program had been implemented, assessed promotional strategies that had been used to communicate the program to employees, and perceived implementation barriers. Moreover, trained staff performed an environmental scan at each campus to make direct observation of food and physical activity-related programs, services and facilities. Specifically, food labeling, education and availability of healthy food options at cafeteria/snack bars (if applicable) and in snack and beverage vending machines at each time point to obtain objective measures of program adoption and level of implementation of Winner's Circle.

Measures

In order to evaluate the Winner's Circle on public health effects and feasibility, we used four dimensions of the RE-AIM framework: "Reach", "Effectiveness", "Adoption" and "Implementation". Maintenance was not assessed in this study.

Reach was defined as the absolute number and proportion of participants who used the food services (i.e., cafeteria and/or vending machines) at the participating community colleges. The Reach was defined in a more practical way because the WC was an environmental intervention, everybody who used the food services on campus were exposed to the WC. The characteristics of the employees who used the campus food services and the reasons why the employees did not eat on campus were examined.

Effectiveness of Winner's Circle program was addressed at the participants' level and defined as its main effect and interaction with the individual-level WAY interventions in the following behavioural and health outcomes: 1) change in healthy eating (i.e., total kilocalorie intake, fruit, vegetable and saturated fat consumption); 2) change in weight. We hypothesized that the effects of web-based weight loss program and cash incentives on employee healthy eating and weight change varied by the WC implementation at the campus level, such that in the campuses with WC implemented, the positive effects of the individual-level WAY interventions on the participants' healthy eating/weight change were stronger compared to those who were in campuses where WC was not implemented during the 12-month intervention period.

Adoption was measured at the organizational level (campus) only and defined as the absolute number, proportion and characteristics of community colleges that implemented any component of the Winner's Circle over the 12 months of intervention.

Implementation was addressed at both the campus level and the participants' level. Implementation at campus level was defined as the extent to which the community colleges successfully implemented the components of the Winner's Circle and was assessed by both the campus contact self-reported implementation and objective measures. Objective implementation was assessed using the Campus Environmental Scans data and rated on a four level scale by using the following criteria: "no WC stickers" indicated no placement of Winners Circle stickers on vending machines or in the cafeteria; "low" defined placement of Winners Circle stickers on vending machines or in the cafeteria; "medium" indicated stickers in the cafeteria and on vending machines or stickers in either the cafeteria or vending machines and at least one additional activity; and "high" indicated the use of stickers on vending machines, and in the cafeteria and one additional Winners Circle activity. Additional Winner's Circle activities included the use of signs, posters, or pamphlets on the program, or specials or promotions.

In addition, two objective implementation measures (i.e., a 7-item "Education and Labeling" index and a 10-item "Access to Healthy Food" index) were also created using the Campus Environmental Scans data to assessed if various labeling or education materials including but not limited to WC-related education and labelling materials were available as well as an employee's access to healthy food in cafeteria and vending machines. Because the two indices were original and constructed by the investigators, the measures were validated and the interrater reliability were 100% and 94% for Education and Labeling and Access to Healthy Food, respectively. Implementation at the participants' level was defined as the participants' awareness and satisfaction with the Winner's Circle.

Data Analysis

Descriptive statistics (percentages and means/standard deviations) were summarized for the worksite and participants' characteristics. A logistic model with mixed effects was used to compare the participants' characteristics between the "WC stickers in place" group and "no WC sticker" group. The Fisher's Exact Test or Wilcoxon Rank-sum Test was used to compare the campus characteristics between the "WC stickers in place" group and "no WC sticker" group for the categorical or continuous variables (including ordinal variables) as appropriate.

To understand research question 1-reach of Winner's Circle, the absolute number, proportion and characteristics of employees who used the food service (i.e., cafeteria and/or vending machines) at the participating community colleges were presented. The main reasons why the participants did not eat in cafeteria were also summarized among those who did not eat on campus. Furthermore, we used a logistic model with mixed effects to examine the relationship between eating on campus and age, gender, race, income, faculty (vs. staff) status, and baseline weight.

To understand research question 2-effectiveness of Winner's Circle, only those who used the food service at the participating community colleges were included in the analysis sample to examine the effectiveness of Winner's Circle. We fitted a 2-level Hierarchical Linear Model (HLM) for the change in each of the healthy eating variables as well as the change of body weight at each time point compared to baseline, which allows us to examine the interactions between the placement of WC stickers ("No WC stickers" vs." WC stickers in place") and the web-based intervention and incentives as well as their main effects on changes in individual's weight (or healthy eating). The web-based intervention and incentives entered into the HLM as the individual-level factors and the placement of WC stickers entered as the campus-level factor which influences both intercept and slope of the relationship between the individual-level intervention and change of weight (or healthy eating). Baseline body weight (or healthy eating), participant demographics (e.g., age, gender, race, education) and the worksite characteristics including number of full time employees, budget for health promotion programs, existence of an Employee Wellness Committees (EWC) and availability of physical activity facilities on campus were included as control variables in the HLMs. Furthermore, we tested the null hypothesis that the group mean of weight loss was not different from zero in the six intervention groups: 1) WC group with WC stickers in place, 2) WC +WEB group with WC stickers in place, 3) WC+WPI group with WC stickers in place, 4) WC group without WC stickers, 5) WC+WEB group without WC stickers and 6) WC+WPI group without WC stickers. The dummy variables of the six intervention groups entered a 2-level mixed effects model (no intercept) as the predictors of the weight loss at certain time point to test H_0: weight loss at certain time point within a given intervention group=0. Multiple imputation (MI) was used to handle the missing data. Ten datasets were generated by assuming a monotone missing data pattern and imputing plausible values for the missing values via a Markov Chain Monte Carlo (MCMC) algorithm [147]. The combined parameter estimates from the separate analyses of 10 datasets were then used for hypothesis testing and inference. A completers-only analysis was also conducted and compared with the MI method. Results were consistent across approaches so we only report results from the MI method here. Age was group-mean centered and unit-level variables were grand mean centered to facilitate interpretation. Differences were considered statistically significant at $p < 0.05$.

To understand research question 3-adoption and implementation of Winner's Circle at the organizational level, descriptive statistics (percentage and means/standard deviations) were used to examine the presence of education and labelling, access to healthy food, workshop/technical assistance the worksite staff utilized, strategies they used to promote the Winner's Circle program among employees and barriers to implementing the Winner's Circle program. The Fisher's Exact Test was used to compare the education and labelling as well as the access to healthy food between campuses with and without WC stickers in place.

To understand research question 4-the implementation at the individual level, descriptive statistics (percentage and means/standard deviations) were used to examine participants' awareness and satisfaction with the Winner's Circle program. Statistical analyses were performed using SAS Version 9.2.

4.3. Results

Participants Characteristics

Table 9 shows the baseline characteristics of all participants (n=1004), as well as the participants who used food services on campus (n=626) compared to those who did not (n=378). On average, WAY to Health participants weighed 204.4 pounds, with a BMI of 33.6 $kg/m^{2.}$ The average age was 46.9 years, with the majority of the sample being female (82.2%), and White (83.2%). Forty-six percent reported having an Associates or Bachelors degree, 42% reported holding an advanced degree (Masters, Professional or Doctoral degree). In terms of job classification, 40.3% were faculty while 57.6% were staff. Approximately half of the participants fell within the $30,001-$50,000 income range. Moreover, among those who used food services on campus (n=626), participants in the "WC stickers in place" group were compared to those in the "No WC stickers" group (n=280). Overweight and obese employees who ate on campus in the "WC stickers in place" group did not differ from those from "no WC sticker" group in terms of gender, age, race, baseline weight, income and faculty (vs. staff) status (Table 8).

Characteristics of Community Colleges

Campuses employed an average of 280 full time employees (Table 10). The campuses with WC stickers in place had greater administrative perceived importance to offer HPP to employees (4.6, STD=0.5, 5-point likert scale) than those without WC stickers (4.0, STD=0.8, 5-point likert scale) (Wilcoxon Two-Sample Test, S=67.5, p=0.5). Half of campuses with WC stickers in place (55.6%) had funding available for health promotion programs while only 16.7% of campuses without WC stickers had funding available for health promotion programs (Fisher's Exact Test, F=5, p=0.29).

All 17 (100%) participating campuses reported having snack and beverage vending machines. Ten campuses (58.8%) had cafeterias on-site, 3 (17.6%) had short-order grills, 2 (11.8%) had snack bars where no prepared food was available and 2(11.8%) had vending machines only. In addition, 14 (82.4%) of campuses have gym facilities accessible to employees and 47% had an active wellness committee.

Table 9. Baseline characteristics of participants by use of campus food services and WC implementation

	A=B+E: All WAY to Health (n= 1004)		B=C+D: All Participants Used Campus Food Services (n=626)		C: Participants Used Food Services on Campus with WC Stickers in Place Group (n=346)		D: Participants Used Food Services on Campus with No WC Sticker (n=280)		E: Participants Did not Use Campus Food Services (n=378)	
Variable	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**
Intervention										
WC	37.4	375	37.1	232	35.8	124	38.6	108	37.8	143
WC+WEB	34.9	350	32.6	204	27.5	95	38.9	109	38.6	146
WC+WPI	27.8	279	30.4	190	36.7	127	22.5	63	23.5	89
Female	82.2	793	81.4	493	84.2	283	77.8	210	83.6	300
Hispanic	1.4	13	1	6	0.9	3	1.1	3	2	7
Race										
White	83.2	799	84.6	512	86.0	288	83.0	224	80.8	287
African American	13.3	128	12.1	73	11.3	38	13.0	35	15.5	55
Other	3.4	33	3.3	20	2.7	9	4.1	11	3.7	13
Household Income										
$0 -30,000	29.2	255	29.9	166	29.6	91	30.1	75	28.1	89
$30,001 - 50,000	43.8	382	44.4	247	45.9	141	42.6	106	42.6	135
$50,000+	27	236	25.7	143	24.4	75	27.3	68	29.3	93
Education										
HS graduate or less	2	19	2	12	2.1	7	1.9	5	2	7
Some college/tech school but no degree	10	96	8.6	52	8.3	28	8.9	24	12.4	44
Assoc/Bach degree	46.2	445	49.3	299	48.7	164	50.0	135	41	146
Post-graduate degree	41.8	403	40.2	244	40.9	138	39.3	106	44.7	159
Job Classification										
Faculty	40.3	393	37.8	231	37.1	126	38.7	105	44.5	162
Staff	57.6	562	59.7	365	59.4	202	60.1	163	54.1	197
Other	2.1	20	2.5	15	3.5	12	1.1	3	1.4	5
Full time	86.8	848	87.6	538	85.1	291	90.8	247	85.4	310
General Health Rating										
Excellent	6	51	6	36	6.7	22	5.1	14	6	15

	A=B+E: All WAY to Health (n= 1004)		B=C+D: All Participants Used Campus Food Services (n=626)		C: Participants Used Food Services on Campus with WC Stickers in Place Group (n=346)		D: Participants Used Food Services on Campus with No WC Sticker (n=280)		E: Participants Did not Use Campus Food Services (n=378)	
Variable	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**
Very good	37.6	320	36.9	222	36.1	119	37.9	103	39.2	98
Good	43.1	367	42.4	255	40.6	134	44.5	121	44.8	112
Fair	11.6	99	12.6	76	13.6	45	11.4	31	9.2	23
Poor	1.8	15	2.2	13	3.0	10	1.1	3	0.8	2
BMI Category										
25.0-29.9	32.6	327	31.6	198	32.9	114	30.0	84	34.1	129
30.0-34.9	30.7	308	31	194	29.8	103	32.5	91	30.2	114
35.0-39.9	20.4	205	20.1	126	21.4	74	18.6	52	20.9	79
40+	16.3	164	17.3	108	15.9	55	18.9	53	14.8	56
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Weight (lbs)	204.4	47.3	206	46.7	203.3	34.8	209.3	46.9	201.7	49.2
BMI	33.6	7.9	33.8	7.2	33.7	5.8	34.0	8.3	33.1	7.4
Age	46.9	12.1	46.3	10.9	46.5	8.3	46.1	13.5	47.7	9.9
Kcals/day	1907.6	893.8	1961.4	872.7	1941.8	668.5	1984.6	1039.4	1796.4	826.8
Mean % from fat	39.9	7.3	40.1	6.4	40.0	4.0	40.3	8.3	39.6	7.6
Fruit and Vegetable Servings	4.4	3.9	4.4	3.4	4.5	3.6	4.3	3.3	4.6	3
Walking (MET-minutes/week)	359.1	928.6	364.6	923.1	351.5	722.6	380.6	1086.3	341.8	525.1
Moderate (MET-minutes/week)	290.5	672.4	292.5	645.1	264.1	632.7	327.0	544.3	284.1	652.5
Vigorous (MET-minutes/week)	691.3	1144	670.1	990	677.7	1066.5	660.7	888.7	757.5	1191.6
Total physical activity (MET-minutes/week)	1334.7	2150	1314.2	1925.8	1285.9	1554.1	1348.9	2235.2	1399.4	1765.8

Table 10. Campus Characteristics by WC implementation

	All (n=17)	WC Stickers in Place (n=9)	No WC Stickers (n=8)
	%	%	%
Intervention			
WC	41.2	44.4	37.5
WC+WEB	29.4	22.2	37.5
WC+WPI	29.4	33.3	25
EWC in Place	47.1	44.4	50
Funding available for HPP	40	55.6	16.7
Gym available to employees	82.4	77.8	87.5
	Mean (SD)	**Mean (SD)**	**Mean (SD)**
Number of employees on campus *100ppl	2.8(1.5)	3.2(1.5)	2.4(1.5)
Administrative perceived importance to offer HPP to employees [5-point]	4.3(0.7)	4.6(0.5)	4(0.8)
Administrative perceived interest of faculty in participating in HPP [5-point]	3.6(0.7)	3.6(0.7)	3.6(0.7)
Administrative perceived interest of staff in participating in HPP [5-point]	3.6(0.7)	3.6(0.7)	3.6(0.7)

Reach

Of all participating employees, 62% (626/1004) reported that they used the food services (i.e., cafeteria or vending machines) on campus thus were reached by the Winner's Circle dinning program. As shown in Table 9, at baseline, overweight and obese employees who ate on campus (N=626) did not significantly differ from those who did not eat on campus (N=378) in terms of gender, age, race, baseline weight, income and faculty (vs. staff) status. Among 626 participants who ate on campus, the average number of days per week they purchased food in the cafeteria was 1.9 days/week (STD=1.2); the average number of days per week they went off campus to purchase food was 2.1 days/week (STD=1.6) at baseline. Among 378 participants who did not eat on campus, the most cited reason for not eating in the cafeteria was there isn't enough variety of food to choose from (7.1%). Other reasons include there aren't enough healthy options (6.6%), the food is too expensive (6.1%) and the food doesn't taste good (3.7%).

Effectiveness

Table 11 presents the effects of individual-level interventions (i.e., WEB, WPI), WC implementation (i.e., placement of WC stickers) as well as WEB×WC and WPI ×WC effects on individual changes in weight and healthy diet over 12 months among the participants who used the campus food services (n=626) controlling for individual-level and campus-level characteristics. The results also show that statistically significant random variation (τ) in participant's weight (healthy diet) change between individuals was sustained with each sequential model, meaning there is still significant variation in participant's weight (healthy diet) change that has not been explained by our models.

We can explain the results of the reduced models (i.e., main effects models or model a) for weight change at 3 and 6 months because the adjusted effect of WEB or WPI did not vary by placement of WC stickers (i.e., the interaction terms were not significant) controlling for the individual-level and campus-level characteristics as shown in the interaction models (model b). As expected, the participants from the campuses with WC stickers in place lost more weight at 3 months (-1.1lb, SE=0.7) and 6 months (-0.3 lbs, SE=1.0) compared to those from the campuses without WC stickers, controlling for individual-level intervention, participant characteristics and campus-level characteristics. The main effect of WC at 12 months (β= 3.1, SE=1.9) was not statistically significant. Importantly, the interaction of WPI ×WC significantly predicted individual weight changes at 12 months (β= -5.7, SE=2.9, $P<.05$), such that the positive effect of WPI on individual's weight loss was significantly stronger among participants from campuses with WC stickers in place compared to those from campuses without WC stickers. On average, participants who received WPI from campuses with WC stickers in place lost 2.6 lbs (3.1-5.7=2.6 lbs) more than those who received WPI from campuses without WC stickers at the 12-month follow-up. Although not the focus of this study, the effects of WEB and WPI were also manifested in model a - compared to the control group, participants lost significantly more weight in the WPI (-6.0 lbs, SE=1.0, $P<.0001$) and WEB intervention groups (-3.7 lbs SE=0.9, $P<.0001$) at 3 months and continued losing more weight in the WPI (-6.9 lbs, SE=1.4, $P<.0001$) and WEB groups (-3.2 lbs SE=1.2, $P<.01$) at 6 months compared to the control group as we expected. Thus, the effect of WC did not produce statistically significant weight loss but its interaction with WPI was significant at 12 months.

To further depict the interactions of WC and individual-level interventions, over time, Figure 9 presents individual changes across time for different intervention groups with and without WC stickers in place. The figure shows that on average, participants in the WC+WPI group achieved greater weight loss than the WC+WEB and WC groups. Participants in the WC+WPI group from campuses with WC stickers in place maintained the leading role of weight loss among the three groups and reported the greatest average weight loss at the 12 months. On the contrary, participants in the WC+WPI group from campuses without WC stickers did not significantly lose more weight compared to the WC group at 12 months.

The results of the statistical tests of H_0: weight loss at certain time point within a given intervention group=0 further confirmed the findings of Figure 1. For campuses with WC stickers in place, the average weight loss among participants in the WC+WPI group was significantly different from zero at 3 months (-3.2lbs, $P<0.0001$), 6 months (-3.8lbs, $P<0.0001$) and 12 months (-4.8lbs, $P<0.0001$); the average weight loss among participants in the WC+WEB group was significantly different from zero at 3 months (-3.1lbs, $P<0.0001$) and 6 months (-3.1lbs, $P<0.01$); the average weight loss among participants in the control (i,e., WC group alone) was not significantly different from zero at 3 months (-0.6lbs, $P>0.05$), 6 months (-0.9lbs, $P>0.05$) or 12 months (-0.3lbs, $P>0.05$).

For campuses without WC stickers in place, the average weight loss among participants in the WC+WPI group was only significantly different from zero at 3 months (-2.4lbs, $P<0.05$) and 6 months (-2.6lbs, $P<0.05$). At the12 months follow-up assessment, the average weight loss among participants in the WC+WPI group was no longer significantly different from zero (-1.1lbs, $P>0.05$); moreover, the average weight loss among participants in the WC+WEB group or WC group alone was not significantly different from zero at 3 months, 6 months or 12 months if the campus has no WC stickers in place.

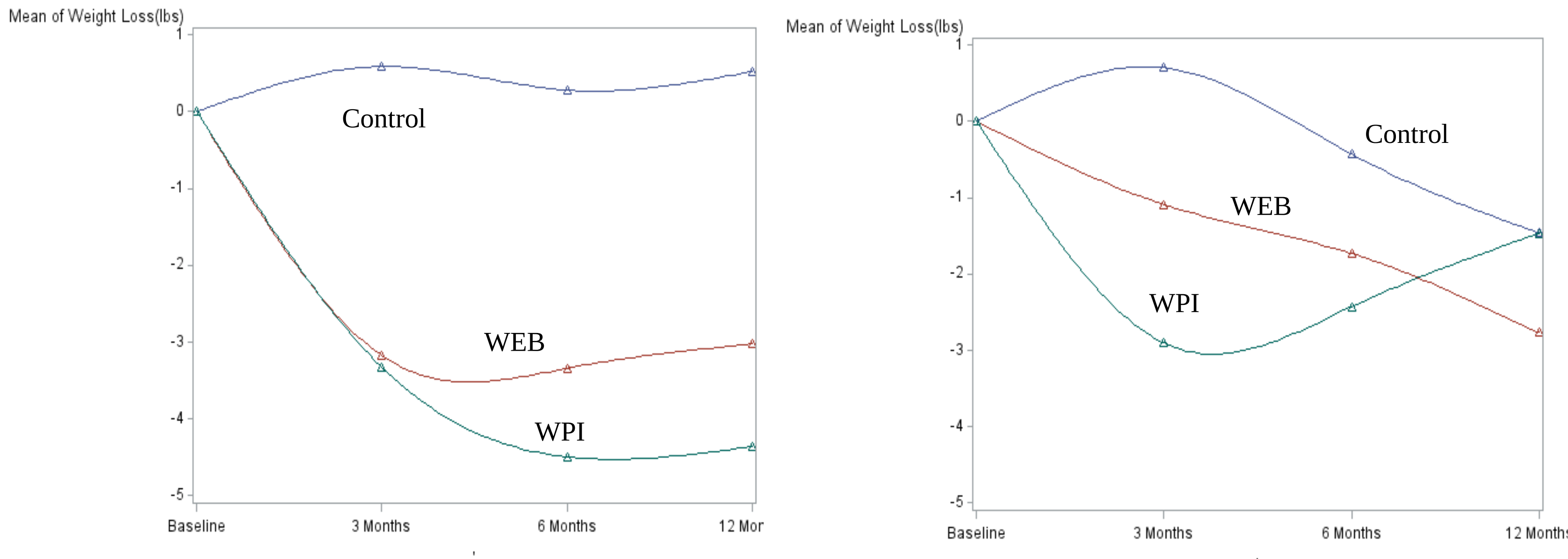
Table 11 also presents the results of WAY interventions and WEB×WC and WPI ×WC effects on healthy diet change at 6 and 12 months (we only collected information on participants' diet habits at baseline, 6 and 12 months). Overall, the changes were in the expected directions except the effect of WC stickers on total calories per day at 6 and 12 months, WEB and WPI effects on total calories per day at 12 months, and WEB effect on the percentage of fat intake and servings of fruit/vegetables at 6 months. None of these effects or interactions of WEB×WC and WPI ×WC were significant in the changes of healthy eating variables.

Table 11. Multilevel, multivariate coefficients (standard errors) from longitudinal analyses of weight and healthy diet change among the participants who used the campus food services over 12 Months (n=626)

		3 Months		6 Months		12 Months	
		Model a Estimate (SE)	**Model b Estimate (SE)**	**Model a Estimate (SE)**	**Model b Estimate (SE)**	**Model a Estimate (SE)**	**Model b Estimate (SE)**
Weight (lbs)	Intercept	0.5(2.1)	0.6(2.2)	3.0(3.3)	2.2(3.3)	4.0(4.1)	3.4(4.1)
	WC	-1.1(0.7)	-0.5(1.1)	-0.3(1.0)	1.8(1.6)	0.5(1.3)	3.1(1.9)
	WEB	-3.7(0.9)***	-2.9(1.4)*	-3.2(1.2)**	-1.0(1.8)	-4.5(1.5)**	-2.7(2.3)
	WPI	-6.0(1.0)***	-5.4(2.1)*	-6.9(1.4)***	-5.1(2.0)*	-6.4(1.7)**	-2.9(2.5)
	WEB*WC		-1.9(1.6)		-3.6(2.3)		-2.9(2.9)
	WPI*WC		-1.1(2.6)		-2.9(2.3)		-5.7(2.9)*
Kcals/day	Intercept			733.3(621.1)	752.1(621.6)	376.7(340.1)	402.3(354.7)
	WC			32.7(115.9)	69.7(140.3)	59.6(99.0)	89.8(126.3)
	WEB			-165.0(141.6)	-198.3(197.2)	25.6(93.9)	-4.6(130.4)
	WPI			-170.6(154.2)	16.2(193.9)	56.1(127.6)	174.6(147.1)
	WEB*WC				67.1(275.0)		35.3(183.9)
	WPI*WC				-315.0(226.3)		-220.1(166.7)
Mean % from fat	Intercept			11.6(6.3)	11.6(6.4)	11.2(4.3)*	11.2(4.4)*
	WC			0.0(1.1)	-0.3(1.7)	-0.2(1.1)	-0.4(1.9)
	WEB			0.6(1.4)	0.4(2.0)	-1.1(1.3)	-1.2(1.7)
	WPI			-1.5(1.5)	-1.8(2.1)	-0.5(1.5)	-1.2(2.1)
	WEB*WC				0.3(2.6)		0.0(2.5)
	WPI*WC				0.4(2.6)		1.1(2.6)
Fruit and Vegetable Servings	Intercept			1.8(2.2)	1.9(2.3)	2.8(1.7)	2.8(1.7)
	WC			0.3(0.5)	0.6(0.7)	0.5(0.4)	0.4(0.7)
	WEB			-0.4(0.6)	-0.4(0.9)	0.7(0.5)	0.6(0.7)
	WPI			0.6(0.7)	1.3(0.9)	0.9(0.5)	0.9(0.8)
	WEB*WC				-0.1(1.0)		0.3(1.0)
	WPI*WC				-1.3(1.1)		0.0(1.0)

*:P<0.05 **: P<0.01 ***:P<.0001

Figure 9. Means of weight loss trajectories by intervention and WC implementation among participants who ate on campus (n=626)



WC Stickers in Place:
4 community colleges in the Control group
2 community colleges received WEB
3 community colleges received WPI

No WC Sticker
3 community colleges in the Control group
3 community colleges received WEB
2 community colleges received WPI

Adoption

Seventeen out of 59 community colleges (17/59, 28.8%) in North Carolina were enrolled in WAY to Health study. The enrolled colleges and employees in these enrolled colleges were similar to (and thus generally representative of) the larger sample of community colleges in the North Carolina system described elsewhere[21]. Briefly, we used available summary data on campus-wide employee-level demographics to examine the representativeness of study sample (e.g. the 17 participating colleges were compared to aggregate data from employees within the all 59 community colleges). Employees at participating campuses were similar in gender makeup (61.1% vs. 62.7% females), percentage of African Americans (20.3% vs. 17.1%), and education level (master's degrees: 37.0% vs. 34.6% and doctoral degrees: 5.0% vs. 4.3%) to the overall employee population. Characteristics of all employees of participating colleges (data available for 16 of the 17 enrolled campuses) were compared to those of all employees of the 32 non-participating colleges who completed the initial survey. Participating campuses were more likely to have an employee wellness committee (EWC) in place than were non-participating campuses ($\chi^2 = 3.60$, $p = 0.06$), but no other important differences were observed. [21].

Initially, the representatives from 12(70.6%) community colleges attended the 4-hour face-to-face training session that was provided at the study kick-off event by project staff. The project staff traveled to five community colleges that did not receive the WC training at the kick-off event to provide a 100% baseline dose of intervention on WC. After the training, two conference calls and one mini-training/booster session were offered to facilitate discussions, problem-solve and motivate the community colleges to take action. But only 7 (41.8%) and 2 (11.8%) community colleges were represented at the two conference calls, respectively. Five (29.4%) community colleges took part in the mini-training/booster session.

Over the 12-month period all 17 campuses (100%) adopted at least one part of the Winner's Circle program. 9 campuses placed WC stickers in either the cafeteria or vending machines; disseminated any signs, posters, or pamphlets on the WC program; or offered specials or promotions related to healthy food options. However, 8 campuses did not place the WC stickers in either the cafeteria or vending machines. Although we did not explore the specific reasons why some campuses implemented the WC stickers while some did not, the barriers for the implementing the WC are described in the following section "Implementation". Mandating point-of-sale nutritional information for customers could combat increased portion sizes and decreased nutritional value of fast-food and cafeteria/restaurant meals as eating out becomes a larger part of US food consumption[169]. This information might enable consumers to make informed dietary decisions. It could also encourage cafeterias and restaurants to modify their ingredients and menus to provide greater healthy and nutritious food and beverage options to their customers.

Implementation

Level of implementation varied greatly across the campuses. Two campuses had implementation that was categorized as "high", three campuses were rated as "medium" implementation level, four campuses were rated as a "low" level of implementation and 8 campuses were rated as "no WC sticker". In this study, we focused on the difference between the campuses (N=8) that were categorized as "no WC sticker" and all other campuses with “WC stickers in place" (N=9). A comparison of campuses with WC stickers in place (N=9) and no WC sticker (N=8) is shown in Table 12. There’s a trend of slightly increased education/labeling and access to healthy food over time. However, the change is very small. In general, the level of education and labeling and access to healthy food were greater among campuses with WC stickers in place than those without WC sticker; but the difference did not reach the statistical significance. Moreover, 3 (37.5%), 1(12.5%) and 3(37.5%) of campuses with WC stickers in place increased both nutrition education/labeling and access to healthy foods at the 3, 6 and 12 months; only 0(0%), 1(12.5%) and 0(0%) of the campuses without WC stickers increased both nutrition education/labeling and access to healthy foods at 3, 6 and 12 months (Table 11).

Table 12. Campus Level Implementation of WC

	WC Stickers in Place (n=9)	No WC Stickers (n=8)	All (n=17)
Nutrition Education and Labeling index [7-point;mean (SD)]			
Baseline	0.3(0.8)	0.3(0.7)	0.3(0.8)
3 Months	0.9(0.9)	0.3(0.7)	0.6(0.9)
6 Months	0.2(0.4)	0.4(0.7)	0.3(0.6)
12 Months	1(1.4)	0.3(0.7)	0.6(1.2)
Access to Healthy Foods index [10-point;mean (SD)]			
Baseline	4.9(3.1)	2.4(2.6)	3.6(3)
3 Months	4.5(2.2)	2.9(2.9)	3.8(2.6)
6 Months	4.5(2.2)	3.6(3.1)	4.1(2.6)
12 Months	4.7(2.2)	3.1(2.8)	3.9(2.6)
Nutrition Education and Labeling increased [%]			
3 Months	62.5	0	31.3
6 Months	25	12.5	18.8
12 Months	50	0	25
Access to Healthy Foods increased [%]			
3 Months	50	37.5	43.8
6 Months	37.5	62.5	50
12 Months	62.5	50	56.3
Both Nutrition Education and Labeling and Access to Healthy Foods increased [%]			
3 Months	37.5	0	18.8
6 Months	12.5	12.5	12.5
12 Months	37.5	0	18.8

Self-reported by the campus contacts, a majority of community colleges implemented at least one part of WC. Overall, the implementation of Winner's Circle increased over time. Overall, community colleges were more likely to adopt nutrition labeling and education materials than increasing access to healthy foods. For example, at the 12-month follow-up, 67% community colleges reported that they had healthy foods labeled and identified, 53% had placed signs or other print materials to promote healthy foods; while only 27% had healthy foods promotion and 27% added more healthy food choices to the menu (Fig 10).

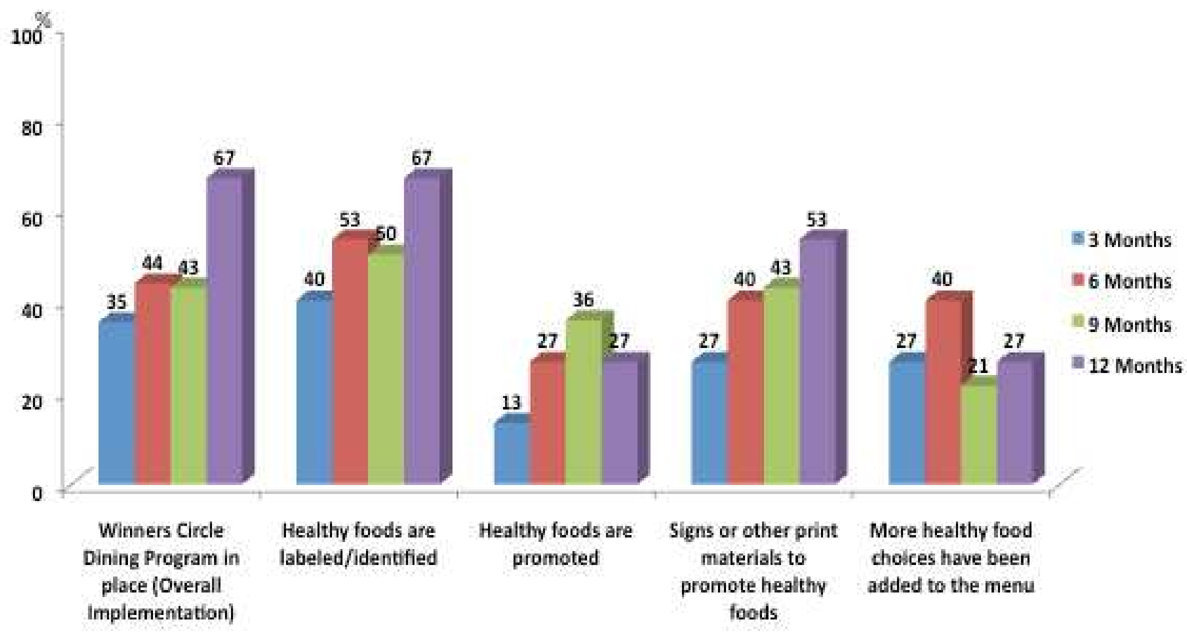


Figure 10. Implementation of Winner's Circle over Time

In terms of utilization of technical assistance available to implement the Winner's Circle, a majority of community colleges sought help from WAY to Health project staff (35-75%) over time, but other resources including the outsider experts like North Carolina Prevention Partners or State Health Department staff, community resources, booster conference calls were underutilized (Fig 11). Campus contacts reported that the community colleges used signs and posters in the cafeteria/vending area (67%), campus-wide emails (60%) and articles in campus newsletters to promote WC (33%). The top 3 barriers to implementing the Winner's Circle as reported by the campus contacts were: 1) it was not viewed as a priority for the vendors of cafeteria/vending machines (60%); 2) there was no time available for staff to implement (40%); and, 3) Winners' Circle was not viewed as a priority for the employees (27%).

During the 12-month intervention period, 90% of campus contacts believed that the WC would help employees make healthier food choices while at work; 85% believed that the WC would help employees lose weight; 86% believed that the Winners Circle Program would help employees who lose weight keep it off (or for healthy weight employees – to maintain a healthy weight).

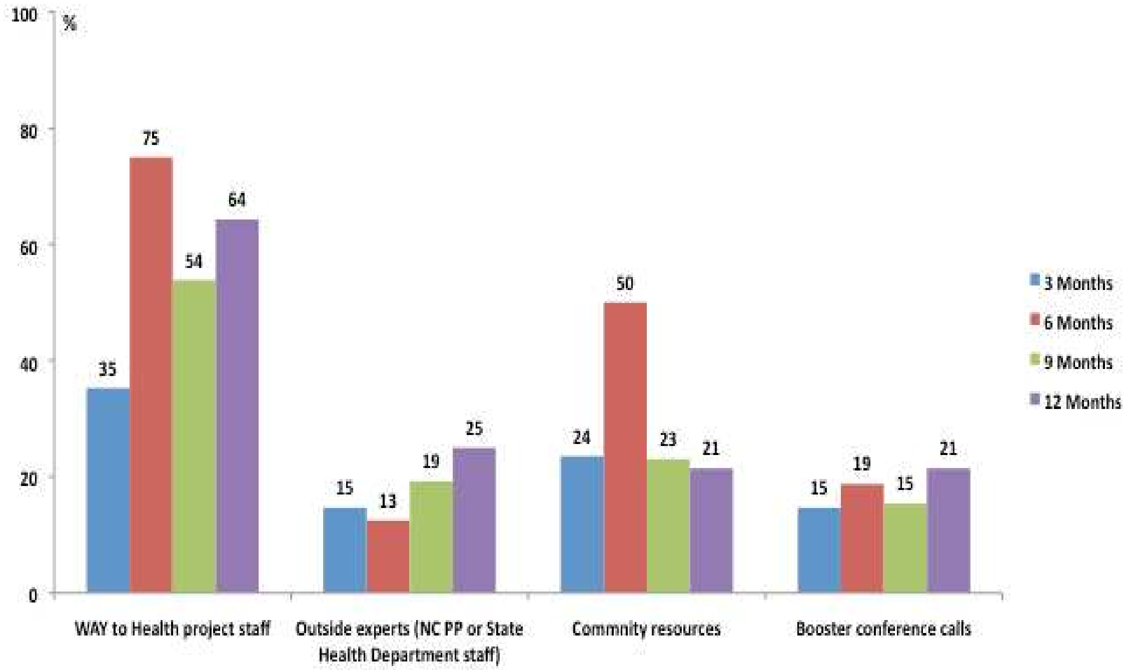


Figure 11. Utilization of Technical Assistance to Implement the Winner's Circle

Among campuses with WC stickers in place, 31.6% of employees who used the campus food services recalled that the Winner's Circle Dining Program was in place at his/her community college at the 3-month follow-up; 38.1% and 50.9% of employees were aware of the Winner's Circle Dining Program in place at the 6-month and 12-month follow-up, respectively. Furthermore, the proportion of employees who said healthy foods were identified or labeled in the cafeteria or vending machines on campuses with WC stickers in place increased from 40.5% at the 3-month follow-up to 42% at the 6-month follow-up and 57% at the 12-month follow-up. Fifty-seven percent and 35.1% of the employees indicated that healthy foods were labeled on their cafeteria menu and vending machines using the Winner's Circle logo, respectively. However, only 0.9% and 1.9% of the employees indicated that the discounts or lower prices were available for healthy foods in their cafeteria or vending machines at the 3 and 6 months, respectively. About a third (29%) of the employees reported that there was a Winner's Circle "manager's special" featured in their cafeteria. Forty-eight percent and 32.5% of the employees sometimes, often or always purchased items that have the Winner's Circle logo in the cafeteria/snack bar and campus vending machines, respectively. Some employees reported that they never purchased items in the cafeteria/snack bar (12.5%) or campus vending machines (17.9%) that have the Winner's Circle logo.

From campuses with or without WC stickers in place, the majority of participants (89.1%) thought that the Winner's Circle Dining Program “To a lot extent” (64.6%) or “To some extent”(24.5%) helped employees make healthier food choices while at work. The employees were also positive about helpfulness of the Winner's Circle Program in helping employees lose weight (88.3%) and maintain a healthy weight (89.3%).

4.4. Discussion

The purpose of this study was to evaluate the Winner’s Circle Dining program - a minimal-intensity worksite-based environmental intervention —and its effect alone as well as in combination with a web-based intervention plus financial incentives in a three-arm trial**.** Because all community colleges were offered WC, the study also serves as a natural experiment to monitor the uptake of the program and its implementation over time.

Sixty-two percent (62%) of employees reported that they used the food services (i.e., cafeteria or vending machines) on campus thus were reachable by the Winner’s Circle program. The average number of days per week they went off campus to purchase food was only 2.1 days/week (STD=1.6) indicating the food services on campus can potentially influence employee's healthy eating behaviors for several reasons. First, because adults spend up to 60% of their working hours at the worksites[8], it is possible to reach a significant proportion of US adults at work. Secondly, workplace environmental modifications are experienced by nearly everyone in a worksite, not just highly motivated individuals who are interested in a health promotion program. Third, because of the fact that environmental and policy changes represent low-cost options for promoting weight loss among employees[170], employers may be willing to invest in these interventions.

The WAY study is testing intervention components (i.e., WC, WC+WEB and WC + WPI). The WC was made available to all participating community colleges, including those who received WEB and WPI. The usual care arm (WC only group) served as the "control" group of the study. In the WAY study, we did not expect WC to produce any effect on weight loss (primary outcome) in a 12-month period, however, it remains important to test its potential effects and interaction with the individual-level interventions not only for evaluating the Winner's Circle but also for better understanding the effects of the individual-level interventions and overall weight loss outcomes.

The main effects of Winner's Circle on employee's healthy eating outcomes or weight were not statistically significant. And no significant interaction of WEB×WC or WPI ×WC was found in the changes of healthy eating outcomes at the 3 and 6-month follow-ups. However, implementing WC program at the campus level (which we indicated by having placed stickers on healthy food options) significantly enhanced the effects of the individual-level intervention "WPI" (i.e., web-based weight loss program plus incentives) on individual weight loss among participants who used campus food services at 12 months. Surprisingly, the data showed that participants who were exposed to the WC program via healthy food labels (i.e., placement of WC stickers) benefited to a statistically significant greater extent from the WPI intervention at 12 months. On average, participants who received WPI from campuses with WC stickers in place lost 2.6 lbs more than those who received WPI from campuses without WC stickers at the 12-month follow-up. Moreover, the results showed favourable interaction effect with the WEB intervention on employee weight at 12 months, but this result did not reach statistical significance.

As suggested by our findings, interventions that produce both great environmental (e.g., nutrition labeling and education) and individual level changes might have a better chance of succeeding than would interventions that promote only environmental or only individual level change, which is consistent with findings of previous research- combined interventions offering environmental and policy changes in combination with individual-level strategies have the most promise for encouraging healthier behaviors among employees[18]. Although the campus food services only represent a small part of the food environments for employees, it's not only about access to healthy food in the cafeteria/vending machines, it can also increase the awareness of healthy food options, educate the employees and identify the healthy foods. The more they learned about the benefits of healthy foods, the more likely they would choose the healthy foods in their daily life, thus changed their eating behaviors outside the workplace. In addition, the WC program received positive feedback from both campus contacts and employees, showing its potential in helping employees make healthier food choices while at work, lose weight and maintain healthy weight.

The initial training at the study kick-off event was well attended and well received by those in attendance. But the number of community colleges participating in the two conference calls and the mini-training/booster session was relatively low and decreased over time. It shows that the initial WC training was successful and was a good start for the program; but more resources are needed to encourage full participation. In fact, several CC's requested specific onsite consultation for their food service staff on how to implement WC but the study had not budgeted for tailored trainings beyond what was offered initially and via conference calls. Future studies may want to budget additional onsite training to enhance program implementation efforts.

After the introduction and training into the program, all community colleges adopted at least one aspect of the program to provide access and highlight healthy foods. Comparison of worksite characteristics of WAY study community colleges to all community colleges in North Carolina suggests that our findings are generalizable. This also reflects that the presumptions about the abilities of the community colleges to carry out the WC program were appropriate. The intervention was successfully adopted by community colleges that were similar to the target population except that the participating community colleges were more likely to have an employee wellness committee (EWC) in place than other community colleges in North Carolina. EWCs help create a health-supportive environment by offering encouragement, programming and advocating for policy changes in the workplace. The PACE project[38], a multilevel intervention to promote activity and changes in eating that included worksite-wide events implemented in partnership with EWCs which successfully achieved changes in the physical activity and nutrition information environments. In future studies, adoption could be enhanced by involvement of EWC in program implementation efforts, acknowledgement and communication of the value of workforce health and wellbeing to the organization and better documentation of cost of the staff and other resources.

The WC included activities designed to create environmental changes (e.g., nutrition labeling and education and increased access to healthy foods). This was a voluntary activity on the part of participating community colleges and as such, served as a natural experiment to see how many of the seventeen community colleges would successfully adopt and implement WC with minimal training, technical assistance and support. Just over half (9/17) of the community colleges placed WC stickers on foods in the cafeteria and/or vending machines over a 12-month period. In environmental interventions to improve nutrition, many uncontrollable factors contribute to the heterogeneity of intervention implementation including community involvement, financial support and worksite context[171]. The Winner's Circle was designed for high dissemination and easy adoption, to be implemented with minimal amount of work and dedication by campus officials. However as evidenced from our results, challenges remain to getting this program fully implemented.

The key barriers reported by campus contacts include not a priority for the vendors of food services or employees and no time available for staff to implement. Much of the WC intervention was delivered by community college staff whose availability and commitment to the WC program determines the level of implementation on campus. Intended WC components not fully implemented were placement of WC stickers and healthy eating options in cafeterias, which relied heavily on food services staff. Their commitment to employee healthy diet, reflected in nutrition information signage and actions to increase access to healthy foods, is critical. Additionally, several sites hired vendors to provide food service so challenges existed when the implementation of WC was not in the contract. In some cases, the new contract did include some healthy changes, but that occurred after the intervention period and so was not documented during our data collection period.

In our study, also found in two other studies[31, 106], community colleges are more willing to implement nutrition labeling and education than increasing access to healthy foods. Perhaps providing evidence that these changes would not adversely affect profit margins is needed before implementation can be successful. Creating employee demand via promotions or discounts on healthier options may also improve implementation of healthy food labeling and improved access to healthy foods in cafeteria or vending machines.

To ensure the sustainability of the intervention, it is essential to ensure that worksite representatives (HR and/or food service personnel) receive adequate training, support, and recognition. Lack of time for training and limited recognition may explain some of the challenges worksites experienced with implementing WC. For example, most food service staff could not attend trainings when food was to be prepared on campus – no staff to take their place. Future large-scale WC programs could include additional onsite booster trainings for worksite representatives especially food service staff on how to overcome barriers, recognize successes, network with other worksites, and develop action plans to institutionalize the program.

Given the study design of the WAY study (WC was served as the usual care), we offered the participating worksites the WC program with access to a minimum amount of training and technical assistance/support. In the future, employers considering the Winner's Circle Dining program should examine how organizational context (e.g., centralization vs. decentralization, number and types of roles people play, span of control for managers, organizational "discipline" and "core competencies") and real-world constraints may influence differential implementation across sites. More evidence-based approaches are needed that accounts for the barriers of these types of programs.

From the employee's point of view, awareness about WC increased over time. The proportion of employees who recalled that healthy foods were identified or labeled in the cafeteria or vending machines increased from 40.5% at 3 months to 57% at 12 months among those who used the campus food services from the campuses with WC stickers in the cafeteria and/or vending machines. Forty-eight percent employees reported purchasing items with the Winner's Circle logo in the cafeteria/snack bar; while fewer (32.5%) purchased items that have the Winner's Circle logo in the campus vending machines. Dumanovsky and his colleagues assessed consumer awareness of menu calorie information at fast-food chains after the introduction of New York City's health code regulation requiring these chains to display food-item calories on menus and menu boards[172]. Six months after all regulated fast-food chain restaurants in New York City were required to post calorie information, and 3 months after full enforcement (including monetary fines) was in place, 72% of customers at the 15 fast-food chains reported seeing calorie information, and 27% of these customers said they had considered that information when making their food choices. The authors argued that the substantial publicity that accompanied New York City's calorie labeling efforts increased awareness. In any case, the data reported in the current study suggest that labeling at the point-of purchase has a substantial impact on employee awareness and use of nutrition information to make informed decisions on food purchases.

Strengths and Limitations

The strength of this study is that it took place in community colleges – similar types of worksites and having similar intervention exposure that allowed for the natural experiment – an ability to study the adoption and implementation of WC over the 12-month intervention period. Another strength is the fact that we have assessed the effects of WC on both the primary (weight loss) and secondary (healthy food purchase, diet) outcomes using all available longitudinal data (baseline, 3, 6 and 12 months). Third, randomized controlled trials (RCT) are the most rigorous way to evaluate the effectiveness of intervention[72]. However, because of their multifaceted nature and dependence on social context (e.g., social norms, social environments, policies), complex interventions pose methodological challenges on monitoring and assessing the effect of intervention[22]. Although WAY project is a RCT, WC has been delivered to all 17 community colleges as a usual care. Unlike WEB or WPI, the nonrandomized design of WC does not allow us to take advantage of RCT. Although comprehensive evaluation plans for RCT are available to practitioners, frameworks for developing a comprehensive evaluation for interventions like WC with a nonrandomized design are less common[72, 171].

On the other hand, several limitations are noteworthy. First, we acknowledged the selection as a major threat to the internal validity when examining the effectiveness. Without randomization, it is unclear if there were specific circumstances at the worksites that were responsible for the effectiveness of the WC program. Systematic difference in participants or worksite characteristics can bias our findings. Luckily, we did not find significant difference in the participants or worksite characteristics between the WC stickers in place group and no WC sticker group. Moreover, even with randomization, we cannot 100% guarantee there was no more or less going on in worksites/cafeterias across the intervention groups during the intervention period. In addition, we controlled for the potential confounders at both organizational (i.e., administrative perceived importance of HPP, funding for HPP, presence of EWC and access to gym on campus) and individual level (i.e., participants demographics) in the models. However, there might be other unmeasured factors that confound the relationship between WC and weight loss. For example, social support from family and friends and various food environments including labeling, educational information, availability and price of healthy foods at supermarkets, grocery stores, home, restaurants, worksite cafeterias and so on. Secondly, the use of multilevel models compromised the power of the study due to the limited number of clusters (N=17). Limited sample sizes also produced low power to test the significance of main effects, interactions, direct and indirect effects. Another limitation of this study is that data was not available to assess maintenance of the WC program.

4.5. Conclusions

A striking paucity in the worksite-based weight loss intervention literature is the role that the worksite environment plays in influencing employee health behaviors. A reductionistic scientific paradigm oversimplifies reality in the quest to isolate efficacious treatments. In WAY to Health project all 17 community colleges, including those who received WEB and WPI, were encouraged to make use of opportunities to implement WC program but it was completely voluntary after the initial training. Our study rigorously tested the reach, effectiveness, adoption and implementation of the environmental intervention (Winners Circle Dining Program) and individual-level interventions on individual employee eating behaviors and weight change using a “real-world” approach. Only by empirically testing the effects of the environmental change, will we have solid answers to whether it works and gain worksite policy and environmental supports to implement these programs for employee wellness. Our data did not support the hypothesis that placement of Winner’s Circle stickers) alone have substantial impact on employee’s weight or healthy eating behaviors in a 12-month period. But it can probably enhance the effects of individual-level interventions, thus, not appropriate to be used as the usual care in a weight management research study. Additionally, Winner’s Circle has the potential to be adopted, implemented, and accepted by both the employers and employees.

CHAPTER 5: UNDERSTANDING PATHWAYS TO WEIGHT LOSS AMONG EMPLOYEES ENROLLED IN THE WAY TO HEALTH WORKSITE-BASED STUDY

5.1. Introduction

Obesity is a major public health problem in the U.S. that is associated with a variety of diseases including but not limited to diabetes, cardiovascular disease, injury and diminished immune response. The latest prevalence and trends in obesity data show that in 2009-2010, 68.8% of US adults were overweight, of whom 35.7% were obese[1]. Energy balance, which refers to the relation of the amount of utilizable energy taken into the body to what is employed for internal work, external work, and the growth and repair of tissues, depends on eating behaviors and physical activity (PA) and is crucial to achieving and maintain a healthy body weight[12]. Gaining a better understanding of the pathways through which interventions positively influence eating and physical activity among overweight and obese adults is warranted.

The workplace is a promising setting for promoting health via health eating, physical activity and/or weight loss programs[8, 12, 13, 15]. Groeneveld,I.F et al. conducted a systematic review of lifestyle-focused interventions at the workplace and recommended that researchers summarizing the results of weight loss trials should also report lifestyle changes achieved in addition to body weight changes to gain better insight into the mechanisms that lead to desired intervention outcomes, such as weight loss[14]. Although there are some exceptions, few studies have investigated the mechanisms of weight loss in worksite-based interventions. In recent years, the science of health behavior change has increasingly emphasized the use of theory to inform and test interventions because theories often inform us on how interventions work by identifying underlying mechanisms, thus providing more proximal targets of intervention (i.e., mediators)[173]. Prestwich (2012) examined behavioral intention, self-efficacy, social influence and perceived enjoyment as potential mediators of the effects of a worksite planning and partner-based intervention upon physical activity over six months, but the mechanisms underlying the effects of the intervention were not clear, as there were no significant mediators in this study[174]. In a 12-month physical activity workplace intervention, Plotnikoff et al. examined the mediation effects of 14 psychosocial constructs across 3 major social-cognitive theories which were operationalized for the intervention materials[175]. Of the 14 constructs, two positive results were identified (i.e., pros of physical activity, experiential processes) with very small effect sizes. To summarize, there are very few methodologically rigorous studies to establish the mechanisms underlying the positive intervention effects of worksite-based weight loss programs.

The Social Cognitive Theory (SCT)[48] suggest that self-efficacy or the confidence in one's ability to maintain healthy eating and Physical activity would be two important psychological precursors to healthy eating, physical activity and therefore, for weight loss among overweight and obese individuals. According to previous mediational research, self-efficacy for selected eating behaviors and physical activity are believed to be critically important for explaining healthy eating and Physical activity [44-46]. It has been suggested that self-efficacy related to eating and physical activity may result in weight change by changing eating and Physical activity [47]. Based on this theoretical underpinning, we will examine the eating and physical activity self-efficacy as pathways in the association between WAY interventions, healthy eating, physical activity and weight change.

A second potential psychological factor of interest when exploring weight loss mechanisms is found within self-determination theory (SDT)[50]. SDT details the motivational basis for self-regulation of human behavior and focuses on the concept of autonomy[176]. Autonomous motivation for lifestyle change indicates that people experience a sense of choice and volition about following a specific recommendation. Controlled regulation, in contrast, indicates that people feel pressured or coerced by themselves (intrapersonal control) or others (interpersonal control) to follow a specific recommendation. Internalization is the process through which motivation becomes more autonomous. An increase in autonomy over time reflects internalization and is expected to result in sustained healthy behavior[176]. Figure 12 provides a visual representation of the continuum of Internalization. Further, autonomous forms of motivation were found to be associated with changes in physical activity, diet and BMI[53, 176, 177].

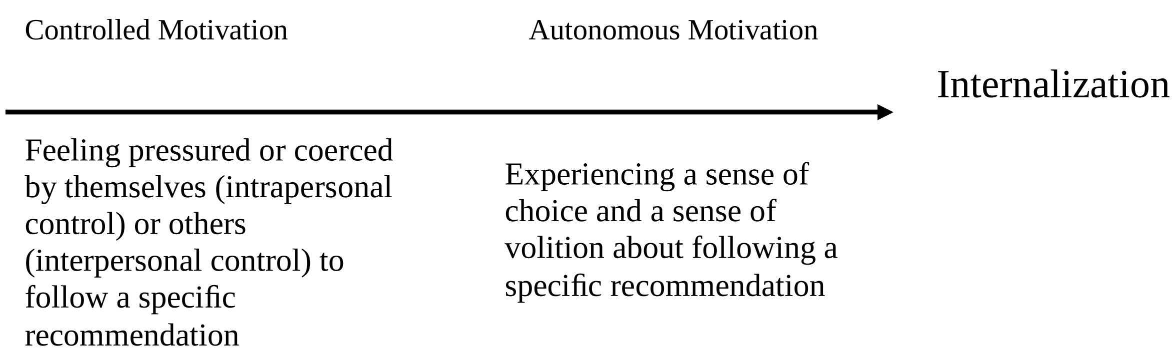


Figure 12. Continuum of Motivation Internalization

Both SDT and SCT start with the same basic assumption: humans are naturally oriented toward growth, health and well-being. SDT has identified three psychological needs (i.e., Autonomy, Competence and Relatedness) critical to supporting the process of internalization[173]. The most noteworthy conceptual overlap and similarity between SDT and SCT is that one of the three psychological needs in SDT -competence- is related to self-efficacy in SCT. Indeed, perceived competence is facilitated by autonomous motivation. Once individuals have a high willingness to act, they are more likely to gain new knowledge and apply new strategies that result in greater perceived competence. SDT predicts that perceived competence alone is not sufficient to motivate behavior; it must be accompanied by autonomy. Mediators (i.e., autonomy motivation, as well as self-efficacy for physical activity and healthy eating) identified through SDT and SCT may help clarify the processes by which a worksite-based weight loss intervention is efficacious. Research on mediation or path analysis is needed to better understand the mechanisms through which the worksite-based weight loss intervention works.

The WAY (Worksite Activities for You) to Health Study was a three year, three-group, randomized and controlled intervention trial designed to test three different types of support for employee weight loss: environmental change; web-based weight loss and cash incentives. The final results showed significant intervention effects in participants' weight at the 12-month follow up[56]. This study will focus on understanding the mechanisms that led to the individual-level effects produced by the web-based weight loss and cash incentive interventions of the WAY to Health study.

To establish the temporality, we used the longitudinal data to examine the research questions -whether interventions change psychological factors at 3 months (T2), lead to diet/PA change at 6 months (T3); and then leads to weight change at 12 months (T4). It's particularly important for us to specify the time sequence of the variables using the longitudinal data. For example, it could be one's healthy eating behaviors changed his/her self-efficacy to maintain a healthy diet if we don't specify the time sequence of the variables. Furthermore, the mediational analysis using the longitudinal data is preferable according to Selig and Preacher[178] for several reasons. First, the causal relationships implied by the paths in the mediation model take time to unfold. Second, it is well known that conclusions based on a causal model that omits a key predictor can be seriously in error, yet a model based on cross-sectional data leaves out several key predictors—namely the variables measured at previous times. When previous levels of the variables are not controlled for, the paths in the mediation model may be over- or underestimated relative to their true values. Third, effects unfold over time, and we would not expect the magnitude of a causal effect to remain the same for all possible intervals. The application of the mediation model to cross-sectional data assumes not only that the causes are instantaneous, but also that the magnitude of the effect is not dependent on the length of time that elapses between the measurements of the variables. The following hypotheses were tested in this study:

Hypothesis 1: The participants who received the individual-level WAY interventions had higher level of autonomous motives, controlled motives, physical activity self-efficacy and/or healthy eating self-efficacy than those who didn't at 3 months.

Hypothesis 2: The participants with higher level of autonomous motives and/or physical activity self-efficacy at 3 months had higher level of physical activity (i.e. total physical activity MET-minutes/week) at 6 months.

Hypothesis 3: The participants with higher level of autonomous motives and/or healthy eating self-efficacy at the 3 months had healthier eating habits (i.e., total calories intake, fruit/vegetable consumption and proportion of calories intake from fat) at 6 months.

Hypothesis 4: The participants with higher level of physical activity and/or healthier eating habits at 6 months achieved greater weight loss at 12 months.

Hypothesis 5 (to link the Hy1-4 and form an overall big mediational hypothesis): The effects of WAY interventions on weight change are partially accounted for by autonomous motives, physical activity self-efficacy and/or healthy eating self-efficacy.

5.2. Methods

Study Design

Seventeen community colleges were enrolled in the WAY study and randomly assigned to one of three interventions: Usual Care/Environment Only (WC), Environmental +Web-based Weight Loss Program (WC+WEB), or Environmental + Web-based Weight Loss Program + Financial Incentives (WC+WPI). The first intervention is an environment-only program called the "Winners' Circle Dining Program"(WC), which attempts to identify and promote healthy food options, to educate consumers about the benefits of choosing healthy foods and to increase access to healthy foods at work. As the usual care, WC was offered to all 17 community colleges. The impact of WC on participant's weight was hypothesized to be the same across three intervention groups during the 12-month randomized controlled trial. A comprehensive assessment of the WC in the WAY study has been described in Chapter 4.

The second intervention adds a web-based weight-loss program to WC. The web-based program developed by Dr. Deborah Tate and colleagues offered weekly nutrition, exercise, and weight loss tips, as well as interactive message boards and participant surveys[49, 65-68]. Tate's evidence-based web-based weight loss program[49, 65-68] was adapted for use in the workplace and was designed to influence psychological factors which may include autonomous and/or controlled motives (these two are believed to be positively correlated[179]), and self-efficacy related to healthy eating and physical activity among participants.

The third intervention offered WC plus the web-based program and cash incentives for those who lost weight. Financial incentives were expected to increase participant's autonomous and/or controlled motivation. However, it can have negative consequences if experienced as controlling[90]. Therefore, it is important to distinguish between autonomous and controlled motives[179].These changes in psychological factors are believed to influence positive change in employee healthy eating and PA, key target behaviors of the WAY interventions[69-71]. Ultimately, healthy eating and improved physical activity is believed to help overweight/obese employees enrolled in the WAY to Health weight loss study to lose weight[12]. A conceptual model visualizing the mechanisms through which the individual-level interventions (i.e., WC+WEB, WC+WPI) worked is shown in Fig 13.

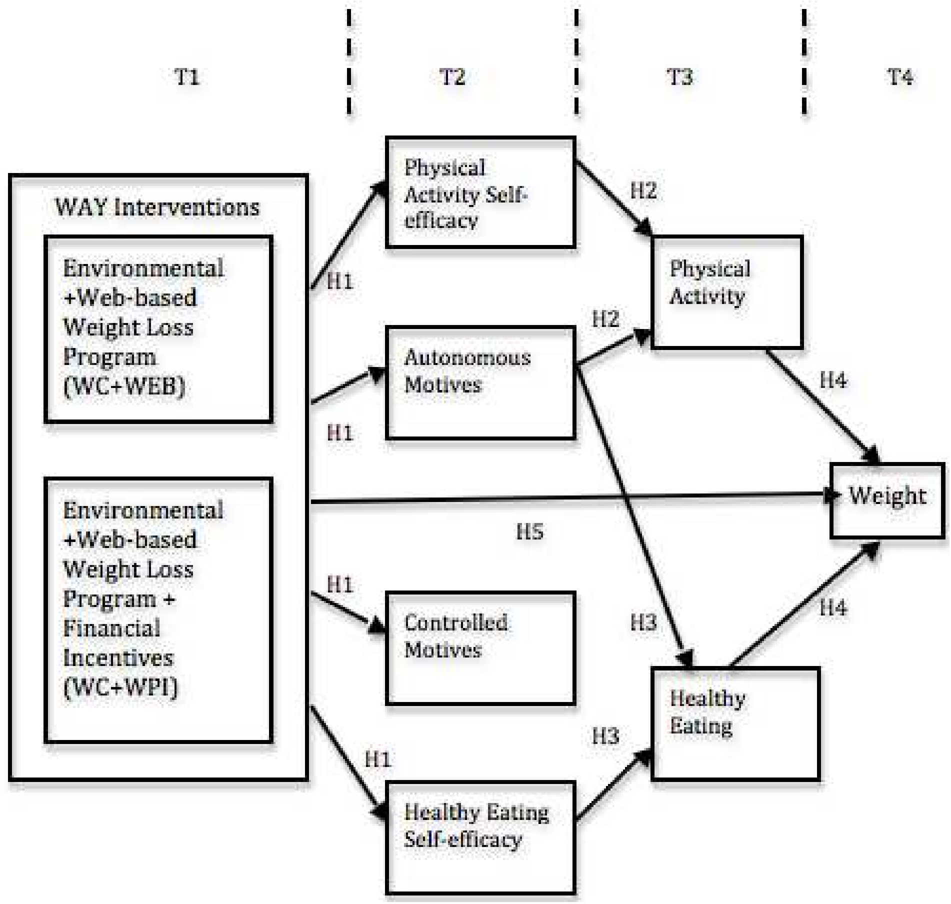


Figure 13. A conceptual model of the mediational study of WAY interventions

Sample

Total 1004 overweight and obese employees from 17 community colleges in North Carolina participated in the WAY project and completed the surveys and anthropometric measurements at baseline, 3(retention rate=72%), 6 (retention rate=70%) and 12 months (retention rate=70%). Eligibility criteria included being at least 18 years of age, working at a participating community college (either full or part-time) and having a body mass index (BMI) greater than 25kg/m$^{2.}$ Participants who were pregnant or lactating, had Type I diabetes, had recent weight loss of 20 lbs. or more, were currently taking weight loss medication, had either undergone or scheduled weight loss surgery, had experienced a malignancy requiring chemotherapy/radiation in the past 5 years, or who lacked Internet access either at home or at work were excluded. The recruitment results and baseline characteristics at the college and employee levels are described elsewhere[21].

Measures and Data Collection

At each assessment event, height (baseline only) and weights were measured using standardized protocols on all participants at baseline, 3, 6 and 12 months. The self-administrated questionnaires collected information on demographics, physical activity, healthy eating, motivations to participate in the weight loss program and self-efficacy of physical activity and specific eating behaviors and were administered onsite after the anthropometric measurements were taken. Mail or email reminders were sent to each enrolled employee 1 week and 1 day before the scheduled weigh-in measurement event.

Body Weight

Weights were measured using standardized protocols on all participants in casual street clothing, without shoes, on a calibrated electronic scale (Tanita BWB-800) and rounded to the nearest 2/10th of a pound at baseline, 3, 6 and 12 months. The anthropometric measurements were conducted by a trained research assistant in a private room so that participant privacy was protected.

Healthy Eating

Total calories intake, fruit/vegetable consumption and proportion of calories intake from fat were assessed onsite by Block Food Frequency questionnaire (version

1998)[137, 138]. This 110 food item questionnaire is designed to assess nutrient intake levels as well as specific foods and food groups (e.g., fruits, vegetables, meats) over extended periods. It takes 30-40 minutes to complete. The food list for this questionnaire was developed from the NHANES III dietary recall data. The nutrient database was developed from the USDA Nutrient Database for Standard Reference. The reliability coefficients for total calories, fruits and vegetables and total and saturated fat are 0.74, 0.84 and 0.72, respectively[137.]

Health Eating Self-efficacy

Health eating self-efficacy was assessed by the Weight Efficacy Life-Style Questionnaire (WEL) as part of the employee survey administered online or at the onsite assessment. Subjects were asked to rate their confidence about being able to successfully resist the desire to eat using a 10-point scale ranging from 0 (not confident) to 9 (very confident). A principal components analysis revealed a five-component solution for the 20 items (4 per component) by two different methods of determining the number of components to retain (Velicer's, 1976, minimum average partial procedure and Horn's, 1965, parallel analysis method). The components are Negative Emotions, Availability, Social Pressure, Physical Discomfort, and Positive Activities. Scale scores were computed by summing the 4 items for each of the five scales. The Cronbach alpha coefficients of internal consistency ranged from. 90 for the Social Pressure scale to. 70 for the Positive Activities scale[144, 145].

Physical activity

Physical activity was assessed by the International Physical Activity Questionnaire-Short Form (IPAQ-Short) in which physical activity is measured by a 7 day recall and the volume of activity is converted to Metabolic Equivalents (MET min/week). Total MET min/week (i.e., the sum of the walking, moderate and vigorous intensity activity MET-minutes/week scores) was used as a global measure of physical activity. This measure has demonstrated validity and reliability and performs similarly to the longer version of the questionnaire [139, 140]. It exhibits moderate correlations with objectively assessed physical activity via pedometer or accelerometer data with criterion validity of a median ρ=0.30[140-143] and produced repeatable data (Spearman's ρ clustered around 0.8) [140-143].

Physical Activity Self-efficacy

Physical activity self-efficacy was measured using a 5-item instrument on which participants indicated their confidence in being able to be physically active in a variety of situations[146]. This instrument uses a 5-point Likert scale ranging from 1 (not at all confident) to 5 (very confident). The Cronbach alpha coefficients of internal consistency reliability is 0.79[146].

Treatment Self-Regulation Questionnaire (TSRQ)

Participants completed the TSRQ as an indicator of their autonomous and controlled motives towards weight loss intervention participation. Autonomous motives for remaining in the program and following the procedures of the program were assessed using three items; controlled motives were assessed by 7 items. Participants responded to each item on a scale of 1 (Not at all true) to 7 (Very true). An example of autonomous motives is "I feel like it's the best way to help myself". An example of controlled motives is "Others would have been angry at me if I didn't". Previous research using the TSRQ has reported internal consistency (Cronbach's α) reliability estimates ranging from

0.67 to 0.87[52] and indicates that greater endorsement of autonomous motives measured by TSRQ scores predicts sustained weight change[96].

Data Analysis

Frequency distributions of participant demographics variables were computed to describe the study sample. Pearson's correlation coefficients were used to examine bivariate associations between the study variables. A structural equation model analysis was used to test the proposed conceptual model using Mplus statistical software (version 6.0)[150]. The advantage of SEM is that it can provide valid statistical inference when some variables of interest are hypothetical constructs (i.e., latent variables) or measured by a set of items[57]. We used a 20-item healthy eating self-efficacy scale, a 5-item physical activity self-efficacy scale, a 3-item autonomous motives scale and a 7-item controlled motives scale to measure the psychological factors. Treating the scale items as the multiple indicators of the latent variable, we can minimize the measurement error in the psychological factor scales. According to the best practice of model specification[180] prior to the analyses of the structural model, a measurement model was examined to identify each latent variable for this model, and it was tested for effective identification of each of the latent variables. By fitting one simultaneous model, all the parameters and standard errors are estimated conditional on the same effects being present in the model. Therefore, both theoretically and empirically, fitting a single SEM model lends more efficient and elegant estimation of parameters or coefficients than regression[74].

Multiple imputations were carried out to handle the missing data in Mplus 6.0. Ten datasets were generated using Bayesian estimation[150]. The combined parameter estimates from the separate analyses of 10 datasets were then used for hypothesis testing and inference. Because the distributions of the variables deviated from normality to some extent, we used the maximum likelihood robust estimation method. This method produces standard errors and a chi-square test statistic that are robust for nonnormality[150]. For the mediation model, direct and indirect effects of WAY interventions on health behaviors and weight and their respective 95% CIs were also derived from Mplus 6.0[150]. Differences were considered statistically significant at $p < 0.05$.

Demographics variables (gender, age, race, income, job status (faculty vs. staff)) were controlled for in the model. All statistical analyses in this study accounted for the cluster random sampling design by multilevel modeling in Mplus, with community college as the unit of sampling, and employee nested within community college as the unit of analysis.

The chi-square (χ^2) goodness of fit statistic is a reasonable measure of model fit. However, because sample size and the strength of the correlations between variables may unpredictably influence model fit according to the χ^2 test statistic, we relied on the comparative fit index (CFI) and root mean error of approximation (RMSEA) to assess model fit[181]. Both indices have been recommended for routine use. CFI values that exceed 0.90 and RMSEA values below 0.08 indicate acceptable model fit[181]; and RMSEA values close to 0.06 have been designated as indicative of "good fit"[182]. The CFI and the RMSEA are both sensitive to model misspecification and are minimally affected by sample size[181].

5.3. Results

Sample Characteristics

The sample participating in the WAY project (n=1004) was 82.2% female, 83.2% White, 46.9 years old, and weighed 204.4 pounds at baseline on average, with 32.6% overweight (BMI 25-29.9 kg/m^2), 30.7% obese class I (BMI 30-34.9 kg/m^2), 20.4% obese class II (BMI 35-39.9 kg/m^2), and 16.3% obese class III (BMI≥40 kg/m^2). Forty-six percent of WAY participants reported having an Associates or Bachelor's degree and 42% reported holding an advanced degree (Masters, Professional or Doctoral degree). A majority (57.6%) of WAY participants were staff, while 40.3% identified as faculty. Approximately half of the WAY participants had a household income of $30,001-$50,000. There were few statistically significant differences among participants by treatment arm at baseline, specifically, WC+WPI participants were significantly more likely to be female, than were WC+WEB; and, WC participants had significantly higher proportion of calories intake from fat. Aside from these differences, group randomization was effective in allocating similar groups across study arms.

Table 13. Baseline WAY Participant Characteristics by Intervention Arm

	ALL WAY to Health (*n*= 1004)		WC (*n*=375)		WC+WEB (*n*=350)		WC+WPI (*n*=279)	
Variable	%	n	%	n	%	n	%	n
Female (%)	82.2	793	81.9	298	77.1**	259	89.1**	236
Hispanic (%)	1.4	13	1.1	4	1.2	4	1.9	5
Race (%)								
White	83.2	799	80.5	293	84.3	280	85.6	226
African American	13.3	128	17.0	62	11.7	39	10.2	27
Other	3.4	33	2.5	9	3.9	13	4.2	11
Household Income (%)								
$0 -30,000	29.2	255	31.3	103	28.3	86	27.5	66
$30,001 - 50,000	43.8	382	44.4	146	42.1	128	45.0	108
$50,000+	27.0	236	24.3	80	29.6	90	27.5	66
Education (%)								
HS graduate or less	2.0	19	1.4	5	2.7	9	1.9	5
Some college/tech school but no degree	10.0	96	9.3	34	10.5	35	10.2	27
Assoc/Bach degree	46.2	445	46.4	169	46.8	156	45.1	120
Post-graduate degree	41.8	403	42.9	156	39.9	133	42.9	114
Job Classification (%)								
Faculty	40.3	393	38.0	139	42.9	147	40.2	107
Staff	57.6	562	59.3	217	54.8	188	59.0	157
Other	2.1	20	2.7	10	2.3	8	0.8	2
Full time (%)	86.8	848	85.0	312	88.4	304	87.2	232

	ALL WAY to Health (*n*= 1004)		WC (*n*=375)		WC+WEB (*n*=350)		WC+WPI (*n*=279)	
Variable	%	n	%	n	%	n	%	n
General Health Rating								
Excellent	6.0	51	7.2	23	5.4	16	5.1	12
Very good	37.6	320	35.5	113	39.9	119	37.3	88
Good	43.1	367	45.3	144	43.0	128	40.3	95
Fair	11.6	99	11.0	35	9.4	28	15.3	36
Poor	1.8	15	0.9	3	2.3	7	2.1	5
BMI Category (%)								
25.0-29.9	32.6	327	30.7	115	33.4	117	34.1	95
30.0-34.9	30.7	308	32.0	120	31.1	109	28.3	79
35.0-39.9	20.4	205	21.9	82	21.1	74	17.6	49
40+	16.3	164	15.5	58	14.3	50	20.1	56
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Weight (lbs)	204.4	47.3	204.4	47.8	205.9	24.7	202.5	60.8
BMI	33.6	7.9	33.6	9.4	33.3	4.1	33.8	8.8
Age	46.9	12.1	46.0	8.3	47.1	14.2	47.6	10.5
Kcals	1907.6	893.8	1895.7	837.2	1879.0	1090.1	1958.2	302.6
Mean % of Kcal from fat	39.9	7.3	40.5*	7.4	39.1*	4.9	40.3	3.4
Total physical activity (MET-minutes/week)	1334.7	2149.9	1255.8	1237.7	1422.7	2551.1	1327.3	2165.5

**: P<0.01 *: P<0.05

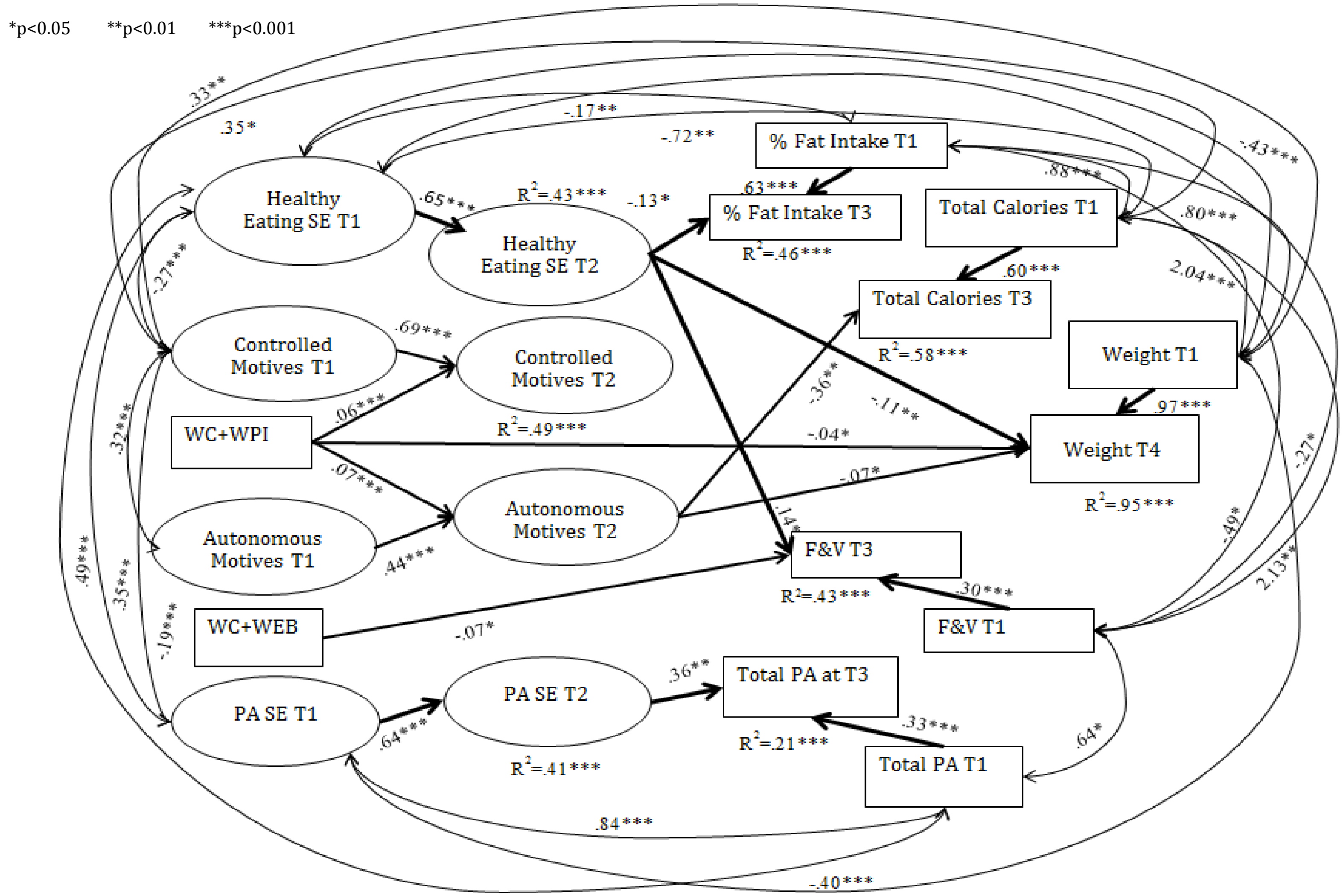


Figure 14. Do self-efficacies and motives mediate between WAY interventions and healthy behaviors and body weight (N=1004)

WAY Interventions Mediation Model

According to the CFI and RMSEA fit statistics, the estimated WAY interventions mediation model demonstrated acceptable fit of the data (Figure 14), χ^2 (df=1489, N = 1004) = 7486.764, p <0.05, CFI = 0.79, RMSEA = 0.063 (STD=0.001). Controlling for the baseline motives, self-efficacies, healthy diet (i.e., total calories intake, fruit/vegetable consumption and proportion of calories intake from fat), physical activity, body weight and demographic variables, the following are the results for hypotheses that are tested simultaneously in the WAY intervention mediation model:

Results for Hypothesis 1: the participants received the individual-level WAY interventions had higher level of autonomous motives (WEB: β=0.02, *p*=0.384; WPI: β=0.07, *p*=0.001) and higher level of controlled motives (WEB: β=0.03, *p*=0.103; WPI: β=0.06, *p*=0.001) than those who didn't at 3 months. There's no significant difference in physical activity self-efficacy (WEB: β=0.001, *p*=0.972; WPI: β=-0.009, *p*=0.573) and/or healthy eating self-efficacy (WEB: β=0.02, *p*=0.097; WPI: β=0.02, *p*=0.142).

Results for Hypothesis 2: the participants with greater physical activity self-efficacy at 3 months had significant higher level of physical activity (i.e. total physical activity MET-minutes/week) at 6 months (β=0.36, *p*=0.007). Autonomous motivation was not significantly associated with physical activity (β=-0.22, *p*=0.108).

Results for Hypothesis 3: the participants with higher level of autonomous motives at 3 months had lower total calories intake (β=-0.36, *p*=0.003) at 6 months. The participants with greater healthy eating self-efficacy at 3 months had smaller proportion of calories intake from fat (β=-0.13, *p*=0.025) and more daily servings of fruit and vegetables (β=0.14, *p*=0.042) at 6 months.

Results for Hypothesis 4: the total physical activity MET-minutes/week (β=-0.02, *p*=0.237), total calories intake (β=0.03, *p*=0.068), the proportion of calories intake from fat (β=0.03, *p*=0.094) and daily servings of fruit and vegetables (β=-0.02, *p*=0.380) at 6 months were not significantly associated with weight loss at 12 months. Participants received the individual-level WAY interventions (WEB: β=-0.03, *p*=0.068; WPI: β=-0.04, *p*=0.047), had higher level of autonomous motives (β=-0.07, *p*=0.032) or greater healthy eating self-efficacy (β=-0.108, *p*=0.002) at 3 months weighted less at 12 months.

Results for Hypothesis 5:

As described above in Hypotheses 1-4, paths from WC+WPI to weight at 12 months, from WC+WPI to autonomous motives at 3 months, from autonomous motives at 3 months to total calories at 6 months and weight at 12 months were significant and in the predicted direction. The indirect effect of WC+WPI on total calories (β=-0.03, *p*=0.023) and weight (β=-0.005, *p*=0.062) mediated by autonomous motives was marginally significant. Therefore, the effects of WAY intervention (WC+WPI) on weight change are partially accounted for by autonomous motives.

While WC+WPI also increased controlled motives at 3 months, the controlled motives were not significantly related to healthy eating or physical activity at 6 months or weight at 12 months, meaning our data did not support that controlled motives mediated the relationship between WAY interventions and weight at 12 months.

As described in Hypotheses 1-4, paths from healthy eating self-efficacy at 3 months to proportion of calories intake from fat and daily servings of fruit and vegetables at 6 months, and to weight at 12 months were significant and in the predicted direction. The path from physical activity self-efficacy at 3 months to physical activity (i.e., total

MET min/week) at 6 months was also significant and in the predicted direction. However, neither healthy eating self-efficacy nor physical activity self-efficacy were significantly related to WAY interventions and did not mediate the relationship between WAY interventions and weight at 12 months.

The control variables at baseline were allowed to covary. The healthy eating self-efficacy and physical activity self-efficacy were significantly and positively related to each other at baseline. Healthy eating self-efficacy was significantly negatively related to controlled motives, the proportion of calories intake from fat, daily total calories and daily servings of fruit and vegetables at baseline. The physical activity self-efficacy was significantly positively related to physical activity and was significantly and negatively related to controlled motives at baseline.

The proportion of calorie intake from fat, daily total calories and daily servings of fruit and vegetables at baseline covaried significantly with one another, which indicates that these health eating behaviors were not isolated. The fruit/vegetable consumption and the physical activity at baseline were significantly positively related with one another, suggesting that the participants who ate more fruit/vegetable tended to exercise more at baseline. In addition to these correlated baseline healthy behaviors, the total calorie intake and proportion of calories intake from fat were significantly and positively related to weight at baseline, suggesting that participants with greater total calorie intake and larger proportion of calories intake from fat weighed heavier at baseline.

Controlling for the baseline values, the full model accounted for 46%, 58%, 43% and 21% of the variability in the proportion of calories intake from fat, daily total calories, daily servings of fruit and vegetables and total MET min/week at 6 months, respectively. The full model constructs accounted for 95% of the variability in weight at 12 months.

5.4. Discussion

Understanding how, why and for whom the intervention worked is an important part of the analysis of data from all studies. To the best of our knowledge, our study was the first study to rigorously and simultaneously test whether key theory-guided psychological constructs (i.e., self-efficacy and motives) related to eating and Physical activity are mechanisms through which complex worksite-based weight loss interventions helped the participants lose more weight in a longitudinal study. Our results indicated that, overall, the estimated model for understanding interventions explained the longitudinal data from a sample of overweight and obese community college employees reasonably well.

Results for Hypothesis 1 indicate that there was a significant increase in autonomous and controlled motivation for participating in a weight loss program in the WC+WPI group compared to the WC only group, while there was no significant difference in autonomous and controlled motivation for participating in a weight loss program in the WC+WEB group compared to the WC only group. We are not sure whether the increase in autonomous and controlled motivation was due to the web-based weight loss program or financial incentives. Even though we have argued that the web-based program only required minimal effort, enrolling in the web-based weight loss program requires time and commitment to the online activities such as participation in the weekly nutrition exercise, interactive message boards, and self-weighing. The autonomous and controlled motivation for remaining in a weight loss program may not necessarily be high enough especially with barriers to use it at the worksite (e.g., no time, no access to computer) unless there were some incentives to keep participants motivated. Therefore, in our study, web-based program plus incentives has significantly increased participant's autonomous and controlled motives.

In another study to test a relevant but different research question-whether the offer or receipt of an incentive would lead individuals to show differential changes in autonomous and controlled motivation for remaining in a weight loss program, Crane et al. only included the participants in the WC+WEB and WC+WPI groups and those who completed the study questionnaires (e.g., excluded those with incomplete data) to compare the motivations between WC+WEB group and WC+WPI group of the WAY to Health Study (N=594)[133]. In her study, the cross-sectional data provides evidence to support that the WC+WPI may have greater influence on autonomous motivation for participating in a weight loss program than WC+WEB at 3 months- there was a significant difference between the WC+WEB and WC+WPI groups at 3 months (mean of WC+WEB: 5.13 ± 1.24; mean of WC+WPI: 5.39 ± 1.13; $P = 0.03$), where the WC+WPI group reported higher levels of autonomous motivation. When the authors used a growth curve model to assess the changes in either autonomous or controlled motivation for participating in a weight loss program over the 12 months, no significant difference was found between the WC+WEB and WC+WPI groups. The authors pointed out several plausible explanations for the lack of changes in motivation related to the incentives --the relatively small incentives, the delay between the behaviors required for weight loss and payment of the incentive, and the small sample size (only completers)[133].

Our study uses more advanced methodologies, adds new knowledge beyond the Crane paper and provides another potential explanation for why the small amount of cash incentives alone may not influence changes in autonomous or controlled motivation for participating in a weight loss program in the long term (e.g., a year after the beginning of the interventions), but it may result in an increase in the participants' autonomous and controlled motivation for participating in a weight loss program in the short term (e.g., 3 months after the beginning of the interventions) when combined with other forms of weight loss support (e.g., web-based weight loss program).

Moreover, while little difference was observed for the physical activity self-efficacy at 3 months across WAY intervention groups, participants in the WC+WPI (β=0.022, *p*=0.142) and WC+WEB group (β=0.023, *p*=0.097) did report greater healthy eating self-efficacy at 3 months compared to the WC only group but none of them reached statistical significance which demonstrated only partial support for Hypothesis 1. This result suggests that the web-based weight loss program may be more effective in increasing the healthy eating self-efficacy than improving the physical activity self-efficacy. Further research is needed to explore why the web-based weight loss program did better job improving the healthy eating self-efficacy than the physical activity self-efficacy.

Self-efficacy has received the most consistent support for mediating the relationship between physical activity interventions and physical activity[44]. Results for Hypothesis 2 show that the increased physical activity self-efficacy at 3 months was significantly associated with higher total MET min/week at 6 months. Consistent with SCT, the WAY web-based weight loss program was designed to increase eating and physical activity self-efficacy. Bandura (1997) specifically cited self-efficacy—one's faith in one's ability to maintain physical activity in the face of challenges and setbacks—as a key to success in regular exercise. Numerous studies have found self-efficacy to be physically active to be associated with physical activity[44, 116]. Our findings are consistent with the previous studies, such that the physical activity self-efficacy was associated with higher level of physical activity.

However, we provided no evidence that the physical activity self-efficacy mediated intervention effects on physical activity or weight loss because based on results for Hypothesis 1, little difference was observed for the physical activity self-efficacy at 3 months across WAY intervention groups. A review of the studies that examined theoretical constructs (i.e., mediators) in physical activity interventions, used experimental designs and met other criteria for evaluating mediation concluded that support for self-efficacy has varied across time point, gender, and outcome variable. [44]. Similar to our findings, two studies that examined the effect of the intervention on self-efficacy found that the intervention group did not report significant increase in self-efficacy than the control group[44]. Of the two studies that examined if self-efficacy was a mediator based on Baron and Kenny's criteria, one study found self-efficacy to be a physical activity mediator among mothers[44]. Another study conducted in a primary care setting found that self-efficacy was not a mediator[44], which is consistent with our findings.

Autonomous motives at 3 months were not significantly associated with physical activity at 6 months. The hypothesis 2 was partially supported.

Results for Hypothesis 3 demonstrate that controlling for all other relationships in the model, the autonomous motives at 3 months were associated with decreased total calories at 6 months and greater weight loss at 12 months. This is consistent with the SDT that proposes that for complex behaviors (e.g., adhering to diet recommendations), behavior change will be maintained to the extent that the behavior is autonomous[96]. Autonomous behavior is an expression of one's self and is undertaken with a full sense of choice. It is accompanied by an internal perceived locus of causality and a sense of true volition[183]. In contrast, controlled behavior, although intentional, has an external perceived locus of causality and is experienced as pressured or coerced. Although WC+WPI increased both autonomous and controlled motives at 3 months, only increased autonomous motives led to the desirable healthy eating behavior and weight loss. Previous studies found that autonomous motivation to participate in a weight loss program measured early in a weight loss program was predictive of behavioral change, weight loss and weight loss maintenance[96]. Their findings of the relationship between the autonomous motivation and weight loss are consistent with our findings.

According to a review of the relationship between psychosocial predictors and fruit and vegetable intake in adults, strong evidence was found for self-efficacy as predictor of adult fruit and vegetable intake[184]. Consistent with previous studies, results for Hypothesis 3 indicate that the healthy eating self-efficacy at 3 months was significantly related to less proportion of calories intake from fat, increased F&V at 6 months. The healthy eating self-efficacy at 3 months was not significantly associated with WAY interventions as demonstrated in the results for Hypothesis 1. Therefore, the evidence to support the fact that healthy eating self-efficacy mediates the intervention effects is insufficient; Hypothesis 3 was only partially supported.

The participants in the WC+WEB group consumed significantly less fruit and vegetables at 6 months compared to those in the WC group. But the association between servings of fruit and vegetables at 6 months and weight at 12 months was not significant as shown in the results for Hypothesis 4. Overall, no significant direct relationship between diet or physical activity at 6 months and weight at 12 months was found. Therefore, Hypothesis 4 was not supported. Noticeably, the proportion of calories intake from fat, daily total calories and daily servings of fruit and vegetables at baseline covaried significantly with one another, suggesting that these healthy eating behaviors were correlated. The fruit/vegetable consumption and the physical activity (Total MET min/week) at baseline were significantly and positively related with one another, meaning that individuals with healthy eating habits were also more likely to be physically active; and, that individuals who were not eating healthy were less likely to be physically active. As expected, the participants with higher total calories intake and proportion of calories intake from fat weighed more at baseline. However, the change in healthy eating and physical activity or "healthy lifestyle" may not be salient enough or measured with enough precision to detect any statistically significant association between the behaviors at 6 months and weight at 12 months.

Hypothesis 5 is to link the Hypotheses 1-4 and form an overall mediational hypothesis that the effects of WAY interventions on weight change are partially accounted for by autonomous motives, physical activity self-efficacy and/or healthy eating self-efficacy. We found a greater intervention effect in the WC+WPI group on the autonomous motives at 3 months, as well as on the weight at 12 months than in the WC only (comparison) group. The relationship between autonomous motives at 3 months and total calories at 6 months was significant and in the predicted direction. Similarly, autonomous motives at 3 months were associated with greater weight loss at 12 months. The indirect effect of WC+WPI on total calories and weight mediated by autonomous motives was marginally significant. Our results suggested that the relationships between WC+WPI intervention and both total calories and weight loss were mediated by autonomous motivation to participate in a weight loss program. Changes in autonomous motivation led to improved nutrition outcomes, accounting for part of the total effect of the WC+WPI intervention on nutrition behavior and weight loss (i.e., partial mediation) among overweight and obese employees. However, no significant mediator was found for WC+WEB group.

According to the results for Hypothesis 2, physical activity self-efficacy at 3 months was significantly associated with increased physical activity (i.e., Total MET min/week) at 6 months. Results for Hypothesis 3 and 4 also indicate that the healthy eating self-efficacy at 3 months was significantly associated with smaller proportion of calories intake from fat at 6 months, more daily servings of fruit and vegetables at 6 months and decreased weight at 12 months. However, because no significant difference in physical activity self-efficacy or healthy eating self-efficacy across the intervention groups was observed in our results for Hypothesis 1, there’s no evidence that the WAY interventions increase the healthy eating self-efficacy or physical activity self-efficacy in our study. These findings do not support the hypothesized mediational model in which self-efficacy mediates the relationship between the WAY interventions and healthy eating, physical activity, or weight. Therefore, Hypothesis 5 was only partially supported.

The participants' physical activity self-efficacy didn't change much after receiving the WAY interventions. The WAY interventions increased healthy eating self-efficacy to some extent but results were not statistically significant. This could be true due to the minimum intensity of the web-based program. Not getting enough exposure to the intervention may be an issue for the self-administered web-based intervention. While retention in the study was good; it didn't necessarily translate to high participation in the intervention. Strategy to ensure the participant gets the full intervention when she/he uses the web-based program is the key. Next step, we should look into the implementation of the web-based weight loss program to make sure the intervention was delivered as planned. Besides, the development of computer-based interventions must rest on a firm theoretical foundation to realize the potential for behavior change and risk reduction. For example, the Nutrition for a Lifetime System© (NLS) is a self-administered, computer-based intervention based on social cognitive theory developed through a series of small efficacy studies centered in supermarkets[121]. SEM analysis suggested that NLS led to higher levels of nutrition-related self-efficacy. The authors also found that changes in specific areas of participant's self-efficacy (e.g., self-efficacy for preparing and eating low-fat meals) mediated the NLS treatment effects on servings of fruits and vegetables and on fat. Our study confirmed that improved healthy eating self-efficacy would lead to more servings of fruits and vegetables and lower fat intake. In addition, it is important to note that many studies including our study have found significant correlations between physical activity self-efficacy and physical activity behavior but the interventions had little effect on physical activity self-efficacy[44]. The results suggest that our interventions to date are not very successful in changing physical activity self-efficacy. If the WAY interventions can significantly improve participant's healthy eating and/or physical activity self-efficacy, the WAY interventions would be more effective helping participants lose weight.

Strengths

One of the strengths of our study was that it included both key theory-guided eating- and PA-related pathways that can reveal the comprehensive picture of mediating mechanisms between weight loss interventions and behavioral/weight change. For many issues concerning mechanisms of nutrition, physical activity interventions and weight loss, the evidence is not definitive, either because the published results are inconsistent, and/or because the methods of studying mediations in human populations are still evolving[63]. Part of the uncertainty has resulted from studies that focus on specific psychological pathways or behaviors in isolation, thereby oversimplifying the complexity of weight loss mechanisms; the importance of dose, timing, and duration of exposure; and the large variations in both healthy eating and physical activity among human populations. Anderson-Bill (2011) investigated how changes at 6 months in participants' psychosocial characteristics contributed to improvements at 16 months in nutrition, physical activity, and weight management as a result of the online, social cognitive theory (SCT)-based Guide to Health intervention (WB-GTH)[46]. But the authors conducted this non-randomized trial analysis in two parts separately for the WB-GTH intervention effects using multivariate repeated measures analysis of variance (MANOVA) and the relationships among SCT-change variables at 6 months and behavioral and weight-change variables at 16 months using SEM among 272 of 655 (41.5%) self-selected participants enrolling in WB-GTH. Anderson-Bills' study indicated that the WB-GTH influenced behavior and weight loss in a manner largely consistent with SCT. Improving social support, self-efficacy, outcome expectations, and self-regulation, in varying combinations, led to healthier diet and exercise habits and concomitant weight loss[46]. Secondly, the use of a multilevel SEM approach allowed for a simultaneous evaluation of multiple relationships, accounting for the design effect or clustered data in the group-randomized trial and modeling of psychological factors as latent variables, which controlled for possible measurement error. Thirdly, we used several rigorous methods to test the mechanisms of change in this study. For example, we used the technique of regressing baseline (T1) scores out of follow-up (T2, T3 or T4) scores to calculate change in the constructs. This technique avoids problems that can occur when one uses the subtraction method associated with possible differences in the variances of two measures that go into the change scores[185]. In addition, we used the longitudinal data that are preferred for the testing of mediation hypotheses to the application of traditional mediation models to cross-sectional data. Many mediational analysis used cross-sectional design which precluded conclusions about causality or its direction[186, 187]. All relations observed in the cross-sectional study could be bidirectional. The longitudinal design of our study strengthened the temporality of the variables as well as structural equation analysis.

Limitations

Despite these strengths, there are several limitations to this study. First, while it is possible that the results do, in fact, accurately reflect a negligible influence of WAY interventions on healthy eating self-efficacy, physical activity self-efficacy, healthy eating or physical activity for our sample, we are limited in our conclusions by the nature of the measurements we used. For example, a systematic review on the validity of the IPAQ-SF showed that correlations between the total physical activity level measured by the IPAQ-SF and objective standards ranged from 0.09 to 0.39; none reached the minimal acceptable standard in the literature (0.50 for objective activity measuring devices, 0.40 for fitness measures)[188]. Therefore, it is possible that our measures lacked sufficient sensitivity to the constructs we intended to measure. Future research may want to examine the hypothesized relationships using additional or more sensitive measures of diet habits and physical activity such as accelerometers. Second, in order to test the mediation process which takes time to unfold, we hypothesized that WAY interventions result in the increased motivations and self-efficacy at the 3-month follow-up, which in turn were related to the behavioral change at the 6-month follow-up and weight loss at the 12-month follow-up. Tate's study demonstrated the efficacy of a theoretically driven, worksite-based Internet weight loss program[67]. Closer analysis of the results reveal that WEB program produced an average weight loss of 2 kg and that 24% of the intervention group lost at least 5 percent of their initial weight at 12 months, which provides a rationale for choosing a 12-month time frame. However, because each regression effect can be interpreted only with reference to that observed interval, the length of intervals between measurement occasions is important in a mediational analysis. We could possibly miss observing the effect of interest because the interval chosen was either too short for the effect to take place or so long that the impact of one construct on the other had faded[178]. In our study, for example, the effects of web-based program on healthy eating self-efficacy and physical activity self-efficacy might actually occur in a shorter time period (e.g., the first month of the intervention). The potential issue of inappropriate lags is compounded for mediation analysis because at least two (and sometimes three) lagged effects are multiplied together to test the indirect effect. Future research would benefit from more measurements or less time in between measures -with new technology, this would be possible. Researchers should also give a thorough consideration of the time scale of the developmental process, evidence from previous studies, and evidence from a pilot study may be useful in addressing this dilemma like what we did in the WAY project. Third, an overarching concept of SCT is reciprocal determinism, which states a constant interaction exists among the characteristics of a person, their behaviors, and their environment [48]. Weight control among employees is dependent on personal characteristics such as self-efficacy, behavioral choices such as portion size, and on external factors like healthy food availability. Several studies have demonstrated that self-efficacy to lose weight affect their behavior[69-71]. Individuals who report they were relatively more motivated and more confident in their ability to lose weight are more likely to achieve behavioral change and weight loss[42]. Our study only assesses self-efficacy as the mechanism of WAY interventions, not the entire SCT. Cognitive factors such as outcome expectations, self-regulation and intentions are also hypothesized to be important determinants of behavior according to SCT [48]. Further research may investigate the full SCT including other constructs such as outcome expectations, self-regulation and social support.

5.5. Conclusions

Pathway analysis is useful for helping understand why some interventions and certain components of those interventions successfully bring about improvement while others fail to do so. Thus, studying key mechanisms of behaviors will help to look into the "black box" of interventions and study the determinants of behavior change. As a result, we gain a deeper understanding of psychological and behavioral mechanisms of worksite-based weight loss interventions that can help develop more targeted and effective interventions in the future. For example, we found that the overweight and obese employees in the WC+WPI group were more likely to have greater autonomous motives at 3 months than those in the WC only group, which results in less total calories at 6 months and lower body weight at 12 months. Our results suggested that the relationships from WC+WPI intervention to both total calories and weight loss were mediated by autonomous motivation to participate in a weight loss program. Financial incentives combined with the web-based weight loss program and organizational change like WC may provide autonomous motives to participate in a weight loss program, which in turn results in the reduced total calorie intake and body weight among overweight and obese employees at worksite. Our findings do not support the hypothesized mediational model in which self-efficacy mediates the relationship between the WAY interventions and healthy eating, physical activity or weight because the WAY interventions didn't significantly improve self-efficacy related to healthy eating and PA. However, self-efficacy did lead to desirable changes in nutrition, physical activity and weight. Interventions that target obesity should take into account the effects of autonomous motives, healthy eating self-efficacy and physical activity self-efficacy on healthy eating, physical activity and weight regulation.

Future research to examine the mechanisms for weight loss interventions should consider adding more constructs of SCT model such as outcome expectations, self-regulation, social support/environment, using more sensitive measures of diet habits and physical activity and choosing shorter time intervals. Furthermore, additional research is important to determine which of these weight loss intervention components are working (i.e., independent effect of financial incentives and web-based weight loss program) and for whom (i.e., intervention effects and mechanisms in other populations). Such information is crucial to guide interventions most likely to have a positive effect in reducing the obesity crisis.

CHAPTER 6: DISCUSSION

6.1. Summary of Findings

Paper 1:

Findings of this paper are highlighted under each domain of the RE-AIM framework to provide a comprehensive overview of the public health effects of WC program.

1) Reach- results indicate that sixty-two percent of participants reported that they used the food services (i.e., cafeteria or vending machines) on campus. DeJoy et al. interviewed the site coordinators in a process evaluation for an environmentally focused worksite weight management study and found that employee patronage at some of the cafeterias was low, which, of course, limited the impact of the altered menu offerings[189]. Low patronage would also help explain the lower awareness levels for menu labels and other similar messages. But in our study, 62% of employees enrolled in WAY reported use of the food services on campus; thus, they were reachable by the WC. The reasons why employees did not use the food services on campus include not enough variety of food to choose from, not enough healthy options, too expensive and the food not taste good. Increasing access to healthy food, improving variety and quality of foods, providing a discount to the employees may help attract more employees, thus raise the reach of the WC program in the future.

2) Adoption- occurs at the organizational level and is measured by two indicators 1) the extent to which the community colleges participated in the WC training; and 2) the absolute number and proportion of community colleges that implemented any component of the Winner's Circle over the 12 months of intervention. By attending the kick-off event (70.6%) or having the project staff deliver the initial training to the community college (29.4%), all campuses (100%) received the baseline dose of WC training. Consistent with Dejoy and Wilson (2012), the participation among WAY community college representatives in the initial training was reasonably good but fell off considerably during the two conference calls and one mini-training/booster session[189]. Given the challenges of getting busy food service staff to attend trainings or conference calls, it would be helpful to have additional resources to go onsite to provide additional assistance on location to assist with ongoing training and implementation of the WC program. After the introduction and training on the program, all campuses (100%) adopted at least one aspect of the program to provide access and highlight healthy foods.

3) Implementation- the intended components of WC program-labeling of healthy food, nutrition education and increasing access to healthy food options in cafeterias/vending machines -- were not fully implemented. Although training was available initially, implementation relied heavily on food services staff. Based on Environmental Scans, nearly half of community colleges (9/17) placed WC stickers on healthy food options in the cafeteria and/or vending machines over a 12-month period. Sixty-seven percent of community college campus contacts reported that they had healthy foods labeled (including but not limited to WC stickers) and identified, 53% had signs or other print materials to promote healthy foods; while only 27% had promotions for

healthy foods and 27% added more healthy food choices to the menu. Based on the employee's survey, less than half of employees sometimes, often or always purchased items that have the Winner's Circle logo in the cafeteria/snack bar (48%) and campus vending machines (32.5%); thus, labeling at the point-of purchase appears to have a big impact on awareness and use of nutrition information to make informed decisions about food purchases.

4) Effectiveness- The design of the WAY to Health study included offering all three arms the Winners Circle Dining Program; and in the arm with Winners Circle only, we did not expect the enrolled overweight and obese employees to lose weight. Specifically, the research team hypothesized (and powered the study) for no weight gain among individuals in the WC only arm, compared to the two intervention arms (WC + WEB and WC + WPI). Results indicate that this hypothesis was confirmed. As expected, this study has demonstrated that there was no main effect on employee weight (or other eating behaviors) among employees enrolled in the community colleges participating in the Winner's Circle only arm of the study. Moreover, there was no significant interaction of WEB×WC or WPI ×WC in healthy eating outcomes or weight at the 3- and 6-month follow-ups, meaning that the WC program did not moderate the relationships between individual-level WAY interventions (i.e., WEB, WPI) and healthy eating outcomes/weight at 3 or 6-month follow-ups.

However, placing WC stickers in the cafeteria or vending machines significantly enhanced the effects of the WPI intervention (i.e., WC + web-based weight loss program and incentives) on individual weight loss among participants who used campus food services at the 12-month follow-up. Brehm et al. determined the effects of a multi-component environmental intervention that included point-of-decision prompts, cafeteria/vending changes, and educational material on obesity, disease risk factors and dietary intake in an employee population[190]. Their findings indicate that the minimum-intensive environmental changes alone, which was similar to the WC program, was not sufficient to improve employees' weight and health; however, such institutional-level approaches may be essential to support and/or sustain individual healthy lifestyle habits that are initiated by more intensive efforts. Consistent with their findings, the significant interaction between the WC and more intensive individual-level intervention (WPI) suggests that organizational-level approaches can provide the environmental support to the individual-level interventions.

Consistent with previous RE-AIM literature, considering reach, adoption, implementation and effectiveness, instead of effectiveness alone, yielded differential impacts across sites, suggesting that worksite characteristics may influence program impact.

Paper 2:

Based on SDT and SCT used in the formation of the WAY interventions, potential mediators (i.e., autonomy motivation, physical activity and healthy eating self-efficacy) were identified and tested through a MSEM model to help clarify the mechanisms by which the WAY interventions were efficacious. Although no significant mediator was found for the effects of WC+WEB on weight, the overweight and obese employees in the WC+WPI group were more likely to have greater autonomous motives at 3 months (T2) than those in the WC only group, which results in lower self-reported total calories intake at 6 months (T3) and lower body weight at 12 months (T4). Our results suggested that the relationships from WC+WPI intervention to both total calories and weight loss were mediated by autonomous motivation to participate in a weight loss program. These results are consistent with a recent review article that showed all forms of autonomous motivation predict exercise participation across a range of populations and settings[191]. Although research on SDT in the domain of eating behavior is still in its early stages and more research is clearly needed, SDT represents a promising theory to more thoroughly study and understand the motivational processes involved in eating regulation[192].

Regarding self-efficacy as a potential mediator, both WAY interventions (WC+WEB and WC+ WPI) increased healthy eating self-efficacy but not physical activity self-efficacy, indicating that the web-based weight loss program may be more effective in increasing the healthy eating self-efficacy than improving the physical activity self-efficacy. The web-based weight loss program was offered to both the WPI and WEB arms, and it was designed to increase the self-efficacy related to diet and PA. Unexpectedly, both WC+WEB and WC+WPI failed to produce a significant effect on self-efficacy. Thus, our findings do not support the hypothesized model in which self-efficacy mediates the relationship between the WAY interventions and healthy eating, physical activity or weight. But even with all other independent and mediating variables controlled, self-efficacy remained a significant predictor of healthy eating, physical activity and weight. This suggests several possibilities: (a) It may be that this population (e.g., overweight and obese, college employees) needs more intense interventions or (b) that the interventions in this study were weak or deficient in modifying self-efficacy. The clinical implications of these possibilities should be explored to improve future interventions. Interventions that target obesity should take into account the positive effects of self-efficacy on healthy eating, physical activity and weight control and put resources and efforts in cognitive-behavioral treatments for obesity such as behavioral modification session on eating behaviors (such as becoming aware of alternate eating patterns), thought processes (such as improving attitudes and restructuring cognitions), relationships (such as increasing and drawing upon social support), exercise (developing enjoyable and maintainable routines), and coping skills (developing stress management techniques)[193].

6.2. Strengths

Paper 1:

Several features of Paper 1 of this dissertation research are noteworthy. First, this research involved a rigorous evaluation of the WC program using the four dimensions of the RE-AIM framework (Reach, Effectiveness, Adoption and Implementation) which has been applied to worksite-based obesity prevention intervention previously[31]. Worksite health promotion program evaluations typically focus on individual behavior change with little attention to intervention implementation or maintenance. For example, in a systematic review of the effectiveness of worksite nutrition and physical activity programs to promote healthy weight among employees, none of the authors of the 47 studies reviewed examined the barriers to implementation[12]. We apply constructs of the RE-AIM framework to an assessment of the WC program, which is compatible with ecological interventions[26]. RE-AIM examines several dimensions of a program, both at the individual and organizational levels, to assess feasibility of translating research findings to practice[26, 105, 194-197].

A second strength is that we took advantage of a natural experiment that took place in the context of a RCT. Ramanathan et al. used the term "natural experiment " to refer to the situations in which the treatment (policy) has been assigned to an entire population and there is a natural variation in the implementation of the treatment; the authors also advocated for the evaluation of natural experiments in public health and suggested that such experiments may provide evidence on the effectiveness of health interventions because of the inherent variation in how, where and to whom interventions are administered[171]. Although it is not possible to generate causal data, this potential to investigate interventions within the context of 'real-life' situations is an advantage of natural experiments. As policymakers must make critical decisions and implement interventions to improve health and reduce health inequalities even in the absence of conclusive scientific data, there is a pressing need for stronger and more accepted research designs to evaluate natural experiments[171].

A third strength is that this dissertation has made a unique contribution to program evaluation methodology and successfully applied some features of quasi-experimental designs to a natural experiment to help understand the effectiveness of an environmental intervention. Despite the nature of the natural experiment, we used a quasi-experimental design (i.e., non-equivalent comparison group design with dependent pretest posttest samples) to evaluate the effectiveness of the WC program. A comparison group was formed by whether there's a placement of WC stickers at the cafeteria or vending machines on campus using the objective measures of the implementation of WC from the environmental scans. The environmental scans of the implementation of WC over the intervention period is certainly an advantage because the best way to assess the validity of the implementation of an environmental intervention would be to have an independent observation of the environment[136]. One of the limitations noted by Biener et al, is that organizational changes reported by informants are typically based on only a single individual's response. For example, to the extent that social desirability pressures led organizational informants to inflate reports of changes in food services; or, informant turnover forces someone different to fill out the survey post-intervention (compared to baseline), the findings may be biased[136, 159]. In this study, objective measures of the implementation of WC at the organizational level and longitudinal outcome data at the individual level (i.e., healthy eating behaviors and weight change at the baseline, 3, 6 and 12 months follow-ups) were used to generate useful data to evaluate this natural experiment.

A fourth important strength of this research is that the effectiveness of the placement of the WC stickers was evaluated on both dietary outcomes (i.e., employee intake of total kilocalories, fruit/vegetables and saturated fats) and an anthropometric outcome (i.e., body weight). Based on a review of the worksite health promotion literature, only a few worksite health promotion studies have evaluated the point-of-purchase food labeling; and even fewer have evaluated both dietary outcomes and anthropometric outcomes at the employee level[8, 18]. Evaluating both dietary outcomes and body weight is consistent with the recommendations derived from a systematic review of lifestyle-focused interventions at the workplace to reduce the risks of CVD[14]. Specifically, in order to gain better insight into the mechanisms that led to the intervention effects, Groeneveld et al. recommended that lifestyle changes achieved should be reported in addition to body weight change.

A fifth important strength of this research is its attempt to estimate interactions between levels of the WAY intervention. Estimating the interaction between the environment (i.e., placement of WC stickers) and individual level interventions (i.e., WEB, WPI) answers a critically important question: What role, if any, does environmental change play on the effect of the individual-level intervention on dietary outcomes and weight change? This largely neglected yet potentially important question attempts to understand the larger context in which workplace interventions influence employee health. [198]. Exploring the role of context, while still accounting for individual level interventions, requires that we examine cross-level interactions that may explain the effects of the multi-component, multilevel weight loss interventions like WAY to Health.

To the best of our knowledge, this dissertation is the first worksite-based weight loss intervention study to explore cross-level interactions by simultaneously investigating the relationships between the individual health outcomes (i.e., diet habits, weight change) and both organizational intervention (WC) and individual-level interventions (WC+WEB, WC+WPI), using a cross-level interaction approach[159]. This approach differentiates the intervention effects of different intervention components and tackles the interplay of environmental and individual level interventions.

Paper 2:

There are many strengths to this study. First, this dissertation is the first rigorous mediation analysis to examine a worksite-based weight loss intervention that was designed using multiple theories and to understand the determinants of diet, physical activity and weight. Testing theoretical constructs to understand the determinants of behavior is a key component of developing effective theory-based behavioral interventions. Behavioral interventions induce change in behavior by operating at least partially through their impact on psychosocial variables. Many theories such as Social Cognitive Theory[48, 84, 91, 121], Transtheoretical Model[199-202], Health Belief Model[203-205], Theory of Planned Behavior[126, 206, 207] and SDT[55, 96, 122, 131, 173, 208]were used to predict the relationship between the psychosocial variables and targeted behaviors including weight loss. However, the limited ability of existing theoretical models of behavior to predict weight loss highlights the need to simultaneously evaluate the combination of multiple theoretical models and their constructs as potential determinants of weight loss. Previous research shows that self-efficacy from SCT and autonomous motivation from SDT were strong predictors of diet and Physical activity that result in weight change[44-46]: The conceptual overlap and similarity between SDT and SCT makes the use of the two theoretical models in a weight loss intervention possible. For example, competence, one of the three psychological needs (i.e., autonomy, competence and relatedness) in SDT, is similar to self-efficacy in SCT. Competence in SDT (or self-efficacy in SCT) is facilitated by autonomous motivation. Once individuals are autonomously motivated to act, they start to apply new strategies and new knowledge/skills that result in desirable behaviors. SDT predicts that competence alone is not sufficient to motivate behavior; it must be accompanied by autonomy. Based on this theoretical underpinning, the present study aims to test the WAY interventions that combined the SCT and SDT and included both self-efficacy and autonomous motivation in the same model.

Second, attempting to examine two behavioral pathways (eating and PA) helps reveal how mediating mechanisms between weight loss interventions and behavioral/weight change may work. For healthy people, levels of energy intake should be commensurate with energy expenditure, so as to achieve energy balance[209]. Desirable energy intakes for obese individuals should be less than their energy expenditure, because weight loss and the establishment of a lower body weight are desirable for them. Thus, it seems logical to examine both energy intakes (diet) and energy expenditure (PA) in the same mediation model to gain the whole picture of the mechanisms of weight loss interventions which we did in this study.

Third, a number of advantages are associated with MSEM, an advanced methodological innovation used in the present study. In performing tests of mediation, MSEM a) produce more accurate estimates and standard errors when observations are nested within groups (or clustered); b) able to model psychological factors as latent variables, which controlled for possible measurement error; and c) allows the specification of "one model that describes all hypothesized relations between independent, intervening, and dependent variables" simultaneously[210]. We tested the mediation in a 1-1-1-1 design, where the first "1" stands for the WAY interventions, the 2nd and 3rd "1" stands for the mediators (i.e., self-efficacy and behaviors), the last "1" refers to the dependent variable weight. "1" means the variables are all at the employee level. As described above, to fulfill the research goals of testing multiple pathways including diet and physical activity as well as the multiple mediators in one path (i.e., 1-1-1-1 design), it's more efficient and accurate to fit one simultaneous model using MSEM. The primary limitation of using MSEM to estimate the multilevel path models – the inability to estimate random effects for more than two levels – did not affect the current study.

Fourth, we used several rigorous methods to test the mechanisms of change in this study. A longitudinal approach is superior to the cross-sectional design in mediational analysis because there is temporal ordering between the independent variable, mediating variable, and dependent variable[211]. Although a significant mediating effect does not establish the presence of a causal mechanism, it offers stronger evidence for drawing causal inferences[186, 187] Therefore, use of mediators at 3 months (T2), behaviors at 6 months(T3) and weight measured at 12 months (T4) have greatly improved the statistical test of mediation. In addition, we used the technique of regressing baseline (T1) scores on follow-up (T2, T3 or T4) scores to calculate change in the constructs. This technique avoids problems that can occur when one uses the subtraction method associated with possible differences in the variances of two measures that go into the change scores[185].

6.3. Limitations

This study is not without its limitations. For the purpose of simplification, these limitations have been organized into three categories: a) research design, b) measurement and c) statistical power.

Research Design

Several limitations of this study relate to research design issues. First, this study utilized a convenience sample; A letter and a brief interest survey was faxed to the president of each of the 59 community colleges within the North Carolina Community College System to determine initial interest in participating and eligibility to participate in a research study addressing employee weight loss[21]. The use of a convenience sample limits its generalizability to other worksites in other places. Lack of external validity is a common problem in intervention research studies that employ non-random sampling strategies.

Second, participants were not randomly assigned to the "placement of WC stickers" or "no WC stickers" group in Paper 1. Lack of randomization increases the potential for pre-existing differences between treatment and comparison group. The presence of systematic differences between study conditions is a form of selection bias that can compromise the internal validity of a study. Selection bias can also result from data attrition; it poses a threat to the internal validity of the study, when levels of attrition differ between treatment groups. With selection bias, it's hard to tell whether the difference in outcomes between study conditions is due to program effects or pre-existing difference between study conditions[212]. We used the baseline data to compare the characteristics of respondents who weighed in with those who did not weigh-in at the 12 months assessment by arm. Fortunately, the non-respondent analysis shows that there's no significant difference between the respondents and non-respondents by arm. Thus, the differential attrition is not a threat to internal validity of the study.

A third limitation is our lack of data to thoroughly explore potential dimensions of key frameworks or theoretical constructs. In Paper 1, this includes such issues as maintenance of WC program (one of RE-AIM framework constructs). In paper 2, we did not examine the complete set of constructs from SCT and SDT for the mediational analysis. And, we also did not fully explore the costs associated with intervention implementation. For example, tracking implementation costs by activity (e.g., staff time and materials) could affect subsequent maintenance at the organization level. It could additionally inform future worksite adoption and dissemination issues. Although important, maintenance was not a key outcome of this study yet we mention this limitation nonetheless.

Finally, this dissertation research excluded covariates of intervention dosage such as the lessons completed and time spent on the web-based weight loss program, the frequency and amount of incentives received. Therefore, heterogeneity in program effects caused by varying levels of exposure to the interventions was not controlled in these analyses. Future studies should explore intervention exposure (e.g., use of the web-based program, incentives received).

Measurement

Several limitations in the measurement aspect of this study are noteworthy. First, the self-reported nature of dietary assessment means there is a substantial risk of bias[8]. The Block FFQ used in this study is an accepted and widely used dietary assessment tool. However, its reliability is limited by a tendency toward under-reporting the energy intake[213]. Low reported energy intake may be due to deliberate or accidental omissions, failure of recall or actual low energy intake[213]. Second, the low reliability of the IPAQ-SF measuring total physical activity may have resulted in attenuated effects or null results for this variable and biased the findings of the associations between WAY interventions, psychological factors, physical activity and weight in this study. Third, more proximal outcome measures such as the cafeteria and vending machines sales data might be more helpful in evaluating the effectiveness of WC program than employee diet habits and weight change. Environmental influences on diet are generally considered to involve two pathways: access to foods for home consumption from supermarkets and grocery stores, and access to ready-made food for home and out-of-home consumption (e.g. takeaways, restaurants, worksite cafeterias)[198]. The environmental change in workplace alone may not result in substantial change in the diet habits or weight because the worksite cafeteria/vending machines only represent a small part of food environments in one's daily life and the weight loss process involves many factors not just environmental change.

Statistical Power

We re-computed power to detect intervention effects in this study and determined there was limited power to detect small effects. For Paper 1, accounting for the ICC among employees nested in community college, the statistical power with total sample size of 613 is 0.05 to detect a difference of -1.08 lbs in weight; the statistical power with total sample size of 1004 is 0.17 to detect a fruit and vegetables intake difference of 0.25 servings per day; the statistical power with total sample size of 745 for is 0.99 to detect a total calories intake difference of 407 kcal per day. For Paper 2, given our data, the power of detecting a mediocre fit and an extremely good fit is 0.90 and 0.87, respectively. In sum, we had limited power to detect small effects except for the total calories intake in Paper 1; and our data had enough power to detect both a mediocre fit and an extremely good fit in Paper 2.

The use of multilevel models compromised the power of the study due to the limited number of clusters (N=17). Smaller sample sizes also produced low power to test the significance of main effects, interactions, direct and indirect effects.

6.4. Implications for Practice

One important implication of these results for practice is that an environmental intervention may need to be combined with individual-level intervention to help employees eat healthier and lose weight.

Individually focused interventions attempting to reduce obesity have tended to ignore the influence of the complex social and physical contexts in which individual behavioral decisions are made and have had limited success[198]. Such critiques have led to a new focus on ‘environmental’ exposures. Consequently, public health strategies have place increasing emphasis on environmental interventions to promote healthy behaviors within the workplace setting[8]. However, results from our study (and previous studies) raise questions about whether the minimum-intensity environmental interventions at worksites are sufficient for producing population-based obesity prevention and control efforts. For example, Linde and her colleagues (YEAR) assessed a worksite-based environmental intervention that focused on healthy food labeling, availability and price, physical activity promotion, scale access, and media enhancements. A majority of intervention components were successfully implemented. However, there were no differences between sites in the key outcome of weight change over the two-year study period ($p = .36$)[106].

Another study conducted by Engbers (2007) tested a 12-month environmental intervention to stimulate healthier food choices and stair use[214]. No significant effects on consumption of fruits, vegetables, dietary fat or BMI were found. The author concluded that this modest environmental intervention was not effective in reducing cardiovascular risk in a population of office workers.

Our findings in the WAY to Health study are fairly consistent with previous studies regarding the limited effects on weight change of worksite-based environmental interventions that focused on healthy food labeling and availability. As the change in individual's diet habits and weight is a complex long-term process that involves psychological factors (e.g., self-efficacy on preparing healthy foods and resisting unhealthy foods), behavioral factors (e.g., exercise, choose low calories foods, small portion size), social norms and support (i.e., support from family and friends), and various food environments including labeling, educational information, availability and price of healthy foods at supermarkets, grocery stores, home, restaurants, worksite cafeterias and so on, it is doubtful that a minimal intensity worksite-based environmental intervention alone would generate significant changes in individual's dietary behaviors and weight outcomes. This is exactly why the research team chose WC alone as the comparison group in this worksite-based weight loss study. Our results confirmed it was a reasonable decision in that no change in weight (or healthy eating behaviors) was identified in the WC only intervention arm.

A meta-analysis of workplace physical activity and dietary behavior interventions on weight outcomes showed a greater reduction in body weight associated with physical activity and diet interventions containing an environmental component[215], which is consistent with our findings on interactions between environmental and individual interventions. We recommend comprehensive worksite-based weight loss interventions including an environment component in order to better help overweight employees lose weight because: 1) the environmental intervention may support individual's healthy lifestyle habits; 2) the clinical relevance of the pooled effects of environmental and individual interventions may be substantial on a population level.

A second implication for practice has to do with strategies for increasing capacity of the organizations to be able to adopt and implement programs like WC. Additional program training that engages multiple stakeholders and provides a variety of training options is the key.

In this natural experiment, specific WC activities designed to create environmental changes (e.g., nutrition labeling and education and increased access to healthy foods) were only partially implemented; and, participating community colleges were more willing to implement nutrition labeling and education than increase access to healthy foods. Perceived by the campus contacts, lack of employer interest and limited capacity to implement WC were two key barriers to program implementation.

Several implications of these barriers for health promotion practice should be discussed. First, sustainable program training at worksites must be designed so that worksite staff can quickly obtain skills, information, and resources they need to implement and maintain the environmental change at worksites. Community college representatives have limited time to leave their work to attend trainings or pick up materials. In our study, while 70.6% participated in the initial training held in Chapel Hill, only 41.8% and 11.8% attended two phone conference calls designed to trouble-shoot potential problems with program implementation. Although project staff traveled to the community colleges that did not receive the WC training at the kick-off event; future studies should consider holding booster trainings at each community college, or using technology or continuing education opportunities to provide trainings that were easy and convenient to attend. In addition, worksite representatives told us that they would have appreciated more opportunities to see demonstrations and/or practice skills needed to prepare and label healthy foods using WC healthy eating criteria.

Another practice-based implication of our results is to reinforce the importance of intervening on multiple levels of the social ecological framework. Researchers and practitioners need to find evidence-based ways to intervene at multiple levels. Engaging with employees, managers, and key leaders is also recommended. For example, although we gained great support from top leadership, collaboration with food services personnel, at a different management level, was not always evident. This may have been due to busyness of the food service staff, conflicts between training times and work demands, or lack of interest/support.

Another level of intervention would be achieved by devising ways to identify and engage informal leaders within workplaces in addition to formal leaders such as supervisors or managers. Specifically, if there are champions of healthy food changes in the cafeteria, it is likely that employee awareness, access to and utilization of the WC program may be increased. Although not a focus in this study, employee wellness committees may help identify program champions and secure desired support for wellness activities and environmental changes[216]. Finally, to accommodate employee schedules and competing demands, differing individual needs and learning styles, a variety of healthy foods and educational materials should be offered from which employees can select their own healthy foods to help them lose weight.

The third implication for practice is that a web-based weight loss program can be more effective in helping employees lose weight if complemented by weight-loss incentives and organizational-level interventions like WC.

The Community Preventive Services Task Force recommends technology-supported multi-component coaching or counseling interventions including web-based programs intended to reduce weight or maintain weight loss on the basis of sufficient evidence that they are effective in improving weight-related behaviors or weight-related outcomes[217]. Many health behavior interventions can be delivered by web-based program such as teaching behavioral management skills, modeling or demonstration, participatory skill development, and individual benchmarking (i.e., goal-setting and achievement), and provide feedback and building social support for behavioral patterns. Such practices can be even more effective if they are complemented by financial incentives, typically given for participation and completing the program[218].

Incentives consist of rewards for weight loss and behavioral change to increase physical activity or improve nutrition. The incentives can vary in size and by timing (or type) and can be used for screening, enrollment, compliance (i.e., staying in the program), completing the program, and maintenance of the changes after completing the program[163]. The greater difference in employee weight loss comparing the WC only group with those of WC+WPI and WC+WEB suggests that providing incentives in worksite-based interventions may strengthen the effects of the web-based weight loss program. Moreover, the organizational-level intervention (WC) may also provide support to the desirable behavioral change and reinforce the effects of the individual-level interventions (WEB, WPI) on weight loss. Additional research to see if these weight changes sustain over time would be beneficial.

Another important implication for practice is that worksite-based weight loss interventions should target autonomous motivation and self-efficacy as pathways to help employees make positive behavioral changes and achieve weight control.

Findings from this dissertation indicate that financial incentives combined with the web-based weight loss program may promote more autonomous motives to participate in the WAY study, which in turn results in the reduced total calorie intake and body weight among overweight and obese employees. After reviewing empirical findings from weight control studies that have used SDT measures and assessed their association with weight outcomes, Teixeira et al (2012) suggest that if individuals fully endorse weight loss-related behavioral goals and feel not just competent but also have a high level of autonomy about reaching them, their efforts are more likely to result in long-lasting behavior change[131]. This finding is promising and suggests that autonomous motives are important to encourage among those who are hoping to lose weight and keep it off over time. The results of Paper 2 deepen our understanding of Teixeira's findings and suggest that the autonomous motives can explain the effects of WAY interventions on the total calorie intake and body weight.

Although WAY weight loss interventions (WEB and WPI) were not successful in changing physical activity self-efficacy, empirical evidence shows that increased self-efficacy may lead to desirable changes in nutrition, physical activity and weight[42, 86, 119, 219]. While testing and developing theory is a worthwhile activity in its own right, the real significance of understanding important constructs from SCT and SDT are most useful if we can integrate these constructs in meaningful ways as part of interventions to help employees lose weight or maintain a healthy weight. In this regard, the growing evidence for the utility of SCT-based and SDT-based interventions for obesity prevention and control is a significant advance[191]. Prevention and interventions directed toward overweight and obese employees at workplaces should target autonomous motives and self-efficacy to promote healthy lifestyle and to help them lose weight, which are both theory- and evidence-based. These dissertation results suggest that helping employee build their self-efficacy and increase their autonomous motives may be efficient ways in delivering weight loss interventions to reduce obesity in workplaces.

6.5. Recommendations for Future Research

First, evaluation of interventions implemented within multilevel systems such as worksites require consideration of multiple levels of influence and impact[220]. In this study and future studies, we need to make decisions related to how results will be used (e.g., to provide empirical evidence for guiding general practice, or to evaluate effectiveness within a specific system), what methods and designs will be employed (e. g., quantitative, qualitative, mixed methods), the evaluation questions, the complexity of the evaluation model (e.g., outcomes are multidimensional vs. one-dimensional; data reflect perspectives of single vs. multiple stakeholders), the intended duration and nature of inquiry (focus on process and immediate outcomes, long-term effects, evaluation of repeated cycles of intervention), and the scope of the intervention (e.g., single vs. multiple sites). For example, acceptability and integrity of a worksite-based intervention might be influenced by cultural norms and expectations within the larger worksite context (e.g., administration does not support time devoted to the goals that are not related to job). Furthermore, efforts to implement sustainable interventions require consideration of priorities, resources and infrastructure at the organizational levels.

It is critical to examine the process, implementation, design characteristics and program content in evaluating the multilevel interventions. Just as medications fail to work when certain active ingredients are missing, interventions may be more likely to fail when particular areas of program content are not sufficiently covered. RE-AIM is a useful tool not only assessing the efficacy of different types of interventions, but also assessing the process of implementing the intervention. Four different types of intervening variables were examined in this study and should be examined in the future studies: a) participant characteristics of those reached by the WC; b) implementation characteristics (e.g., implementation of the WC program at both individual and organizational level); c) design characteristics (e.g., appropriate design and analytic procedures for multicomponent, multilevel interventions); and, d) program content (e.g. the mediational analysis in Paper 2 took into account the program content such as self-efficacy and autonomous motives and examined whether the WAY interventions worked through certain program content).

Secondly, alternatives to RCTs are necessary to fully understand the conditions under which interventions work in real-life settings[221]. We have presented the RE-AIM framework combined with a natural experiment in the context of a large randomized controlled trial that involves assessing multiple dimensions of program success, drawing on perspectives of multiple stakeholders, and employing multiple methods for data collection. Evaluation of sustainable multilevel interventions requires the use of evaluation data to inform program implementation and adaptation to variations across individuals, levels and time[171].

The complexity of multilevel interventions presents several challenges for evaluators and calls for consideration of alternatives to traditional experimental designs. Practically, researchers face the following challenges when designing an evaluation of multilevel interventions: feasibility of randomized controlled trials within community-based multilevel intervention; acceptability and social or cultural validity of evaluation procedures; implementer, recipient, and contextual variations in program success; interactions among levels of the intervention; differential attrition or selection bias; unanticipated changes or conditions; multiple indicators of program success; engaging multiple stakeholders in a participatory process; and evaluating sustainability and institutionalization[221]. Surmounting the challenges of multilevel interventions holds promise for developing and testing interventions that can be effectively translated to practice in real-life settings.

Thirdly, there is an urgent need for future worksite dietary intervention studies to include objective measures of weight, dietary behavior, and environmental conditions. Examples of such objective measures include body weight as well as environmental indicators such as cafeteria and/or vending machine sales data, and nutritional analysis of foods available at worksites. Future studies should also consider assessing dietary intake outside the workplace (e.g. at home) because of the potential for compensatory behavior in the home. An example of assessing home food environments can be found in the Consumer Behavior Questionnaire that was obtained as part of the NHANES Family Questionnaire[222] regarding food availability in the home, family food expenditures, time spent cooking dinner, number of meals eaten together as a family, and number of meals eaten together cooked at home.

Another important recommendation for research is that future subgroup analyses are needed to inform practitioners about which interventions (or components of an intervention) work best for whom. This could guide future program development, implementation and evaluation.

Practitioners will benefit from knowing which interventions (or intervention components) are most effective for which types of people Individual characteristics, such as race, gender, and risk status influence program effects. Understanding results in ways that can inform practitioners in the process of program development, implementation and evaluation is helpful. We suspect future studies may come to identify significant moderating factors for the effects of specific weight loss interventions, such as weight at baseline, age, gender, previous health conditions, or social norms and social support. Tests of moderation offer information about which programs elements may be more relevant for particular populations or subgroups of overweight and obese employees. Equipped with knowledge about "what works" and "for whom," intervention researchers may be able to have a larger impact on a greater number of employees.

Lastly, choosing an appropriate time frame is crucial when conducting mediational analysis. There is increasing evidence that high autonomous motivation is important to sustain exercise behaviors over time, although the pool of studies supporting this inference is limited[191]. Longer-term studies and follow-ups will be especially important in evaluating the efficacy of autonomous motivation in weight maintenance. For that reason, our study is perfect in choosing a relatively long-term (i.e., 12 months) time frame for testing the autonomous motivation as a mediator between WAY interventions and weight loss. Conversely, some researchers found that web-based programs promote self-management in a short and midterm time frame (i.e., 3-5 months)[223]. It is very important to select an appropriate time frame when collecting data to access the mediation effects on self-efficacy. Given the available time points, we examined the relationships among the WAY interventions and self-efficacy at 3 months and behaviors at 6 months and weight at 12 months. If the time frame is inappropriate (e.g., the independent and dependent variables are measured far apart when the effects diminish or are too close when the effects haven't had enough time to show), the results will be biased. Future research could consider new methods of collecting the real-time data on psychological factors such as ecologic momentary analysis or use of new tablet or other devices that allow continuous real-time data uploads. In addition, the Synergetic Navigation System (SNS) is a new internet-based technology of data collection and data analysis that has been applied to increase quality and efficacy in psychotherapy[224]. Such methods can probably provide more time-sensitive data that are amenable for mediational analysis in future weight loss studies.

6.6. Conclusions

Although weight loss interventions are increasingly required to be evidence-based, few evaluations of these programs have examined cross-level interactions between the intervention components or whether theory-based psychological processes and targeted behaviors account for program success[42, 43]. Without this knowledge, one cannot justifiably conclude how or by which content a particular intervention program produced effects. In Paper 1, we used RE-AIM as the evaluation framework, we assessed the reach, adoption, implementation and effectiveness of a minimum-intensity environmental intervention on both the primary (weight loss) and secondary (diet) outcomes using all available longitudinal data (baseline, 3, 6 and 12 months), mixed methods (e.g. environmental scans, campus contact and employee surveys) and multilevel models. We found that the synergistic effects of environmental change programs and individually focused health promotion hold great promise for reducing the burden of overweight and obesity among employees. Results of Paper 1 also suggest that Winner's Circle has the potential to be adopted, implemented and accepted by both the employers and employees. Paper 2 of this dissertation used the 1-1-1-1 design in mediational analysis to examine key theoretically guided mechanisms of weight loss in the WAY to Health interventions (e.g. WC + WEB; WC +WPI). Results revealed pathways linking worksite-based weight loss interventions, employees' self-efficacy and autonomous motives with behavioral outcomes and weight loss. Taken together, these dissertation results help clarify key mechanisms associated with WAY to Health interventions and provide useful insights to help develop and evaluate effective workplace-based weight loss interventions.

REFERENCES

1. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. *JAMA*. 2012;307:491-497.

2. Finkelstein EA, DiBonaventura M, Burgess SM, Hale BC. The costs of obesity in the workplace. *J Occup Environ Med*. 2010;52:971-976.

3. Ruhm C. Current and Future Prevalence of Obesity and Severe Obesity in the United States. 2007;2:1-26.

4. Gaziano JM. Fifth phase of the epidemiologic transition: the age of obesity and inactivity. *JAMA*. 2010;303:275-276.

5. North American Association for the Study of Obesity., National Heart, Lung, and Blood Institute., National Institutes of Health (U.S.), NHLBI Obesity Education Initiative. The practical guide : Identification, evaluation, and treatment of overweight and obesity in adults. In: Bethesda Md: National Institutes of Health National Heart Lung and Blood Institute NHLBI Obesity Education Initiative North American Association for the Study of Obesity; 2000:12.

6. Kumanyika SK, Obarzanek E, Stettler N, et al. Population-based prevention of obesity: the need for comprehensive promotion of healthful eating, physical activity, and energy balance: a scientific statement from American Heart Association Council on Epidemiology and Prevention, Interdisciplinary Committee for Prevention (formerly the expert panel on population and prevention science). *Circulation*. 2008;118:428-464.

7. Chapman LS. Building a sustainable administrative infrastructure for worksite wellness programs. *Am J Health Promot*. 2009;24:TAHP1-10, iii.

8. Ni Mhurchu C, Aston LM, Jebb SA. Effects of worksite health promotion interventions on employee diets: a systematic review. *BMC Public Health*. 2010;10:62.

9. Hutfless S, Maruthur NM, Wilson RF, et al. AHRQ Comparative Effectiveness Reviews: Strategies to Prevent Weight Gain Among Adults. *AHRQ Comparative Effectiveness Reviews.* Rockville (MD): Agency for Healthcare Research and Quality (US); 2013.

10. Lemon SC, Zapka J, Li W, Estabrook B, Magner R, Rosal MC. Perceptions of worksite support and employee obesity, activity, and diet. *Am J Health Behav*. 2009;33:299-308.

11. Heinen L, Darling H. Addressing obesity in the workplace: the role of employers. *Milbank Q*. 2009;87:101-122.

12. Anderson LM, Quinn TA, Glanz K, et al. The effectiveness of worksite nutrition and physical activity interventions for controlling employee overweight and obesity: a systematic review. *Am J Prev Med*. 2009;37:340-357.

13. Conn VS, Hafdahl AR, Cooper PS, Brown LM, Lusk SL. Meta-analysis of workplace physical activity interventions. *Am J Prev Med*. 2009;37:330-339.

14. Groeneveld IF, Proper KI, van der Beek AJ, Hildebrandt VH, van Mechelen W. Lifestyle-focused interventions at the workplace to reduce the risk of cardiovascular disease - a systematic review. *Scand J Work Environ Health*. 2010.

15. Task Force on Community Preventive Services. A recommendation to improve employee weight status through worksite health promotion programs targeting nutrition, physical activity, or both. *Am J Prev Med*. 2009;37:358-359.

16. Matson-Koffman DM, Brownstein JN, Neiner JA, Greaney ML. A site-specific literature review of policy and environmental interventions that promote physical activity and nutrition for cardiovascular health: what works? *Am J Health Promot*. 2005;19:167-193.

17. Brug J, Kremers SP, Lenthe F, Ball K, Crawford D. Environmental determinants of healthy eating: in need of theory and evidence. *Proc Nutr Soc*. 2008;67:307-316.

18. Kahn-Marshall JL, Gallant MP. Making Healthy Behaviors the Easy Choice for Employees: A Review of the Literature on Environmental and Policy Changes in Worksite Health Promotion. *Health Educ Behav*. 2012.

19. Finkelstein EA, Fiebelkorn IC, Wang G. State-level estimates of annual medical expenditures attributable to obesity. *Obes Res*. 2004;12:18-24.

20. Linnan, L., Brooks, A., Haws, S., Benedict, S., Birken, B., French, E., Gizlice, Z., Britt, A. Community colleges as settings for promoting employee health. *Am Journal of Health Studies*. 2010;25:86-91.

21. Linnan L, Tate DF, Harrington CB, et al. Organizational- and employee-level recruitment into a worksite-based weight loss study. *Clin Trials*. 2012;9:215-225.

22. Oakley A, Strange V, Bonell C, Allen E, Stephenson J, RIPPLE Study Team. Process evaluation in randomised controlled trials of complex interventions. *BMJ*. 2006;332:413-416.

23. Hill JO, Peters JC. Environmental contributions to the obesity epidemic. *Science*. 1998;280:1371-1374.

24. French SA, Story M, Jeffery RW. Environmental influences on eating and physical activity. *Annu Rev Public Health*. 2001;22:309-335.

25. Nestle M, Jacobson MF. Halting the obesity epidemic: a public health policy approach. *Public Health Rep*. 2000;115:12-24.

26. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *Am J Public Health*. 1999;89:1322-1327.

27. Vuillemin A, Rostami C, Maes L, et al. Worksite physical activity interventions and obesity: a review of European studies (the HOPE project). *Obes Facts*. 2011;4:479-488.

28. Abildso CG, Zizzi SJ, Reger-Nash B. Evaluating an insurance-sponsored weight management program with the RE-AIM Model, West Virginia, 2004-2008. *Prev Chronic Dis*. 2010;7:A46.

29. Akers JD, Estabrooks PA, Davy BM. Translational research: bridging the gap between long-term weight loss maintenance research and practice. *J Am Diet Assoc*. 2010;110:1511-22, 1522.e1-3.

30. Kim AE, Towers A, Renaud J, et al. Application of the RE-AIM framework to evaluate the impact of a worksite-based financial incentive intervention for smoking cessation. *J Occup Environ Med*. 2012;54:610-614.

31. Estabrook B, Zapka J, Lemon SC. Evaluating the implementation of a hospital work-site obesity prevention intervention: applying the RE-AIM framework. *Health Promot Pract*. 2012;13:190-197.

32. Aittasalo M, Rinne M, Pasanen M, Kukkonen-Harjula K, Vasankari T. Promoting walking among office employees - evaluation of a randomized controlled

intervention with pedometers and e-mail messages. *BMC Public Health*. 2012;12:403-2458-12-403.

33. King DK, Glasgow RE, Leeman-Castillo B. Reaiming RE-AIM: using the model to plan, implement, and evaluate the effects of environmental change approaches to enhancing population health. *Am J Public Health*. 2010;100:2076-2084.

34. Benedict MA, Arterburn D. Worksite-based weight loss programs: a systematic review of recent literature. *Am J Health Promot*. 2008;22:408-416.

35. Perlmutter CA, Canter DD, Gregoire MB. Profitability and acceptability of fat- and sodium-modified hot entrees in a worksite cafeteria. *J Am Diet Assoc*. 1997;97:391-395.

36. Bertera RL. Behavioral risk factor and illness day changes with workplace health promotion: two-year results. *Am J Health Promot*. 1993;7:365-373.

37. Engbers LH, van Poppel MN, Chin A Paw MJ, van Mechelen W. Worksite health promotion programs with environmental changes: a systematic review. *Am J Prev Med*. 2005;29:61-70.

38. Beresford SA, Bishop SK, Brunner NL, et al. Environmental assessment at worksites after a multilevel intervention to promote activity and changes in eating: the PACE project. *J Occup Environ Med*. 2010;52 Suppl 1:S22-8.

39. French SA, Harnack LJ, Hannan PJ, Mitchell NR, Gerlach AF, Toomey TL. Worksite environment intervention to prevent obesity among metropolitan transit workers. *Prev Med*. 2010.

40. Raudenbush, S.W., & Bryk, A.S., ed. *Hierarchical Linear Models: Applications and Data
analysis AMethods.* 2nd ed. Thousand Oaks, CA: Sage Publications, Inc; 2002.

41. Sorensen G, Linnan L, Hunt MK. Worksite-based research and initiatives to increase fruit and vegetable consumption. *Prev Med*. 2004;39 Suppl 2:S94-100.

42. Anderson ES, Wojcik JR, Winett RA, Williams DM. Social-cognitive determinants of physical activity: the influence of social support, self-efficacy, outcome expectations, and self-regulation among participants in a church-based health promotion study. *Health Psychol*. 2006;25:510-520.

43. Kremers S, Reubsaet A, Martens M, Aet al. Systematic prevention of overweight and obesity in adults: a qualitative and quantitative literature analysis. *Obes Rev*. 2010;11:371-379.

44. Lewis BA, Marcus BH, Pate RR, Dunn AL. Psychosocial mediators of physical activity behavior among adults and children. *Am J Prev Med*. 2002;23:26-35.

45. Anderson ES, Wojcik JR, Winett RA, Williams DM. Social-cognitive determinants of physical activity: the influence of social support, self-efficacy, outcome expectations, and self-regulation among participants in a church-based health promotion study. *Health Psychol*. 2006;25:510-520.

46. Anderson-Bill ES, Winett RA, Wojcik JR, Winett SG. Web-based guide to health: relationship of theoretical variables to change in physical activity, nutrition and weight at 16-months. *J Med Internet Res*. 2011;13:e27.

47. Okay DM, Jackson PV, Marcinkiewicz M, Papino MN. Exercise and obesity. *Prim Care*. 2009;36:379-393.

48. Bandura A. Social foundations of thought and action: A Social Cognitive Theory. . 1986.

49. Tate DF. A randomized trial comparing human e-mail counseling, computer-automated tailored counseling, and no counseling in an Internet weight loss program. *Archives of internal medicine (1960)*. 2006;166:1620.

50. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am Psychol*. 2000;55:68-78.

51. Williams GC, Minicucci DS, Kouides RW, et al. Self-determination, smoking, diet and health. *Health Educ Res*. 2002;17:512-521.

52. Williams GC, McGregor HA, Zeldman A, Freedman ZR, Deci EL. Testing a self-determination theory process model for promoting glycemic control through diabetes self-management. *Health Psychol*. 2004;23:58-66.

53. Wilson PM, Blanchard CM, Nehl E, Baker F. Predicting physical activity and outcome expectations in cancer survivors: an application of Self-Determination Theory. *Psychooncology*. 2006;15:567-578.

54. Verstuyf J, Patrick H, Vansteenkiste M, Teixeira PJ. Motivational dynamics of eating regulation: a self-determination theory perspective. *Int J Behav Nutr Phys Act*. 2012;9:21.

55. Teixeira PJ, Carraca EV, Markland D, Silva MN, Ryan RM. Exercise, physical activity, and self-determination theory: A systematic review. *Int J Behav Nutr Phys Act*. 2012;9:78.

56. Linnan L. Results of the CDC WAY to Health Study. San Diego, CA: American Public Health Association Annual Meeting; 2008.

57. Tomarken AJ. Structural equation modeling: strengths, limitations, and misconceptions. *Annual review of clinical psychology*. 2005;1:31-65.

58. Sallis JF, Owen N. Ecological models of health behavior. In: Glanz K, Rimer BK, Lewis FM, ed. *Health Behavior and Health Education: Theory, Research, and Practice.* 3rd Edition ed. San Francisco, CA: Jossey-Bass; 2002:462-484.

59. French SA, Harnack LJ, Hannan PJ, Mitchell NR, Gerlach AF, Toomey TL. Worksite environment intervention to prevent obesity among metropolitan transit workers. *Prev Med*. 2010.

60. Nigg CR, Albright C, Williams R, et al. Are physical activity and nutrition indicators of the checklist of health promotion environments at worksites (CHEW) associated with employee obesity among hotel workers? *J Occup Environ Med*. 2010;52 Suppl 1:S4-7.

61. Parker KB, DeJoy DM, Wilson MG, Bowen HM, Goetzel RZ. Application of the Environmental Assessment Tool (EAT) as a process measure for a worksite weight management intervention. *J Occup Environ Med*. 2010;52 Suppl 1:S42-51.

62. Hayne CL, Moran PA, Ford MM. Regulating environments to reduce obesity. *J Public Health Policy*. 2004;25:391-407.

63. Kushi LH, Byers T, Doyle C, et al. American Cancer Society Guidelines on Nutrition and Physical Activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer J Clin*. 2006;56:254-81; quiz 313-4.

64. Blanck HM, Gillespie C, Kimmons JE, Seymour JD, Serdula MK. Trends in fruit and vegetable consumption among U.S. men and women, 1994-2005. *Prev Chronic Dis*. 2008;5:A35.

65. Webber KH, Tate DF, Michael Bowling J. A randomized comparison of two motivationally enhanced Internet behavioral weight loss programs. *Behav Res Ther*. 2008;46:1090-1095.

66. Tate DF, Finkelstein EA, Khavjou O, Gustafson A. Cost effectiveness of internet interventions: review and recommendations. *Ann Behav Med*. 2009;38:40-45.

67. Tate DF, Jackvony EH, Wing RR. Effects of Internet behavioral counseling on weight loss in adults at risk for type 2 diabetes: a randomized trial. *JAMA*. 2003;289:1833-1836.

68. Tate DF, Wing RR, Winett RA. Using Internet technology to deliver a behavioral weight loss program. *JAMA*. 2001;285:1172-1177.

69. Kraemer HC, Stice E, Kazdin A, Offord D, Kupfer D. How do risk factors work together? Mediators, moderators, and independent, overlapping, and proxy risk factors. *Am J Psychiatry*. 2001;158:848-856.

70. Bock BC, Marcus BH, Pinto BM, Forsyth LH. Maintenance of physical activity following an individualized motivationally tailored intervention. *Ann Behav Med*. 2001;23:79-87.

71. Calfas KJ, Sallis JF, Nichols JF, et al. Project GRAD: two-year outcomes of a randomized controlled physical activity intervention among young adults. Graduate Ready for Activity Daily. *Am J Prev Med*. 2000;18:28-37.

72. Cook TD, Campbell DT. *Quasi-experimentation: Design & analysis issues for field settings*. In: Boston: Houghton Mifflin; 1979:37-94.

73. Lockwood CM, DeFrancesco CA, Elliot DL, Beresford SA, Toobert DJ. Mediation analyses: applications in nutrition research and reading the literature. *J Am Diet Assoc*. 2010;110:753-762.

74. Iacobucci D. *Mediation Analysis.* Los Angeles: Sage; 2008.

75. Pratt CA, Lemon SC, Fernandez ID, et al. Design characteristics of worksite environmental interventions for obesity prevention. *Obesity (Silver Spring)*. 2007;15:2171-2180.

76. Linnan LA, Sorensen G, Colditz G, Klar DN, Emmons KM. Using theory to understand the multiple determinants of low participation in worksite health promotion programs. *Health Educ Behav*. 2001;28:591-607.

77. Giles-Corti B, Donovan RJ. The relative influence of individual, social and physical environment determinants of physical activity. *Soc Sci Med*. 2002;54:1793-1812.

78. Muto T, Yamauchi K. Evaluation of a multicomponent workplace health promotion program conducted in Japan for improving employees' cardiovascular disease risk factors. *Prev Med*. 2001;33:571-577.

79. Jeffery RW, Forster JL, French SA, et al. The Healthy Worker Project: a work-site intervention for weight control and smoking cessation. *Am J Public Health*. 1993;83:395-401.

80. Erfurt JC, Foote A, Heirich MA. Worksite wellness programs: incremental comparison of screening and referral alone, health education, follow-up counseling, and plant organization. *Am J Health Promot*. 1991;5:438-448.

81. Abrams DB, Follick MJ. Behavioral weight-loss intervention at the worksite: feasibility and maintenance. *J Consult Clin Psychol*. 1983;51:226-233.

82. Abrams DB, Follick MJ. Behavioral weight-loss intervention at the worksite: feasibility and maintenance. *J Consult Clin Psychol*. 1983;51:226-233.

83. The Community Guide Branch, Epidemiology Analysis Program Office (EAPO), Office of Surveillance, Epidemiology, and Laboratory Services (OSELS), Centers for Disease Control and Prevention. Obesity Prevention and Control: Worksite Programs Research Gaps. Available at: http://www.thecommunityguide.org/obesity/supportingmaterials/RG-worksite.html. Accessed 09/13, 2011.

84. Winett RA, Tate DF, Anderson ES, Wojcik JR, Winett SG. Long-term weight gain prevention: a theoretically based Internet approach. *Prev Med*. 2005;41:629-641.

85. Van Zundert RM, Nijhof LM, Engels RC. Testing Social Cognitive Theory as a theoretical framework to predict smoking relapse among daily smoking adolescents. *Addict Behav*. 2009;34:281-286.

86. Anderson-Bill ES, Winett RA, Wojcik JR, Winett SG. Web-based guide to health: relationship of theoretical variables to change in physical activity, nutrition and weight at 16-months. *J Med Internet Res*. 2011;13:e27.

87. Patten CA, Petersen LR, Hughes CA, et al. Feasibility of a telephone-based intervention for support persons to help smokers quit: A pilot study. *Nicotine Tob Res*. 2009.

88. Rhodes RE, Fiala B. Building motivation and sustainability into the prescription and recommendations for physical activity and exercise therapy: the evidence. *Physiother Theory Pract*. 2009;25:424-441.

89. Mankiw NG. *Principles of Economics.* Fort Worth, TX: Harcourt College Pub; 2001.

90. Moller AC, McFadden HG, Hedeker D, Spring B. Financial motivation undermines maintenance in an intensive diet and activity intervention. *J Obes*. 2012;2012:740519.

91. Hallam JS, Petosa R. The long-term impact of a four-session work-site intervention on selected social cognitive theory variables linked to adult exercise adherence. *Health Educ Behav*. 2004;31:88-100.

92. Hallam J, Petosa R. A worksite intervention to enhance social cognitive theory constructs to promote exercise adherence. *Am J Health Promot*. 1998;13:4-7.

93. Whittaker R, Maddison R, McRobbie H, et al. A multimedia mobile phone-based youth smoking cessation intervention: findings from content development and piloting studies. *J Med Internet Res*. 2008;10:e49.

94. Tate DF. A series of studies examining Internet treatment of obesity to inform Internet interventions for substance use and misuse. *Subst Use Misuse*. 2011;46:57-65.

95. Glanz, K., Rimer, B. K., Lewis, F. M. *Health Behavior and Health Education: Theory, Research,
and Practice.* San Francisco: Wiley & Sons; 2002.

96. Williams GC, Grow VM, Freedman ZR, Ryan RM, Deci EL. Motivational predictors of weight loss and weight-loss maintenance. *J Pers Soc Psychol*. 1996;70:115-126.

97. Bull SS, Gillette C, Glasgow RE, Estabrooks P. Work site health promotion research: to what extent can we generalize the results and what is needed to translate research to practice? *Health Educ Behav*. 2003;30:537-549.

98. Glasgow RE, Klesges LM, Dzewaltowski DA, Estabrooks PA, Vogt TM. Evaluating the impact of health promotion programs: using the RE-AIM framework to form summary measures for decision making involving complex issues. *Health Educ Res*. 2006;21:688-694.

99. Glasgow RE, Nelson CC, Strycker LA, King DK. Using RE-AIM metrics to evaluate diabetes self-management support interventions. *Am J Prev Med*. 2006;30:67-73.

100. Collard DC, Chinapaw MJ, Verhagen EA, van Mechelen W. Process evaluation of a school based physical activity related injury prevention programme using the RE-AIM framework. *BMC Pediatr*. 2010;10:86.

101. Jenkinson KA, Naughton G, Benson AC. The GLAMA (Girls! Lead! Achieve! Mentor! Activate!) physical activity and peer leadership intervention pilot project: a process evaluation using the RE-AIM framework. *BMC Public Health*. 2012;12:55-2458-12-55.

102. Dunton GF, Lagloire R, Robertson T. Using the RE-AIM framework to evaluate the statewide dissemination of a school-based physical activity and nutrition curriculum: "Exercise Your Options". *Am J Health Promot*. 2009;23:229-232.

103. Dzewaltowski DA, Estabrooks PA, Klesges LM, Bull S, Glasgow RE. Behavior change intervention research in community settings: how generalizable are the results? *Health Promot Int*. 2004;19:235-245.

104. Vuillemin A, Rostami C, Maes L, et al. Worksite physical activity interventions and obesity: a review of European studies (the HOPE project). *Obes Facts*. 2011;4:479-488.

105. Jilcott S, Ammerman A, Sommers J, Glasgow RE. Applying the RE-AIM framework to assess the public health impact of policy change. *Ann Behav Med*. 2007;34:105-114.

106. Linde JA, Nygaard KE, MacLehose RF, et al. HealthWorks: results of a multi-component group-randomized worksite environmental intervention trial for weight gain prevention. *Int J Behav Nutr Phys Act*. 2012;9:14-5868-9-14.

107. Donoghue, Molloy. Winner's Circle Healthy Dining Program, Practice Notes: Strategies in Health
Education. *Health Education and Behavior*. 2002;29.

108. NC Prevention Partners. Winner's Circle Healthy Eating Criteria . Available from: www.winnerscirclehealthydining.com. Accessed 11/11, 2013.

109. Linnan L, Bowling M, Childress J, et al. Results of the 2004 National Worksite Health Promotion Survey. *Am J Public Health*. 2008;98:1503-1509.

110. Schulz LO, Schoeller DA. A compilation of total daily energy expenditures and body weights in healthy adults. *Am J Clin Nutr*. 1994;60:676-681.

111. Ledoux TA, Hingle MD, Baranowski T. Relationship of fruit and vegetable intake with adiposity: a systematic review. *Obes Rev*. 2011;12:e143-50.

112. Tate DF, Jeffery RW, Sherwood NE, Wing RR. Long-term weight losses associated with prescription of higher physical activity goals. Are higher levels of physical activity protective against weight regain? *Am J Clin Nutr*. 2007;85:954-959.

113. Fogelholm M, Kukkonen-Harjula K. Does physical activity prevent weight gain--a systematic review. *Obes Rev*. 2000;1:95-111.

114. MAYER J, MARSHALL NB, VITALE JJ, CHRISTENSEN JH, MASHAYEKHI MB, STARE FJ. Exercise, food intake and body weight in normal rats and genetically obese adult mice. *Am J Physiol*. 1954;177:544-548.

115. Hagan RD, Upton SJ, Wong L, Whittam J. The effects of aerobic conditioning and/or caloric restriction in overweight men and women. *Med Sci Sports Exerc*. 1986;18:87-94.

116. McAuley E, Blissmer B. Self-efficacy determinants and consequences of physical activity. *Exerc Sport Sci Rev*. 2000;28:85-88.

117. Miller YD, Trost SG, Brown WJ. Mediators of physical activity behavior change among women with young children. *Am J Prev Med*. 2002;23:98-103.

118. Luszczynska A, Cieslak R. Mediated effects of social support for healthy nutrition: fruit and vegetable intake across 8 months after myocardial infarction. *Behav Med*. 2009;35:30-38.

119. Franko DL, Cousineau TM, Trant M, et al. Motivation, self-efficacy, physical activity and nutrition in college students: randomized controlled trial of an internet-based education program. *Prev Med*. 2008;47:369-377.

120. E.S. Anderson, R.A. Winett, P.G. Bickley, J. Walberg-Rankin, J.F. Moore and M. Leahy. The effects of a multimedia system in supermarkets to alter shoppers' food purchases: nutritional outcomes and caveats. *J Health Psychol*. 1997:221-232.

121. Anderson ES, Winett RA, Wojcik JR, Winett SG, Bowden T. A computerized social cognitive intervention for nutrition behavior: direct and mediated effects on fat, fiber, fruits, and vegetables, self-efficacy, and outcome expectations among food shoppers. *Ann Behav Med*. 2001;23:88-100.

122. Leong SL, Madden C, Gray A, Horwath C. Self-determined, autonomous regulation of eating behavior is related to lower body mass index in a nationwide survey of middle-aged women. *J Acad Nutr Diet*. 2012;112:1337-1346.

123. Mansour S, Bruce KR, Steiger H, et al. Autonomous motivation: a predictor of treatment outcome in bulimia-spectrum eating disorders. *Eur Eat Disord Rev*. 2012;20:e116-22.

124. Mata J, Silva MN, Vieira PN, et al. Motivational "spill-over" during weight control: increased self-determination and exercise intrinsic motivation predict eating self-regulation. *Health Psychol*. 2009;28:709-716.

125. Gillison FB, Standage M, Skevington SM. Relationships among adolescents' weight perceptions, exercise goals, exercise motivation, quality of life and leisure-time exercise behaviour: a self-determination theory approach. *Health Educ Res*. 2006;21:836-847.

126. Jacobs N, Hagger MS, Streukens S, De Bourdeaudhuij I, Claes N. Testing an integrated model of the theory of planned behaviour and self-determination theory for different energy balance-related behaviours and intervention intensities. *Br J Health Psychol*. 2011;16:113-134.

127. Jeffery RW. Financial incentives and weight control. *Prev Med*. 2012;55 Suppl:S61-7.

128. Gingerich SB, Anderson DR, Koland H. Impact of financial incentives on behavior change program participation and risk reduction in worksite health promotion. *Am J Health Promot*. 2012;27:119-122.

129. Finkelstein EA, Linnan LA, Tate DF, Birken BE. A pilot study testing the effect of different levels of financial incentives on weight loss among overweight employees. *J Occup Environ Med*. 2007;49:981-989.

130. Osilla KC, Van Busum K, Schnyer C, Larkin JW, Eibner C, Mattke S. Systematic review of the impact of worksite wellness programs. *Am J Manag Care*. 2012;18:e68-81.

131. Teixeira PJ, Silva MN, Mata J, Palmeira AL, Markland D. Motivation, self-determination, and long-term weight control. *Int J Behav Nutr Phys Act*. 2012;9:22-5868-9-22.

132. O'Donnell MP. Financial incentives for workplace health promotion: what is equitable, what is sustainable, and what drives healthy behaviors? *Am J Health Promot*. 2012;26:iv-vii.

133. Crane MM, Tate DF, Finkelstein EA, Linnan LA. Motivation for participating in a weight loss program and financial incentives: an analysis from a randomized trial. *J Obes*. 2012;2012:290589.

134. Thomas S, Reading J, Shephard RJ. Revision of the Physical Activity Readiness Questionnaire (PAR-Q). *Can J Sport Sci*. 1992;17:338-345.

135. Abrams DB, Boutwell WB, Grizzle J, Heimendinger J, Sorensen G, Varnes J. Cancer control at the workplace: the Working Well Trial. *Prev Med*. 1994;23:15-27.

136. Biener L, Glanz K, McLerran D, et al. Impact of the Working Well Trial on the worksite smoking and nutrition environment. *Health Educ Behav*. 1999;26:478-494.

137. Wirfalt AK, Jeffery RW, Elmer PJ. Comparison of food frequency questionnaires: the reduced Block and Willett questionnaires differ in ranking on nutrient intakes. *Am J Epidemiol*. 1998;148:1148-1156.

138. Boucher B, Cotterchio M, Kreiger N, Nadalin V, Block T, Block G. Validity and reliability of the Block98 food-frequency questionnaire in a sample of Canadian women. *Public Health Nutr*. 2006;9:84-93.

139. Hagstromer M, Oja P, Sjostrom M. The International Physical Activity Questionnaire (IPAQ): a study of concurrent and construct validity. *Public Health Nutr*. 2006;9:755-762.

140. Craig CL, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc*. 2003;35:1381-1395.

141. Mader U, Martin BW, Schutz Y, Marti B. Validity of four short physical activity questionnaires in middle-aged persons. *Med Sci Sports Exerc*. 2006;38:1255-1266.

142. Ekelund U, Sepp H, Brage S, et al. Criterion-related validity of the last 7-day, short form of the International Physical Activity Questionnaire in Swedish adults. *Public Health Nutr*. 2006;9:258-265.

143. Wolin KY, Heil DP, Askew S, Matthews CE, Bennett GG. Validation of the International Physical Activity Questionnaire-Short among Blacks. *J Phys Act Health*. 2008;5:746-760.

144. Clark MM, King TK. Eating self-efficacy and weight cycling: a prospective clinical study. *Eat Behav*. 2000;1:47-52.

145. Clark MM, Abrams DB, Niaura RS, Eaton CA, Rossi JS. Self-efficacy in weight management. *J Consult Clin Psychol*. 1991;59:739-744.

146. Marcus BH, Selby VC, Niaura RS, Rossi JS. Self-efficacy and the stages of exercise behavior change. *Res Q Exerc Sport*. 1992;63:60-66.

147. Elobeid MA, Padilla MA, McVie T, et al. Missing data in randomized clinical trials for weight loss: scope of the problem, state of the field, and performance of statistical methods. *PLoS One*. 2009;4:e6624.

148. Iacobucci D. A meditation on mediation: Evidence that structural equations models perform better than regressions. *Journal of consumer psychology*. 2007;17:139.

149. Preacher KJ, Zyphur MJ, Zhang Z. A General Multilevel SEM Framework for Assessing Multilevel Mediation
. *Psychological Methods*. 2010.

150. Muthen LK, Muthen BO. *Mplus User's Guide.* 6th ed. Los Angeles, CA: Muthen & Muthen; 2010.

151. Bhave DP, Kramer A, Glomb TM. Work-family conflict in work groups: social information processing, support, and demographic dissimilarity. *J Appl Psychol*. 2010;95:145-158.

152. Press R. An Integrative, Multilevel, and Transdisciplinary Research Approach to Challenges of Work, Family, and Health. . 2013.

153. Bopp M, Wilcox S, Laken M, et al. Using the RE-AIM framework to evaluate a physical activity intervention in churches. *Prev Chronic Dis*. 2007;4:A87.

154. Zapka J, Goins KV, Pbert L, Ockene JK. Translating efficacy research to effectiveness studies in practice: lessons from research to promote smoking cessation in community health centers. *Health Promot Pract*. 2004;5:245-255.

155. Nash JM, McCrory D, Nicholson RA, Andrasik F. Efficacy and effectiveness approaches in behavioral treatment trials. *Headache*. 2005;45:507-512.

156. Glasgow RE, Lichtenstein E, Marcus AC. Why don't we see more translation of health promotion research to practice? Rethinking the efficacy-to-effectiveness transition. *Am J Public Health*. 2003;93:1261-1267.

157. Dzewaltowski DA, Estabrooks PA, Klesges LM, Bull S, Glasgow RE. Behavior change intervention research in community settings: how generalizable are the results? *Health Promot Int*. 2004;19:235-245.

158. DeJoy DM, Parker KM, Padilla HM, Wilson MG, Roemer EC, Goetzel RZ. Combining environmental and individual weight management interventions in a work setting: results from the Dow chemical study. *J Occup Environ Med*. 2011;53:245-252.

159. Herold DM, Fedor DB, Caldwell SD. Beyond change management: a multilevel investigation of contextual and personal influences on employees' commitment to change. *J Appl Psychol*. 2007;92:942-951.

160. Biener L, Glanz K, McLerran D, et al. Impact of the Working Well Trial on the worksite smoking and nutrition environment. *Health Educ Behav*. 1999;26:478-494.

161. French SA, Jeffery RW, Story M, et al. Pricing and promotion effects on low-fat vending snack purchases: the CHIPS Study. *Am J Public Health*. 2001;91:112-117.

162. Dawson J, Dwyer JJ, Evers S, Sheeshka J. Eat smart! Workplace Cafeteria Program evaluation of the nutrition component. *Can J Diet Pract Res*. 2006;67:85-90.

163. The Task Force on Community Preventive Services. *Community Guide* Recommendations and CDC's Promising Practices. Available at: http://www.cdc.gov/leanworks/resources/communityguide.html. Accessed 04/28, 2013.

164. Sorensen G, Stoddard A, Hunt MK, et al. The effects of a health promotion-health protection intervention on behavior change: the WellWorks Study. *Am J Public Health*. 1998;88:1685-1690.

165. Sorensen G, Stoddard A, Peterson K, et al. Increasing fruit and vegetable consumption through worksites and families in the treatwell 5-a-day study. *Am J Public Health*. 1999;89:54-60.

166. Beresford SA, Thompson B, Feng Z, Christianson A, McLerran D, Patrick DL. Seattle 5 a Day worksite program to increase fruit and vegetable consumption. *Prev Med*. 2001;32:230-238.

167. Leighton F, Polic G, Strobel P, et al. Health impact of Mediterranean diets in food at work. *Public Health Nutr*. 2009;12:1635-1643.

168. Heimendinger J, Feng Z, Emmons K, et al. The Working Well Trial: baseline dietary and smoking behaviors of employees and related worksite characteristics. The Working Well Research Group. *Prev Med*. 1995;24:180-193.

169. Mozaffarian D, Afshin A, Benowitz NL, et al. Population approaches to improve diet, physical activity, and smoking habits: a scientific statement from the American Heart Association. *Circulation*. 2012;126:1514-1563.

170. Trogdon J, Finkelstein EA, Reyes M, Dietz WH. A return-on-investment simulation model of workplace obesity interventions. *J Occup Environ Med*. 2009;51:751-758.

171. Ramanathan S, Allison KR, Faulkner G, Dwyer JJ. Challenges in assessing the implementation and effectiveness of physical activity and nutrition policy interventions as natural experiments. *Health Promot Int*. 2008;23:290-297.

172. Dumanovsky T, Huang CY, Bassett MT, Silver LD. Consumer awareness of fast-food calorie information in New York City after implementation of a menu labeling regulation. *Am J Public Health*. 2010;100:2520-2525.

173. Patrick H, Williams GC. Self-determination theory: its application to health behavior and complementarity with motivational interviewing. *Int J Behav Nutr Phys Act*. 2012;9:18.

174. Prestwich A, Conner MT, Lawton RJ, Ward JK, Ayres K, McEachan RR. Randomized controlled trial of collaborative implementation intentions targeting working adults' physical activity. *Health Psychol*. 2012;31:486-495.

175. Plotnikoff RC, Pickering MA, Rhodes RE, Courneya KS, Spence JC. A test of cognitive mediation in a 12-month physical activity workplace intervention: does it explain behaviour change in women? *Int J Behav Nutr Phys Act*. 2010;7:32-5868-7-32.

176. Masse LC, Allen D, Wilson M, Williams G. Introducing equating methodologies to compare test scores from two different self-regulation scales. *Health Educ Res*. 2006;21 Suppl 1:i110-120.

177. Levesque CS, Williams GC, Elliot D, Pickering MA, Bodenhamer B, Finley PJ. Validating the theoretical structure of the Treatment Self-Regulation Questionnaire (TSRQ) across three different health behaviors. *Health Educ Res*. 2007;22:691-702.

178. Selig JP, Preacher KJ. Mediation Models for Longitudinal Data in Developmental Research. *Research in human development*. 2009;6:144.

179. Wilson PM, Blanchard CM, Nehl E, Baker F. Predicting physical activity and outcome expectations in cancer survivors: an application of Self-Determination Theory. *Psychooncology*. 2006;15:567-578.

180. Bowen NK. *Structural Equation Modeling.* Oxford ;New York: Oxford University Press; 2012.

181. Rigdon EE. CFI versus RMSEA: A comparison of two fit indexes for structural equation modeling. *Structural Equation Modeling: A Multidisciplinary Journal*. 1996;3:369-379.

182. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*. 1999;6:1-55.

183. DeCharms R. *Personal Causation; the Internal Affective Determinants of Behavior.* New York, Academic Press, 1968; 1968.

184. Shaikh AR, Yaroch AL, Nebeling L, Yeh MC, Resnicow K. Psychosocial predictors of fruit and vegetable consumption in adults a review of the literature. *Am J Prev Med*. 2008;34:535-543.

185. Cohen J, ed. *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences.* 3rd ed. Mahwah, N.J.: L.Erlbaum Associates; 2003.

186. Konttinen H, Silventoinen K, Sarlio-Lahteenkorva S, Mannisto S, Haukkala A. Emotional eating and physical activity self-efficacy as pathways in the association between depressive symptoms and adiposity indicators. *Am J Clin Nutr*. 2010;92:1031-1039.

187. Osborn CY, Rivet Amico K, Fisher WA, Egede LE, Fisher JD. An information-motivation-behavioral skills analysis of diet and exercise behavior in Puerto Ricans with diabetes. *J Health Psychol*. 2010;15:1201-1213.

188. Lee PH, Macfarlane DJ, Lam TH, Stewart SM. Validity of the International Physical Activity Questionnaire Short Form (IPAQ-SF): a systematic review. *Int J Behav Nutr Phys Act*. 2011;8:115.

189. DeJoy DM, Wilson MG, Padilla HM, et al. Process evaluation results from an environmentally focused worksite weight management study. *Health Educ Behav*. 2012;39:405-418.

190. Brehm BJ, Gates DM, Singler M, Succop PA, D'Alessio DA. Environmental changes to control obesity: a randomized controlled trial in manufacturing companies. *Am J Health Promot*. 2011;25:334-340.

191. Teixeira PJ, Carraca EV, Markland D, Silva MN, Ryan RM. Exercise, physical activity, and self-determination theory: a systematic review. *Int J Behav Nutr Phys Act*. 2012;9:78-5868-9-78.

192. Verstuyf J, Patrick H, Vansteenkiste M, Teixeira PJ. Motivational dynamics of eating regulation: a self-determination theory perspective. *Int J Behav Nutr Phys Act*. 2012;9:21-5868-9-21.

193. Shin H, Shin J, Liu PY, Dutton GR, Abood DA, Ilich JZ. Self-efficacy improves weight loss in overweight/obese postmenopausal women during a 6-month weight loss intervention. *Nutr Res*. 2011;31:822-828.

194. Dzewaltowski DA, Glasgow RE, Klesges LM, Estabrooks PA, Brock E. RE-AIM: evidence-based standards and a Web resource to improve translation of research into practice. *Ann Behav Med*. 2004;28:75-80.

195. King DK, Glasgow RE, Leeman-Castillo B. Reaiming RE-AIM: using the model to plan, implement, and evaluate the effects of environmental change approaches to enhancing population health. *Am J Public Health*. 2010;100:2076-2084.

196. Gaglio B, Shoup JA, Glasgow RE. The RE-AIM framework: a systematic review of use over time. *Am J Public Health*. 2013;103:e38-46.

197. Glasgow RE, Askew S, Purcell P, et al. Use of RE-AIM to Address Health Inequities: Application in a low-income community health center based weight loss and hypertension self-management program. *Transl Behav Med*. 2013;3:200-210.

198. Cummins S, Macintyre S. Food environments and obesity--neighbourhood or nation? *Int J Epidemiol*. 2006;35:100-104.

199. Brug J, Conner M, Harre N, Kremers S, McKellar S, Whitelaw S. The Transtheoretical Model and stages of change: a critique: observations by five commentators on the paper by Adams, J. and White, M. (2004) why don't stage-based activity promotion interventions work? *Health Educ Res*. 2005;20:244-258.

200. Hollister MC, Anema MG. Health behavior models and oral health: a review. *J Dent Hyg*. 2004;78:6.

201. Tillis TS, Stach DJ, Cross-Poline GN, Annan SD, Astroth DB, Wolfe P. The transtheoretical model applied to an oral self-care behavioral change: development and testing of instruments for stages of change and decisional balance. *J Dent Hyg*. 2003;77:16-25.

202. Astroth DB, Cross-Poline GN, Stach DJ, Tilliss TS, Annan SD. The transtheoretical model: an approach to behavioral change. *J Dent Hyg*. 2002;76:286-295.

203. Poss JE. Developing a new model for cross-cultural research: synthesizing the Health Belief Model and the Theory of Reasoned Action. *ANS Adv Nurs Sci*. 2001;23:1-15.

204. Rosenstock IM, Strecher VJ, Becker MH. Social learning theory and the Health Belief Model. *Health Educ Q*. 1988;15:175-183.

205. Aho WR. Smoking, dieting, and exercise: age differences in attitudes and behavior relevant to selected health belief model variables. The perceived seriousness is an important factor in influencing behavior. *R I Med J*. 1979;62:85-92.

206. Kam JA, Matsunaga M, Hecht ML, Ndiaye K. Extending the theory of planned behavior to predict alcohol, tobacco, and marijuana use among youth of mexican heritage. *Prev Sci*. 2009;10:41-53.

207. Armitage CJ, Conner M. Efficacy of the Theory of Planned Behaviour: a meta-analytic review. *Br J Soc Psychol*. 2001;40:471-499.

208. Gonzalez-Cutre D, Sicilia A. Motivation and exercise dependence: a study based on self-determination theory. *Res Q Exerc Sport*. 2012;83:318-329.

209. Brooks GA, Butte NF, Rand WM, Flatt JP, Caballero B. Chronicle of the Institute of Medicine physical activity recommendation: how a physical activity recommendation came to be among dietary recommendations. *Am J Clin Nutr*. 2004;79:921S-930S.

210. Hox J, ed. *Multilevel Analysis: Techniques and Applications.* Mahwah, NJ: Lawrence Erlbaum; 2002.

211. MacKinnon DP, Lockwood CM, Hoffman JM, West SG, Sheets V. A comparison of methods to test mediation and other intervening variable effects. *Psychol Methods*. 2002;7:83-104.

212. Rhodes W, Pelissier B, Gaes G, Saylor W, Camp S, Wallace S. Alternative solutions to the problem of selection bias in an analysis of federal residential drug treatment programs. *Eval Rev*. 2001;25:331-369.

213. Shahar DR, Yu B, Houston DK, et al. Misreporting of energy intake in the elderly using doubly labeled water to measure total energy expenditure and weight change. *J Am Coll Nutr*. 2010;29:14-24.

214. Engbers LH, van Poppel MN, van Mechelen W. Modest effects of a controlled worksite environmental intervention on cardiovascular risk in office workers. *Prev Med*. 2007;44:356-362.

215. Verweij LM, Coffeng J, van Mechelen W, Proper KI. Meta-analyses of workplace physical activity and dietary behaviour interventions on weight outcomes. *Obes Rev*. 2011;12:406-429.

216. Felter EM, Nolan BA, Colombi A, Albert SM, Pringle JL. We're working hard, but is it hardly working? Why process is critical in the delivery of worksite health promotion programs. *J Occup Environ Med*. 2013;55:586-592.

217. U.S.Centers for Disease Control and Prevention. Obesity Prevention and Control: Technology-Supported Multicomponent Coaching or Counseling Interventions to Reduce Weight and Maintain Weight Loss The Community Guide. Available at: http://www.thecommunityguide.org/obesity/TechnologicalCoaching.html. Accessed 04/28, 2013.

218. Task Force on Community Preventive Services. Recommendations for worksite-based interventions to improve workers' health. *Am J Prev Med*. 2010;38:S232-6.

219. Bauman AE, Reis RS, Sallis JF, et al. Correlates of physical activity: why are some people physically active and others not? *Lancet*. 2012;380:258-271.

220. Nastasi BK, Hitchcock J. Challenges of evaluating multilevel interventions. *Am J Community Psychol*. 2009;43:360-376.

221. Nastasi BK, Hitchcock J. Challenges of evaluating multilevel interventions. *Am J Community Psychol*. 2009;43:360-376.

222. National Center for Health Statistics. National Health and Nutrition Examination Survey. . Accessed September 19, 2013.

223. Nes AA, Eide H, Kristjansdottir OB, van Dulmen S. Web-based, self-management enhancing interventions with e-diaries and personalized feedback for persons with chronic illness: A tale of three studies. *Patient Educ Couns*. 2013.

224. Maurer G, Aichhorn W, Leeb W, Matschi B, Schiepek G. Real-time monitoring in psychotherapy - methodology and casuistics. *Neuropsychiatr*. 2011;25:135-141.