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MULTIPLE HEALTH BEHAVIOR RISKS: REDEFINING CO-ACTION AND INVESTIGATING MULTIPLE HEALTH BEHAVIOR CHANGE USING THE TRANSTHEORETICAL MODEL

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BY

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ABSTRACT

Despite considerable evidence to support efficacious and effective intervention for single health behaviors, relatively little is known about simultaneous multiple health behavior change. This research analyzed multiple health behavior change for three very different health risk behaviors. The sample (N=9,461) was predominantly White (93.8%), middle-aged (X= 43.9 years-old, SD=10.74) adults who met criteria for smoking, unhealthy diet, and unprotected sun exposure. Specifically, when sun protection and diet, smoking and diet, and smoking and sun protection were analyzed as three sets of behavior pairs from baseline to 24-month follow-up, results consistently demonstrated that simultaneous intervention on multiple health behavior risks increased the likelihood that participants moved to criteria on both behaviors. More specifically, across all the behavior pair analyses and treatment conditions, 70 out of the 71 odds ratios revealed that participants were more likely to meet criteria on both behaviors compared to participants who only met criteria on the second behavior. Overall, results provide empirical support for the advantages of simultaneous intervention for multiple health behavior change as paired action, co-progression, and reduction on severity was observed across treatment conditions. Finally, results provide empirical support for shifting the fundamental unit of analysis from separate behaviors at outcome to behavior pairs at outcome and to use dynamic variables to help elucidate the science of behavior change.

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Data used for this project were drawn from a National Cancer Institute (NCI)-funded grant (P01; #CA27821, Principle Investigator, Prochaska) that assessed the effectiveness of home, school, worksite, and medical practice-based prevention programs designed to reduce multiple behavior risks for cancer. I would like to thank Dr. James Prochaska for providing me with access to the dataset and for supporting this project. I would like to thank Dr. Andrea Paiva, my major professor, for her continued guidance and unwavering support throughout this project. Additionally, I would like to thank Drs. Joseph Rossi, Mark Robbins, Barbara Newman, and Jacqueline Sparks, the rest of my dissertation committee, whose contribution to this project and my professional development has been equally invaluable.

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Finally, as a secondary data analysis that did not access participant personal health information (PHI), the Institutional Review Board (IRB) granted this project an exemption. All statistical procedures were conducted with SPSS, and all literature was accessed through the URI library reference databases.

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CHAPTER 1

INTRODUCTION

Although research has advanced clinical science in some areas, other areas continue to lag. For example, despite considerable evidence to support efficacious and effective intervention for single health behaviors, relatively little is known about multiple health behavior change. Moreover, simultaneous intervention on multiple health behavior risks challenges the dominant separate behavior paradigm which evaluates interventions based on single behavior outcomes as the fundamental unit of analysis in order to establish intervention efficacy and effectiveness.

In response to the growing demands for more rigorous evaluation of intervention efficacy, effectiveness, and cost efficiency, multiple health behavior change holds considerable promise for the future of intervention and prevention research and practice. Moreover, multiple health behavior change is important because certain populations are among the greatest risk for chronic disease, disability, and premature death (Prochaska, 2008) and because of the increased prevalence of obesity and sedentary lifestyles in the United States. So, although behavioral interventions have long demonstrated to be critical, cross-cultural, and cost-effective factors germane to the development and prevention of numerous medical conditions including cardiovascular disease and some cancers, it remains unclear how simultaneous intervention on multiple health behavior risks fares when the fundamental unit of analysis is shifted from separate behaviors at outcome to behavior pairs at outcome. Such a shift is important because doing so may reveal synergistic effects currently undetected by the dominant separate behavior paradigm and its analytic approaches, in addition to advancing the knowledge-base and scientific evaluation of behavioral interventions for multiple health behavior change.

Given the direct and considerable impact of health risks on mortality, quality of life, and health care costs, in combination with the cutting edge research on multiple health behavior change, the following research is important because it serves to: 1) promote population-based health and wellness; 2) understand the underlying mechanisms and interrelationships of effective intervention for multiple health behavior change; and 3) help elucidate the science of behavior change. Moreover, this research will advance the current knowledge-base in intervention and prevention research, possibly provide an empirical basis to shift the dominant separate behavior paradigm, and help guide the future of intervention and prevention research and practice toward an integrative model of multiple health behavior change.

CHAPTER 2

REVIEW OF LITERATURE

Intervention is a broad enterprise replete with myriad aims and goals. Although specification of a treatment and evaluation of its feasibility and efficacy are of central importance (Kazdin, 2003), equally important are considerations about its' effectiveness, cost-efficiency, and potential for iatrogenic effects. Considered together, these distinct aims can be coalesced into a larger, more comprehensive analysis known as treatment evaluation (Nelson & Steele, 2006). This framework is not only part of the impetus behind the evidenced-based practice (EBP) movement in psychology, but also part of the larger scientific zeitgeist calling for more precise and methodologically rigorous research. Toward that aim, the Transtheoretical Model (TTM) (Prochaska & DiClemente, 1983) has emerged as an important advancement in behavioral intervention by establishing strong empirical support for effectively intervening on more than 48 problem behavioral areas by providing individually and expertly tailored, stage-based interventions based on an individual's stage of change (Hall & Rossi, 2008).

The TTM is an integrative model of intentional behavior change centrally organized around the temporal Stage of Change (SOC) dimension (Prochaska & DiClemente, 1983). Specifically, the TTM is comprised of five stages of change: Precontemplation (i.e., PC- not intending to take action in the next six months), Contemplation (i.e., C- intending to action in the next 6 months), Preparation (i.e., PR- intending to take action in the next thirty days), Action, (i.e., A- there has been an overt behavior change which has not been maintained for six months), and Maintenance (i.e., M- a behavior change has been maintained for at least six months). Essentially, SOC describe the processes through which behavior change occurs in individuals or populations (e.g., smokers) over time. Critical to behavior change is that movement through the SOC varies as some people remain in a certain SOC for a period of time while others may relapse to earlier stages before behavioral change goals are met (Prochaska, Redding & Evers, 2008). In addition to SOC, there are several other constructs central to the TTM.

Decisional Balance (DB) is the construct that refers to the Pros and Cons of behavior change (Velicer, DiClemente, Prochaska & Brandenberg, 1985). Specifically, this construct refers to an individual's perception about the relative weights about making behavior change (Velicer et al, 1985); the benefits of a behavior change are labeled Pros, whereas the costs of a behavior change are labeled Cons. For example, a Pro of quitting smoking may be reduced cancer risk or saving money, whereas a Con may be concerns of weight gain or experiencing nicotine withdrawal symptoms. DB is important as it has been shown to be particularly useful in predicting movement through the SOC (Prochaska, Velicer & Rossi, 1994), and because the relationship between the Pros and Cons has been replicated across 48 problem areas (Hall & Rossi, 2008). An outgrowth of this consistent pattern across multiple problem areas is referred to as the strong and weak principles (Prochaska, 1994). The former states that progression from PC to A is a function of approximately one standard deviation increase in the Pros of a health behavior change, while the latter states that progression from PC to A is a function of approximately a half standard deviation decrease in the Cons of a health behavior change. Although this relationship has been replicated across a variety of single behaviors, little is known about the relationship between DB and simultaneous multiple health behavior change.

Self-Efficacy (SE) is the construct that refers to the situation specific confidence an individual has to cope with high risk situations or temptations (Velicer, DiClemente, Rossi & Prochaska, 1990). Similar to DB, SE has been shown to be particularly important to predicting movement through the SOC. Specifically, Velicer, DiClemente, Rossi & Prochaska (1990) found that individuals in earlier SOC (i.e., PC/C) typically report lower confidence in a behavior change as compared to those individuals who are in later SOC (i.e., A/M). This finding suggests that an individual's SE increases as the individual progresses through the TTM. However, with regard to multiple health behavior change specifically, little is known whether increasing an individual's SE on one behavior leads to an increase in the individual's SE on a second behavior. Thus, although the TTM has established efficacy and effectiveness for intervening on numerous single health behaviors (e.g., smoking cessation, diet, unprotected sun exposure), little is known whether and how TTM intervention affects multiple health behavior change simultaneously.

Processes of Change (POC) is the construct that refers to the covert and overt strategies and techniques people use to alter their experiences and environment to progress through the various SOC (Prochaska, Velicer, DiClemente & Fava, 1988). By integrating various theoretical orientations (e.g., psychodynamic, social-learning), the TTM has derived ten POC comprised of two higher order constructs that are either experiential or behavioral in nature. The five experiential processes are: Consciousness Raising, Dramatic Relief, Social Liberation, Self-reevaluation, and Environmental

Reevaluation (Prochaska, Velicer, DiClemente & Fava, 1988). The five behavioral processes are: Stimulus Control, Helping Relationships, Reinforcement Management, Self-liberation, and Counter Conditioning (Prochaska, Velicer, DiClemente & Fava, 1988). Interestingly, Prochaska, Velicer, DiClemente, Guadagnoli, & Rossi (1991) found that the use of each POC was highly related to an individual's SOC. Specifically, they found that experiential POC (e.g., Consciousness Raising) were emphasized at earlier SOC (i.e., PC/C), whereas behavioral POC (e.g., Helping Relationships) were emphasized at later SOC (i.e., A/M). With regard to multiple health behavior change, however, little is known about how movement through the SOC on one behavior is related to movement through the SOC on a second behavior.

For example, do smokers who make stage progress toward smoking cessation (i.e., PC-C or C-PR) but not to Action criteria also make stage progress on other health behaviors associated with improved health outcomes such as diet, exercise, or unprotected sun exposure? Or, is it that individuals remain stable or possibly regress to an earlier SOC on a different problem area because of the difficulty associated with behavior change? In addition to these important yet unanswered questions, research has revealed how issues of multiculturalism and diversity are also essential considerations when evaluating stage and population-based behavioral intervention for health behavior risks. Specifically, research has shown that diverse groups have different baseline staging for various health behaviors. In addition, research has also revealed that certain groups are at more risk than other groups to engage in multiple health behavior risks. Given these findings, group membership with regard to sex, gender, age, race, sexual orientation, and religious affiliation are important factors when assessing and intervening with stage-based behavioral intervention.

Blum et al. (2001) found that White adolescents were more likely to smoke cigarettes, drink alcohol, and attempt suicide in younger years than Black and Hispanic youth, but that Black youths were more likely to engage in sexual intercourse while Black and Hispanic youths were both more likely than White adolescents to engage in violence. When considering sexual orientation and adolescents, Garofalo, Wolf, Kessel, Paslfrey, & DuRant (1998) found that gay, lesbian, and bisexual (GLB) youth were more likely than their peers to have been victimized and threatened and to have engaged in a variety of health risk behaviors including suicidal ideation and attempts, multiple substance use, and sexual risk behaviors.

In a 30-year longitudinal study on religious affiliation and health behaviors, Strawbridge, Shema, Cohen, & Kaplan (2001) found that weekly religious attendance reduced severity on health risk behaviors and helped maintain good health behaviors, while also improving and maintaining good mental health, increased social relationships, and marital stability with stronger effects for women than men. Similarly, and specific to sex and gender differences for sunscreen use and diet, Weinstock, Rossi, Redding, Maddock & Cottrill (2001) found women were more likely than men to engage in sun protective behaviors, while Campbell et al. (1999) found that women more likely than men to be in the Action/Maintenance (i.e., A/M) stage for fruit and vegetable consumption.

With respect to independent baseline predictors and group-level patterns of alcohol use, Brennan, Schutte, & Moos (2010) found that although males tend to have and maintain more problems associated with alcohol consumption than females across the lifespan, the single strongest predictor of 10-year drinking trajectories was baseline alcohol consumption in excess of recommended drinking guidelines for older adults, regardless of sex, gender, race, or socioeconomic status. Furthermore, these findings are consistent with previous research that revealed heavier initial drinking predicts steeper decline in subsequent alcohol use in both mixed-aged and older populations (Kerr et al., 2004; Moore et al. 2005).

Despite the importance of demographic variables such as race, ethnicity, gender, age, socioeconomic status and education level on baseline staging, demographic variables have not been shown to be reliable predictors of treatment outcome. For example, with smoking outcomes across five studies, Velicer, Redding, Sun, & Prochaska (2007) found no significant differences across gender, race, and ethnicity; however, they did find a few significant findings and small effect sizes for age and education subgroups. Similarly, with smokers, Redding et al. (2011) also found that behavior changes were not consistently related to demographic variables and group membership. Instead, they found significant small-to-medium-sized differences between stable smokers from maintainers/relapsers based on baseline SOC, problem severity, and effort. Overall, the consistent finding that gender is not a significant variable for smoking cessation was part of the Surgeon General’s Report (U.S. Department of Health & Human Services, 2011) concluding that, “cessation interventions are generally of similar effectiveness to women and men and, to date, few gender differences have been identified” (p. 8).

With regard to race, ethnicity, and smoking cessation, Velicer et al. (2007) found a lack of significant relationships between these baseline variables and treatment outcome. Specifically, with effect sizes were near zero for race and small effect sizes for ethnicity, they concluded that tailored behavioral intervention is about equally effective across racial and ethnic subgroups. Research in addictions has further shown that problem severity such as time to first cigarette in the day (i.e., Fagerstrom's Index) is inversely related to success across demographics (Falba, Jofre-Bonet, Busch, Duchovney, & Sindalar, 2004). Including demographic variables other than gender, race, and ethnicity, Sheeran's (2002) meta-analysis across multiple health behaviors confirmed that intention to change (i.e., SOC in TTM) is vital to promoting change, but that intention alone is insufficient to predict outcome as only 47 percent of those with positive intention to take Action on a behavior actually did take Action; that is, move to healthy criteria.

When specifically analyzing smoking, diet, and unprotected sun exposure, Blissmer et al. (2010) also found that demographic variables were not reliable predictors of treatment outcome. However, what they did find is that four effects do reliably predict treatment outcome. Specifically, as measured by decisional balance (DB), processes of change (POC), and self-efficacy (SE), Blissmer et al. (2010) found that 1) treatment, 2) baseline SOC, 3) addiction severity, and 4) effort all predicted treatment outcome during multiple health behavior change. Interestingly, the largest effect sizes were observed with the SOC, followed by SE, treatment, and effort, respectively. Similar to previous findings, they also found that demographic variables had the smallest effect sizes. Ultimately, this suggests that static variables at baseline such as demographics do not predict treatment outcome and, in contrast, that dynamic variables do predict treatment outcome. Therefore, the dynamic variables of SOC, DB, and problem severity are important when investigating multiple health behavior change as they have been shown to be among the best predictors of treatment outcome. Moreover, these findings further suggest that dynamic variables are among the most salient factors relevant to health behavior change and that, perhaps, they are among the most important variables to help elucidate the science of multiple health behavior change.

Given the intricacies of behavior change, and some of the inherent difficulties with behavioral health research, the dominant paradigm of intervention and prevention research has been to intervene on a problem area by first establishing a baseline criteria, then measure that behavior at intervention outcome and, ideally, at some follow-up time point. A natural and logical outgrowth of this approach has been, historically, for interventions to report outcome criteria on separate behaviors in order to establish intervention efficacy and effectiveness, independent from its possible effect on other problem areas. For example, smoking cessation interventions are considered efficacious (i.e., internal validity) if and only if the intervention leads to the individual meeting an abstinence criterion for smoking at outcome and at some follow-up time point. Conversely, interventions are considered to lack efficacy if they do not lead to an individual meeting the abstinence criterion at whether at outcome or at follow-up.

In contrast to abstinence-based outcomes, motivational interviewing (MI; Miller & Rollnick, 1995; 2002) and other harm reduction models have emerged to show that although individuals may not meet a stringent abstinence criterion on a problem area (e.g., alcohol), interventions that reduce behavioral risks are nonetheless clinically useful and help accelerate individuals toward reduced risk and healthier outcomes. Additionally, and similar to finding with the TTM, MI has also demonstrated that certain changes within individuals during an intervention can predict their behavior change at future time points. For example, Baer et al. (2008) demonstrated how client change talk (i.e., CT) during brief, 15-minute MI interviews can significantly and prospectively predict behavioral changes in substance use at 1 and 3-month follow-up.

Amrhein et al. (2003) demonstrated how commitment strength (CS), defined as desire, readiness, and reasons to change, during intervention can predict reduced substance use at 3 and 6-month follow-up. In their analyses, they also identified three specific patterns of substance abuse users: maintainers, changers, and strugglers. In Amrhein et al.'s research, maintainers referred to those participants who remained active users, changers were those participants who took action toward cessation or reduced use, and strugglers were those participants who frequently relapsed; similar to the pattern found in the Redding et al. study. Although MI has demonstrated efficacy and effectiveness for severity reduction and behavior change for a variety of substance abuse and addictive behaviors (e.g., alcohol), particularly for resistant individuals (i.e., PC in the TTM), MI has also has targeted separate behaviors and analyzed separate behaviors as the fundamental unit of analysis. Therefore, despite MI helping to advance the literature for health behavior risks and single behavior change, it has not advanced multiple health behavior change. So, despite its many advances and contributions, MI is also limited in its empirical contribution to this area.

Multiple health behavior change is critical as certain populations are among the greatest risk for chronic disease, disability, and premature death (Prochaska, 2008). Among tobacco users, for example, it is estimated that approximately 92% also meet criteria for at least one additional risk behavior such as heavy alcohol drinking, physical inactivity, or low consumption of fruits and vegetables (Pronk et al., 2004; Klesges, Eck, Isbell, Fulliton & Hanson, 1990). However, with over 6,000 studies on smoking cessation (Fiore, 2000), there remains a paucity of research that evaluates intervention for simultaneous multiple health behavior change despite the well established association between health behavior risks and other problem areas. Taken together, although there is considerable and compelling research on behavioral intervention for smoking, diet, and unprotected sun exposure as separate behaviors, there are many notable gaps in the literature for simultaneous intervention on multiple health behavior risks. This is important because smoking, diet, and unprotected sun exposure are not only the most prominent lifestyle factors associated with cardiovascular disease, diabetes, and some cancers, they are also among the top causes of preventable deaths in the United States.

Given the growing need for multiple health behavior change, research has recently started to address the efficacy and effectiveness of behavioral interventions designed to simultaneously change two or more targeted health behavior risks (Prochaska, 2008). That is, research has recently shifted toward understanding the particular interrelationships among health behaviors and the interventions designed to promote change in more than one health behavior risk simultaneously (Prochaska, Spring, & Nigg, 2008). Toward this end, Paiva (2012) recently defined co-action of behavior change as the extent to which change on one behavior is associated with change on a second behavior at the same follow-up time point. With multiple health behavior change specifically, Paiva et al. (2012) found that individuals in the treatment condition who progressed to Action/Maintenance on one behavior were more likely to progress on a second behavior compared to those participants in the same treatment condition group who did not move to Action/Maintenance on the first behavior. These preliminary findings are important as they begin to explore the intricacies of simultaneous change of multiple health behaviors, but additional research is necessary to further refine the current knowledge base.

At present, the science of multiple health behavior change is in its nascent stages. As such, many important questions remain unclear or unanswered. For example, how exactly does effective change on one behavior affect change on a second behavior? If individuals take Action on one behavior, is this related to taking effective Action on a second behavior (i.e., co-action), do they progress toward Action on both behaviors (i.e., paired action), do they make stage progress toward Action but do not meet Action criteria (i.e., co-progression), or do they remain stable, or possibly even regress to earlier stages of change? Ultimately, because these questions all aim to identify and elucidate the interrelationships among behavior change, co-variation can be used to describe the broader construct of co-action, paired action, and co-progression. Specifically, co-variation may be considered the broader construct as co-action, paired action, and co-progression may well be conceptualized as three different types of co-variation. However, given the specific definitions for co-action, paired action, and co-progression in the literature, this research will adhere to the definitions provided in the literature and define movement to Action criteria on a second behavior as co-action (Paiva, 2012), and define stage progress, increases on DB, and reduced severity as co-progression.

Additionally, it is not clear whether there are any synergistic effects during multiple health behavior change and, if so, whether these effects are specific to the treatment condition or if they naturally occur in the control condition as a natural outgrowth of multiple health behavior change. Moreover, it remains unclear whether and how multiple health behavior change may vary by different behavior pairs. For example, it is possible that there are differences when addictive behaviors (e.g., smoking) are paired together with non-addictive behaviors (i.e., unprotected sun exposure, exercise). Finally, it also remains unclear how paired action (i.e., changes in both behaviors of a pair), singular action (i.e., change in only a single behavior of a pair), and total action (i.e., changes in a full set of behaviors that is expected to produce synergy with the changes in untreated behaviors but only when a tipping point is reached in terms of the magnitude of change in treated behaviors per participant) (Prochaska et al., 2011) relates to multiple health behavior change when the fundamental unit of analysis is changed from separate behaviors at follow-up to behavior pairs at follow-up.

The consistent findings with SOC, DB, problem severity (e.g., dynamic variables) and treatment outcome for separate behaviors has lent considerable support to the TTM's focus on stage and stage progress particularly during the initial phase of intervention (Velicer et al., 2007). However, relatively little is known about the interrelationships of the dynamic variables and multiple health behavior change. Therefore, even less is known about how defining success as: 1) movement to A/M on both behaviors, 2) reduction on severity on both behaviors, or 3) accelerating participants through the SOC on both behaviors may affect and predict treatment outcomes.

The justification for this study's hypotheses is based on the TTM's definition of change as stage progress and success as progressing to A/M criteria, the phenomenon of co-action and co-progression, the consistent findings that dynamic (i.e., not static) variables reliably predict treatment outcome, as well as the clinical value and utility of severity reduction on health risk behaviors. Specifically, investigating paired action and co-progression to reveal how SOC, DB, and problem severity affect multiple health behavior change is important because these dynamic variables have proven to be among the best predictors of treatment outcome within the paradigm of separate behavior change. Therefore, investigating how baseline SOC, the Pros and Cons of behavior change (i.e., DB), and problem severity relates to multiple health behavior is especially important in order to help establish an empirical basis to answer existing questions and guide future research. Finally, these hypotheses may also help guide the future of behavioral health intervention and prevention research to shift from the dominant paradigm of separate behavior change and embrace an integrative model of multiple health behavior change.

The specific hypotheses for this project are:

H1) Participants in Contemplation (C) or Preparation (PR) at baseline for two behaviors will be more likely to move to criteria (Action/Maintenance) on both behaviors at final follow-up (i.e., paired action) than participants who are in Precontemplation (PC) at baseline for both behaviors.

H2) Participants who make stage progress (i.e., progress at least one stage) on one behavior will also make stage progress on a second behavior, with more co-progression observed in the treatment than the control group.

H3) Participants who decrease their severity by a defined amount on one behavior will also decrease their severity on a second behavior, with more co-progression observed in the treatment than the control group.

H4) Participants who increase their Pros and Cons by a defined amount on one behavior will do the same for a second behavior, with more co-progression observed in the treatment than the control group.

H5) As an exploratory approach, it is expected that participants who move to Action/Maintenance on only one behavior will also show smaller signs of success as defined by: a) making stage progress on a second behavior, b) decreasing severity on a second behavior; and c) increasing their Pros and decreasing their Cons on a second behavior. It is also expected that these changes will be observed in the treatment group more than in the control group.

H6) Paired action and co-progression are not expected to vary by race or gender.

CHAPTER 3

METHODOLOGY

This research was a secondary data analysis that investigated multiple health behavior change, co-action, paired action, and co-progression using the Transtheoretical Model. Data used for this project were drawn from a National Cancer Institute (NCI)-funded center grant (P01; CA27821, Principle Investigator, Prochaska) that assessed the effectiveness of home, school, worksite, and medical practice-based prevention programs designed to reduce multiple behavior risks for cancer. Specifically, this P01 evaluated the effectiveness of stage-matched, interactive, computer-tailored intervention (CTI) designed to accelerate individuals through each of the five Stages of Change (SOC) for multiple health risk behaviors: diet (i.e., high fat and low fiber diets), unprotected sun exposure, smoking, sedentary lifestyle, and adherence to breast cancer screening recommendations over a five-year period with several assessment time points. Additional details of this grant including, but not limited to, primary and secondary aims, inclusion and exclusion criteria for participants, measures, and continuous IRB approval are available for further review. The following research project includes analyses on the health behavior risks of smoking, diet, and unprotected sun exposure and, specifically, analyzes the behavior pairs: sun protection and diet, smoking and diet, and smoking and sun protection.

The primary aim of this research was to elucidate multiple health behavior change during stage-based, interactive and computer-tailored intervention (CTI) for multiple health risk behaviors with the goal of broadening the phenomenon of co-action to include a series of smaller changes deemed clinically important. Specifically, this study analyzed the behavior pairs 1) sun protection and diet, 2) smoking and diet, and 3) smoking and sun protection to reveal paired action and co-progression rates in order to answer some of the important, yet unanswered, questions about multiple health behavior change.

There were also several secondary aims of this study. First, this study was designed to help promote population health and wellness by advancing the knowledge base about intervention efficacy and multiple health behavior change by targeting a few of the most prominent lifestyles risk factors (e.g., smoking, diet, unprotected sun exposure) associated with preventable deaths in the United States including cardiovascular disease and some cancers (e.g., lung). Second, this study was designed to help elucidate the science of behavior change by revealing how the Stages of Change (SOC) and the mathematical relationship of decisional balance (DB) relates to multiple health behavior change. Third, this study aimed to provide an empirical basis to possibly shift the dominant separate behavior paradigm and, in so doing, help guide the future of intervention and prevention research and practice toward an integrative model of multiple health behavior change.

Participants

Participants of the study were adults in the United States proactively recruited by telephone. Upon telephone contact, prospective participants were screened in order to satisfy explicit inclusionary criteria and be sure they did not meet exclusionary criteria. The sample (N=9,461) was comprised of parents of adolescents who were participants in a school-based study, patients from a health insurance provider, and employees from 22 identified worksites. Participants were predominantly middle-aged (X= 43.9 years-old, SD=10.74), White (93.8%), and female (65.4%). All participants were assessed at baseline and at 6-month intervals through 30 months post-intervention. Additional details on the inclusion and exclusion criteria as well as the specific Procedures for each project within the P01 were determined by each principle investigator (PI) and are available on the original grant.

Measures:

Demographics:

Single items were used to assess age, gender, education, ethnicity, marital status and perceived general health.

Stage of Change:

Smoking: SOC was measured by a staging algorithm that assessed participants' readiness to quit smoking with response options of 1=Precontemplation (i.e., PC- not intending to quit smoking in the next six months), 2=Contemplation (i.e., C- intending to quit smoking in the next six months), 3=Preparation (i.e., PR- intending to quit smoking in the next thirty days), 4=Action, (i.e., A- quit smoking less than six months ago), and 5=Maintenance (i.e., M- quit smoking more than six months ago).

Diet: SOC was assessed in a 3-step process. First, intention was assessed by the following question, "Do you consistently avoid eating high-fat foods?" Subjects responding "No" were assigned to either: a) Precontemplation– "No, and I do not intend to in the next 6 months"; b) Contemplation– "No, but I intend to in the next 6 months; or c) Preparation– "No, but I intend to in the next 30 days." Second, subjects responding "Yes," must have met a behavioral criterion of estimated fat intake ≤ 30% calories (based on the Dietary Behavior Questionnaire) to be classified into Action– "Yes, but for less than 6 months" or Maintenance– "Yes, for more than 6 months." Third, subjects who perceived that they consistently avoid high fat foods, but fail to meet the behavioral criterion were classified into Precontemplation, Contemplation, or Preparation based on intention to change eating habits (Greene et al., 1999).

Sun Exposure:

Decisional Balance, Self-Efficacy, and Problem Severity: Table 1.

Table 1: Decisional Balance, Self-Efficacy, and Problem Severity: Smoking, Diet, and Sun Exposure.

	Number of Items	**Response Options**	**Reliability**	**Reference**
Decisional Balance				
Smoking	4 Pros of quitting 4 Cons of quitting	1="Not At All Important" to 5="Extremely Important"	Pros (α=.87) Cons (α=.90)	Velicer, DiClemente, Prochaska, & Brandenburg, 1985
Diet	3 Pros of high fat diet 3 Cons of high fat diet	1="Not At All Important" to 5="Extremely Important"	Pros (α = .52) Cons (α = .47)	Greene, Rossi, Rossi, Fava et al., 2001;Greene, Rossi, Rossi, Velicer et al., 1999; Prochaska et al., 1994; Rossi et al., 1994b; Rossi, Rossi, & Hargreaves, 1997
Sun Exposure				
Self-Efficacy				
Smoking	9 situational temptations	1="Not At All Tempted" to 5="Extremely Tempted"	α =	Velicer, DiClemente, Rossi, & Prochaska, 1990
Diet	9 situational temptations	1="Not At All Tempted" to 5="Extremely Tempted"	α = .71	Greene et al., 2001;Greene et al., 1999; Prochaska et al., 1994; Rossi et al., 1994b; Rossi, Rossi, & Hargreaves, 1997
Sun Exposure				
Problem Severity				
Smoking	2 items	Continuous measures: number of cigarettes time to first cigarette	n/a	Fagerstrom, Heatherton, & Kozlowski, 1990
Diet	Dietary Behavior Questionnaire: 22-items (4 subscales)	Previous month: 1=*"Never"* to 5=*"Almost Always*"	α ranges from 0.67 to 0.84	Greene et al., 1996
Sun Exposure				

Data Analytic Strategies

The primary and secondary aims of this study were achieved by the following analyses. The first set of analyses ran descriptive statistics and bivariate plots to determine whether the assumptions of the general linear model (GLM) were met and to assess any issues with non-normal data including skewness, kurtosis, and missing data. Although logistic regression (LR) does not require GLM assumptions to be met, preliminary analyses were critical to ensure LR was an appropriate, and perhaps optimal, statistical method for this research. Were there missing data, multiple imputation (MI) would have been utilized as it has been shown to be the most reliable estimation of missing data values.

H1) Participants in Contemplation (C) or Preparation (PR) at baseline for two behaviors will be more likely to move to criteria (Action/Maintenance) on both behaviors at final follow-up (i.e., paired action) than participants who are in Precontemplation (PC) at baseline for both behaviors.

Analysis 1: A series of logistic regression (LR) analyses determined whether being in later SOC (i.e., C and PR) at baseline for two behaviors was predictive of more stage related paired action as compared to participants in PC at baseline. Predictors were assessed at baseline and 24-month follow-up. Behavior pairs were examined within the treatment and control groups separately, resulting in 6 LR analyses.

LR was performed to see how well one categorical, independent variable predicted membership of a dichotomous dependent variable. Specifically, LR compared the odds of moving to A/M on both behaviors in the behavior pair at 24-month follow-up given the participant was either in PC or C/PR for both behaviors at baseline. Therefore, results show the participants who progressed to criteria as well as the odds ratios of progressing to A/M on both behaviors at 24-month follow-up based on whether the participant was in PC or C/PR for both behaviors at baseline by treatment condition.

The independent variables were analyzed by the behavior pairs: 1) sun protection and diet, 2) smoking and diet, 3) smoking and sun protection. Specifically, the dataset was categorized to identify participants who were in PC for both behaviors at baseline and participants who were in either C or PR for both behaviors at baseline. Participants who were in PC for both behaviors were categorized with a 0 (i.e., 'being in PC for both behaviors') and participants who were in either C or PR for both behaviors were categorized with a 1 (i.e., 'being in Contemplation or Preparation for both behaviors').

The dependent variables were analyzed by the same behavior pairs: 1) sun protection and diet, 2) smoking and diet, 3) smoking and sun protection and SOC for both behaviors at 24-month follow-up. Specifically, the dataset was categorized to identify the participants who were in A/M for both behaviors in the behavior pair at 24-month follow-up and the participants who were not in A/M for both behaviors in the behavior pair at 24-month follow-up. Participants who did not move to A/M on both behaviors at 24-month follow-up were categorized with a 0 (i.e., 'did not change on both behaviors') and participants who did move to A/M on both behaviors at 24-month follow-up were categorized with a 1 (i.e., 'changed on both behaviors').

After running each LR, a series of crosstabulations was conducted in order to identify the specific number of participants who were in PC for both behaviors at baseline and who moved to A/M on both behaviors at 24-month follow-up and the specific number of participants who were in C/PR for both behaviors at baseline and moved to

A/M on both behaviors at 24-month follow-up by treatment condition. As such, the reported proportions reflect the percentage that number of participants represents relative to all the participants who progressed to A/M on both behaviors at follow-up given they were either in PC or C/PR at baseline for that treatment condition and not relative to the total sample of the study. In addition, conditional confidence intervals were calculated for each proportion of each behavior pair analysis. Therefore, the reported proportions allow for a direct comparison between treatment and control conditions.

H2) Participants who make stage progress (i.e., progress at least one stage) on one behavior will also make stage progress on a second behavior, with more co-progression observed in the treatment than the control group.

Analysis 2: A series of LR analyses evaluated the likelihood of whether making stage progress on one behavior increases the likelihood of making stage progress on a second behavior, and assessed any differences between the treatment and control groups. Behavior pairs were examined within the treatment and control groups separately, resulting in 6 LR analyses.

LR was performed to see how well one categorical, independent variable predicted membership of a dichotomous dependent variable. Specifically, in this analysis, LR compared the odds of participants making stage progress on a second behavior given stage progress on the first behavior compared to the odds of participants making stage progress on the second behavior given no stage progress on the first behavior from baseline to 24-month follow-up. Therefore, the results show the participants and odds of making stage progress on both behaviors from baseline to 24-month follow-up compared to the odds of making stage progress only on the second behavior not having made stage progress on the first behavior from baseline to 24-month follow-up.

The independent and dependent variables were analyzed by the same behavior pairs: 1) sun protection and diet, 2) smoking and diet, 3) smoking and sun protection and SOC at baseline and at 24-month follow-up by treatment condition. Specifically, each behavior within the pair was dichotomized into participants who did and did not progress at least one SOC from baseline to 24-month follow-up on each behavior in the behavior pair. Participants who did not progress at least one SOC were categorized with a 0 (i.e., 'stable/regress') and participants who did progress at least one SOC from baseline to 24-month follow-up were categorized with a 1 (i.e., 'stage progress'); with the first behavior in the behavior pair as the independent variable and the second behavior in the behavior pair as the dependent variable. All analyses were run separately for the control, treatment, and total conditions.

After running each LR, a series of crosstabulations was conducted in order to identify the specific number of participants who made stage progress on the first behavior at 24-month follow-up and whether the participant also made stage progress on the second behavior at 24-month follow-up by treatment condition. As such, the reported proportions reflect the percentage of participants who made stage progress on the second behavior given they made stage progress on the first behavior compared to participants who made stage progress on the second behavior not having made stage progress on the first behavior in the behavior pair relative to that treatment condition. Again, conditional confidence intervals were calculated for each proportion for each behavior pair by treatment condition. Therefore, results allow for a direct comparison of the treatment and control conditions.

H3) Participants who decrease their severity by a defined amount on one behavior will also decrease their severity on a second behavior, with more co-progression observed in the treatment than the control group.

Analysis 3: A series of LR analyses evaluated the likelihood of whether reduction in severity on one behavior increased the likelihood of reduction of severity on a second behavior, and to assess any differences between the treatment and control groups. See appendix 1.

LR was performed to see how well one categorical, independent variable predicted membership of a dichotomous dependent variable. Specifically, in this analysis, LR compared the odds of participants who had a reduction of severity on the second behavior given a reduction of severity on the first behavior compared to participants who only had a reduction of severity on the second behavior and did not have a reduction of severity on the first behavior from baseline to 24-month follow-up by treatment condition. Therefore, results show the odds of participants who had a reduction of severity on both behaviors compared to the odds of reduction of severity only on the second behavior from baseline to 24-month by treatment condition.

Drawing from harm reduction theory and the literature on decisional balance for separate behaviors, analyses defined reduction in severity in the following ways. For smoking, reduction in severity was defined as a 30% reduction in smoking from baseline to 24-month follow-up. For diet, reduction in severity was defined as a .3 SD increase on the total behavior score at 24-month follow-up. For sun protection, reduction in severity was defined as a .3 SD increase on the total behavior score at 24-month follow-up. The .3 SD increase on the diet and sun protection behavior measures is based on each measure having higher total scores correlated with reduced health risk on that specific behavior.

The independent and dependent variables were analyzed by the same three behavior pairs: 1) sun protection and diet, 2) smoking and diet, 3) smoking and sun protection at baseline and at 24-month follow-up. Specifically, each behavior within the pair was dichotomized into participants who did and did not meet reduction in severity criteria from baseline to 24-month follow-up. Participants who did not meet criteria were categorized with a 0 (i.e., 'did not meet reduction in severity criteria') and participants who did meet reduction in severity criteria from baseline to 24-month were categorized with a 1 (i.e., 'did meet reduction in severity criteria'). All analyses were run separately for the control, treatment, and total conditions.

After running each LR, a series of crosstabulations was conducted to reveal the specific number of participants who met criteria for both behaviors in the behavior pair by treatment condition compared to the participants who met the reduction on severity criteria on the second behavior but did not meet reduction on severity criteria on the first behavior. Thereafter, conditional confidence intervals were then calculated to reveal the specific proportion that number of participants represents for each behavior pair by treatment condition. As such, the reported proportions reflect the number of participants who met reduction in severity criteria on both behaviors compared to participants who only met the reduction of severity criteria on the second behavior but not on the first behavior for each behavior pair by treatment condition. Therefore, results allow for a direct comparison between treatment and control conditions.

H4) Participants who increase their Pros and Cons by a defined amount on one behavior will do the same for a second behavior, with more co-progression observed in the treatment than the control group.

Analysis 4: A series of LR analyses evaluated the likelihood of whether increasing Pros by one standard deviation and decreasing Cons one half standard deviation on one behavior increased the likelihood of doing the same on a second behavior, and assessed any differences between the treatment and control groups.

LR was performed to see how well one categorical, independent variable predicted membership of a dichotomous dependent variable. Specifically, in this analysis, LR compared the odds of participants who increased their Pros by one standard deviation and reduced their Cons by a half standard deviation on the second behavior having met the same criteria on the first behavior compared to participants who only increased their Pros by one standard deviation and reduced their Cons by a half standard deviation on the second behavior not having met the same criteria on the first behavior from baseline to 24-month follow-up by treatment condition.

Similar to previous analyses, the independent and dependent variables were analyzed by behavior pairs: 1) sun protection and diet, 2) smoking and diet, 3) smoking and sun protection. In these analyses, the independent variables (i.e., the first behavior of the pair) and the dependent variables (i.e., the second behavior of the pair) were both categorized as either increasing Pros one standard deviation and reducing Cons by a half standard deviation from baseline to 24-month follow-up on that behavior, either yes or no. Participants who did not meet this criterion were categorized with a 0 (i.e., “did not met strong and weak principles”) and participants who met this criterion were categorized with a 1 (i.e., “met strong and weak principles”). Given the stringent criteria, the strong and weak principles analyses were not able to be completed as planned because there were zero participants who met criteria for behavior pairs across each condition.

Also, because the original strong and weak principles were based on the transitions from participants progressing from PC-A for separate behaviors, and this research examined all Stages of Change (SOC) movements including PC-A, C-A, and PR-A, a revised approach using a .4 SD Pros increase for each behavior in the behavior pair was used to better understand how decisional balance relates to multiple health behavior change. Therefore, in this analysis, LR compared the odds of participants who increased their Pros by .4 SD on the second behavior given participants increased their Pros .4 SD on the first behavior compared to participants who only increased their Pros .4 SD on the second behavior, not having increased their Pros by .4 SD on the first behavior, from baseline to 24-month follow-up by treatment condition.

To complete the revised analyses, the same three behavior pairs were examined using the same independent and dependent variables: 1) sun protection and diet, 2) smoking and diet, 3) smoking and sun protection at baseline and at 24-month follow-up. Specifically, the dataset was categorized to identify those participants who made a .4 SD increase on Pros on the second behavior given a .4 SD increase on Pros on the first behavior, either yes or no (i.e., 1= “met .4 SD Pros increase criteria” and 0= “did not meet .4 SD Pros increase criteria”), and participants who only met the .4 SD increase on Pros on the second behavior given no .4 SD increase on Pros on the first behavior, either yes or no (i.e., 1= “met .4 SD Pros increase criteria” and 0= “did not meet .4 SD Pros increase criteria”), from baseline to 24-month follow-up by treatment condition.

After running each LR, a series of crosstabulations was conducted to reveal the specific number of participants who met the .4 SD increase on Pros criteria for both behaviors in the behavior pair compared to the participants who met the .4 SD increase on Pros criteria only for the second behavior but not for the first behavior. As such, the reported proportions represents the number of participants who met the .4 SD increase on Pros criteria for both behaviors compared to the number of participants who met the .4 SD increase on Pros criteria only on the second behavior. Conditional confidence intervals were then calculated to reveal the specific proportion that number of participants represents for each behavior pair for each treatment condition. Therefore, results allow for a direct comparison between treatment and control conditions.

H5) As an exploratory approach, it is expected that participants who move to Action/Maintenance on only one behavior will also show smaller signs of success as defined by: a) making stage progress on a second behavior, b) decreasing severity on a second behavior; and c) increasing their Pros and decreasing their Cons on a second behavior. It is also expected that these changes will be observed in the treatment group more than in the control group.

Analysis 5: Descriptive statistics and crosstabulations evaluated whether participants who moved to criteria (i.e., Action/Maintenance) on only one behavior also made smaller changes (described above) on other behaviors. Upon a thorough review of the data, this hypothesis was answered by previous analyses as outlined in the results and discussion sections.

H6) Paired action and co-progression are not expected to vary by race or gender.

Analysis 6: The series of LR analyzed in H2 through H4 were repeated to assess any differences in paired action and co-progression rates between race and gender. The same categorization outlined in the previous analyses was repeated with the dataset having first been filtered for race (i.e., 0=Whites and 1=Non-Whites) and then re-run having been filtered for gender (i.e., 0=females and 1=males). Therefore, these analyses revealed any differences between race and gender on the odds of meeting criteria (i.e., defined differently for each hypothesis) on the second behavior having met criteria on the first behavior compared to the odds of meeting criteria on the second behavior and not having met criteria on the first behavior from baseline to 24-month follow-up for each behavior pair by treatment condition.

CHAPTER 4

FINDINGS

Sample:

The participants (N=9,461) were predominantly White (93.8%), middle-aged (X= 43.9 years-old, SD=10.74), female (65.4%), and recruited solely from a Northeastern state. Table 2 provides additional detail on the three referral sources (i.e., parent, patient, and worksite) as well as the gender, marital status, and ethnic composition for the control, treatment, and total sample.

Hypotheses:

H1) Participants in Contemplation (C) or Preparation (PR) at baseline for two behaviors will be more likely to move to criteria (Action/Maintenance) on both behaviors at final follow-up (i.e., paired action) than participants who are in Precontemplation (PC) at baseline for both behaviors.

Table 3 provides the participants who moved to criteria and the paired action odds ratios of progressing to A/M on both behaviors at 24-month follow-up (i.e., the dependent variable) given the participant was either in PC or C/PR for both behaviors at baseline (i.e., the independent variable).

Sun Protection and Diet

Entire Sample: Results were significant, OR=5.40 [2.68, 10.90], $p < .001$, indicating that participants in Contemplation or Preparation (i.e., C/PR) for sun protection and diet at baseline were almost five and a half times more likely to progress to Action/Maintenance (i.e., A/M) on both behaviors at 24-month follow-up than participants who were in Precontemplation (i.e., PC) for both behaviors at baseline.

Treatment Group: Results were significant, OR=4.53 [1.89, 10.85], p <.001, indicating that participants who were in C/PR for sun protection and diet at baseline were over four and a half times more likely to move to A/M on sun protection and diet than participants who were in PC for both behaviors at baseline.

Control Group: Results were significant, OR=6.97 [2.11, 23.04], p <.001, indicating that participants who were in C/PR for both behaviors were almost seven times more likely to move to A/M on both sun protection and diet than participants who were in PC for both behaviors at baseline.

Smoking and Diet

Entire Sample: Results were not significant, OR=2.22, [0.79, 6.27], p <.132, indicating that although participants in C/PR for both smoking and diet at baseline were more than two times more likely to progress to A/M on smoking and diet at 24-month follow-up than participants who were in PC for both behaviors at baseline, the odds ratio between the groups was not reliably different.

Treatment Group. Results were not significant, OR=2.22 [0.45, 10.98], p <.330, indicating that although participants who were in C/PR for smoking and diet at baseline were more than two times more likely to progress to A/M on both behaviors at 24-month follow-up than participants who were in PC for both behaviors at baseline, the difference between the groups was not significantly different.

Control Group. Results were not significant, OR=2.14 [0.54, 8.44], p <.278, indicating that although participants who were in C/PR for both behaviors were more than two times more likely to progress to A/M on smoking and diet at 24-month follow-up than participants who were in PC for both behaviors at baseline, the odds ratio between participants who were in C/PR compared to PC was not significant.

Smoking and Sun Protection

Entire Sample: Results were significant, OR=4.38 [1.00, 19.03], p <.049, indicating that participants who were in C/PR for smoking and sun protection at baseline were more than four times more likely to progress to A/M on both behaviors at 24-month follow-up than participants who were in PC for both behaviors at baseline.

Treatment Group. Odds ratios were not able to be calculated between the groups because zero participants who were in PC for both behaviors at baseline progressed to A/M on both behaviors at 24-month follow-up. Therefore, although 14 participants who were in C/PR for both behaviors at baseline did progress to A/M on both behaviors at 24-month follow-up, odds ratios could not be calculated because zero participants met criteria in the comparison group.

Control Group. Results were not significant, OR=1.20 [0.23, 6.30], p <.831, indicating that although participants who were in C/PR for smoking and sun protection were more likely to progress to A/M on both behaviors at 24-month follow-up, the difference between the comparison groups was not significant.

Table 2. Demographics and descriptive statistics for control, treatment, and total sample, baseline-24 months[#].

		Control (N=4800)			Treatment (N=4661)		Total (N=9461)	
		N	%		N	%	N	%
Study	Parent	1238	25.8%		1197	25.7%	2435	25.7%
	Patient	2620	54.6%		2550	54.7%	5170	54.6%
	Worksite	942	19.6%		914	19.6%	1856	19.6%
Gender	Male	1596	34.6%		1545	34.6%	3141	34.6%
	Female	3017	65.4%		2921	65.4%	5938	65.4%
Marital Status	Married	3265	70.9%		3176	71.3%	6441	71.1%
	Not Married, living w/Partner	163	3.5%		157	3.5%	320	3.5%
	Not Married	460	10.0%		462	10.4%	922	10.2%
	Separated	89	1.9%		90	2.0%	179	2.0%
	Divorced	480	10.4%		452	10.1%	932	10.3%
	Widowed	149	3.2%		119	2.7%	268	3.0%
Ethnicity	American Indian, Alaskan	21	0.5%		20	0.4%	41	0.5%
	Asian, Pacific Islander	40	0.9%		34	0.8%	74	0.8%
	Black, Non-Hispanic	74	1.6%		82	1.8%	156	1.7%
	Hispanic	46	1.0%		45	1.0%	91	1.0%
	White	4319	93.7%		4184	93.8%	8503	93.7%
	Other/Combination	109	2.4%		96	2.2%	205	2.3%
		Mean	SD	N	Mean	SD	Mean	SD
	Age	44.07	10.7	4589	43.74	10.7	43.90	10.7

[#] Recruited in 1999 in the United States.

Table 3. Comparison of paired action rates among participants who were either in Precontemplation (PC) or in Contemplation/Preparation (C/PR) for both behaviors at baseline and were in Action/Maintenance (A/M) for both behaviors at 24-month follow-up.

	Control Proportion (n/total N) Confidence Interval	Treatment Proportion (n/total N) Confidence Interval	Total Proportion (n/total N) Confidence Interval
Sun Protection & Diet			
Paired Action: Participants who progressed to A/M on sun protection and diet given PC at baseline	.01 (3/401) [.00, .02]	.02 (6/261) [.00, .04]	.01 (9/662) [.00, .02]
Paired Action: Participants who progressed to A/M on sun protection and diet given C/PR at baseline	.05 (29/581) [.03, .07]	.10 (40/415) [.07, .13]	.07 (69/996) [.05, .09]
Paired action odds ratio[a]	**6.97*** (2.11, 23.04)**	**4.53*** (1.89, 10.85)**	**5.40*** (2.68, 10.90)**
Smoking & Diet			
Paired Action: Participants who progressed to A/M on smoking and diet given PC at baseline	.02 (3/134) [.00, .04]	.03 (2/71) [.00, .07]	.02 (5/205) [.00, .04]
Paired Action: Participants who progressed to A/M on smoking and diet given C/PR at baseline	.05 (7/150) [.02, .08]	.06 (7/116) [.02, .10]	.07 (14/266) [.04, .10]
Paired action odds ratio[a]	**2.14 (0.54, 8.44)**	**2.22 (0.45, 10.98)**	**2.22 (0.79, 6.27)**
Smoking & Sun Protection			
Paired Action: Participants who progressed to A/M on smoking and sun protection given PC at baseline	.02 (2/95) [.00, .05]	.00 (0/60) [.00, .00]	.01 (2/155) [.00, .02]
Paired Action: Participants who progressed to A/M on smoking and sun protection given C/PR at baseline	.03 (5/199) [.00, .05]	.09 (14/152) [.05, .14]	.05 (19/351) [.03, .08]
Paired action odds ratio[a]	**1.20 (0.23, 6.30)**	**0.00 (0.00, 0.00)**	**4.38** (1.00, 19.03)**

** $p < .05$. *** $p < .001$;

[a] Percentages in control and treatment conditions reflect proportion within that condition, not the total;

[#] Recruited in 1999 in the United States.

H2) Participants who make stage progress (i.e., progress at least one stage) on one behavior will also make stage progress on a second behavior, with more co-progression observed in the treatment than the control group.

Table 4 provides the participants who progressed to criteria and the co-progression odds ratios of making stage progress on a second behavior given stage progress on the first behavior compared to the odds of participants who made stage progress on the second behavior not having made stage progress on the first behavior from baseline to 24-month follow-up for each behavior pair and treatment condition.

Sun Protection and Diet

Entire Sample: Results were significant, OR= 1.46 [1.25, 1.70], $p < .000$, indicating that participants who made stage progress on diet given stage progress on sun protection were almost one and a half times more likely to make stage progress on diet compared to participants who only made stage progress on diet.

Treatment Group: Results were significant, OR= 1.85 [1.48, 2.32], $p < .000$, indicating that participants who made stage progress on diet given stage progress on sun protection were almost twice as likely to make stage progress on diet compared to participants who only made stage progress on diet.

Control Group: Results were not significant, OR= 1.10 [0.88, 1.37], $p < .414$, indicating that although participants who made stage progress on diet given stage progress on sun protection were slightly more likely to make stage progress on diet compared to participants who only made stage progress on diet, the difference between the comparison groups was not significant.

Smoking and Diet

Entire Sample: Results were significant, OR= 1.40 [1.05, 1.86], $p < .021$, indicating that participants who made stage progress on diet given stage progress on smoking were almost one and a half times more likely to make stage progress on diet compared to participants who only made stage progress on diet.

Treatment Group: Results were not significant, OR= 1.17 [0.76, 1.80], $p < .484$, indicating that although participants who made stage progress on diet given stage progress were slightly more likely to make stage progress on diet compared to participants who only made stage progress on diet, the difference between the groups was not reliable.

Control Group: Results were significant, OR= 1.56 [1.07, 2.28], $p < .021$, indicating that participants who made stage progress on diet given stage progress on smoking were more than one and a half times more likely to make stage progress on diet compared to participants who only made stage progress on diet.

Smoking and Sun Protection

Entire Sample: Results were not significant, OR= 1.16 [0.87, 1.55], $p < .305$, indicating that although participants who made stage progress on sun protection given stage progress on smoking were slightly more likely to make stage progress on sun protection compared to participants who only made stage progress on sun protection, the difference between the comparison groups was not significant.

Treatment Group: Results were not significant, OR= 1.22 [0.81, 1.85], $p < .358$, indicating that although participants who made stage progress on sun protection given stage progress on smoking were almost one and a quarter times more likely to make progress on sun protection compared to participants who only made stage progress on sun protection, the difference between the comparison groups was not significant.

Control Group: Results were not significant, OR= 1.03 [0.70, 1.55], $p < .907$, indicating that although participants who made stage progress on sun protection given stage progress on smoking were slightly more likely to make stage progress on sun protection compared to participants who only made stage progress on sun protection, the difference between the comparison groups was not significant.

Table 4. Stage progress co-progression rates from baseline to 24-month follow-up by treatment condition[#]; Percentages in control and treatment conditions reflect proportion within that condition, not total.

	Control Proportion (n/total N) Confidence Interval	Treatment Proportion (n/total N) Confidence Interval	Total Proportion (n/total N) Confidence Interval
Sun Protection & Diet			
Participants who made stage progress on diet given stage progress on sun protection	.34 (167/498) [.29, .38]	.48 (256/536) [.33, .57]	.41 (423/1034) [.38, .44]
Participants who made stage progress on diet given no stage progress on sun protection	.32 (399/1266) [.29, .34]	.33 (256/774) [.30, .36]	.32 (655/2040) [.30, .34]
Co-progression odds ratio[a]	**1.10 (0.88, 1.37)**	**1.85***(1.48, 2.32)**	**1.46***(1.25, 1.70)**
Smoking & Diet			
Participants who made stage progress on diet given stage progress on smoking	.37 (69/188) [.30, .44]	.39 (57/148) [.31, .46]	.38 (126/336) [.32, .43]
Participants who made stage progress on diet given no stage progress on smoking	.27 (95/351) [.22, .32]	.35 (74/212) [.28, .41]	.30 (169/563) [.26, .34]
Co-progression odds ratio[a]	**1.56**(1.07, 2.28)**	**1.17 (0.76, 1.80)**	**1.40** (1.05, 1.86)**
Smoking & Sun Protection			
Participants who made stage progress on sun protection given stage progress on smoking	.27 (47/175) [.20, .33]	.39 (65/167) [.32, .46]	.33 (112/342) [.23, .43]
Participants who made stage progress on sun protection given no stage progress on smoking	.26 (91/345) [.22, .31]	.34 (76/221) [.28, .41]	.30 (167/586) [.26, .34]
Co-progression odds ratio[a]	**1.03 (0.70, 1.55)**	**1.22 (0.81, 1.85)**	**1.16 (0.87, 1.55)**

** $p < .05$. *** $p < .001$;
[a] Co-progression rates of stage progress on second behavior given stage progress on the first behavior;
[#] Recruited in 1999 in the United States.

H3) Participants who decrease their severity by a defined amount on one behavior will also decrease their severity on a second behavior, with more co-progression observed in the treatment than the control group.

Table 5 provides the participants who progressed to criteria and the co-progression odds ratios of reduction on severity on a second behavior given reduction on severity on the first behavior compared to the odds of participants who had a reduction on severity on the second behavior not having reduced severity on the first behavior from baseline to 24-month follow-up for each behavior pair by treatment condition. Specifically, reduction on severity was defined as a 30% reduction in the number of cigarettes smoked from baseline to 24-month follow-up and at least a .3 SD increase on the diet behavior total score for diet and a .3 SD increase on the sun exposure behavior total score for unprotected sun exposure, both from baseline to 24-month follow-up.

Sun Protection and Diet

Entire Sample: Results were significant, OR= 1.26 [1.09, 1.46], $p < .002$, indicating that participants who had a reduction on severity on diet given a reduction on severity on sun protection were more than one and a quarter times more likely to reduce severity on diet compared to participants who only reduced severity on diet alone.

Treatment Group: Results were significant, OR= 1.34 [1.08, 1.67], $p < .008$, **i**ndicating that participants who reduced severity on diet given reduced severity on sun protection were more than one and a third times more likely to reduce severity on diet compared to participants who only reduced severity on diet alone.

Control Group: Results were not significant, OR= 1.11 [0.92, 1.35], $p < .280$, indicating that although participants were slightly more likely to reduce severity on diet given reduced severity on sun protection compared to participants who reduced severity on diet alone, the difference between the comparison groups was not reliable.

Smoking and Diet

Entire Sample: Results were significant, OR= 1.40 [1.01, 1.77], p < .039, indicating that participants who reduced severity on diet given reduced severity on smoking were more than one and a third times more likely to reduce severity on diet compared to participants who only reduced severity on diet alone.

Treatment Group: Results were not significant, OR= 0.94 [0.62, 1.44], p < .787, indicating that although participants had a slightly lower likelihood of a reduction on severity diet given a reduction of severity on smoking compared to participants who had a reduction on diet alone, the difference between the comparison groups was not reliable.

Control Group: Results were significant, OR= 1.69 [1.17, 2.45], p < .005, indicating that participants who reduced severity on diet given reduced severity on smoking were more than one and a half times more likely to reduce severity on diet compared to participants who only reduced severity on diet alone.

Smoking and Sun Protection

Entire Sample: Results were not significant, OR= 1.16 [0.88, 1.52], p < .288, indicating that although participants who reduced severity on sun protection given reduced severity on smoking were slightly more likely to reduce severity on sun protection compared to participants who only reduced severity on sun protection alone, the difference between the groups was not reliable.

Treatment Group: Results were not significant, OR= 1.35 [0.90, 2.05], p < .152, indicating that although participants who reduced severity on sun protection given reduced severity on smoking were more likely to reduce severity on sun protection compared to participants who only reduced severity on sun protection alone, the difference between this group was not reliably different.

Control Group: Results were not significant, OR= 1.00 [0.70, 1.44], $p < .987$, indicating that although participants who reduced severity on sun protection given reduced severity on smoking were just as likely to reduce harm on sun protection as participants who only reduced harm on sun protection alone, the difference between the comparison groups was not reliable.

Table 5.Reduction on severity co-progression rates baseline to 24-month follow-up by treatment condition[#]; 30% reduction in smoking and a .3 SD reduction in severity on diet and sun total behavior scores; Percentages in control and treatment conditions reflect proportion within that condition, not total.

	Control Proportion (n/total N) Confidence Interval	Treatment Proportion (n/total N) Confidence Interval	Total Proportion (n/total N) Confidence Interval
Sun Protection & Diet			
Participants who reduced severity on diet given reduced severity on sun protection	.38 (307/814) [.35,.41]	.52 (379/733) [.48,.56]	.44 (686/1547) [.42,.46]
Participants who reduced severity on diet given no reduced severity on sun protection	.35 (339/962) [.32,.38]	.44 (262/590) [.40,.48]	.39 (601/1552) [.37,.41]
Co-progression odds ratio[a]	**1.11 (0.92, 1.35)**	**1.34** (1.08, 1.67)**	**1.26** (1.09, 1.46)**
Smoking & Diet			
Participants who reduced severity on diet given reduced severity on smoking	.43 (75/176) [.36,.50]	.44 (60/138) [.36,.52]	.43 (135/314) [.38,.48]
Participants who reduced severity on diet given no reduced severity on smoking	.31 (116/380) [.26,.36]	.45 (106/236) [.39,.51]	.36 (222/616) [.32,.40]
Co-progression odds ratio[a]	**1.69** (1.17, 2.45)**	**0.94 (0.62, 1.44)**	**1.40** (1.01, 1.77)**
Smoking & Sun Protection			
Participants who reduced severity on sun protection given reduced severity on smoking	.47 (80/170) [.39,.55]	.60 (84/141) [.52,.68]	.53 (164/311) [.47,.59]
Participants who reduced severity on sun protection given no reduced severity on smoking	.47 (179/381) [.42,.52]	.52 (136/261) [.46,.58]	.49 (315/642) [.45,.53]
Co-progression odds ratio[a]	**1.00 (0.70, 1.44)**	**1.35 (0.90, 2.05)**	**1.16 (0.88, 1.52)**

** $p < .05$. *** $p < .001$;
[a] Odds of stage progress on second behavior given stage progress on the first behavior;
[#] Recruited in 1999 in the United States.

H4) Participants who increase their Pros and Cons by a defined amount on one behavior will do the same for a second behavior, with more co-progression observed in the treatment than the control group.

Table 6 provides the participants and co-progression odds ratios for participants who made a .4 SD increase in Pros on the second behavior given a .4 SD increase in Pros on the first behavior compared to participants who only made a .4 SD increase on the second behavior in the behavior pair from baseline to 24-month follow-up by treatment condition.

Sun Protection and Diet

Entire Sample: Results were significant, OR= 1.38 [1.14, 1.67], $p < .001$, indicating that participants who increased their Pros by .4 SD on diet given a .4 SD increase of their Pros on sun protection were more than one and a third times more likely to increase their Pros .4 SD on diet compared to participants who only increased their Pros .4 SD on diet alone.

Treatment Group: Results were not significant, OR= 1.06 [0.79, 1.43], $p < .693$, indicating that although participants who increased their Pros on diet by .4 SD given they also increased their Pros .4 SD on sun protection were slightly more likely to increase their Pros .4 SD on diet compared to participants who only increased their Pros by .4 SD on diet, the difference between the comparison groups was not reliable.

Control Group: Results were significant, OR= 1.71 [1.33, 2.19], $p < .000$, indicating that participants who increased their Pros .4 SD on diet given they increased their Pros .4 SD on sun protection were almost two times as likely to increase their Pros .4 SD on diet compared to participants who increased their Pros .4 SD on diet alone.

Smoking and Diet

Entire Sample: Results were not significant, OR= 1.38 [0.97, 1.97], $p < .072$, indicating that although participants who increased their Pros .4 SD from baseline to 24-month follow-up on diet given they increased their Pros .4 SD on smoking were almost one and a half times more likely to increase their Pros by .4 SD on diet compared to participants who increased their Pros on diet alone, the difference between the comparison groups was not reliable.

Treatment Group: Results were significant, OR=1. 75 [0.99, 3.09], $p < .052$, indicating that smokers who increased their Pros .4 SD on diet given a .4 SD increase on Pros on smoking had a one and three quarter increased likelihood of increasing their Pros .4 SD on diet compared to smokers who only increased their Pros by .4 SD on diet alone.

Control Group: Results were not significant, OR= 1.19, [0.76, 1.87], $p < .448$, indicating that although participants who increased their Pros .4 SD on diet given a .4 SD increased Pros on smoking were almost one and a quarter times more likely to increase their Pros on diet by .4 SD compared to smokers who only increased their Pros by .4 SD on diet, the difference between the comparison groups was not reliable.

Smoking and Sun Protection

Entire Sample: Results were significant, OR= 1.48 [1.07, 2.05], $p < .019$, indicating that participants who increased their Pros .4 SD on sun protection given a .4 SD increased Pros on smoking were almost one and a half times more likely to increase their Pros .4 SD on sun protection compared to smokers who only increased their Pros .4 SD on sun protection alone, the difference between the comparison groups was not reliable.

Treatment Group: Results were not significant, OR= 1.07 [0.64, 1.78], $p < .799$, indicating that although participants who increased their Pros .4 SD on sun protection given a .4 SD increased Pros on smoking were slightly more likely to increase their Pros .4 SD on sun protection compared to participants who increased their Pros by .4 SD on sun protection alone, the difference between the comparison groups was not reliable.

Control Group: Results were significant, OR= 1.87 [1.22, 2.87], $p < .004$, indicating that smokers who increased their Pros .4 SD on sun protection given a .4 SD increased Pros on smoking were almost two times more likely to increase their Pros by .4 SD on sun protection compared to smokers who increased their Pros by .4 SD on sun protection alone.

Table 6. .4 SD Pros increase on both behaviors from baseline to 24-mo. follow-up by treatment condition[#]; Percentages in control and treatment conditions reflect proportion within that condition, not total;

	Control Proportion (n/total N) Confidence Interval	Treatment Proportion (n/total N) Confidence Interval	Total Proportion (n/total N) Confidence Interval
Sun Protection & Diet			
Participants with .4 SD Pros increase on diet given a .4 SD Pros increase on sun protection	.29 (124/425) [.25,.33]	.21 (79/384) [.17,.25]	.25 (203/809) [.22,.28]
Participants with .4 SD Pros increase on diet given no .4 SD Pros increase on sun protection	.19 (249/1281) [.17,.21]	.20 (170/867) [.17,.23]	.20 (419/2148) [.18,.22]
Co-progression odds ratio[a]	**1.71*** (1.33, 2.19)**	**1.06 (0.79, 1.43)**	**1.38*** (1.14, 1.67)**
Smoking & Diet			
Participants with .4 SD Pros increase on diet given a .4 SD Pros increase on smoking	.24 (35/145) [.20,.28]	.28 (23/82) [.18,.38]	.26 (58/227) [.20,.32]
Participants with .4 SD Pros increase on diet given no .4 SD Pros increase on smoking	.21 (82/389) [.17,.25]	.18 (51/280) [.13,.23]	.20 (133/669) [.17,.23]
Co-progression odds ratio[a]	**1.19 (0.76, 1.87)**	**1.75** (0.99, 3.09)**	**1.38 (0.97, 1.97)**
Smoking & Sun Protection			
Participants with .4 SD Pros increase on sun protection given a .4 SD Pros increase on smoking	.35 (46/130) [.27,.43]	.28 (27/96) [.19,.37]	.32 (73/226) [.26,.38]
Participants with .4 SD Pros increase on sun protection given no .4 SD Pros increase on smoking	.23 (95/420) [.19,.27]	.25 (82/306) [.212,.32]	.24 (177/726) [.21,.27]
Co-progression odds ratio[a]	**1.87** (1.22, 2.87)**	**1.07 (0.64, 1.78)**	**1.48** (1.07, 2.05)**

** $p < .05$. *** $p < .001$;
[a] Odds of increasing Pros by .4 SD on second behavior given increased Pros by .4 SD on the first behavior;
[#] Recruited in 1999 in the United States.

H5) As an exploratory approach, it is expected that participants who move to Action/Maintenance on only one behavior will also show smaller signs of success as defined by: a) making stage progress on a second behavior, b) decreasing severity on a second behavior; and c) increasing their Pros and decreasing their Cons on a second behavior. It is also expected that these changes will be observed in the treatment group more than in the control group.

For part “a” of hypothesis 5, a series of crosstabulations explored whether participants who progressed to A/M on the first behavior of the behavior pair at 24-month follow-up made stage progress on the second behavior at 24-month follow-up. After completing the crosstabulations, it was clear that this part of hypothesis 5 was answered in the first and second set of logistic regressions. Specifically, the first set of logistic regression analyses calculated the odds ratios for participants in earlier (i.e., PC) versus later (i.e., C/PR) stages of change (SOC) at baseline and whether they moved to A/M on both behaviors at 24-month follow-up. The second set of logistic regression analyses calculated the odds ratios of participants who made stage progress on either or both behaviors in the behavior pair from baseline to 24-month follow-up, regardless of baseline stage of change. That is, unlike the first set of logistic regressions, the second set of analyses allowed participants to be in either PC, C, PR, or A for either or both of the behaviors in the behavior pair and to progress one stage by 24-month follow-up. After identifying those participants, analyses calculated the odds ratios between the participants who made stage progress on the second behavior given stage progress on the first behavior compared to the participants who only made stage progress on the second behavior from baseline to 24-month follow-up. Given the thorough and more stringent criteria for these analyses, part “a” of this hypothesis was already answered.

For part “b” of hypothesis 5, a series of crosstabulations explored whether participants who progressed to A/M on the first behavior of the behavior pair at 24-month follow-up reduced severity on the second behavior at 24-month follow-up. Similar to the initial set of planned analyses for hypothesis 3, there was insufficient sample size to complete analyses as initially planned. Similar to part “a” of this hypothesis, this part of hypothesis 5 was already answered by the logistic regressions performed for hypothesis 3. Specifically, the reduction in severity analyses (i.e., 30% reduction in smoking and a .3 SD reduction in harm on diet and unprotected sun exposure) as presented in hypothesis 3 answered this part of the hypothesis.

For part “c” of hypothesis 5, a series of crosstabulations explored whether participants who progressed to A/M on the first behavior of the behavior pair at 24-month follow-up increased their Pros one standard deviation and reduced their Cons by a half standard deviation on the second behavior at 24-month follow-up. Similar to the original analyses for hypothesis 4, there was an insufficient sample size in order to conduct these analyses as there was zero and at most three participants who met the strong and weak principle criteria on the first behavior with even fewer participants who met the criteria for the second behavior. Therefore, the revised analyses (i.e., .4 SD Pros increase) for each behavior in the same three behavior pairs as presented in hypothesis 4 will be relied upon to answer this part of hypothesis 5.

For the last part of hypothesis 5, expecting greater co-progression rates in treatment versus control conditions, this will be evaluated in the discussion section as a general conclusion based on the overall results of this research. That is, the discussion will consist of empirically supported conclusions based on the general and specific findings of this research.

H6) Paired action and co-progression are not expected to vary by race or gender.

Stage progress (i.e., H2) by race and gender

Table 7 presents the participants who progressed to criteria and the co-progression odds ratios of making stage progress on the second behavior given stage progress on the first behavior compared to the participants who made stage progress on the second behavior not having made stage progress on the first behavior from baseline to 24-month follow-up for Whites and Non-Whites.

Sun Protection and Diet

Results were significant for Whites, OR= 1.49 [1.27, 1.74], $p < .001$, indicating that Whites were almost one and half times more likely to make stage progress on diet given stage progress on sun protection compared to Whites who only made stage progress on diet. However, results were not significant for Non-Whites, OR= 1.24 [0.59, 2.60], $p < .578$, indicating that although Non-Whites were slightly more likely to make stage progress on diet given stage progress on sun protection compared to Non-Whites who only made stage progress on diet alone, the difference between the Non-White comparison groups was not reliable.

Smoking and Diet

Results were significant for Whites, OR= 1.41 [1.05, 1.89], $p < .021$, indicating that Whites were almost one and a half times more likely to make stage progress on diet given stage progress on smoking compared to Whites who only made stage progress on diet. However, results were not significant for Non-Whites, OR= 1.11 [0.29, 4.31], $p < .879$, indicating that although Non-Whites had a slightly higher likelihood of making stage progress on diet given stage progress on smoking compared to Non-Whites who only made stage progress on diet, the difference between the Non-White comparison groups was not reliable.

Smoking and Sun Protection

Results were not significant for Whites, OR= 1.16 [0.86, 1.56], $p < .334$, or Non-Whites, OR= 1.26, [0.30, 5.30], $p < .755$, indicating that although both races were slightly more likely to make stage progress on sun protection given stage progress on smoking compared to their cohort who only made stage progress on sun protection, the difference between the comparison groups within each race was not reliable.

Table 7. Stage progress on second behavior given stage progress on the first behavior by race; Co-progression odds ratios from baseline to 24 months[#].

	Whites Proportion (n/total N) Confidence Interval	Non-Whites Proportion (n/total N) Confidence Interval
Sun Protection & Diet		
Participants who made stage progress on diet given stage progress on sun protection	.41 (405/980) [.38, .44]	.35 (18/52) [.22, .48]
Participants who made stage progress on diet given no stage progress on sun protection	.32 (628/1953) [.29, .34]	.30 (24/80) [.20, .40]
Co-progression odds ratio[a]	**1.49*** (1.27, 1.74)**	**1.24 (0.59, 2.60)**
Smoking & Diet		
Participants who made stage progress on diet given stage progress on smoking	.38 (120/320) [.33, .43]	.36 (5/14) [.11, .61]
Participants who made stage progress on diet given no stage progress on smoking	.30 (159/533) [.26, .34]	.33 (9/27) [.15, .51]
Co-progression odds ratio[a]	**1.41** (1.05, 1.89)**	**1.11 (0.29, 4.31)**
Smoking & Sun Protection		
Participants who made stage progress on sun protection given stage progress on smoking	.33 (107/329) [.28, .38]	.36 (4/11) [.08, .64]
Participants who made stage progress on sun protection given no stage progress on smoking	.29 (157/534) [.25, .33]	.31 (10/32) [.15, .47]
Co-progression odds ratio[a]	**1.16 (0.86, 1.56)**	**1.26 (0.30, 5.30)**

** $p < .05$. *** $p < .001$.
[a] Odds of stage progress on the second behavior given stage progress on the first behavior;
[#] Recruited in 1999 in the United States.

Table 8 presents the participants who progressed to criteria and the co-progression odds ratios of making stage progress on the second behavior given stage progress on the first behavior compared to making stage progress on the second behavior and not having made stage progress on the first behavior from baseline to 24-month follow-up for males and females.

Sun Protection and Diet

Results were significant for males, OR= 1.72 [1.35, 2.20], $p < .001$, and females, OR= 1.30 [1.06, 1.59], $p < .01$ indicating that both sexes were more likely to make stage progress on diet given stage progress on sun protection compared to their cohort on making stage progress on diet alone; with males almost one and three quarters more likely and females almost one and a half times more likely to make stage progress on diet and sun protection compared to diet alone.

Smoking and Diet

Results were not significant for males, OR= 1.62 [.98, 2.69], $p < .062$, or females, OR= 1.31, [0.92, 1.85], $p < .132$, indicating that although each sex was more likely to make stage progress on diet given stage progress on smoking compared to making stage progress on diet alone, the differences within the respective cohorts was not reliable.

Smoking and Sun Protection

Results were not significant for males, OR= 1.48 [0.88, 2.45], $p < .133$, or females, OR= 1.05 [0.74, 1.51], $p < .774$, indicating that although both sexes had increased likelihood of making stage progress on sun protection given stage progress on smoking compared to their cohort who only made stage progress on sun protection alone, the differences within the comparison groups was not reliable.

Table 8. Stage progress on second behavior given stage progress on the first behavior by gender; Co-progression odds ratios from baseline to 24 months[#].

	Males Proportion (n/total N) Confidence Interval	Females Proportion (n/total N) Confidence Interval
Sun Protection & Diet		
Participants who made stage progress on diet given stage progress on sun protection	.40 (162/410) [.35, .45]	.42 (261/623) [.38, .46]
Participants who made stage progress on diet given no stage progress on sun protection	.28 (248/902) [.25, .31]	.36 (404/1132) [.33, .39]
Co-progression odds ratio[a]	**1.72***(1.35, 2.20)**	**1.30** (1.06, 1.59)**
Smoking & Diet		
Participants who made stage progress on diet given stage progress on smoking	.35 (40/114) [.26, .44]	.39 (85/220) [.33, .45]
Participants who made stage progress on diet given no stage progress on smoking	.25 (47/188) [.19, .31]	.33 (121/372) [.28, .38]
Co-progression odds ratio[a]	**1.62 (0.98, 2.69)**	**1.31 (0.92, 1.85)**
Smoking & Sun Protection		
Participants who made stage progress on sun protection given stage progress on smoking	.30 (38/129) [.22, .38]	.35 (73/211) [.30, .38]
Participants who made stage progress on sun protection given no stage progress on smoking	.22 (43/195) [.16, .28]	.33 (124/371) [.29, .41]
Co-progression odds ratio[a]	**1.48 (0.88, 2.45)**	**1.05 (0.74, 1.51)**

** $p < .05$. *** $p < .001$.
[a] Odds of stage progress on the second behavior given stage progress on the first behavior;
[#] Recruited in 1999 in the United States.

Reduction on severity (i.e., H3) by race and gender

Table 9 presents the participants who progressed to criteria and the co-progression odds ratios for reduction on severity for each behavior pair from baseline to 24-month follow-up by race. Specifically, Table 9 presents the participants and odds of reduction on severity on the second behavior given reduction of severity on the first behavior compared to the reduction of severity on the second behavior and no reduction on severity on the first behavior from baseline to 24-month follow-up for Whites and Non-Whites.

Sun Protection and Diet

Results were significant for Whites, OR= 1.28 [1.10, 1.48], $p < .001$, indicating that Whites were more than one and a quarter times more likely to reduce severity on diet given reduced severity on sun protection compared to Whites who only reduced severity on diet alone. However, results were not significant for Non-Whites, OR= 1.02 [0.50, 2.05], $p < .968$, indicating that although Non-Whites were slightly more likely to reduce severity on diet given reduced severity on sun protection compared to Non-Whites who reduced severity on diet alone, the difference within the Non-White comparison groups was not reliable.

Smoking and Diet

Results were significant for Whites, OR= 1.35 [1.02, 1.80], $p < .037$, indicating that Whites were more than one and a third times more likely to reduce severity on diet given reduced severity on smoking compared to Whites who reduced severity on diet alone. In contrast, results were not significant for Non-Whites, OR= 1.59 [0.40, 6.38], $p < .515$, indicating that although Non-Whites who reduced severity on diet given reduced severity on smoking were more than one and a half times more likely to reduce severity on diet compared to Non-Whites who reduced severity on diet alone, the difference within the comparison group was not reliable.

Smoking and Sun protection

Results were not significant for Whites, OR= 1.16 [0.88, 1.53], $p < .287$, or Non-Whites, OR= 1.07 [0.28, 4.12], $p < .920$, indicating that although both groups were slightly more likely to reduce severity on sun protection given reduced severity on smoking compared to reduced severity on sun protection alone, the differences within each comparison group was not reliable.

Table 9. Reduction on severity on second behavior given reduction on severity on first behavior by race; 30% reduction in smoking and a .3 SD reduction in severity on diet and sun total behavior scores; Co-progression odds ratios from baseline to 24 months[#].

	Whites Proportion (n/total N) Confidence Interval	Non-Whites Proportion (n/total N) Confidence Interval
Sun Protection & Diet		
Participants who reduced severity on diet given reduced severity on unprotected sun exposure	.45 (658/1474) [.42, .48]	.39 (26/67) [.27, .51]
Participants who reduced severity on diet given no reduced severity on unprotected sun exposure	.39 (575/1484) [.37, .41]	.39 (25/65) [.27, .51]
Co-progression odds ratio[a]	**1.28***(1.10, 1.48)**	**1.02 (0.50, 2.05)**
Smoking & Diet		
Participants who reduced severity on diet given reduced severity on smoking	.44 (130/298) [.38, .50]	.36 (5/14) [.11, .61]
Participants who reduced severity on diet given no reduced severity on smoking	.36 (212/583) [.32, .40]	.26 (7/27) [.09, .42]
Co-progression odds ratio[a]	**1.35** (1.02, 1.80)**	**1.59 (0.40, 6.38)**
Smoking & Sun Protection		
Participants who reduced severity on unprotected sun exposure given reduced severity on smoking	.53 (156/296) [.47, .59]	.50 (6/12) [.22, .78]
Participants who reduced severity on unprotected sun exposure given reduced severity on smoking	.49 (298/609) [.45, .53]	.48 (14/29) [.30, .66]
Co-progression odds ratio[a]	**1.16 (0.88, 1.53)**	**1.07 (0.28, 4.12)**

** $p < .05$. *** $p < .001$.
[a] Odds of reduced severity on the second behavior given reduced severity on the first behavior;
[#] Recruited in 1999 in the United States.

Table 10 presents the participants who progressed to criteria and the co-progression odds ratios for reduction on severity for each behavior pair from baseline to 24-month follow-up by gender. Specifically, Table 10 presents the participants and odds of reduction on severity on the second behavior given reduction on severity on the first behavior compared to the reduction on severity on the second behavior and no reduction on severity on the first behavior from baseline to 24-month follow-up for males and females.

Sun Protection and Diet

Results were significant for males, OR= 1.24 [1.00, 1.55], $p < .053$, and females, OR= 1.27 [1.05, 1.54], $p < .013$, indicating that both sexes were more likely to reduce severity on diet given reduced severity on sun protection compared to reducing severity on diet alone. Specifically, males were just under and females were just over one and a quarter times more likely to reduce severity on diet and sun protection compared to reducing severity on diet alone.

Smoking and Diet

Results were not significant for males, OR= 1.29 [0.80, 2.10], $p < .303$, indicating that although males were more likely to reduce severity on diet given reduced severity on smoking compared to males who reduced severity on diet alone, the difference within the group was not reliable. In contrast, results were significant for females, OR= 1.41 [1.00, 1.99], $p < .048$, indicating that females were almost one and a half times more likely to reduce severity on diet given reduced severity on smoking compared to females who reduced severity on diet alone.

Smoking and Sun Protection

Results were not significant for males, OR= 1.23 [0.78, 1.95], $p < .371$, or females, OR= 1.11 [0.79, 1.56], $p < .534$, indicating that although each sex was more likely to reduce severity on sun protection given reduced severity on smoking compared to their cohort who reduced severity on sun protection alone, the differences within each cohort were not reliable.

Table 10. Reduction on severity on second behavior given reduction of severity on first behavior by gender; 30% reduction in smoking and a .3 SD reduction in severity on diet and sun total behavior scores; Co-progression odds ratios from baseline to 24 months[#].

	Males Proportion (n/total N) Confidence Interval	Females Proportion (n/total N) Confidence Interval
Sun Protection & Diet		
Participants who reduced severity on diet given reduced severity on unprotected sun exposure	.44 (286/649) [.40, .48]	.45 (398/894) [.42, .48]
Participants who reduced severity on diet given no reduced severity on unprotected sun exposure	.39 (260/670) [.35, .43]	.39 (340/879) [.36, .42]
Co-progression odds ratio[a]	**1.24** ** **(1.00, 1.55)**	**1.27** ** **(1.05, 1.54)**
Smoking & Diet		
Participants who reduced severity on diet given reduced severity on smoking	.41 (45/110) [.32, .50]	.45 (90/202) [.38, .52]
Participants who reduced severity on diet given no reduced severity on smoking	.35 (70/200) [.28, .42]	.36 (149/411) [.31, .41]
Co-progression odds ratio[a]	**1.29 (0.80, 2.10)**	**1.41** ** **(1.00, 1.99)**
Smoking & Sun Protection		
Participants who reduced severity on unprotected sun exposure given reduced severity on smoking	.50 (54/109) [.40, .60]	.54 (108/199) [.47, .61]
Participants who reduced severity on unprotected sun exposure given reduced severity on smoking	.44 (102/230) [.38, .50]	.52 (211/409) [.47, .57]
Co-progression odds ratio[a]	**1.23 (0.78, 1.95)**	**1.11 (0.79, 1.56)**

** p< .05. *** p< .001.

[a] Odds of reduced severity on the second behavior given reduced severity on the first behavior;

[#] Recruited in 1999 in the United States.

Decisional Balance (DB) (i.e., H4) by race and gender

Table 11 presents the participants who progressed to criteria and the co-progression odds ratios for participants who increased their Pros .4 SD on the second behavior given a .4 SD increase on Pros on the first behavior compared to participants who increased their Pros .4 SD on the second behavior but did not increase their Pros .4 SD on the first behavior from baseline to 24-month follow-up for Whites and Non-Whites.

Sun Protection and Diet

Results were significant for Whites, OR= 1.34 [1.10, 1.63], $p < .004$, indicating that Whites were more than one and a third times more likely to increase their Pros on diet by .4 SD given a .4 SD increase on sun protection compared to Whites who only increased their Pros .4 SD on diet alone. In contrast, results were not significant for Non-Whites, OR= 1.83 [0.85, 3.96], $p < .125$, indicating that although Non-Whites were almost two times more likely to increase their Pros .4 SD on diet given a .4 SD on sun protection compared to Non-Whites who increased their Pros .4 SD on diet alone, the difference within the comparison groups was not reliable.

Smoking and Diet

Results were not significant for Whites, OR= 1.24 [0.86, 1.81], $p < .249$, indicating that although Whites were slightly more likely to increase Pros .4 SD on diet given a .4 SD increase on Pros on smoking compared to Whites who made a .4 SD increase on diet alone, the difference within this group was not reliable. In contrast, results were significant for Non-Whites, OR= 6.13 [1.46, 25.72], $p < .013$, indicating that Non-Whites were over six times more likely to increase their Pros .4 SD on diet given a

.4 SD increase on Pros on smoking compared to Non-Whites who increased their Pros .4 SD on diet alone.

Smoking and Sun Protection

Results were significant for Whites, OR= 1.47 [1.05, 2.06], $p < .025$, indicating that Whites were almost one and half times more likely to increase their Pros .4 SD on sun protection given a .4 SD increase on Pros on smoking compared to Whites who only increased their Pros .4 SD on sun protection alone. In contrast, results were not significant for Non-Whites, OR= 1.43 [0.37, 5.55], $p < .606$, indicating that although Non-Whites were almost one and a half times more likely to increase Pros .4 SD on sun protection given a .4 SD increased Pros on smoking compared to Non-Whites who increased their Pros by .4 SD on sun protection alone, the difference within Non-Whites was not reliable.

Table 11. .4 SD Pros increase on second behavior given .4 SD Pros increase on first behavior by race; Co-progression odds ratios from baseline to 24 months[#].

	Whites Proportion (n/total N) Confidence Interval	Non-Whites Proportion (n/total N) Confidence Interval
Sun Protection & Diet		
Participants who increased Pros .4 SD on diet given a .4 SD increase on Pros for sun protection	.24 (184/759) [.18, .30]	.38 (18/48) [.24, .51]
Participants who increased Pros .4 SD on diet given no .4 SD increase on Pros for sun protection	.19 (398/2063) [.18, .21]	.25 (20/81) [.15, .34]
Co-progression odds ratio[a]	**1.34** (1.10, 1.63)**	**1.83 (0.85, 3.96)**
Smoking & Diet		
Participants who increased Pros .4 SD on diet given a .4 SD increase on Pros for smoking	.24 (50/212) [.18, .29]	.57 (8/14) [.31, .83]
Participants who increased Pros .4 SD on diet given no .4 SD increase on Pros for smoking	.20 (127/639) [.17, .23]	.18 (5/28) [.04, .32]
Co-progression odds ratio[a]	**1.24 (0.86, 1.81)**	**6.13** (1.46, 25.72)**
Smoking & Sun Protection		
Participants who increased Pros .4 SD on sun protection given a .4 SD increase on Pros for smoking	.32 (68/213) [.26, .38]	.42 (5/12) [.14, .70]
Participants who increased Pros .4 SD on sun protection given no .4 SD increase on Pros on smoking	.24 (166/687) [.21, .27]	.33 (11/33) [.17, .49]
Co-progression odds ratio[a]	**1.47 (1.05, 2.06)**	**1.43 (0.37, 5.55)**

** $p < .05$. *** $p < .001$.

[a] [a] Odds of increasing Pros .4 SD on second behavior given .4 SD increase on Pros on the first behavior;

[#] Recruited in 1999 in the United States.

Table 12 presents the participants who progressed to criteria and the co-progression odds ratios for participants who increased their Pros by .4 SD on the second behavior given a .4 SD increase on Pros on the first behavior compared to participants who increased their Pros .4 SD on the second behavior but did not increase their Pros .4 SD on the first behavior from baseline to 24-month follow-up for males and females.

Sun Protection and Diet

Results were not significant for males, OR= 1.20 [0.89, 1.63], $p < .238$, indicating that although males were slightly more likely to increase their Pros .4 SD on diet given a .4 SD increase on Pros on sun protection compared to males who made a .4 SD increase on diet alone, the difference within the White comparison group was not reliable. In contrast, results were significant for females, OR=1.50 [1.18, 1.93], $p < .001$, indicating that females were one and a half times more likely to increase their Pros .4 SD on diet given a .4 SD increased Pros on sun protection compared to females who increased their Pros .4 SD on diet alone.

Smoking and Diet

Results were not significant for males, OR= 1.19 [0.64, 2.21], $p < .576$, or females, OR=1.50 [0.98, 2.31], $p < .065$, indicating that although both sexes were more likely to increase their Pros on diet .4 SD given a .4 SD increased Pros on smoking compared to their cohort who increased their Pros .4 SD on diet alone, the differences within each comparison group was not reliable.

Smoking and Sun Protection

Results were not significant for males, OR= 1.41 [0.80, 2.46], $p < .232$, indicating that although males were almost one and a half times more likely to increase their Pros .4

SD on sun protection given a .4 SD increase on Pros on smoking compared to males who increased their Pros .4 SD on sun protection alone, the difference within the male cohort was not reliable. In contrast, results were significant for females, OR= 1.50 [1.00, 2.24], $p < .049$, indicating that females were one and a half times more likely to increase their Pros .4 SD on sun protection given a .4 SD increased Pros on smoking compared to females who increased their Pros .4 SD on sun protection alone.

Table 12. .4 SD Pros increase on second behavior given .4 SD Pros increase on first behavior by gender; Co-progression odds ratios from baseline to 24 months[#].

	Males Proportion (n/total N) Confidence Interval	Females Proportion (n/total N) Confidence Interval
Sun Protection & Diet		
Participants who increased Pros .4 SD on diet given a .4 SD increase on Pros for sun protection	.22 (74/340) [.17, .26]	.27 (128/468) [.23, .31]
Participants who increased Pros .4 SD on diet given no .4 SD increase on Pros for sun protection	.19 (175/931) [.16, .21]	.20 (243/1214) [.18, .22]
Co-progression odds ratio[a]	**1.20 (0.89, 1.63)**	**1.50*** (1.18, 1.93)**
Smoking & Diet		
Participants who increased Pros .4 SD on diet given a .4 SD increase on Pros for smoking	.23 (18/78) [.14, .32]	.27 (40/149) [.20, .34]
Participants who increased Pros .4 SD on diet given no .4 SD increase on Pros for smoking	.20 (45/224) [.15, .25]	.20 (87/443) [.16, .23]
Co-progression odds ratio[a]	**1.19 (0.64, 2.21)**	**1.50 (0.98, 2.31)**
Smoking & Sun Protection		
Participants who increased Pros .4 SD on sun protection given a .4 SD increase on Pros for smoking	.29 (24/82) [.19, .39]	.34 (49/144) [.30, .40]
Participants who increased Pros .4 SD on sun protection given no .4 SD increase on Pros on smoking	.23 (58/255) [.18, .28]	.26 (119/465) [.21, .30]
Co-progression odds ratio[a]	**1.41 (0.80, 2.46)**	**1.50** (1.00, 2.24)**

** *p*< .05. *** *p*< .001.
[a] [a] Odds of increasing Pros .4 SD on second behavior given .4 SD increase on Pros on the first behavior;
[#] Recruited in 1999 in the United States.

CHAPTER 5
CONCLUSIONS

Discussion

Results provide empirical support for the advantages of simultaneous multiple health behavior change for three very different health behaviors. Specifically, when smoking, diet, and unprotected sun exposure were analyzed as the three sets of behavior pairs sun protection and diet, smoking and diet, and smoking and sun protection, results consistently demonstrated that intervening simultaneously on multiple health behavior risks increased the likelihood that participants progressed toward healthier outcome criteria on both behaviors from baseline to 24-month follow-up compared to participants who only progressed on the second behavior in the behavior pair from baseline to 24-month follow-up. Of particular importance is that, as expected, favorable results occurred across the control, treatment, and total conditions. Moreover, favorable results were revealed when the outcome was defined by less stringent as well as the most stringent criteria. That is, when treatment outcomes were defined by stage progress, reduction in severity, and increased Pros (i.e., less stringent) or defined by meeting Action/Maintenance (i.e., A/M) criteria (i.e., the most stringent) on both behaviors at 24-month follow-up, results consistently demonstrated that simultaneous intervention increased the likelihood that participants progressed on both behaviors compared to only making progress only on the second behavior from baseline to 24-month follow-up.

The first hypothesis was supported. The clearest and strongest support occurred in the sun protection and diet behavior pair analyses which revealed significant and increased odds ratios in all three conditions. A more modest finding was in the smoking and sun protection behavior pair analyses which revealed significant and increased odds ratios in the overall condition. Although the treatment and control conditions in the smoking and sun protection behavior pair analyses were not significant, also the case for all three conditions in the smoking and diet behavior pair analyses, it is worth noting that all the odds ratios revealed were in the expected and favorable direction. That is, all eight of the paired action odds ratios demonstrated that participants in later versus earlier SOC were more likely to progress to A/M on both behaviors compared to progressing to A/M only the second behavior at 24-month follow-up regardless of the treatment condition. Additionally, four of the eight results were significant. Thus, the combination of significant findings and consistent pattern of results in both expected and favorable directions of the non significant findings lends support to hypothesis one. More specifically, analyses clearly show that participants in later SOC (i.e., C/PR) at baseline for multiple health behavior risks were more likely to move to A/M on both behaviors at 24-month follow-up than participants who were in the earliest SOC (i.e., PC) for both behaviors at baseline.

The second hypothesis was generally supported. The strongest support occurred in the sun protection and diet behavior pair analyses which revealed significant and higher co-progression odds ratios in the treatment and overall conditions. Specifically, findings revealed that participants in the treatment condition were almost two times more likely to make stage progress on diet given stage progress on sun protection compared to participants who only made stage progress on diet. In the smoking and diet behavior pair analyses, participants in the control group were approximately one a half times more likely to make stage progress on diet given stage progress on smoking while the treatment group was not significant; a significant finding in the control condition and not in the treatment condition provides partial support to this hypothesis. However, modest support for hypothesis two was found in the smoking and sun protection behavior pair analyses in that there were higher odds ratios in the treatment versus control condition for participants to make stage progress on sun protection given stage progress on smoking. Ultimately, all nine of the co-progression odds ratios demonstrated that participants were more likely to make stage progress on both behaviors compared to making stage progress only on the second behavior from baseline to 24-month follow-up regardless of the treatment condition. Additionally, four of the nine results were significant. Thus, the significant findings and general pattern of results in both expected and favorable directions of the non-significant findings lends support for hypothesis two. More specifically, results clearly provide empirical support for the advantages of co-progression and defining treatment outcome as stage progress from baseline to 24-month follow-up, a less stringent criterion than paired action defined in hypothesis one.

The third hypothesis was supported. The strongest support occurred in the sun protection and diet behavior pair analyses with significant results in the total and treatment conditions, indicating increased likelihood of a reduction on severity on both sun protection and diet compared to a reduction on severity on diet alone. Significant results in the total and control conditions for the smoking and diet behavior pair analyses indicated that participants were just under and over one and a half times more likely to reduce severity on both smoking and diet compared to a reduction of severity on diet alone. Ultimately, eight of the nine co-progression odds ratios demonstrated that participants were more likely to reduce severity on both behaviors compared to reduced severity only on the second behavior from baseline to 24-month follow-up regardless of the treatment condition. Additionally, four of the nine results were significant. Of note, the only reduced likelihood of progressing on both behaviors compared to the second behavior was a slightly reduced likelihood and it was not significant. Thus, results provide empirical support for using reduction in severity as an outcome criterion for treatment, corroborating reduction in severity as one of the four factors. Furthermore, and similar to previous findings with MI intervention, results also show that reduction in severity can be predictive of behavior change at future follow-up time points. Therefore, in addition to holding treatment outcomes to the most stringent criteria (i.e., A/M) typically used to establish intervention efficacy and effectiveness, these data suggest that reduction in severity may be especially important for multiple health behavior change given the well established difficulty of changing one health risk behavior to A/M criteria, let alone the difficulty of changing multiple health behavior risks to A/M criteria at the same time.

The fourth hypothesis was generally supported. Although the first set of planned analyses proved to be too stringent a criteria to complete as planned, the revised decisional balance (DB) criteria provided an empirical basis to evaluate the interrelationships of the Pros of behavior change and multiple behavior change. That is, increasing Pros by .4 SD from baseline to 24-month follow-up on either or both behaviors yielded several significant results across the control, treatment, and total conditions. Specifically, all nine of the co-progression odds ratios were in the predicted and favorable direction revealing increased likelihood of progressing on both behaviors compared to progressing only on the second behavior regardless of treatment condition. Additionally, five of the nine results were significant. This is important because it clearly shows that the Pros of DB, long established as important for single health risk behavior change, is also important to multiple health behavior change. With five significant and all nine odds ratios all three behavior pairs and treatment conditions, results further suggest that dynamic variables are critical to the process of multiple health behavior change. However, additional research is necessary in order to clarify just how the Pros of behavior change relates to multiple behavior change, and to begin to reveal how decisional balance (i.e., Pros and Cons) relates to multiple health behavior change.

The fifth hypothesis was generally supported and answered by the analyses and results of hypothesis one through hypothesis four.

The sixth hypothesis was generally supported. For the stage progress with race and gender analyses, eight of the twelve results were not significant. Of the significant findings, there was one for males, one for females, two for Whites, and none for Non-Whites. Therefore, there was no clear trend in the data. For the reduction in severity with race and gender analyses, seven out of the twelve analyses were not significant. Of the significant findings, there was one for males, two for females, two for Whites and none for Non-Whites. Again, there was no clear trend in the data. For the Pros with race and gender analyses, eight out of the twelve results were not significant. Similarly, there was no clear trend in the data. Altogether, twenty three out of the thirty six analyses (i.e., almost two-thirds) of the results were not significant and of the significant findings, there was no clear trend in the data as results varied by race, gender and treatment condition. However, further generalization of these results is limited given the demographic composition of this dataset as discussed in the limitation section. So, as hypothesized, results did not yield significant differences between race or gender with regard to multiple health behavior change whether outcome criteria was defined as paired action or co-progression from baseline to 24-month follow-up.

Overall, in absolute terms, although there was one more significant finding across the control conditions compared to the treatment conditions, this research does not support either condition's advantage. Taken together, what these results do clearly suggest is that there are important advantages to simultaneous intervention for multiple health behavior change whether the intervention is stage-based, computer-tailored intervention or treatment as usual (TAU) as simultaneous intervention on multiple health risk behavior accelerated participants toward healthy criteria at outcome regardless of intervention. However, given SOC and DB are central constructs to the TTM, it seems the TTM may have a slight advantage in helping to elucidate the science of multiple health behavior as the model has several dynamic variables which seem relevant to reveal the interrelationships and synergy that occurs during multiple health behavior change; although additional research is needed before any firm conclusions can be drawn.

Results of this research recognize that although demographic variables are important factors to baseline SOC for various health risk behaviors, they are not reliable predictors of treatment outcome. However, results do provide additional support that the dynamic variables of SOC, problem severity, and the Pros of DB are reliable predictors of treatment outcome and that they are important to multiple health behavior change. As such, this research provides additional support to three of the four factors specifically (e.g., baseline SOC, DB, and addiction severity) and lends some support to the fourth factor (i.e., effort) as measured all participants analyzed in this study completed requirements over a two and a half year time period. What is particularly compelling about these results, however, is that the original four factors findings were revealed when the fundamental unit of analysis was separate health risk behaviors at outcome and these results were revealed when the fundamental unit of analysis was shifted to behavior pairs from baseline to 24-month follow-up.

Limitations

There were several limitations of this research. First, this was a secondary data analysis and, therefore, all analyses were limited to the existing dataset and its composition. Although the primary aim of the P01 used for this research project intervened simultaneously on multiple health behavior risks, making it an ideal dataset to answer the stated hypotheses, analyzing behavior pairs and calculating paired action and co-progression odds ratios among treatment, control, and total conditions was not the primary aim of the original project. Therefore, while analyses compared differences between treatment and control conditions, conclusions cannot be drawn directly comparing the two groups to one another. That is, all comparisons in this research describe the likelihood of participants making progress as defined by outcome criteria (i.e., paired action or co-progression) that occurred in each treatment condition and not compared to each treatment condition.

Second, the predominantly White (n=8,503, 93.7%), female (n=5,938, 65.4%), middle-aged recruitment solely from a Northeastern state presents certain limitations as well. For example, with race, such a large sample of Whites likely provided sufficient power to find significant differences in the analyses between Whites who met criteria (i.e., progressed on the second behavior given progress on the first behavior) compared to Whites who did not (i.e., who only made progress on the second behavior) versus Non-Whites which had a very small sample size. So, this may help explain why the sun protection and diet and the smoke and diet analyses was significant for Whites, but not significant for Non-Whites because there would have to be a very large effect size in order for the analyses to detect a significant difference in the Non-Whites group. Also, and consistent with the literature that race affects baseline SOC for health risk behaviors, race may also have affected all the analyses involving sun protection. Specifically, fairer skin Whites, who are at greater risk for unprotected sun exposure than darker skin Whites, may have a different baseline SOC from one another. Similarly, Non-Whites, who are at lower risk of unprotected sun exposure, may have a different SOC due to the reduced risk on this behavior. Moreover, with such a small sample sizes for Non-Whites, this research recoded race as Whites and Non-Whites, an amalgamation of all Non-White races, ignoring important and possible variability between and within each group, respectively.

Third, the sample size mean age was 43-years-old with a standard deviation of ten years. Therefore, 68% of the sample ranged from 33 to 53-years-old and 96% of the sample ranged from 23 to 63-years-old. Given the physical, cognitive, and social differences between middle-aged adults and other age groups, it is unclear how these results generalize to other populations and demographics. For example, it is unclear how the normative stressors associated with middle adulthood (e.g., balancing marriage, parenting, family, career, finances, aging parents, etc.), quite distinct from other developmental stages (e.g., childhood, adolescence, late adulthood, very old age), may affect the processes of change for multiple health behavior change. That is, it is not clear how reduced harm or the Pros of behavior change may vary by lifespan development.

Fourth, all the participants were recruited from a Northeastern state. As such, results may not generalize to other regions of the country given possible geographic differences with other parts of the country. Another limitation of sample's recruitment is that the Northeast has considerable seasonal variability and it is not clear how this may have affected baseline and follow-up SOC for unprotected sun exposure. Specifically, the summer has a higher risk of unprotected sun exposure for all races and both genders, but more so for Whites than Non-Whites, while the winter has a much lower risk for all races and both genders. This temporal dimension was not accounted for by the analyses conducted in this research. Therefore, its effect is unknown.

There were several other limitations to this project as well. The inability to complete all the planned analyses due to insufficient sample size and stringent criteria for the strong and weak principles for the behavior pairs obviated the opportunity to conduct analyses on decisional balance or the strong and weak principles for behavior pairs as has been established for separate behaviors. Therefore, this project did not address these important gaps in the literature. In addition, because of the cumulative nature of some of the hypotheses, some of the analyses were not able to be performed throughout the project as observed in the strong and weak principles for race and gender (i.e., hypothesis six). Another limitation is that decisional balance measure (i.e., the Pros and Cons) for sun exposure was a 20-item Likert-scale. However, decisional balance for smoking and diet were both assessed on a 5-item Likert-scale. Although this was accounted for in calculating the mean and standard deviations for each behavior in each of the treatment conditions, it is not clear how a 20-item Likert-scale for sun exposure and two 5-item Likert scales for smoking and diet may have affected participants' responses.

Summary

Results provide empirical support for the advantages of simultaneous intervention for multiple health behavior change as paired action, co-progression, and reduction in severity was observed across the control, treatment and total conditions. With approximately an equal amount of significant findings across the control and treatment conditions for paired action, co-progression, and reduction on severity, results do not support either condition's advantage. However, taken together, results do provide empirical support for the advantages and synergistic effect when intervening on multiple health behavior risks simultaneously, in addition to demonstrating the importance and value of the most stringent (i.e., A/M) as well as less stringent (i.e., stage progress, reduction of severity) outcome criteria when elucidating the science of behavior change.

Results further suggest that simultaneous intervention targeting multiple health behavior risks for three very different behaviors increases the likelihood that participants will accelerate stage progress toward healthier behavioral lifestyles, including smoking cessation, healthy diet, and reduced risk for unprotected sun exposure. Results of this research do not suggest that simultaneous intervention on multiple health behavior risks is too taxing, stressful, or difficult which would have been revealed with paired action or co-progression odds ratios lower than 1.0 in any of the behavior pair analyses across any of the treatment conditions. In fact, only one out of the 71 odds ratios revealed a lower likelihood of progressing toward favorable and healthier outcome criteria whether in the most or less stringent outcome criteria analyses. Specifically, the only exception was an odds ratio of .94 for the smoking and diet behavior pair analyses in the treatment condition for reduction in severity; however, this odds ratio was not significant. Finally, results do provide empirical support for shifting the fundamental unit of analysis from separate behaviors at outcome to behavior pairs at outcome.

Recommendations for future research include efficacy trials to systematically evaluate the difference between treatment-enhanced and naturally occurring paired action and co-progression. Research could also broaden the behavior pairs of analysis to investigate many other problem areas which bear directly on mortality, quality of life and health care costs. Although numerous examples abound, one specific example would be to further understand the intricacies and interrelationships between medication adherence, diet, exercise, and substance abuse (e.g., smoking, alcohol) with diabetics. Such advancements could provide invaluable information to help advance, inform, and guide integrated treatment as well as prevention research. Of course, this is just a few of the behavior pair analyses that could help provide valuable contributions to the management, treatment, and prevention of many other chronic medical conditions such as cardiovascular disease and some cancers. With countless other examples critical to issues of quality of life, disease management and prevention, healthcare costs, and public policy, continued research on multiple health behavior change is of paramount importance. Such efforts will not only help elucidate the science of behavior change, but will also help guide the future of research and practice toward an integrative model of multiple health behavior change.

APPENDIX

Appendix 1

1) The original hypothesis, "participants who decrease their severity by a defined amount on one behavior (i.e., cutting back by a certain percentage of cigarettes per day) will also reduce their severity on other behaviors, with more co-progression observed in the treatment group than the control group" was slightly modified given data analytic problems. Similar to previous analyses, the independent and dependent variables were analyzed by the same three behavior pairs: sun protection and diet, smoking and diet, and smoking and sun protection. Specifically, the independent variable was the participant's number of cigarettes smoked, diet total score, and sun protection total score at baseline and the dependent variable was whether the participant reduced their smoking habit by 50% from baseline to 24-month follow-up, either yes or no, and whether they progressed to A/M on diet, either yes or no, and whether they progressed to A/M on sun protection, either yes or no, at 24-month follow-up. Given so few participants (i.e., sometimes zero) met this criteria, analyses could not be completed as planned. Therefore, this hypothesis was slightly revised and described and presented in hypothesis 3.

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