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Psychosocial predictors of dietary fat reduction: the role of stress and the transtheroetical model in a dietary intervention

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PSYCHOSOCIAL PREDICTORS OF DIETARY FAT REDUCTION:  
THE ROLE OF STRESS AND THE TRANSTHEORETICAL MODEL  
IN A DIETARY INTERVENTION  

A Dissertation  

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ABSTRACT

Dietary fat is related to cardiovascular disease and numerous intensive, controlled clinical trials have successfully reduced dietary fat in symptomatic populations. However, there has been less success in large, community-based studies with healthy or mildly at-risk populations. Little is known about predictors associated with actual change in dietary fat intake and this is an important omission because dietary interventions are more likely to be successful if they are based on factors known to influence behavior. The purpose of this study was to investigate the psychosocial predictors of dietary fat and dietary fat reduction through the framework of the transtheoretical model (TTM) and minor stress.

Participants were part of a larger study examining reversal of cardiovascular signs in a healthy population by reducing dietary fat intake to less than 20% of calories from fat. This study consisted of 179 adults who enrolled and had complete data. Participants were randomly assigned to the intervention or control groups. The intervention consisted of attending individual instruction and dietary groups. The following measures were administered at baseline and six months: Weekly Stress Inventory and the processes of change (i.e., experiential and behavioral subscales), decisional balance, and self-efficacy questionnaires from the TTM. Dietary fat intake was measured with four-day food records. Hierarchical regression analyses, with BMI as a covariate, were conducted to determine psychosocial predictors of dietary fat intake at baseline and change in dietary fat at six months. The experiential processes variable was the only unique predictor of dietary fat intake and the relationship was moderated by minor stress. The experiential processes were also related to dietary fat reduction. Results of a repeated measure MANOVA revealed that use of behavioral and experiential processes increased for participants in the intervention group over six months of the intervention. Results revealed a modest relationship
between variables associated with the TTM and dietary fat and dietary fat reduction, with limited evidence that stress moderates this relationship.
INTRODUCTION

A significant amount of attention has been given to the relationship between diet and health, particularly in the area of dietary fat and chronic disease. Evidence suggests that dietary fat is related to cardiovascular disease (CVD), breast cancer, colon cancer, diabetes mellitus, and obesity (National Cholesterol Education Program [NCEP], 2001). Of these diseases, CVD (e.g., coronary heart disease, stroke, and hypertension) is the leading cause of death in the United States, accounting for 42% of all deaths (Field, Barnoya, & Colditz, 2002). A major causal factor for CVD is hyperlipidemia (i.e., high cholesterol), which is related to dietary intake of total and saturated fat (Levine, Keaney, & Vita, 1995; Van Horn & Kavey, 1997).

Reductions in cholesterol have been shown to reduce risk of morbidity and mortality from cardiovascular disease. Estimates indicate that a 10% reduction in serum cholesterol will reduce coronary heart disease by 25% within five years and by approximately 50% by age 40 (Law, Wald, & Thompson, 1994). A recent meta-analysis reported 24% and 14% reductions in non-fatal and fatal myocardial infarctions due to cholesterol lowering (Roussouw, 1994). Despite the reduction in CVD attained with cholesterol lowering therapy, the absolute CVD rates are still above those in a low-risk population (NCEP, 2001). Thus, primary prevention in the form of guidelines and recommendations for the general population has become a major target for reducing CVD (NCEP, 2001).

Current recommendations indicate that the general public should eat no more than 30% of daily calories from dietary fat and 8% to 10% of calories from saturated fat (NCEP, 2001). However, a significant portion of Americans consume dietary fat at much higher levels. Recent estimates suggest that Americans are eating 35% of total calories from fat and 17% of calories from saturated fat (U.S. Department of Health and Human Services [USDHHS]-Public Health Service [PHS], 1995). From another perspective, only 25% of the population consumes the
recommended less than 30% and almost half of the population consumes between 30% and 40% of dietary fat (Kumanyika et al., 2000).

Although reduction of dietary fat results in significant decreases in morbidity and mortality in those at risk, as noted above, little is known about how reduction of dietary fat can reverse the progression of cardiovascular disease in a healthy population. This is important given the large percentage of adults that are placing themselves at risk for CVD with higher than recommended levels of dietary fat. An intervention study was conducted at the Pennington Biomedical Research Center (PBRC) in Louisiana to investigate reversal of cardiovascular signs in a healthy population by targeting a dietary fat goal of less than 20% of calories from dietary fat. This low level of dietary fat was needed to detect sufficient change in biomarkers of atherosclerotic disease. Although large dietary fat reductions have been attainable in carefully controlled dietary studies using participants symptomatic for chronic disease, significant reductions have not been demonstrated in a healthy population (see Brunner, 1997, for review).

The goal of this study is to expand on the PBRC intervention study by investigating the psychosocial predictors associated with dietary fat in a healthy population. A brief summary of dietary fat interventions and outcomes will be presented below, followed by a general review of the psychosocial predictors of dietary change, including a model of behavior change entitled the Transtheoretical Model of Behavior Change. Finally, a review of the role of stress on eating behavior will be presented with a description of how it may be related to dietary fat consumption and therefore impact success of dietary interventions.
LITERATURE REVIEW

Dietary Fat Interventions

Numerous studies of dietary fat reduction have been conducted over the past 20 years and overall they have demonstrated modest decreases in dietary fat. A recent meta-analysis examined randomized controlled trials of dietary interventions that lasted at least three months and targeted prevention of chronic disease (Brunner et al., 1997). Of the six studies that specifically examined dietary fat intake over a three to six month period, four included individuals with no health risk or mild cardiovascular risk (i.e., not symptomatic), and the samples attained a reduction of six percent of energy from fat. Two studies targeted women at risk for breast cancer and these participants had a reduction of 40% of energy from fat (Brunner et al., 1997). These results suggest that significant levels of dietary change are possible; however, it may be groups that are most at risk for disease that have the largest amounts of dietary fat reduction.

Barnard and colleagues (1995) descriptively examined dietary fat reduction in 30 studies designed to reduce cardiovascular risk factors. Therefore, results must be interpreted with caution due to differing sample sizes and lack of control for extraneous variables. Dietary goals for all studies ranged from 5% to 35% of daily calories from fat and included participants symptomatic for heart disease, vascular disease, hypertension, obesity, and diabetes. Additionally, there were nine studies were composed of individuals who were considered “normal” and ten studies with participants who were considered healthy but high risk. Overall, of the 30 studies examined, 50% met their stated target dietary fat goals, 27% were within five percentage points above, and 23% were more than five percentage points above the targeted goal (Barnard et al., 1995). Notably, there appeared to be little difference between success of studies with longer duration (e.g., one year) as compared to those with a shorter duration. For example, of the 18 studies that were one year or longer, final mean fat intake of 29% was attained as compared to 28% of fat intake for the
21 shorter studies. Studies that had highly restrictive goals for daily fat intake (e.g., 10%) actually attained the lowest level of fat intake ranging from 7% to 16% of daily energy from fat. However, these studies were conducted with populations diagnosed with cardiovascular disease and may indicate larger levels of fat reduction for those who believe they are at high health risk. Although a majority of the studies did not report drop-out rates, those that did reported 0% to 29% of participants were excluded due to dropping out, death, or other factors (Barnard et al., 1995). These results suggest that dietary change is possible for studies of longer duration and more restrictive dietary goals. Again, however, a majority of the studies were intensive, highly controlled clinical trials involving participants who were symptomatic for chronic diseases.

The significant dietary fat reductions of the intensive, controlled trials may not generalize to less restrictive studies (Kumanyika et al., 2000). For example, large work-site interventions have not been shown to have large decreases in dietary fat (e.g., reductions of .9% to .36%; Sorensen et al., 1996; Tilley et al., 1999). The Multiple Risk Factor Intervention Trial (MRFIT) that included 12,000 men at risk of CVD reported dietary fat reductions of 4% that were maintained after six years, but the overall dietary fat intake remained above the recommended 30% of calories from dietary fat (Gorder, Bartsch, Tillotson, Grandits, & Stamler, 1997).

In summary, dietary interventions, even those with goals of 20% or less of daily calories from fat, have demonstrated successful adherence. However, many of the studies were highly controlled and included individuals who were at risk or symptomatic for chronic disease. The significant reductions that were demonstrated in these studies do not appear to generalize to larger, less intense, community-based interventions (Kristal, Hedderson, Patterson, & Neuhauser, 2001; Kumanyika et al., 2000). Therefore, it may be important to identify characteristics that are associated with dietary change in order to facilitate generalization of successful health behavior
change from intense controlled trials to less intensive dietary interventions and potentially to community-based samples.

Predictors of Dietary Fat Intake and Reduction

Although identification of the factors related to dietary fat consumption and the process of health behavior change appears crucial to the design of dietary interventions, only a few studies have examined predictors or characteristics associated with success in dietary interventions (e.g., Glanz, Patterson et al., 1998; Gorder et al., 1997). This is surprising given the known difficulty of adherence to lifestyle change (e.g., diet, exercise) in general and the lower rates of adherence in less controlled dietary interventions with asymptomatic individuals (Brownell & Cohen, 1995; Carmody, Matarazzo, & Istvart, 1987; Chrisler, 1997; McCann, Retzlaff, Dowdy, Walden, & Knopp, 1990). Interventions are most likely to be successful if they are based on factors that are known to influence food choice and are related to health behavior change theory (Glanz, Lewis, & Rimer, 1997). Identification of these factors is more difficult than it may seem since food selection is a complex behavior that is a function of physiological, psychosocial, and cognitive influences (Lewis, Sims, & Shannon, 1989). There is a significant amount of literature regarding food selection processes (e.g., Birch, 1999; Eertmans, Baeyens, & VandenBergh, 2001; Nestle et al., 1998). However, it is only recently that researchers have begun examining these factors in relation to dietary fat consumption. The sociodemographic and psychosocial variables associated with dietary fat intake are discussed below.

Sociodemographic Predictors

Sociodemographic predictors such as gender, age, education, socioeconomic status, and weight characteristics have been associated with dietary fat intake. Cross-sectional studies have indicated women tend to have lower dietary fat intake (Glanz et al., 1994; Roos, Lahelma, Virtanen, Prattala, & Pietinen, 1998; Steptoe & Wardle, 1999; Steptoe, Wijetunge,
Doherty, & Wardle, 1996), whereas longitudinal studies have had mixed results (Kristal, Glanz, Tilley, & Li, 2001; Steptoe, Doherty, Kerry, Rink, & Hilton, 2000). Furthermore, some have suggested that women have healthier diets but are not more likely to respond to dietary interventions (Anderson et al., 1992; Ehnholm et al., 1982; Steptoe et al., 2000). Older individuals have been shown to have diets lower in fat than younger individuals (Glanz et al., 1994; Gorder et al., 1997; Van Horn, Dolecek, Grandits, & Skweres, 1997) and are more likely to achieve dietary fat reduction (Kristal et al., 2000; Winkleby, Flora, & Kraemer, 1994). Higher education level has been shown to be related to diet (Glanz et al., 1994) and to dietary change (Kristal et al., 2000; Urban, White, Anderson, Curry, & Kristal, 1992). Researchers have reported that individuals with low socioeconomic status have higher fat intake (Roos et al., 1998; Shimakawa et al., 1994), but data from a large U.S. survey indicated that there were no differences between those above and below poverty level (Federation of American Societies for Experimental Biology [FASEB], Life Sciences Research Office [LSRO], 1995).

Although people with a higher body mass index (BMI; an index of body weight to height) tend to have diets higher in fat (Drewnowski, 2002), these individuals tend to report being farther along in readiness to change behavior, suggesting they may be amenable to dietary change (Glanz et al., 1994). However, other research suggests that lower BMI was associated with increased adherence in the MRFIT trial for men (Van Horn et al., 1997).

**Psychosocial Predictors**

Recent research has examined psychosocial determinants of dietary fat intake such as social support, knowledge, stress, and beliefs. Social support and encouragement from others, particularly family and spouses, has been shown to be associated with success in efforts to achieve dietary fat reduction (Bovbjerg et al., 1995; Feunekes, de Graaf, Meyboom, & van Staveren, 1998; Kelsey et al., 1996; Steptoe et al., 2000). Knowledge, including use of nutrition labels, has been
shown to be a necessary component of dietary interventions and some studies have indicated that it is associated with reduction of dietary fat (Kristal et al., 2001; Neuhouser, Kristal, & Patterson, 1999; Patterson, Kristal, & White, 1996). However, it is generally acknowledged that knowledge is not sufficient for dietary change (Brownell & Cohen, 1995). Personal beliefs, attitudes, and motivations regarding changing dietary behavior have been shown to be associated with dietary fat intake and reduction (Glanz, Kristal, Tilley, & Hirst, 1998; Glanz et al., 1994; Kristal et al., 2000).

Finally, there is preliminary evidence that stress affects dietary fat intake and predicts success in dietary fat reduction interventions, including the intervention in this study. Research with dietary compliance in diabetic patients indicates that situations that could be classified as minor stressors, such as time pressure, planning, and competing priorities, tended to be reported as barriers to dietary adherence (Schlundt, Rea, Kline, & Pichert, 1994). In the MRFIT trial for men, a baseline predictor of successful dietary fat reduction was no occurrence of major stressful life events over the past year (Gorder et al., 1997). Furthermore, there is an area of research suggesting that stress may affect individual’s responsiveness to high-fat, sugary (i.e., palatable) foods, indicating that stress may impact success in dietary fat reduction interventions (Laitinen, Ek, & Sovio, 2002; Oliver & Wardle, 1999). A full discussion of the role of stress in eating behavior will be detailed further.

In summary, sociodemographic and psychosocial predictors have been shown to be related to dietary fat intake. It will be crucial for future dietary interventions to include psychosocial predictors of change in order to identify targets that facilitate dietary fat reduction (Kristal et al., 2001). Interventions are most likely to be successful if they are based on factors that are known to influence behavior and are related to health behavior change theory (Glanz et al., 1997). The Transtheoretical Model of Behavior Change, as detailed below, was used in this study to examine factors associated with dietary fat intake.
Transtheoretical Model of Behavior Change

The Transtheoretical Model of Behavior Change, also known as the Stages of Change Model, is a widely used model of behavior change that provides a theoretical framework to explain and predict health behavior change (Prochaska & DiClemente, 1983). Initial research on this model developed from investigations into how people change in therapy (Prochaska, 1984). Prochaska compared different strategies of behavior change compiled from various theoretical orientations and found 10 processes that appeared to be associated with change. This integration from differing orientations led to the term transtheoretical (Prochaska, Redding, & Evers, 1997). Initial research within this model was conducted in the area of smoking cessation (DiClemente & Prochaska, 1982). However, its use has expanded to a wide variety of health behaviors including: exercise adoption, substance abuse, weight control, mammography utilization, condom use, and dietary fat (Curry, Kristal, & Bowen, 1992; DiClemente & Hughes, 1990; Galavotti et al., 1995; Marcus, Rossi, Selby, Niaura, & Abrams, 1992; Prochaska, Norcross, Fowler, Follick, & Abrams, 1992; Rakowski, Fulton, & Feldman, 1993).

Prochaska, DiClemente, & Norcross (1992) proposed that individuals progress through five stages of change when attempting to cease high-risk behaviors or adopt health-promoting behaviors. The initial stage of the model is Precontemplation in which the individual has no intention to change behavior in the next six months and hasn’t even considered changing. Contemplation occurs when the individual is thinking about changing a behavior in the next six months but hasn’t done anything to initiate the process. Preparation is the stage in which there is some action towards change but it doesn’t meet the criteria required for the behavior (e.g., using skim milk instead of whole milk but still consuming >30% dietary fat). The Action stage occurs when the actual behavior change takes place. It requires the most effort and time and has occurred in the past six months (Prochaska, DiClemente, & Norcross, 1992). People in this stage must
attain the criterion determined by professionals in the area to reduce disease. For example, in the dietary fat literature, 30% of calories from dietary fat is the general consensus. Maintenance is the stage at which the individual has successfully made a behavior change for at least six months. The authors propose that this model is not linear, but more of a spiral pattern suggesting that people relapse in their attempts to change behavior and fall back to earlier stages of change (Prochaska, DiClemente, & Norcross, 1992).

In addition to the stages of change, the transtheoretical model is composed of three other constructs that have been associated with movement through the stages of change and with health behavior change: self-efficacy, decisional balance, and processes of change (Prochaska, DiClemente, & Norcross, 1992). These constructs will be discussed in detail below. Only one study has applied stages of change and all of the transtheoretical constructs to dietary fat intake (Ounpuu, Woolcott, & Greene, 2000). However, the researchers utilized a cross-sectional design examining dietary fat intake across stages of change in a sample of women.

One potential reason for the limited research investigating the TTM and dietary fat intake is the difficulty in assessing stage of change for dietary fat. There has been discussion regarding the classification scheme for this measure (Brug et al., 1997; Greene & Rossi, 1998; Ni Mhurchu, Margetts, & Speller, 1997). A major problem is that individuals are unable to estimate their actual amount of dietary fat intake, leading to inflated and inaccurate representation in the action and maintenance stages of change (Kristal et al., 1999; Povey, Conner, Sparks, James, Shepherd, 1999). Therefore it has been suggested that nutrient intake cut-offs be used based on food frequency records to determine actual stage of change (Greene & Rossi, 1998). However, this method becomes tautological when one uses the dependent variable to define the independent variable (Kristal et al., 1999). Given these considerations, the stage of change construct will not
be used in this study. Rather the psychosocial constructs associated with the model will be used as predictors of actual dietary fat intake.

Each construct of the transtheoretical model will be discussed below, first in relation to general patterns identified across several health behaviors, followed by a summary of the available data related to dietary fat reduction.

Decisional Balance

The decisional balance construct of the transtheoretical model was based on the decision-making model of Janis and Mann (1977). Velicer and colleagues (1985) tested this decision-making model across the stages of change for smoking cessation and produced a two-factor model that they identified as the pros (i.e., advantages or benefits) and cons (i.e., disadvantages, barriers) of behavior change. For example, a pro for reducing dietary fat is “People close to me disapprove of my eating a diet which is too high in fat” and a con is “I am more content with myself when I am eating the high fat foods I enjoy” (Rossi, Rossi, Prochaska, & Velicer, 1993). Early research demonstrated that the pros and cons vary according to stages of change and the general pattern is robust across 12 health behaviors, including dietary fat intake (Prochaska et al., 1994). Results demonstrated that in all 12 behaviors, individuals who were not planning on changing a behavior endorsed more negative than positive views of changing. Conversely, for those who were actively engaging in behavior change, the pros outweighed the cons in 11 of the 12 behaviors. Furthermore, it was determined that 7 of the 12 behaviors demonstrated a crossover of the pros and cons during the contemplation stage and the remaining 5 behaviors, including dietary fat, had a crossover in the action stage. Although this pattern was demonstrated cross-sectionally, it suggests that as individuals begin to think about behavior change the benefits of changing become more important than the disadvantages. Overall, the decisional balance construct has been demonstrated to be an important component of the transtheoretical model.
Dietary Fat and Decisional Balance

Decisional balance and dietary fat intake have only been investigated in relation to validation of the decisional balance scale. Three validation studies (Rossi, 1993; Rossi, Rossi et al., 1993; Rossi et al., 1994b) demonstrated that the pros and cons were found to vary by stages of change and in the same pattern as the other health behaviors in the seminal study noted above (Prochaska et al., 1994). In other words, the cons were more important in the precontemplation stage and the pros were more important in the action stage. Again, this suggests that as individuals are reducing dietary fat, the pros of changing behavior become more important and may have implications for dietary interventions. For example, if the pros of dietary fat reduction are found to predict actual dietary change then this indicates that changing attitudes would be a target for an intervention. Clearly, further research is necessary to examine the relationship between decisional balance and dietary fat consumption.

Processes of Change

Processes of change in the transtheoretical model are covert and overt activities that people use to progress through the stages of change. They consist of two groups of processes: experiential and behavioral. Experiential processes focus on thoughts, feelings, and experiences and include: consciousness raising, dramatic relief, environmental reevaluation, self-reevaluation, social liberation and self-liberation. The behavioral processes focus on behaviors and reinforcement and include: reinforcement management, helping relationships, counterconditioning, stimulus control, and interpersonal systems control.

The processes of change are the least researched of all the transtheoretical model constructs (Greene et al., 1999). Research has shown that processes of change vary across stages for many different health behaviors, including dietary fat intake. Experiential processes are
typically used in the early stages of change and behavioral strategies are used in the later action and maintenance stages (Rossi, 1992).

Dietary Fat and Processes of Change

There is a paucity of research investigating the role of the processes of change in dietary fat reduction. This may be an important omission as the processes are explicit attitudes and behavioral strategies that could provide information about the predictors of actual dietary change. Understanding what processes are used by those who successfully reduce dietary fat consumption may provide areas to target in future dietary fat reduction studies (Ni Mhurchu et al., 1997).

Self-Efficacy

Self-efficacy is conceptualized as a person’s confidence in or perceived ability to perform a task (Bandura, 1977). It is a core construct in Bandura’s Social Cognitive Theory (1977) and has been adapted for use in the transtheoretical model (DiClemente, Prochaska, & Gilbertini, 1985). A major tenet of self-efficacy theory is that the belief in one’s ability to perform a behavior is predictive of the actual ability to engage in that behavior, how long they persist in doing it, and how much distress is experienced when challenged (Bandura, 1997). Self-efficacy is influenced by several factors including: mastery experiences, vicarious experiences, social persuasion, and somatic and emotional states, particularly stress (Bandura, 1997).

A comprehensive review of self-efficacy and health behavior interventions suggests that the effectiveness of interventions is significantly mediated by self-efficacy (Bandura, 1992). Self-efficacy has been shown to be associated with a variety of health behaviors including smoking cessation (DiClemente et al., 1985), weight loss (Stotland & Zuroff, 1991), adoption and maintenance of exercise (Marcus, Selby, Ni aura, & Rossi, 1992), and adherence to medical regimens (Kavanagh, Gooley, & Wilson, 1993; McCaul, Glasgow, & Schafer, 1987).
Within the transtheoretical model, a linear progression of increasing self-efficacy across the stages of change from precontemplation to maintenance has been demonstrated in the following health behaviors: condom use (Galavotti et al., 1995), weight control (Prochaska, Norcross et al., 1992), exercise (Marcus et al., 1992), and smoking (DiClemente et al., 1985). Although relatively few longitudinal studies have examined self-efficacy in relation to actual health behavior change, it has been shown to predict exercise behavior and smoking cessation (McAuley & Courneya, 1993; Prochaska, Velicer, Guadagnoli, & Rossi, 1991).

Dietary Change and Self-Efficacy

A recent review of self-efficacy and eating behaviors indicated that few studies have examined the association between self-efficacy and dietary fat reduction (AbuSabha & Achterberg, 1997). Cross-sectionally, higher self-efficacy has been shown to be related to lower fat intake (Steptoe et al., 2000; Van Duyn et al., 2001) and to progression of stages of change (Brug et al., 1997; Sporny & Contento, 1995). Even fewer studies have investigated the role of self-efficacy over time. McCann and colleagues (1995) demonstrated increases in self-efficacy that were associated with dietary fat reductions for situations characterized by negative affect after four weeks of dietary instruction. These associations remained at the three month follow-up but not at 12 months. However, this study suffered from a small sample size (N=25). A more recent study reported higher self-efficacy was associated with lower dietary fat consumption in individuals entering a primary care behavioral counseling intervention but not at four months post intervention (Steptoe et al., 2000). Interestingly, the change in self-efficacy was associated with change in dietary fat. Based on this information, the authors hypothesized that self-efficacy is directly involved in the processes used during behavior change but is not predictive of who will benefit from a dietary intervention (Steptoe et al., 2000).
Although the studies in this area have generally shown an inverse relationship between self-efficacy and dietary fat consumption, there is little consistency in the measures used for measuring self-efficacy and many use only one or two item questions (Brug et al., 1997; Glanz et al., 1994; Steptoe et al., 2000). Measurement of self-efficacy with one item does not provide an accurate picture of perceived abilities and has been shown to be less predictive of health behavior (Bandura, 1997; Lee & Bobko, 1994).

One factor that has been neglected in both the transtheoretical model and dietary fat reduction literature is the role of stress. This is surprising given the fact that stress is known to affect eating behavior (see Greeno & Wing, 1994 for review), impede success in dietary interventions (Gorder et al., 1997), and interact with self-efficacy (Bandura, 1997). Many dietary interventions contain relapse prevention components apparently presuming stressful situations affect the ability to adhere to dietary change (Brownell & Cohen, 1995). However, there is usually no actual measure of the impact of stress on behavior change. Prior to delineating the links between stress and health behavior change, a brief review of important constructs in the area of stress will be presented.

**Stress**

Early conceptualizations of stress stemmed from the works of Cannon (1914) and Selye (1956) who focused on the body’s predictable patterns of physiological response to external demands in the environment. Selye defined stress as a “nonspecific result of any demand upon the body, be the effect mental or somatic” (1982, p. 7). The stress response first identified by Selye has been shown to affect a variety of areas including: physiological functioning, performance, sleep habits, aggressive behavior, and engagement in high-risk health behaviors (Dougall & Baum, 2001). These early works formed the foundation of stress theory and initially defined stress as a response (Dougall & Baum, 2001).
Subsequent psychological theories of stress have typically focused on the role of stress as a stimulus or “stressor.” Holmes and Rahe (1967) were the first to attempt to operationalize environmental demands as life events and measure their impact on disorders and disease. Their initial research posited that life events, positive and negative, were considered stressful if they created change in the environment. This seminal work led to a long line of research investigating life events and health status. Later theories, such as the transactional theory of stress, emphasized that individual characteristics such as cognitions and personality mediate one’s response to stress and has generated research in the area of coping (Lazarus & Folkman, 1984).

**Major and Minor Stressors**

With the advent of the Holmes and Rahe study (1967), major life event research grew significantly (Monroe & McQuaid, 1994). Examples of major life events include the death of a family member or loss of a job. Instruments such as the Social Readjustment Rating Scale (Holmes & Rahe, 1967) and the Life Experiences Survey (Sarason, Johnson, & Siegel, 1978) are typically used to measure life events. Although early research suggested that life events had a significant impact on physical health and disease, these associations have only been modest (Rabkin & Struening, 1976). This has led to strong criticisms of major life event research, one of which is the difficulty in establishing a temporal relationship between major life events and illness or disease (Monroe & McQuaid, 1994). As a result, investigation into minor stressors was initiated to address the methodological problems associated with major life event research.

Minor stressors are events that occur on a day-to-day basis that would be considered daily hassles. Examples would include having to wait in line, having car trouble, or having an argument with a spouse, and are typically measured using instruments such as the Daily Stress Inventory (Brantley, Catz, & Boudreaux, 1997), Weekly Stress Inventory (Brantley, Jones, Boudreaux, & Catz, 1997), and the Hassles Scale (DeLongis, Coyne, Dakof, Folkman, & Lazarus, 1982). Minor
stressors have been shown to have a larger impact on well-being than major life events (Garrett, Brantley, Jones, & McKnight, 1991; Holahan & Holahan, 1987; Monroe, 1983; Weinberger, Hiner, & Tierny, 1987). Additionally, they have been shown to be better predictors of health status than major life events (Brantley & Jones, 1993; DeLongis et al., 1982; Kanner, Coyne, Schaefer, & Lazarus, 1981).

**Stress and Health Behavior**

Stress is believed to affect health directly through psychophysiological processes (e.g., autonomic and neuroendocrine) or indirectly through modification of health behaviors (Steptoe, 1991). Given space limitations and that the aim of this project was to assess change in health behavior, the relationship between physiological responses and stress will not be discussed. The remaining literature review will concentrate on the effects of stressors on health behaviors. Minor stressors can impact health behavior by affecting an individual’s ability to engage in health promoting behavior or by increasing engagement in negative health behaviors (DeLongis et al., 1982; Wiebe & McCallum, 1986). For example, stressors have been associated with increases in smoking (Cohen & Lichtenstein, 1990), alcohol consumption (Cooper, Russell, Skinner, Frone, & Mudor, 1992), and eating (Greeno & Wing, 1994). Individuals may engage in these types of negative health practices to reduce tension or regulate affective responses to stress (Carmody, 1989).

Less information is known about the effects of stress on positive health behaviors, such as exercise, diet, and medical regimen adherence (Griffin, Friend, Eitel, & Lobel, 1993; Stetson, Rahn, Dubbert, Wilner, & Mercury, 1997). Stress may impede one’s ability to schedule or engage in healthy activities or it may lead to a belief that one is unable to carry out healthful behaviors (Griffin et al., 1993). For example, minor stressors were associated with decreased exercise and lower self-efficacy for meeting exercise goals in a sample of women (Stetson et al., 1997).
Additionally, poor adherence to medication and dietary regimens in patients diagnosed with diabetes and HIV have been related to minor stressors (Peyrot, McMurry, & Kruger, 1999; Proctor, Tesfa, & Tompkins, 1999).

In summary, stress appears to impact health behaviors by either affecting the ability to engage in health promoting behavior or increasing negative health behavior. Although there is little understanding of the mechanisms related to stress and health behavior change, several models have been developed to investigate stress and eating behavior specifically. A summary of the research on stress and eating will be presented below, followed by an examination of the role of stress on dietary fat intake.

**Stress and Eating Behavior**

It is generally accepted that stress affects eating behavior in humans and in animals (Greeno & Wing, 1994). The dominant theory in human literature is the individual differences model that posits that learning history, attitudes, or biology determines the effects of stress on eating (Greeno & Wing, 1994). The overall conclusion resulting from this model is that women and restrained eaters tend to eat increased amounts of food under stress (Grunberg & Straub, 1992; Polivy & Herman, 2002). There are mixed results about obese individuals (Greeno & Wing, 1994). A limitation of these studies is that many were conducted in the laboratory setting with acute stressors (e.g., mood induction, cognitive tasks) that may not be generalizable to stressors that would occur on a daily basis. Additionally, all of the studies conducted in the restrained eating population were composed of college-aged women (Greeno & Wing, 1994).

In summary, restrained eaters and women are more likely to eat increased amount of food under stress. Little is known about predictors of stress-related eating in individuals that are not obese or chronically dieting. Furthermore, there is little investigation into particular nutrients (e.g., sugars, fats) that would be affected by stress. This is surprising, given the assumption that
individuals eat more fatty foods when under stress (Greeno & Wing, 1994). Studies examining the specific impact of stress on preference for high fat foods in “normal” healthy populations will be discussed below.

**Stress and Dietary Fat Intake**

Despite the common perception that individuals eat more high fat foods under stressful circumstances, there is a paucity of research regarding types or quality of food selected during these times. A shift in preference towards more palatable food under stress may serve to obtain energy quickly when demands are high and eating has taken a low priority (Greeno & Wing, 1994). This was demonstrated in one study where women ate two times more sweet foods in a high stress condition than in a low stress condition (Grunberg & Straub, 1992). In addition, Michaud et al. (1990) reported that fat consumption increased in high school students, particularly girls, on stressful days. Two survey studies also reported increased intake of higher fat foods when individuals were stressed. Laitinen, Ek, & Sovio (2002) surveyed 31-year-old men and women in a large population based study and reported that men and women who were labeled “stress driven eaters” ate high fat foods (e.g., sausages, pizza, chocolate) more frequently than those who were not stress driven eaters. However, because the authors did not assess intake of non-fatty foods it cannot be determined whether the stress driven eaters had an overall increase in food consumption. Oliver & Wardle (1999) administered a survey to young adults and reported that all participants reported an increase in snacking behavior when stressed, particularly for sweets, chocolate, cake, biscuits, and “savory” snacks. The authors point out that these foods share properties of being highly palatable, easy to prepare, and of high caloric density.

Studies with naturalistic designs have demonstrated mixed results with regard to stress and fat intake. Some investigators have reported higher fat intake during stressful time periods (Michaud et al., 1990; Wardle, Steptoe, Oliver, & Lipsey, 2000; Weidner, Kohlmann, Dotzauer, &
Burns, 1996). Other studies have found increased fat intake in relation to objective stress (e.g., hours worked) rather than perceived stress (McCann, Warnick, & Knopp, 1990). Finally, others have found no change in fat intake between high and low stress times (Bellisle et al., 1990; Pollard, Steptoe, Canaan, Davies, & Wardle, 1995; Stone & Brownell, 1994). Clearly, there is no clear pattern regarding the relationship between stress and increased dietary fat intake. This may be due to differing measures of stress that are not based on validated instruments, poor measurement of food intake, and problems inherent to cross-sectional and laboratory based designs.

In summary, self-reported stress has been shown to increase food consumption and possibly dietary fat in some studies. Although none of the studies addressed potential mechanisms that would explain increases in high fat foods, it has been suggested that stress may affect performance of health behaviors by impacting frequency and patterns of eating (Griffin et al., 1993). Time pressures may make speed and convenience more important than actual nutritional quality of food (Oliver & Wardle, 1999).

These factors may have a bearing on success in dietary interventions, particularly those with dietary fat reduction as a goal. There is little information on the effects of stress on success in dietary interventions. The MRFIT trial found that individuals who reported no occurrence of major stressful life events over the past year had better dietary compliance compared to those with one or more stressful life events (Gorder et al., 1997). Furthermore, preliminary data from this study indicated that stressful minor life events and global perception of stress was associated with lower self-efficacy to resist dietary fat (Martin et al., 2001). Given the known effects of minor stressors on health behaviors and the hypothesized increase of high fat foods under stress for certain populations, investigation into the impact of stress on dietary fat reduction in an intervention would be beneficial.
Rationale for the Study

The relationship between dietary fat intake and cardiovascular disease has been firmly established (NCEP, 2001). Numerous intense, controlled clinical trials have successfully reduced dietary fat in symptomatic populations (see Barnard et al., 1995; Brunner, 1997, for reviews). However, there has been less success in large, less controlled studies with healthy or mildly at-risk populations (e.g., Sorensen et al., 1996). Although various predictors associated with dietary fat consumption have been investigated cross-sectionally, little is known about predictors associated with actual change in dietary intake. This is an important omission because dietary interventions are more likely to be successful if they are based on factors that are known to influence behavior and are related to health behavior change theory (Glanz et al., 1997).

Although the transtheoretical model is widely used to explain health behavior change, there has been very limited work in the area of dietary fat and this research is still in the descriptive and explanatory phases (Burkholder & Evers, 2002). Three studies have longitudinally investigated the stages of change in relation to dietary fat and they did not include an examination of decisional balance, processes of change, or self-efficacy (Glanz, Patterson, et al., 1998; Greene & Rossi, 1998; Kristal et al., 1999). It has been suggested that it is important to use all dimensions of the transtheoretical model rather than just the stage dimension alone in order to “capture the richness, complexity, and multivariate nature of behavior change” (Greene et al., 1999, p. 674).

Stress has a demonstrated effect on eating behavior with some evidence that it increases consumption of dietary fat (e.g., Greeno & Wing, 1994; Oliver & Wardle, 1999). This has implications for the success of dietary fat interventions. Therefore, it is important to understand the association of stress to dietary fat intake and possibly with psychosocial predictors of dietary change.
This study investigated the psychosocial predictors of dietary fat and dietary fat reduction through the framework of the transtheoretical model and its relationship with minor stress. In addition, constructs of the transtheoretical model were measured at baseline and six months to determine if change in the variables corresponded to changes in dietary fat.

**Research Questions and Hypotheses**

**Question #1a:** What psychosocial variables associated with the transtheoretical model predict dietary fat intake of healthy participants entering a dietary intervention (See Table 1)? Is minor stress a predictor of dietary fat intake?

**Hypothesis:** Higher self-efficacy will be the strongest predictor of lower dietary fat intake. It is hypothesized that higher pros of changing to a low fat diet and more frequent use of the behavioral and experiential processes will be associated with lower dietary fat intake. Finally, higher numbers of minor stressors are expected to be associated with greater dietary fat intake.

**Question #1b:** For participants entering a dietary intervention, does minor stress moderate the relationship between the transtheoretical model variables and baseline dietary fat intake?

**Hypothesis:** It is hypothesized that stress will moderate the relationship between self-efficacy and dietary fat such that at higher levels of stress, lower self-efficacy will be associated with higher dietary fat. It is hypothesized that at high levels of stress, lower use of behavioral and experiential processes will be associated with higher dietary fat. Finally, it is hypothesized that at high levels of stress, more cons of reducing dietary fat will be associated with higher dietary fat intake.

**Question #2a:** What are the baseline psychosocial constructs associated with the transtheoretical model that predict change in dietary fat intake from baseline to 6 months for participants enrolled in a dietary intervention? Is minor stress a predictor of dietary fat reduction?
Hypothesis: It is hypothesized that higher self-efficacy will be the most significant predictor of dietary fat reduction. In addition, it is hypothesized that higher pros of changing to a low fat diet and more frequent use of the behavioral and experiential processes, will predict dietary fat reduction. Finally, it is hypothesized that higher levels of minor stress will predict lower dietary fat reduction.

Question #2b: Does minor stress moderate the relationship between the transtheoretical model variables and dietary fat reduction?

Hypothesis: It is hypothesized that minor stress will moderate the relationship between self-efficacy and dietary fat such that at higher levels of stress, lower self-efficacy will be associated with less dietary fat reduction. It is hypothesized that at high levels of stress, lower use of behavioral and experiential processes will be associated with less dietary fat reduction. Finally, it is hypothesized that at high levels of stress, the more cons of changing dietary fat will be associated with lower dietary fat reduction.

Question #3: Are there significant changes in the constructs associated with the TTM between the intervention and control groups over the course of the intervention?

Hypothesis: It is hypothesized that participants in the dietary intervention will increase self-efficacy, increase the pros of changing to a low fat diet, increase the use of the behavioral processes, and decrease the use of the experiential processes.

Table 1
Predictor, moderator, and outcome variables for research questions #1 and #2

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Moderator</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-efficacy</td>
<td>Weekly Stress Inventory</td>
<td>Baseline percentage of dietary fat intake</td>
</tr>
<tr>
<td>Decisional Balance (pros-cons)</td>
<td></td>
<td>Change in dietary fat intake (baseline – six months)</td>
</tr>
<tr>
<td>Experiential Processes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behavioral Processes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
METHODS

Participants

Over a two-year period, participants were recruited to enroll in a study investigating the effects of dietary fat reduction on markers of atherosclerotic disease and on atherosclerotic disease progression. Participants were healthy men and women between the ages of 45 and 70. Exclusionary criteria included: presence of coronary artery disease or use of lipid lowering medication; diabetes mellitus; uncontrolled hypertension or use of hypertensive medication; renal, hepatic, endocrine, gastrointestinal or other systemic diseases; body mass index greater than 35; history of alcohol or drug abuse; history of eating disorder; presence of psychotic disorder; or use of antipsychotic or mood stabilizing medications.

Three hundred fifty two participants were enrolled in the study and 278 completed the six-month follow-up indicating high retention rates for the overall sample. Although this full sample was intended to be the sample used for this study, there was a clerical error and administrative decision that limited the sample size for these analyses. At baseline, 153 participants did not receive the decisional balance questionnaire due to an error in the copying of data packets and 20 participants did not receive the processes of change questionnaire. Additionally, at the six-month time interval, it was necessary to shorten the questionnaire battery due to subject complaints about the length of the battery. Therefore, the decisional balance questionnaire was removed at the six-month interval since there was no baseline information for many participants on this measure. The total sample used for this study was composed of the 179 participants who had complete data, including the decisional balance questionnaire, at baseline. To achieve power of .80 for both regression analyses, the recommended sample size is 130 participants using the rule, $N \geq 50 + 8m$ ($m =$ number of predictors; Green, 1991).
At the six-month follow-up, 162 (90%) participants remained in the study, indicating high retention rates similar to the original larger sample. There were no significant differences on age, race, education level, baseline BMI, or baseline percent of dietary fat between those with or without the decisional balance questionnaire. Additionally, there were no significant differences on age, race, education level, baseline BMI, baseline percentage of dietary fat, or on any of the baseline TTM measures between those who dropped out at six months and the remaining sample.

The baseline sample for this study was composed of 117 female (65%) and 62 male (35%) participants, with a mean age of 55.37 (SD = 5.25). A majority of the sample was Caucasian and married with some college education. The mean dietary fat intake at baseline was slightly above recommended values (range 9% - 48%) and average BMI indicated the sample was overweight (See Table 2). Following randomization, 65.4% of participants were enrolled in the dietary intervention and 34.6% of the participants in the control group.

Table 2
Baseline Demographics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Sample N=179</th>
<th>Control n=62</th>
<th>Intervention n=117</th>
</tr>
</thead>
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<tr>
<td>Age</td>
<td>55.37 5.25</td>
<td>54.98 5.39</td>
<td>55.57 5.19</td>
</tr>
<tr>
<td>% DF</td>
<td>31.18 7.62</td>
<td>30.63 5.90</td>
<td>31.48 8.39</td>
</tr>
<tr>
<td>BMI</td>
<td>27.26 4.16</td>
<td>26.55 3.80</td>
<td>27.64 4.30</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>65.4</td>
<td>69.4</td>
<td>63.2</td>
</tr>
<tr>
<td>Male</td>
<td>34.6</td>
<td>30.6</td>
<td>36.8</td>
</tr>
<tr>
<td>Ethnicity</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>92.2</td>
<td>91.9</td>
<td>92.3</td>
</tr>
<tr>
<td>African-American</td>
<td>7.30</td>
<td>6.5</td>
<td>7.7</td>
</tr>
<tr>
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<td>--</td>
</tr>
<tr>
<td>Marital Status</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>3.9</td>
<td>4.8</td>
<td>3.4</td>
</tr>
<tr>
<td>Married</td>
<td>71.5</td>
<td>72.6</td>
<td>70.9</td>
</tr>
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</table>

(Table continued)
<p>| | | | |</p>
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<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Divorced</td>
<td>21.2</td>
<td>22.6</td>
<td>20.5</td>
</tr>
<tr>
<td>Widowed</td>
<td>3.4</td>
<td>--</td>
<td>5.1</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>&lt; 12 years</td>
<td>.6</td>
<td>--</td>
<td>.9</td>
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<tr>
<td>12 years</td>
<td>15.1</td>
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<tr>
<td>12-16 yrs</td>
<td>30.7</td>
<td>32.3</td>
<td>29.9</td>
</tr>
<tr>
<td>16 yrs</td>
<td>25.7</td>
<td>30.6</td>
<td>24.8</td>
</tr>
<tr>
<td>&gt;16 yrs</td>
<td>25.7</td>
<td>25.8</td>
<td>25.6</td>
</tr>
<tr>
<td>Unknown</td>
<td>1.1</td>
<td>--</td>
<td>1.7</td>
</tr>
</tbody>
</table>

*Note.* M = mean; SD = standard deviation.

**Procedure**

Participants were recruited through radio and newspaper advertisements for a two-year study examining the effects of a low fat diet on heart disease progression. Once participants were enrolled, they completed a four-week baseline period in which pre-intervention data was obtained. They were instructed not to modify their normal eating habits or food selections during this time. Following the baseline period, participants were randomized to either a no-intervention control group or to a dietary-intervention group. Those placed in the no-intervention control group completed questionnaires and food records on the same schedule as individuals in the intervention group. All measures were collected at baseline and at 6, 12, 18, and 24 months. Psychosocial constructs and food records administered at baseline and six months were used for this study.

**Dietary Intervention**

Participants in the dietary intervention arm received intensive group and individual dietary counseling from trained dietitians. Goals for the study were to decrease total dietary fat to less than or equal to 20% of daily caloric intake and saturated fat to 4% to 6% of daily caloric intake. For the time frame of this study, group dietary instruction involved 10 dietary sessions over six months. For the first four months of the study, group interventions were conducted every other week and then decreased to once a month for months five and six of the study. Groups contained
12-15 participants and lasted approximately one hour. The group interventions were didactic and were composed of education and information on behavioral strategies for decreasing dietary fat. Topics included: reading nutrition labels, types of dietary fat, how to choose low fat foods, how to modify recipes, how to follow a low-fat diet in social situations and restaurants, and shopping and food preparation to meet low-fat dietary goals.

Individual dietary interventions occurred once during months one, three, and six were conducted by the same dietitian running the group intervention. During these individual sessions the dietitian provided feedback to the participant about dietary intake based on the food records. These sessions were designed to target areas of dietary fat improvement and generate strategies to improve compliance in these areas.

Measures

The demographic information and the decisional balance questionnaire were administered at baseline. The remaining measures were completed at both baseline and at the six-month interval.

Demographic Information

The following demographic information was obtained by self-report during the initial screening phone call that determined eligibility for the study: age, gender, marital status, race, and educational level.

Weight

Participants were weighed two consecutive times without shoes or heavy clothing. The average of these two weights was used for the final weight.

Body Mass Index (BMI)

BMI was calculated as kg/m².
**Decisional Balance Questionnaire for Dietary Fat Reduction** (Rossi, Rossi, et al., 1993)

The decisional balance questionnaire is an eight-item inventory designed to measure the pros and cons of changing to a low fat diet. There are four items measuring the pros (e.g., People close to me disapprove of my eating a diet which is too high in fat) and four items measuring the cons (e.g., I am more content with myself when I am eating the high fat foods I enjoy). Items are rated on a five-point Likert scale from 1 (not important at all) to 5 (extremely important). Higher scores indicate higher importance of pros or cons. Internal consistency (alpha) coefficients indicate good reliability for pros (.82 - .86) and cons (.83 - .84; Rossi et al., 1994b; Rossi, Rossi et al., 1993). The pros and cons were found to vary across stages of change indicating that the decisional balance questionnaire is externally valid. In this study, the decisional balance score was calculated by subtracting the cons from the pros resulting in a score range of –16 to 16. Therefore, a positive score indicates endorsement of more pros and a negative score indicates endorsement of a larger number of cons.

**Processes of Change for Dietary Fat Reduction** (Rossi & Rossi, 1993)

The processes of change instrument is a 33-item measure assessing the frequency of the use of behavioral and experiential strategies for decreasing dietary fat. This instrument uses a five-point Likert scale ranging from 1 (repeatedly) to 5 (never), with higher scores indicating less use of the processes of change. It is composed of two subscales: the behavioral processes (e.g., not bringing high fat foods into the home or avoiding others who are eating high fat foods) and the experiential processes (e.g., seeking information about lowering dietary fat or caring about the consequences of eating high fat foods). The behavioral processes include: helping relationships, reinforcement management, interpersonal systems control, stimulus control, and counterconditioning. The experiential processes include: consciousness raising, self-liberation, social liberation, self-reevaluation, and environmental reevaluation. Internal consistency for the
eleven scales was adequate and ranged from .73 (counterconditioning and stimulus control) to .90 (dramatic relief; Rossi & Rossi, 1993; Rossi et al., 1994a). Additionally, the processes were found to vary across stage of change suggesting that the measure is externally valid.

**Self-Efficacy Questionnaire for Dietary Fat Reduction (Rossi et al., 1994c)**

The self-efficacy questionnaire is a 12-item inventory designed to measure confidence in resisting high fat foods in three different situations: Positive/Social Situations, Negative/Affective Situations, and Difficult Situations. The positive/social situations subscale measures ability to resist high fat foods when there is a positive feeling and a social situation (e.g., while eating out at a restaurant with close friends). Negative/affective situations involve a bad feeling and a negative situation (e.g., had argument with someone close to me), and a difficult situation is when there is trouble in obtaining or preparing lower fat foods (e.g., when only high fat foods are available). Items are rated on a five-point scale from 1 (extremely confident) to 5 (not at all confident) with higher scores indicating lower self-efficacy. Internal consistency is adequate with reliability coefficients for the subscales ranging from .73 (difficult situations) to .95 (negative/affective situations) and .88 for the total scale (Rossi et al., 1994c). Self-efficacy was found to increase as stage of change progressed in the developmental sample (Rossi et al., 1994c).

**Weekly Stress Inventory (WSI; Brantley, Jones, Boudreaux, & Catz, 1997)**

The WSI is an 87 item self-report measure assessing the number and appraised stressfulness (on a 0 to 7 Likert scale) of minor stressors that occurred over the past week. Two scores are obtained from the WSI, the event score and the impact score. The event score is the total number of events that occurred during the past week and the impact score is the sum of the ratings of the events that occurred over the past week. However, only the event score was used for this study. Internal consistency has been shown to be high with alphas ranging from .92 - .96 for the WSI event score. Test-retest reliability of the WSI was conducted on 170 students in which
they were given the WSI on two occasions separated by 1-3 hours. Reliability coefficients were adequate for both scales (WSI-event, \( r = .83 \)). The WSI was compared to the Hassles Scale (Kanner et al., 1981) and found to have adequate concurrent validity (\( r = .61 - .69 \)).

**Dietary Intake**

Dietary intake was measured using a 4-day food record that was designed for use at the Pennington Biomedical Research Center and has been included in several published studies (e.g., Lovejoy, Champagne, Smith, deJonge, & Xie, 2001). Participants were instructed on how to complete food records and were provided with sample records. They were instructed to record everything they ate or drank during the time period. The four days required for recording dietary intake included one weekend day and three weekdays within a span of a 7-day period. For this study, food records that were collected at baseline and 6 months were used. Following a review of the records by the dietitian, the records were analyzed using the PBRC Food Diary Program (Pennington Biomedical Research Foundation). As part of the extensive dietary output from the food records, percentage of energy from fat was used for this study.
RESULTS

Data Analytic Plan

Prior to testing the study hypotheses, descriptive statistics were determined for all of the study variables at baseline and six months collapsed across group (see Table 2). The baseline and six month scores on the variables associated with the TTM, dietary fat intake, and the WSI were examined for assumptions of univariate and multivariate analyses. The decisional balance difference score was positively skewed. Therefore, a logarithmic transformation was applied after first adding a constant of 16 to avoid taking the log of a negative or zero number. The baseline and six-month WSI event score was also positively skewed and a square root transformation was applied. For ease of interpretation, the original means of these two variables are reported in Table 3. No multivariate outliers were revealed using the mahalanobis distance test (Tabachnick & Fidell, 2001).

Research Question #1: Predictors of Baseline Dietary Fat Intake

Prior to testing the research question, correlations between baseline percentage of dietary fat, the constructs associated with the TTM, minor stress, and demographic variables were conducted and are presented in Table 4. Education, marital status, and gender were not significantly associated with dietary fat intake at baseline and were not added to the subsequent regression analyses as covariates. Experiential processes, self-efficacy, and BMI were significantly correlated with baseline percentage of dietary fat. Higher dietary fat was associated with larger BMI, less use of experiential processes (as indicated by a higher number), and lower self-efficacy (as indicated by a higher number). Minor stress was not significantly associated with dietary fat or any of the variables associated with the TTM.

To address research question #1, (i.e., What are the psychosocial variables associated with the transtheoretical model that predict dietary fat intake of healthy participants entering a dietary
intervention? Is minor stress a predictor of dietary fat intake and does it moderate the relationship between the transtheoretical model variables and baseline dietary fat intake?), a hierarchical regression analysis was conducted. Prior to conducting the regression, the predictor variables were centered to prevent the negative impact of multicollinearity (Aiken and West, 1991). The centered variables were computed by subtracting the overall mean of the predictor from each individual score to create variables with means of zero. These centered predictors were then multiplied to create the interaction terms. Significant interactions were examined using simple slope analyses and plots. Post-hoc probing was conducted using t-tests of the significant interactions to determine which slope was significantly different from zero. Plots were created by examining the moderator at one standard deviation above and below the mean (Aiken & West, 1991; Holmbeck, 2002).

Table 3
Mean scores of psychosocial constructs for total sample at baseline and six months (n = 179)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline Mean</th>
<th>Baseline SD</th>
<th>Six Months Mean</th>
<th>Six Months SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Dietary Fat</td>
<td>31.18</td>
<td>7.62</td>
<td>23.81</td>
<td>9.48</td>
</tr>
<tr>
<td>Behavioral processes&lt;sup&gt;a&lt;/sup&gt;</td>
<td>45.36</td>
<td>9.82</td>
<td>42.85</td>
<td>9.69</td>
</tr>
<tr>
<td>Experiential processes&lt;sup&gt;a&lt;/sup&gt;</td>
<td>44.94</td>
<td>11.90</td>
<td>43.21</td>
<td>11.51</td>
</tr>
<tr>
<td>Self-efficacy&lt;sup&gt;b&lt;/sup&gt;</td>
<td>29.66</td>
<td>8.49</td>
<td>28.67</td>
<td>7.55</td>
</tr>
<tr>
<td>Decisional Balance&lt;sup&gt;cd&lt;/sup&gt;(pros-cons)</td>
<td>2.76</td>
<td>4.75</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Weekly Stress&lt;sup&gt;c&lt;/sup&gt;</td>
<td>26.73</td>
<td>13.34</td>
<td>25.93</td>
<td>13.95</td>
</tr>
</tbody>
</table>

<sup>Note.</sup>  
<sup>a</sup>Higher scores indicate less use of processes.  
<sup>b</sup>Higher scores indicate less self-efficacy.  
<sup>c</sup>Original values are presented for ease of interpretation.  
<sup>d</sup>Higher scores indicate greater pros.  
<sup>e</sup>Decisional balance was not collected at six months.
Table 4

Bivariate correlations between demographic variables, psychosocial constructs and baseline dietary fat intake (n=179)

<table>
<thead>
<tr>
<th>Variable</th>
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<th>2</th>
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<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. % Dietary Fat</td>
<td>-</td>
<td>-09</td>
<td>.03</td>
<td>-05</td>
<td>.20**</td>
<td>.14</td>
<td>.25**</td>
<td>.17*</td>
<td>-10</td>
<td>.01</td>
</tr>
<tr>
<td>2. Gender</td>
<td>-</td>
<td>-.28*</td>
<td>.21*</td>
<td>-.18</td>
<td>-.15*</td>
<td>-.27**</td>
<td>.05</td>
<td>-.05</td>
<td>-.08</td>
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</tr>
<tr>
<td>3. Education</td>
<td>-</td>
<td>-.09</td>
<td>.03</td>
<td>.16*</td>
<td>.01</td>
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<td>-.02</td>
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<tr>
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</tr>
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<td></td>
</tr>
<tr>
<td>9. DB</td>
<td>-</td>
<td>-.09</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. WSI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. BP = behavioral processes; EP = experiential processes; SE = self-efficacy; DB = decisional balance. * p < .05. ** p < .01.

BMI was entered into step 1 of the regression to control for the association between BMI and dietary fat intake. To examine the contribution of each psychosocial variable, scores on behavioral processes, experiential processes, self-efficacy, log transformed decisional balance difference, and the square root transformation of the WSI were entered into Step 2. Finally, the interactions between WSI and each of the constructs associated with the TTM were entered into Step 3 to address whether stress moderates the relationship between the elements of the TTM and dietary fat intake.

The results of this analysis indicated that the model was significant (See Table 5). BMI accounted for 4% of the variance in dietary fat, $F(1,177) = 7.56, p < .01$. After controlling for BMI, the second step as a whole was significant, $F(6,172) = 3.66, p < .01$, accounting for an additional 7.2% of the variance. The interactions as a whole were significant, $F(10,168) = 3.03, p < .01$ but
did not significantly improve the variance accounted for dietary fat intake above BMI and the elements of the TTM. Examination of the variables within the second step revealed that experiential processes was the only significant predictor ($\beta = .20, p < .05$), demonstrating that lower use of experiential processes was related to higher dietary fat at baseline. Additionally, there was a significant interaction between experiential processes and minor stress, ($\beta = .20, p < .03$). This interaction is illustrated in Figure 1. There were no significant interactions between minor stress and the constructs associated with the TTM.

Follow-up simple slope analysis on the interaction revealed that the interaction was significant at higher levels of WSI, $t (174) = 4.00, p < .001$, but not at lower levels of stress, $t (174) = .73, p > .05$. These results indicate that at higher levels of minor stress, more use of experiential processes was associated with a lower percentage of dietary fat intake. In contrast, among individuals who reported lower levels of minor stress there was no significant association between experiential processes and dietary fat.

Table 5

Summary of hierarchical regression analysis examining the psychosocial predictors of dietary fat consumption at baseline

<table>
<thead>
<tr>
<th>Variable</th>
<th>Step One</th>
<th>Step Two</th>
<th>Step Three</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$B$</td>
<td>$\beta$</td>
<td>$B$</td>
</tr>
<tr>
<td>BMI</td>
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<td>.35*</td>
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<td>BP</td>
<td>.02</td>
<td>.02</td>
<td>.01</td>
</tr>
<tr>
<td>EP</td>
<td>.13*</td>
<td>.20*</td>
<td>.13*</td>
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<tr>
<td>SE</td>
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<td>.12</td>
<td>.12</td>
</tr>
<tr>
<td>DB</td>
<td>-1.79</td>
<td>-.03</td>
<td>-2.14</td>
</tr>
</tbody>
</table>

(Table continued)
WSI

BP x WSI

EP x WSI

SE x WSI

DB x WSI

\( R^2 = .04 \) for Step 1; \( \Delta R^2 = .07\) for Step 2; \( \Delta R^2 = .04 \) for Step 3. BP=behavioral processes; EP=experiential processes; SE = self-efficacy; DB = decisional balance. *\( p < .05 \); **\( p < .01 \).

Note: R^2 = .04 for Step 1**; \( \Delta R^2 = .07\) for Step 2; \( \Delta R^2 = .04 \) for Step 3. BP=behavioral processes; EP=experiential processes; SE = self-efficacy; DB = decisional balance. *\( p < .05 \); **\( p < .01 \).

<table>
<thead>
<tr>
<th></th>
<th>.24</th>
<th>-.04</th>
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</tr>
</thead>
<tbody>
<tr>
<td>BP x WSI</td>
<td>.01</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EP x WSI</td>
<td>.09*</td>
<td>.20*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SE x WSI</td>
<td>-.01</td>
<td>-.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DB x WSI</td>
<td>5.16</td>
<td>.09</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1: Interaction effect of minor stress and experiential processes in the prediction of dietary fat intake at baseline

Research Question #2: Predictors of Dietary Change

Participants in the intervention group significantly reduced their dietary fat intake from 31.24% to 19.44% by the six month follow-up, \( t (105) = 13.77, p < .001 \), indicating that the intervention was successful. In order to identify baseline predictors of dietary change, a dietary fat change score was computed for those in the intervention group: baseline percentage of dietary fat minus six-month percentage of dietary fat. Larger numbers were indicative of greater decreases in dietary fat intake.
Bivariate correlations between percent change in dietary fat, baseline variables associated with the TTM, minor stress, and BMI are presented in Table 6. Greater change in dietary fat was significantly associated with higher baseline BMI and, contrary to expectation, less use of experiential processes. The relationship between dietary fat change, minor stress, and the other TTM variables failed to reach significance.

To test research question #2, (i.e., What are the baseline psychosocial constructs associated with the transtheoretical model that predict change in dietary fat intake from baseline to six months for participants enrolled in a dietary intervention? Is minor stress a predictor of dietary fat reduction?), a hierarchical regression analysis was conducted. Just as in the first analysis, the predictor variables were centered and then multiplied to create the interaction terms (Aiken & West, 1991; Holmbeck, 2002). BMI was entered into Step 1, to control for the significant association between BMI and dietary fat intake. Behavioral processes, experiential processes, self-efficacy, log transformed decisional balance difference score, and the square root transformation of the WSI were entered into Step 2. Finally, to examine research question #2b (i.e., Does stress moderate the relationship between the variables associated with the TTM and dietary fat reduction?), the interactions between minor stress and each of the TTM constructs were entered into Step 3.

The results of this analysis indicated that the model was significant (See Table 7). BMI accounted for 5.8% of the variance in dietary fat change, $F(1,104) = 6.41, p < .02$. After controlling for BMI, the second step as a whole was significant, $F(6,99) = 2.24, p < .05$ but did not account for a significant increase in variance over BMI. The interactions in step three were not significant, $F(10,95) = 1.67$, ns, and they did not add significant variance to the model. None of the individual baseline variables of the TTM or the interactions with minor stressor predicted percent change in dietary fat intake.
### Table 6
Bivariate correlations between change in dietary fat, BMI, and TTM constructs (n=106)

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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</thead>
<tbody>
<tr>
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<td>.24*</td>
<td>.12</td>
<td>.25*</td>
<td>.14</td>
<td>-.01</td>
<td>-.04</td>
</tr>
<tr>
<td>BMI</td>
<td>-</td>
<td>-</td>
<td>-.09</td>
<td>.08</td>
<td>.12</td>
<td>.19</td>
<td>.16</td>
</tr>
<tr>
<td>BP</td>
<td>-</td>
<td>-</td>
<td>.63**</td>
<td>.16</td>
<td>-.14</td>
<td>-.06</td>
<td></td>
</tr>
<tr>
<td>EP</td>
<td>-</td>
<td>-</td>
<td>.34**</td>
<td>-.29*</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SE</td>
<td>-</td>
<td>-</td>
<td>.05</td>
<td>.07</td>
<td>.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DB</td>
<td>-</td>
<td>-</td>
<td>.09</td>
<td>.21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WSI</td>
<td>-</td>
<td>-</td>
<td>-.54</td>
<td>-.08</td>
<td>-.41</td>
<td>.06</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Higher numbers indicate larger decrease in dietary fat. BP=behavioral processes; EP=experiential processes; SE = self-efficacy; DB = decisional balance. *p < .05. **p < .01.

### Table 7
Hierarchical regression analysis examining psychosocial predictors of dietary fat consumption (n = 106).

<table>
<thead>
<tr>
<th>Variable</th>
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<th>Step Three</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>β</td>
<td>B</td>
</tr>
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<td>BMI</td>
<td>.50*</td>
<td>.24*</td>
<td>.45*</td>
</tr>
<tr>
<td>BP</td>
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<td>EP</td>
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<tr>
<td>DB</td>
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<td>.03</td>
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</tr>
<tr>
<td>WSI</td>
<td>-.54</td>
<td>-.08</td>
<td>-.41</td>
</tr>
</tbody>
</table>

(Table continued)
Follow-up Analysis

The sample for the previous regression analysis included the 106 individuals with complete data who remained in the intervention group at the six-month follow-up interval. The power rule used in this study (see Participants Section) indicated that 130 subjects are required for adequate power (i.e., .80), indicating that the sample size for the previous regression analysis was inadequate. Therefore, after conducting the analysis as originally proposed, an additional analysis was conducted to determine whether the results were likely the result of a lack of power.

To clarify the results of research question #2, the follow-up analysis was conducted with the entire intervention sample by eliminating the decisional balance questionnaire from the regression. This is a slight modification of the research question, but allows for sufficient power to investigate the remaining elements of the TTM and minor stress. The results of this analysis are presented below.

As reported in the method section, 352 participants were enrolled in the study and 236 (67%) were randomized to the dietary intervention. At the six-month interval, 187 were remaining in the intervention. These participants significantly reduced their dietary fat intake from 31% to 20% by the six month follow-up, $t(186) = 18.56, p < .001$, indicating that the intervention was successful. In order to identify baseline predictors of dietary change, a dietary fat change score was computed for those in the intervention group: baseline percentage of dietary fat minus six-
month percentage of dietary fat. Larger numbers were indicative of greater decreases in dietary fat intake.

Bivariate correlations between percent change in dietary fat, baseline elements of the TTM, minor stress, and BMI are presented in Table 8. Greater change in dietary fat was significantly associated with higher baseline BMI and, contrary to expectation, less use of experiential processes. The relationship between dietary fat change, minor stress, and the other elements of the TTM failed to reach significance.

To test research question #2, (i.e., What are the baseline psychosocial constructs associated with the transtheoretical model that predict change in dietary fat intake from baseline to six months for participants enrolled in a dietary intervention? Is minor stress a predictor of dietary fat reduction?), a hierarchical regression analysis was conducted without the decisional balance questionnaire. Just as in the previous analyses, the predictor variables were centered and then multiplied to create the interaction terms (Aiken & West, 1991; Holmbeck, 2002). BMI was entered into Step 1, to control for the significant association between BMI and dietary fat intake. Behavioral processes, experiential processes, self-efficacy, and the square root transformation of the WSI were entered into Step 2. Finally, to examine whether stress moderates the relationship between constructs associated with the TTM and dietary fat reduction (e.g., research question #2b), the interactions between minor stress and each of the remaining TTM constructs were entered into Step 3.

The results of this analysis indicated that the model was significant (See Table 9). BMI accounted for 2.3% of the variance in dietary fat change, $F(1,185) = 4.27, p < .05$. After controlling for BMI, the second step as a whole was significant, $F(5,181) = 2.97, p < .05$ and accounted for an additional 5.3% of the variance in dietary fat change. The interactions in step three were significant, $F(8,178) = 2.03, p < .05$, but they did not add significant variance to the
model. Examination of the variables within the second step revealed that the experiential processes variable was the only unique predictor ($\beta = .26, p < .01$) of change in dietary fat. None of the interactions were unique predictors of dietary fat change. Although it appears there was a lack of power to detect significant results in the original analysis, these results further demonstrate only modest relations between the TTM variables, stress, and dietary fat change. Interestingly, the results suggest that participants in the intervention who used less of the cognitive processes (e.g., thought less about committing to change) at baseline tended to have greater reductions in dietary fat intake over the course of six months.

Table 8

Bivariate correlations between change in dietary fat, BMI, and variables associated with the TTM$^{a,b}$

<table>
<thead>
<tr>
<th>Variable</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<tbody>
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<td>.15*</td>
<td>.08</td>
<td>.22**</td>
<td>.10</td>
<td>.03</td>
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<tr>
<td>2. BMI</td>
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<td>-.13</td>
<td>.01</td>
<td>.06</td>
<td>.17*</td>
<td></td>
</tr>
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<td>3. BP</td>
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<td>.61*</td>
<td>.28**</td>
<td>-.01</td>
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</tr>
<tr>
<td>4. EP</td>
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<td>.26**</td>
<td>.05</td>
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<td></td>
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<tr>
<td>5. SE</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. WSI</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* BP = behavioral processes; EP = experiential processes; SE = self-efficacy; DB = decisional balance. $^aN=187$. $^b$Analysis does not include decisional balance; $^c$Larger numbers indicate a larger decrease in dietary fat. $^*p < .05$. $^{**}p < .01$. 
Table 9
Hierarchical regression analysis examining psychosocial predictors of the change in dietary fat consumption

<table>
<thead>
<tr>
<th>Variable</th>
<th>Step One</th>
<th></th>
<th>Step Two</th>
<th></th>
<th>Step Three</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>(\beta)</td>
<td>B</td>
<td>(\beta)</td>
<td>B</td>
<td>(\beta)</td>
</tr>
<tr>
<td>BMI</td>
<td>.33*</td>
<td>.15*</td>
<td>.30*</td>
<td>.14*</td>
<td>.29</td>
<td>.13</td>
</tr>
<tr>
<td>BP</td>
<td>-.07</td>
<td>-.08</td>
<td>-.05</td>
<td>-.07</td>
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</tr>
<tr>
<td>EP</td>
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<td>.18**</td>
<td>.24**</td>
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<td>.06</td>
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<tr>
<td>EP x WSI</td>
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<td>-.05</td>
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<tr>
<td>SE x WSI</td>
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<td>.01</td>
<td>.02</td>
<td></td>
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</tr>
</tbody>
</table>

Note. N=187. \(R^2 = .02\) for Step 1*; \(\Delta R^2 = .05\) for Step 2*; \(\Delta R^2 = .01\) for Step 3. BP = behavioral processes; EP = experiential processes; SE = self-efficacy; DB = decisional balance. *p < .05. **p < .01.

Research Question #3: Change in TTM Constructs over Six Months

To address hypothesis #3 that elements of the TTM would change over time for the intervention group as compared to the control group, a 2 (Group: Intervention, Control) by 2 (Time: Baseline-Six Months) MANOVA with repeated measures on time for the TTM variables was conducted for the following dependent variables: self-efficacy, behavioral processes, and experiential processes (Table 10). The decisional balance questionnaire was not included in this analysis since it was not administered at the six-month interval. The sample was the same as that used to test the original research question #2. Post-hoc ANOVA’s were conducted to examine significant effects.
The analysis revealed no significant main effect for time (Wilks’ \( \lambda = .96 \), \( F(3,158) = 2.31 \), ns) or group (Wilks’ \( \lambda = .96 \), \( F(3,158) = 2.17 \), ns). The group by time interaction was significant, Wilks’ \( \lambda = .90 \), \( F(3,158) = 5.89 \), \( p < .001 \).

Three ANOVA’s were conducted on the within subject factors as follow-up tests to the significant interaction. Using the Bonferroni method, each ANOVA was tested at the \( p < .02 \) level. Use of behavioral processes significantly increased in the intervention group, \( F(1,160) = 10.58 \), \( p < .001 \). The experiential processes also significantly increased in the intervention group, \( F(1,160) = 10.24 \), \( p < .01 \). There was no significant difference between the two groups on self-efficacy at six months, \( F(1,160) = 5.17 \), \( p < .05 \).

Table 10

Baseline and six-month means and standard deviations for intervention and control participants on the TTM constructs

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control group (n=57)</th>
<th>Intervention (n=105)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline Mean (SD)</td>
<td>6 month Mean (SD)</td>
</tr>
<tr>
<td>Self-efficacy\textsuperscript{a}</td>
<td>29.75 (8.19)</td>
<td>31.07 (8.02)</td>
</tr>
<tr>
<td>Experiential Processes\textsuperscript{b}</td>
<td>45.58 (11.47)</td>
<td>46.98 (13.7)</td>
</tr>
<tr>
<td>Behavioral Processes\textsuperscript{b}</td>
<td>45.75 (9.94)</td>
<td>46.25 (10.36)</td>
</tr>
</tbody>
</table>

Note. \textsuperscript{a}Higher scores indicate less self-efficacy; \textsuperscript{b}Higher scores indicate less use of processes. \textsuperscript{c}significantly different from baseline, \( p < .01 \).
DISCUSSION

This study examined responses to psychosocial questionnaires of community adults participating in a dietary change program aimed at reducing their dietary fat intake. The goal of this study was to determine whether participant responses indicative of key components of the transtheoretical model including: self-efficacy, decisional balance, experiential processes, and behavioral processes would predict baseline dietary fat and dietary fat reduction. The study also addressed the role of stress as a direct predictor of dietary fat and as a moderator of the relationship between the components of the TTM and dietary fat. Results suggested a modest relationship between the elements of the TTM and dietary fat with limited evidence that stress may moderate this relationship.

A general overview of the results will be presented below followed by a discussion of each hypothesis and the pertinent findings. Research question #1 addressed predictors of dietary fat at intake and the results revealed that participants’ self-reported use of experiential processes was significantly related to dietary fat intake at baseline. Participants who reported more use of experiential processes had lower dietary fat intake and this relationship was stronger at levels of high stress rather than low stress. For example, when experiencing higher numbers of weekly stressors, individuals who used strategies such as ‘I tell myself I can choose to eat a low fat diet’ or ‘I consider articles I have seen about lowering the amount of fat in my diet’ tended to have lower levels of dietary fat than those who used less of these strategies. The association between baseline variables of the TTM and dietary fat reduction, as addressed in research question #2, was less clear. Participants in the intervention group significantly decreased their average dietary fat intake and increased their use of behavioral and experiential processes over the six-month dietary change program. Despite these changes, none of the elements of the TTM proved to be significant predictors of dietary change in the original analysis. However, a follow-up analysis with a larger
sample and adequate power revealed a modest relationship between TTM variables and dietary fat reduction. Furthermore, less use of experiential processes at baseline was related to greater reductions in dietary fat intake at the six-month interval. These findings will be discussed below in greater detail.

**Predictors of Dietary Fat Intake**

The investigation of psychosocial predictors of dietary fat intake revealed that the combination of variables associated with the TTM, BMI, minor stress and interactions between minor stress and the TTM variables accounted for an approximately 15% of the variance in dietary fat intake for participants entering a dietary change program. Although this is a modest amount of variance accounted for, it is comparable to other models investigating psychosocial factors and diet (Glanz, et al., 1998). The significant relationship found between higher dietary fat intake and less use of the experiential processes is difficult to directly compare with previous research because most previous studies examine the association of TTM constructs to stage of change, rather than to changes in a specific health behavior. However, extrapolating from previous literature, if one considers that use of experiential processes tends to be lower in individuals that have higher self-reported dietary fat, then the present results would seem to be consistent (Ounpuu et al., 2000). In short, those who are thinking more (i.e., making commitments, increasing awareness about high fat foods) about reducing dietary fat are more likely to have lower dietary fat intake. The relationship between experiential processes and dietary fat was moderated by minor stress. Individuals who continued to remind themselves of their commitment to dietary change or continued to be aware of the negative impact of dietary fat when experiencing minor stressors were more likely to have lower levels of dietary fat consumption. The reverse was also true, those who did not use the processes as frequently were more likely to have higher dietary fat intake. It may be that those individuals who are using the experiential processes have a higher level of
commitment to behavior change and during times of increased stressful events they are able to use these strategies to their benefit. On the other hand, for some individuals, more stressors may lead to a reduction in the use of these strategies as a result of competing demands (Stetson et al., 1997). For example, individuals may have difficulty eating a low fat diet when dealing with many stressful events and subsequently “give-up” on the diet or use less experiential processes during that time frame. Since this present study does not test the causality of these behaviors, further examination of these experiential processes would be necessary to determine the temporal time frame between stressful events and negative cognitions.

The question remains, why was the experiential processes variable the only significant predictor of dietary fat intake? The hypothesis that greater use of the behavioral processes would predict lower dietary fat intake was not supported. Although individuals had not begun the intervention, one would expect that those who actively engaged in behavioral strategies to reduce dietary fat intake would actually have lower dietary fat consumption. One possibility is that the composite behavioral processes variable may overlook the unique contribution of each individual process. The behavioral processes variable in this study was composed of five different processes (e.g., stimulus control, counterconditioning) and it may be that individual processes are more predictive of actual fat intake than the total score of all behavioral strategies. Regarding self-efficacy and decisional balance, it is unclear as to why these variables were not predictive of dietary fat intake. Higher self-efficacy was related to lower dietary fat intake at the univariate level, but the relationship did not hold in the multivariate analysis. Furthermore, decisional balance was not significantly related to dietary fat intake at the univariate or multivariate level.

Minor stressful events did not independently predict dietary fat intake and except for the experiential processes variable, minor stress did not moderate the relationship between the elements of the TTM and percentage of dietary fat intake. There was a limited range of stressful
events in this sample since a majority of participants endorsed average levels of stressful events. While this supports that the number of events experienced by the participants is similar to other investigations involving the WSI, it may be that higher levels of stress are required to capture the relationship between stress and dietary fat intake. Additionally, recent researchers examining the relation between perceived stress and fatty food intake in adolescents found a modest relationship between stress and increased fat intake (Cartwright et al., 2003). The authors suggest that everyday stress may be more diffuse and therefore likely to have weaker relationships with food intake than more acute stressors (e.g., exam weeks) often used in dietary studies (Cartwright et al., 2003). Given the weak relationships between stress and dietary fat intake and between many the TTM variables and dietary fat intake, it is not surprising that minor stress was not a moderator of the TTM-dietary fat relationship.

**Predictors of Dietary Fat Reduction**

There was not enough power to adequately test the planned analysis for the research question investigating predictors of dietary fat reduction. Therefore, an additional analysis was conducted that slightly modified the original question in order to have sufficient power to detect significant differences. The research question addressed the same predictors of dietary fat reduction but excluded the decisional balance questionnaire. This allowed for investigation of predictors in the entire intervention group, as originally planned, instead of restricting the analysis to only those participants who completed the decisional balance questionnaire.

Participants in the intervention group reported significant decreases in dietary fat from 31% to 20%. With sufficient power, the combination of constructs associated with the TTM, BMI, minor stress, and the interactions between minor stress and the TTM variables accounted for 8.4% of the variance in dietary fat reduction. The experiential processes variable was a unique contributor to dietary fat reduction for participants in the intervention group and the relationship
indicated that those participants who endorsed less use of the experiential processes prior to beginning the intervention tended to have greater dietary fat reductions. This was contrary to the hypothesis that those with more use of experiential processes at baseline (i.e., more awareness, more frequent self-commitment) would have greater reductions in dietary fat. One possibility for these results is that those who had difficulty making self-commitments or who did not pay attention to information about dietary fat prior to the intervention actually benefited more from the structure and support of an intervention.

Another possibility is that these participants had greater room to change their dietary fat intake. The initial cross-sectional analysis on predictors of dietary fat intake demonstrated that those who used less experiential processes tended to have higher dietary fat intake. Given the use of the dietary fat change score as the dependent variable in this analysis, those with higher levels of dietary fat could have the appearance of greater change than those who were already consuming lower levels of dietary fat. For example, someone who was consuming 40% of their calories from dietary fat at baseline and was not using experiential processes such as ‘paying attention to information on dietary fat’ may be able to reduce their fat intake to 28%, whereas someone who was eating 25% dietary fat at intake and successfully reduces to the dietary goal of 20% has the appearance of less reduction, although they did achieve the study goal. Many of the reasons cited in response to the first research question about the lack of relationship between the other TTM variables apply to this analysis. However, it is interesting that despite increases in use of behavioral processes over the six-month interval of the intervention, behavioral processes were not predictive of dietary fat reduction. It may be that the TTM theory is not as effective a model for dietary behaviors compared to other health behaviors. Further discussion of the adequacy of the model will be detailed in a later section. However, it might be interesting to examine the change in TTM constructs in relation to the change in dietary fat. Previous research conducted in primary
care clinics indicated the pattern of cross-sectional associations between psychological factors and dietary fat intake was not the same as that observed longitudinally (Steptoe et al., 2000). The author’s determined that self-efficacy and constructs similar to decisional balance did not predict change in dietary fat but there were significant relationships between changes in the variables.

**Change in TTM Constructs over Six Months**

The hypotheses that elements of the TTM (self-efficacy, behavioral processes, and experiential processes) would change over the course of the intervention was partially supported by the hypothesized increase in behavioral processes over the six months. The behavioral processes include common strategies for changing eating habits such as stimulus control, use of distraction, and social support. Although the dietary intervention did not target the specific behavioral processes construct, it did address and encourage use of many of the strategies. The results suggest that use of behavioral strategies increased for individuals participating in a dietary fat reduction intervention, lending some validity to the behavioral processes construct. It would be interesting to follow the individuals over a longer period of time to determine if relapse in dietary fat change coincided with a subsequent decrease in use of behavioral processes.

Self-efficacy increased for those who participated in the intervention, but it did not approach significance due to multiple comparisons. It was hypothesized that increases in self-efficacy would occur over the course of the intervention but further research would have been necessary to determine the temporal nature of the relationship since one could argue that successful dietary change could lead to increased self-efficacy rather than increased self-efficacy leading to dietary change.

The increase in experiential processes over the six-month intervention was contrary to expectation. In the smoking literature, the most well-researched area of the TTM model, levels of experiential processes are highest prior to the initiation of behavior change (Prochaska et al.,
1991). However, discrepancies between health behaviors (e.g., smoking cessation, exercise, diet) on the patterns of the processes of change were recently reported (Rosen, 2000). Specifically, smoking cessation is best characterized as the termination of a negative behavior and exercise is the initiation of a positive behavior. Dietary fat reduction is a combination of the cessation of a negative behavior (e.g., eating less fatty foods) and initiation of a positive behavior (e.g., eating healthy foods in place of the fatty foods). Rosen (2000) posits that change in dietary fat requires continued use of both processes of change and that there is no taper in the use of the experiential processes. Since decisions about dietary fat intake likely occur several times a day, continued reminders to oneself about issues such as commitment to change and consequences of high dietary fat intake may be necessary to sustain dietary change, lending support to the increase in experiential processes over the course of the intervention.

Although this study was not a formal test of the TTM model, it calls into question the relationship between the TTM constructs and actual health behavior. As stated previously, a majority of the research in this area examines the TTM constructs across the stages of change. This is somewhat problematic given the often-cited critique of the model that the stages of change are tautological (Kristal et al., 1999). Specifically, the definition for each stage of change is based on the health behavior itself. For example, to be in the action stage one must be actively eating lower fat foods. Excluding the difficulties associated with estimating personal dietary fat intake, one would expect the action stage of change to be associated with lower dietary fat. Therefore, it would seem more useful to identify factors other than stage of change that would be associated with specific health behaviors. Similarly to this study, two studies in the smoking literature have attempted to examine the TTM constructs as predictors of smoking cessation (i.e., an actual health behavior) independent of stage of change (Abrams, Herzog, Emmons, Linnan, 2000; Carlson, Taenzer, Koopmans, Casebeer, 2003). The results of these studies also found minimal predictive
value in elements of the TTM above demographic variables and generated significant discussion amongst researchers. Future research examining the TTM constructs in direct relation to health behaviors appears warranted.

**Limitations**

Several methodological issues must be taken into account when interpreting the results of this study. First, the intervention was not developed to test the transtheoretical model and the constructs were not specifically targeted in the intervention. Furthermore, a majority of studies examine the TTM variables through the stage of change concept, which also makes it difficult to compare these results with previous research in the dietary fat area. Therefore, cautious interpretation is required, particularly regarding hypotheses about the utility of the TTM variables as predictors. Second, recent criticisms of percent dietary fat intake as an outcome have implications for understanding and evaluating factors associated with dietary fat intake. Shepherd (2002) argues that percentage of dietary fat is an outcome composed of many different behaviors and is not a behavior in and of itself. For example, one must decrease dietary fat in several food groups and also change food preparation behaviors in order to decrease the percentage of calories from dietary fat. It is possible that one may decrease their dairy and meat sources of fat but may continue to eat high fat snack foods. Although it would be very cumbersome to measure individual dietary behaviors, the variety of behaviors may make it difficult for questionnaires to identify useful predictors of dietary fat intake and reduction. Shepherd raises an interesting point that needs to be addressed before prediction models of dietary fat intake can be improved. The TTM model may need to be adjusted for dietary behavior in order to increase its usefulness in understanding and predicting dietary change.
Conclusion

In summary, there was modest support of variables associated with the transtheoretical model in explaining dietary fat intake and reduction in this study. More frequent use of experiential processes under higher levels of stress was related to lower dietary fat intake suggesting that reminding oneself about commitment to change and other cognitive processes may be important during stressful times. Although less use of the experiential processes at baseline was predictive of greater dietary fat reduction, there was little evidence that minor stress was a useful moderator of the model in explaining dietary fat change. Finally, individuals who participated in the intervention demonstrated increased use of the experiential and behavioral processes.

Given the previously reported low success rates for dietary interventions in healthy populations, it is promising that dietary fat intake was significantly reduced at six months in this study. The success further supports the need to understand and identify factors related to dietary fat intake and reduction. Research on dietary fat intake as it relates to the transtheoretical model is still in the early phases. At this point future research may need to focus on the measurement characteristics of the TTM constructs to ensure that they are adequately capturing the nuances of health behavior change. Determining whether the constructs are associated with objective behavior change rather than subjective motivations would be beneficial in order to adequately test the model. Further research needs to be conducted to determine if the measurement of dietary fat intake is the best way to assess TTM factors associated with interventions. Despite being cumbersome, examination of individual behaviors (e.g., reducing dairy fat or eating lean meats) may be more helpful in understanding how participants decrease their dietary fat intake. Finally, future studies need to establish stronger relations between the TTM constructs and dietary fat change, moving beyond cross sectional research to focus on experimentally increasing self-
efficacy, decisional balance, and processes of change in interventions in order to determine the utility of the model in predicting behavior change.
REFERENCES


VITA
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