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SYSTEMATIC REVIEWS AND META-ANALYSES

The use of psychological methodologies in cardiovascular disease interventions promoting a Mediterranean style diet: A systematic review

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KEYWORDS
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Abstract *Aims:* To evaluate theory-based psychological approaches that have been effective in promoting behavior change in interventions promoting a Mediterranean style diet (MD) for the reduction of cardiovascular disease (CVD) risk.
Data synthesis: A systematic review of primary research articles using PRISMA recommendations was conducted. References were retrieved using keyword searches from MEDLINE via PUBMED and included studies targeted participants at high risk for CVD. Two hundred and ninety one studies were reviewed; however, only six met the inclusionary criteria. Three articles describe the same intervention; therefore, only four were included. Included studies incorporated social cognitive theory, social learning theory, goal-system theory, social ecological theory, selfdetermination theory, and the transtheoretical model of behavior change. Overall, studies were nutrition interventions in clinical settings with participants at high risk for or with CVD.
Conclusions: Results from use of the social cognitive theory and self-determination theory in increasing MD adherence for the reduction of CVD risk and events are encouraging. However, we encourage future long-term interventions focusing on dietary behavior change to provide not only an in-depth description of the psychological methodologies used but also how these methodologies were implemented in order ascertain the most effective theory for promoting dietary behavior change towards patterns of a MD.

Introduction

Obesity and heart disease rates are primary public health concerns in the United States, and there is a current need to understand which interventions are most effective in reducing risk factors for these nutrition-related conditions. The American Heart Association (AHA) provides diet and lifestyle recommendations for preventing cardiovascular disease (CVD), including burning as many calories as you

Acronyms: American Heart Association, AHA; cardiovascular disease, CVD; social cognitive theory, SCT; self-determination theory, SDT; Mediterranean diet, MD; Mediterranean Lifestyle Trial, MLT; transtheoretical model of behavior change, TMBH; Mediterranean diet score, MDS.

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consume and eating a variety of foods from all the food groups. In following these recommendations, weight management and CVD risk reduction should ensue. Based on data from the National Health and Nutrition Examination Survey from 2007 to 2010 and the *2015–2020 Dietary Guidelines for Americans*, the AHA has recently concluded that most Americans are eating below the recommended intakes for fruits, vegetables, dairy, and oils while consuming above recommended amounts of added sugars, saturated fats, and sodium all of which are contrary to AHA recommendations [1,2].

Interventions, including internet-based, are effective in promoting health behavior change [3,4], and efficacy of behavior change increases by more extensive use of theory-based psychological techniques [5]. Interventions promoting healthy food consumption – a principle contributor to health and wellbeing – are approaches to decrease obesity and CVD risk. Thus, it is important to evaluate which theories have been implemented in studies designed to reduce CVD incidence and/or risk factors. A nutrition intervention that has proven effective in improving CVD risk factors and reducing CVD-related mortality is based on the dietary patterns of the Mediterranean region [6–10]. Specifically, nutrition education combined with the supplementation of nuts or extra virgin olive oil in the diets of individuals at risk for CVD have shown effective in reducing the risk of future cardiovascular events [7,11]. Moreover, large cohort studies in Europe have demonstrated that adherence to a Mediterranean diet (MD) is associated with lower mortality rates, reduced blood pressure, improved lipid profiles, and reductions in CVD risk [7,8,12–15]. Researchers are developing protocols for similar studies in the United States [16]. Yet, how theory has been applied to interventions promoting the MD has not been systematically reviewed.

The objective of this systematic review was to evaluate theory-based psychological methodologies that have been effective in CVD clinical trials promoting the dietary patterns of a MD.

Methods

This systematic review followed the recommendations of the 'PRISMA' Statement for Reporting Systematic Reviews and Meta-analyses, which sets minimum requirements for reporting and completing systematic reviews and meta-analyses [17].

Eligibility criteria

This systematic review investigated trials which assessed effects of education in relation to CVD and MD nutrition interventions. Studies were required to explicitly state the specific theory used in the framework, development and/or implementation of the intervention. Review articles were also excluded.

Information sources and searches

A literature search was completed in Medline via PubMed and covered dates from January 1, 1976 until August 1, 2017. Retrieved publications were read to determine appropriateness. Additional studies were identified through a review of references cited by each of the retrieved publications. These studies were identified by evaluating the titles in context of the citation in the reviewed paper.

Study selection

One researcher was responsible for assessing all titles and abstracts and ensuring that full-text articles met selection criteria. EndNote X8 was used as the reference manager [18]. Selected articles were imported into Endnote [18] and then duplicate articles were removed. Exclusion criteria included the following:

- Children or adolescents as primary participants
- Non-CVD related study
- Not a clinical trial
- Non-MD study
- Non-nutrition focused intervention
- Education, behavioral, or psychological theory not specified

Results

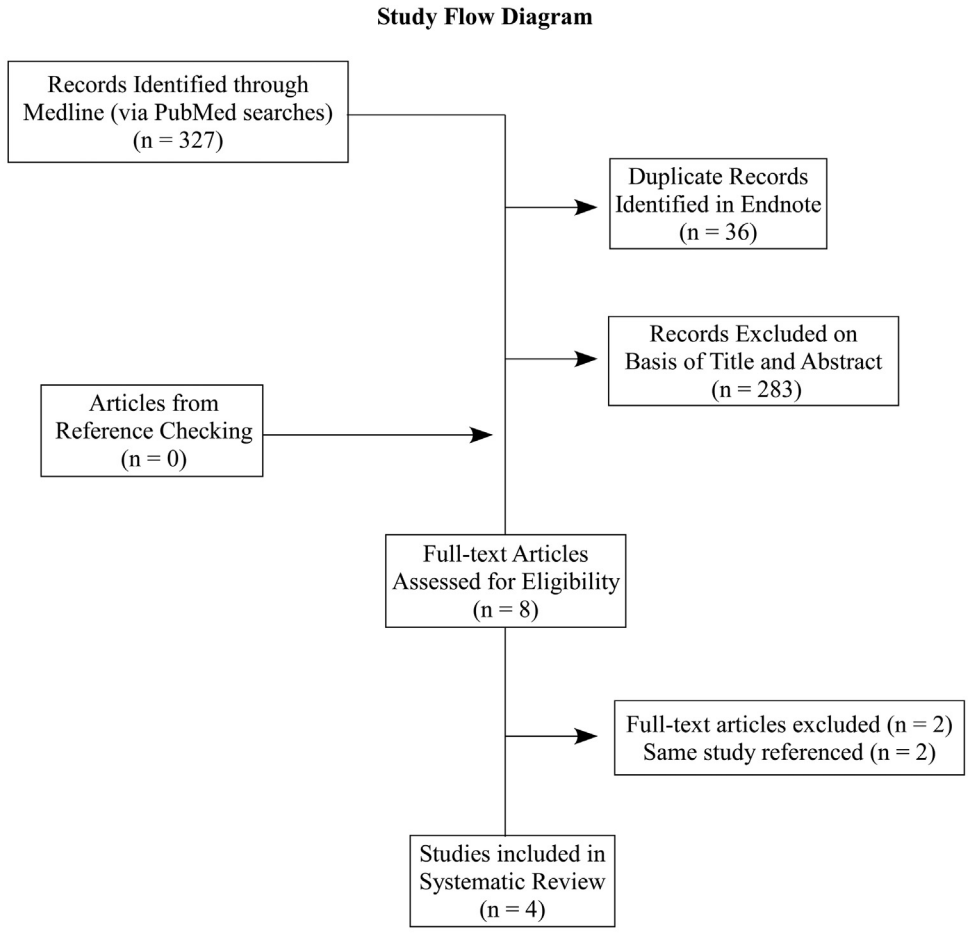
Study selection

The literature searches of Medline via PubMed returned 327 articles which were imported into Endnote (Fig. 1). Thirty six of the records were duplicates leaving 291 unique results meeting the search criteria. After title and abstract review, 285 articles were excluded. Reference review of the remaining 8 articles resulted in 0 additional articles with titles that met the inclusion criteria. Thus, a total of 8 articles were available for full-text review. Three of the articles represented the same study; therefore, only the primary article which discussed the theory was included. Four articles described specific theories which had been incorporated in studies involving the diets or lifestyles specifically designed to reduce CVD risk factors using the MD.

Characteristics of included studies

The characteristics of the four studies include: participants; theory; intervention; and major findings (Table 1). The major distinction between the studies are the psychological methodologies, or theories, used in the interventions. One study focused on using the transtheoretical model of behavior change (TMBC) to implement a MD while a second study used the TMBC in conjunction with the social learning theory [19,20]. Toobert et al., used the Social Cognitive Theory (SCT) in a MD

A



B

Search Strategy

1	(“education” OR “theory” AND “dietary intervention” AND “Mediterranean diet” AND “Cardiovascular disease”)
2	(“nutrition education” OR “theory” AND “Cardiovascular disease” AND “Mediterranean diet”)
3	(“nutrition education” OR “theory” AND “Mediterranean diet”)
4	(“Mediterranean diet” + “Education” + “Nutrition” + “Intervention” + “Disease”)

Figure 1 **Study flow diagram and search strategy**. (A) The study flow diagram detailing inclusion and exclusion of articles from the systematic review and (B) the search strategy terminology.

intervention in conjunction with goals-system theory and social ecological theory; however, the results of this study were not published in the article retrieved by the inclusion search [21]. Social learning theory was the primary individual educational theory incorporated [22]. The final study implemented the self-determination model to assess how the interaction of nutrition education and the self-determination theory (SDT) impacted different genders attempting to implement a MD [23].

The number of participants in the studies ranged from 58 to 279 and included men and women except for one study [21]. One of the articles provided only the protocols and the theory behind the research being conducted, and the reporting of the study findings were not found in the literature review [21]. Overall, four studies consisted of nutrition interventions using experimental educational trials [19–21,23].

Risk of bias within the studies

Risk of bias using the Cochrane Collaboration’s tool [24] was not assessed because 3 of the 4 studies did not provide data about retention or blinding in the given articles.

Table 1 Characteristics of included studies.

Study	Setting	Baseline Participants	Theory	Study Details	Outcomes
Siero et al., 2000 [19]	Netherlands	Mean Serum Cholesterol 6 −8 m/mol Two additional CVD risk factors 55% female Low income $n_0 = 262$	Transtheoretical Model of Behavior Change	Length: 16 weeks Three groups: control, meetings with MD education, and meetings plus tailored education MD Education consisted of three meetings Assessed food intake and attitudes	Fish intake increased in non-control groups Education improved attitude Tailor-based education showed no additional benefits
Logan et al., 2010 [20]	Belfast, UK	$n_0 = 58$ $n_{12} = 36$ CVD diagnosis	Social Learning Theory Transtheoretical model of behavior change	Length: 12 months Randomized trial Control group v MD education using nutrition counseling v MD education using behavioral counseling MD compliance assessed using MDS Biochemical variables assessed	Increase in MDS and biochemical markers in all groups MD education using nutrition counseling and behavioral counseling had no statistical impact
Toobert et al., 2002 [21]	Oregon	279 postmenopausal women Type 2 diabetes diagnosis for at least 6 months Under age of 70	Social Cognitive Theory Goal-systems Theory Social Ecological Theory	24 months MD and lifestyle management program At 6 months, divided into program with lay leaders or personalized social support Behavior and physiological endpoints	Outcomes not reported
Leblanc et al., 2014 [23]	Quebec, Canada	n = 123 (52% men) Premenopausal women Slightly elevated LDL-C or total-C to HDL-C ratio>5 At least one other symptom of metabolic syndrome	Self-Determination Theory	Length: 12 weeks + 6 months follow-up Group education (3 sessions) and individual counseling (3 sessions)	Both men and women showed physiological and adherence improvements, but men showed greater improvements Men maintained eating behaviors and physiological improvements longer than women

Theories

Table 2 provides a brief overview of included psychological methodologies.

Transtheoretical model of behavior change

One phycological technique, the TMBH, is a model or framework that has been applied to education development in nutrition interventions. This model focuses on behavior change being a dynamic process occurring in stages. These stages include pre-contemplation, contemplation, preparation, action, and maintenance [25,26].

Siero et al., conducted a study in a socio-economically deprived region of the Netherlands using the TMBH to promote behavior change in a population with high risk of CVD [19]. Participants had a mean serum cholesterol between 6 and 8 mmol/l and two additional CVD risk factors. Exclusionary criteria were age (greater than 70 years old), diabetes mellitus diagnosis, and use of medications [19].

Participants were divided into three groups. Group A_1, the control group, received a leaflet with the Dutch national nutrition guidelines which is the usual care received in the Netherlands. Group A_2 received nutrition education in a group setting. Group A_3 received the same group education plus additional stage-matched education. Groups A_2 and A_3 were all from Winschoten County to prevent information on the MD spreading to the control group (Group A_1). Participants from Winschoten Country were divided into ten subgroups of ten before five subgroups were randomly selected to receive the additional tailored education [19].

Groups A_2 and A_3 received three 2-h group education sessions. The first education session focused on increasing MD knowledge. The second session promoted a positive attitude towards the MD and the final session dealt with improving skills to prepare a MD. All 3 groups received margarine to replace butter and cream in the diet [19].

Participants in group A_3 were mailed a tailored letter and received group education. Based on baseline measurements and a psychological questionnaire, the letter

Table 2 Theory-based psychological techniques overview.

Theory	Theory Overview	Theory Strengths	Theory Weaknesses
Transtheoretical Model of Behavior Change [19,20,25,26]	Behavior change theory 5 stages of change individuals go through in the process of developing new behaviors Model used to develop stage-based education, supporting each stage of change	Individualized education/ intervention Education/intervention changes as participants progresses through stages of change	Time consuming for study investigators
Self-Determination Theory [23,27]	Motivational theory Rationalizes human growth with inherent psychological needs: competence, relatedness, autonomy When psychological needs are met, self-motivation increases	Links growth to needs Needs impact integration Practical implications	Does not account for personal extrinsic motivators Some individuals need team support
Social Cognitive/Learning Theory [20,21,29,30]	A learning theory Learning occurs between stimulus and response Behavior can be derived from observational learning Social learning falls under SCT umbrella and the community involvement in planning, implementation, evaluation, and management is crucial	Encourages people in community to become involved Multiple avenues for education Increases reach of health professionals	Requires willing volunteers to lead Individuals who are non-social may feel overwhelmed
Goal-Systems [21,31]	A cognitive and motivational theory Links higher level goals to lower sub-goals which are needed to achieve higher level goals	Encourages the use of smaller, achievable goals to reach larger, more difficult goals Provides connections between cognition and physical manifestation of goals and achievements	Cognitive properties partially determine motivational properties
Social Ecological Theory [21,31–34]	Theory based framework Frames community interventions to examine the relationship between the individual and the broader community	Links environmental factors to behaviors and decisions Assessing interrelations of both personal and environmental factors	Model is most effective when all five levels are incorporated into the intervention

contained information that would support the participant based on attitude, self-efficacy, social norm, and stage of change. Stage of change was assessed at both baseline and 16-weeks and was based on the consumption of fish, fruit, and vegetables. The effects of education were statistically evaluated to determine the impact on behavior and attitude [19].

Participants who received nutrition education had a more positive attitude regarding fish consumption ($p < 0.001$). This was evident in evaluations regarding attitude and social norm. Self-efficacy regarding fish consumption, however, was not statistically different. Education also improved the intent of fish consumption ($p < 0.001$). Education moved participants from the contemplation stage to the preparation stage where participants were planning how to incorporate this into lifestyle changes [19].

When assessing fruit and vegetable consumption, the interventions did cause a shift in stage of change from preparation to action ($p < 0.05$), and education influenced attitudes toward fruit and vegetable consumption. Participants who received tailored nutrition showed consistently higher numerical scores than the group education only; these differences were not statistically significant. Overall, there was no evidence that individually tailored education based on stage of change was more effective in changing behavior towards the MD than group education [19].

Self-determination theory

The SDT is a motivational theory that rationalizes how human growth tendencies and inherent psychological needs impact self-motivation and integration. Three needs have been identified under this model: the need for competence, relatedness, and autonomy [27].

A Canadian study used constructs of the SDT in a 12-week MD intervention that evaluated eating behaviors, anthropometric, and metabolic variables. All participants, 64 men and 59 premenopausal women, showed signs of CVD risk factors. The primary objective was to assess differences between genders [23].

Participants received three group education sessions which covered MD principles, cooking lessons, and a potluck dinner. Additionally, participants had three individual counseling sessions and four follow-up phone calls. Fasting blood samples, anthropometric and blood pressure measurements, dietary intake assessments (Food

Frequency Questionnaire) [23], and the Three-Factor Eating Questionnaire [28] were all conducted at baseline. These assessments as well as perceived MD adherence assessments were conducted at 12-weeks, 3-months post intervention and 6 months post intervention [23,28].

At 12-weeks, 3-months post intervention, and 6-months post intervention men had a significant decreases in both baseline energy density ($p = 0.02$) and in energy intake from carbohydrates ($p = 0.03$) and lipids ($p = 0.01$). When comparing MD scores, both men and women achieved significant increase in scores over time ($p < 0.0001$); yet, the differences between men and women were not significant. However, food intake changes between genders were observed for red meat ($p = 0.03$) and whole fruit ($p = 0.04$), where men showed greater changes towards following the MD [23].

When assessing anthropometric measures, men had significantly lower waist circumference at the end of the intervention and maintained it post-intervention. Women had a lower waist circumference at the end of intervention; however, it tended to regress post-intervention. Positive changes in lipid profiles were more pronounced in men during and post-intervention. Overall, the authors suggest that the 12-week intervention modeled on the SDT may be more beneficial for men than women [23].

Multi-model approach

The SCT builds on concepts of behaviorist learning theories by suggesting that processes also occur between stimulus and response and that behavior can be derived from observational learning. The social learning theory falls under the umbrella of the SCT. The social learning theory requires community involvement in the planning, implementation, evaluation, and management of the system [29,30].

Toobert et al. began diabetes management research in the northwest United States, using just the SCT; however, over time other behavioral models, such as the goal-system theory [31] and social ecological theories [21,32–34], were incorporated. This combination was developed to address the hindrances and support factors which impact behavior change. It was then applied to a 24-month long nutrition education program that followed 279 postmenopausal women with a diagnosis of type 2 diabetes, putting them at high risk for CVD [21].

The control group contained 123 participants and the Mediterranean Lifestyle Trial (MLT) group 156. At 6 months, the MLT group was further separated into two groups: one group which was engaged in lay person-led peer group support ($n = 78$) and a second group in computer-based community resources ($n = 78$) [21]. Participants in the MLT group underwent a three-day retreat where participants were educated by registered dietitians on the MD. Dietitians individualized carbohydrate and fat recommendations to optimize blood glucose and lipid concentrations. Participants were also educated and encouraged to replace butter and cream with olive oil. Additionally, physical activity, stress management, and community engagement was encouraged. After 6 months, the lay-led group continued to have weekly meetings for 6 months, bi-weekly for the following 6 months, then finally monthly for the remainder of the study. These meetings included physical activity and support groups.

The computer resource group took the Chronic Illness Resources Survey [35] to determine what resources would be most helpful [21]. Individual support took place four times over 18 months and these sessions included motivational interviewing and computer-based assessments. Most education and interactions focused on both supportive and interfering factors as these are primary constructs of both the SCT and the social ecological theory. Statistical analyses comparing the impacts of the education model were not presented as a part of this article [21].

The final study, conducted in Belfast, United Kingdom, used a multi-model approach incorporating the social learning theory and the TMBH. Fifty eight participants were randomized into three groups: conventional dietetic advice, advice for MD using nutritional counseling, and advice to implement MD with behavioral counseling. The conventional dietetic advice group received conventional dietary advice during admission. The MD nutritional counseling group were given detailed information on how to follow the MD. Home visits from the dietitians occurred in months 1, 2, and 4. The MD behavioral counseling group had a similar visitation pattern with the dietitian; however, behavioral counseling was used to disseminate the MD information. These interventions were tailored to the individual based on the individual's readiness [20].

Adherence to a MD was evaluated using MD score (MDS) assessed through a validated questionnaire. While all three groups showed significant increases in the MDS, there was no statistical difference between the groups at 6- or 12-months. No statistical differences between the groups were seen in vitamin C, oleic acid status, and eicosapentaenoic acid status despite within group statistical improvements in these biochemical markers. These results suggest that neither the nutritional counseling nor the behavioral counseling provided in this study had any significant impact on adherence or biomarkers [20].

Discussion

There is a lack of published data linking the psychological methodology of specific theories used in MD nutrition education targeting participants at high risk for CVD. Many of the studies conducted either did not have a formal nutrition education program or the research did not specifically address which theory/theories were incorporated. In addition, few theories have been adequately documented to assess their effectiveness for MD education (Table 3). The current literature search found few published studies that discussed combining specific theories with nutritional interventions for CVD that promote a MD when there is significant evidence to support that the dietary pattern is cardioprotective [7,8,12–15,36]. Nevertheless, it is expected that education strategies successfully implemented in the previously mentioned studies would

Table 3 Theory-based psychological technique evaluation in studies reviewed.

Study	Theory	Strengths of Theory	Weaknesses of Theory
Siero et al., 2000 [19]	Transtheoretical Model of Behavior Change	The method showed improved adherence to MD	Individualized education was not more effective than less demanding techniques
Logan et al., 2010 [20]	Social Learning Theory/ Transtheoretical Model of Behavior Change	Improvements in adherence and biological variables	Results were not statistically different than control group showing additional efforts may not have been more effective than traditional efforts
Toobert et al., 2002 [21]	Social Cognitive/Goal-Systems/ Social Ecological Theory	No results were provided in the study	Study results were not provided
Leblanc et al., 2014 [23]	Self-Determination Theory	Adherence to MD and biological markers improved	Males showed greater improvements than females using this theory

be effective when educating on the MD to populations at high risk for CVD.

Two studies incorporated tailored experiences for participants; however, both studies were unable to show statistical benefits of this individualized effort [19]. Similar results were seen through basic MD education or using conventional methods of education. Therefore, the TMBH may not be the most beneficial for MD nutrition interventions as it requires more time and has shown few fruitful results.

The SDT was reported to be more beneficial for MD adherence and anthropomorphic results in males. While the SDT worked for some individuals, other individuals needed the support of a team. Encouragement and engagement by the community can spur the individual on to success just as much as personal drive [23].

In addition to the lack of published theory-based psychological approaches, there are other limitations to this current review. Significant outcomes in the included studies, such as changes in waist-circumference and lipid profiles, could be as a result of many other variables other than the specific psychological method used. In order to ascertain if these significant changes were a direct result of the theory used, studies with large cohorts of participants must be conducted to validate these findings. Also, interventions included in this study were short term. To adequately assess if specific psychological techniques influence adherence to a MD and the occurrence of cardiovascular events, long-term interventions are needed.

Conclusions

Based on the given systematic literature review, a combination of 5 different psychological techniques have been used to evaluate education designed to reduce CVD risk factors in conjunction with a MD nutrition intervention: TMBH, SCT in conjunction with goal-system theory and social ecological theory, the SDT, and social learning theory with the TMBH. Utilization of the majority of behavioral/education models revealed no statistical advantages. The SDT was more successful for men than women. Even though the results of the study combining the SCT, goal-system theory and social ecological theory combination were not published with the project methodologies [21], other have reported that the SCT was successful when implemented in community and clinical trials in non-MD studies [37–40]. Importantly, behavioral change techniques which have been shown to increase dietary intervention effectiveness align with both the SCT and the SDT [41]. Recent studies have also reported that the SCT and SDT were affective in promoting health behavior change [42–50]. These studies provide encouraging insight to psychological techniques that could be beneficial in increasing MD adherence for the reduction of CVD risk and events. However, these studies were limited in number and were short-term in duration. Therefore, we encourage future long-term interventions focusing on dietary behavior change to provide not only an in-depth description of the psychological methodologies used but also how these methodologies were implemented in order ascertain the most effective theory for promoting dietary behavior change towards patterns of a MD.

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