



# Associated Factors with Dietary Adherence among People with Cardiovascular Metabolic Risk Factors based on PRECEDE Framework: a Mixed-Method Study

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## ABSTRACT

**Aims** Difficulty in adhering to the recommended diet is a common problem among most people with metabolic risk factors of cardiovascular diseases. The purpose of this study was to identify factors associated with dietary adherence among people with metabolic risk factors based on a psychological theory.

**Materials & Methods** This research was a mixed-method study. In the qualitative phase, 50 people who had at least one metabolic risk factor and were referred to the diabetes units of Karaj health centers were interviewed, and the interviews were analyzed using NVivo10. In the quantitative phase, a survey was carried out to investigate factors associated with dietary adherence. The data were analyzed using structural equation modeling via AMOS18.

**Findings** Personal factors especially perceived self-efficacy ( $\beta=0.49$ ;  $p=0.001$ ) and perceived barriers ( $\beta=-0.33$ ;  $p=0.001$ ), were the most important predictors influencing dietary adherence. However, the findings of interviews and surveys were not aligned with structural and social factors. The structural factor was perceived as a deep factor influencing healthy eating behaviors in the qualitative phase, but the social factor was a significant predictor in the quantitative phase ( $\beta=0.67$ ;  $p=0.001$ ).

**Conclusions** Only 51.07% of people with at least one cardiovascular metabolic risk factor adheres to healthy eating behaviors. Although personal determinants are the most dominant contributors of dietary adherence among people with cardiovascular metabolic risk factors, social and structural factors should be considered to enhance dietary adherence.

**Keywords** Healthy Eating Behaviors; Theoretical Model; Type 2 Diabetes; High Blood Pressure; Hyperlipidemias

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## Introduction

Cardiovascular diseases (CVDs) are the number one cause of death around the world. Per year, many people die from CVDs more than any other cause [1]. According to WHO, 17.9 million people died from CVDs in 2016, representing 31% of all global deaths [1]. It is predicted that by 2030, roughly 23.6 million people will have died from CVD, especially coronary heart disease and stroke [2]. It is estimated that 54% of deaths related to non-communicable diseases in the Eastern Mediterranean Region are due to cardiovascular diseases. The prevalence of cardiovascular diseases is due to sedentary lifestyles and common risk factors, such as hypertension, diabetes, and hypercholesterolemia [3].

In addition to obesity, diabetes, hypertension, and dyslipidemia, unhealthy dietary patterns (i.e., processed foods, added sugars, excessive use of salt, unhealthy fats, low consumption of fiber, fruit, and vegetables) develop CVD [4]. On the other hand, healthy eating plays a crucial role in managing metabolic risk factors, such as diabetes, hypertension, and dyslipidemia. At the end of the twentieth century, it was reported that management of behavioral risk factors could only prevent 40% to 70 % of all premature deaths, one-third of all cases of acute diabetes, and two-thirds of chronic diabetes [5]. Moreover, since the beginning of the twenty-first century, behavioral patterns are still the unique factors affecting health [5]. Researchers have repeatedly demonstrated that people find it difficult to follow dietary recommendations [6]. Barriers to dietary adherence are in a wide range of psychosocial issues, including intra- and interpersonal factors, economic constraints, cultural preferences, social influences, environmental conditions, and myriad psychological factors [6]. The research identified the factors related to dietary adherence, but those did not use a theory to understand health behavior change based on psychosocial processes [7, 8]. Indeed, interventions based on theory specify the presumed influences on behavior mediators that should be changed in interventions [9]. The PRECEDE framework was developed by Green *et al.* [10]. In this model, the factors associated with behavior are classified as predisposing, reinforcing, and enabling [10]. Predisposing factors are antecedents to behavior that motivate the behavior and include knowledge, attitudes, beliefs, preferences, and self-efficacy [10]. Reinforcing factors follow a behavior that provides a continuing reward for the persistence or repetition of the behavior. They include social support, peer influence, significant others, and favorable behavioral outcomes [10]. Enabling factors are antecedents to behavioral or environmental change and include programs, services, essential resources and the new skills [10]. The use of the PRECEDE model is a logical model which is used to analyze the determinants of a behavior [11]. Identifying behavioral determinants will help health planners to design

future interventions and select the most appropriate methods and applications in order to address the determinants and enhance dietary adherence [11]. This study investigated the factors associated with dietary adherence among people with cardiovascular metabolic risk factors based on the PRECEDE framework.

## Materials and Methods

This study was mixed-method research (qualitative and quantitative). A sequential transformative design with the exploratory sequential features was used since the authors applied the PRECEDE framework and carried out the qualitative study before the quantitative study.

### The Qualitative phase

The participants in the qualitative phase were 50 people who had at least one cardiovascular metabolic risk factor for at least one month. They were selected using purposive, and convenience sampling with maximum variation in terms of (gender, age, education level, occupation, and type of disease) among the people referred to the diabetes centers of Karaj-Iran in 2014. The people with cardiovascular disease and stroke and those who were illiterately excluded from the study.

Directed content analysis was used to obtain the participants' perceptions about the causes of following or not following their healthy eating behaviors. The directed content analysis aims to validate or extend a conceptual, theoretical framework [12]. In this approach, an initial coding begins with the existing theory, and the theory helps to focus on research questions [12]. If one's blood pressure at two different times was equal to or greater than 140/90mmHg, they were diagnosed with hypertension. If the level of one's fasting blood sugar (FBS) was  $100 \leq \text{FBS} < 126 \text{mg/dl}$ , they were diagnosed with pre-diabetic. If their FBS level two times was equal to or higher than 126mg/dl, they were diagnosed with diabetes. The people with triglyceride levels higher than 200mg/dl, cholesterol equal to or higher than 200mg/dl, LDL cholesterol higher than 130mg/dl, and HDL cholesterol equal to or less than 40mg/dl was diagnosed with hyperlipidemia [13]. Data collected via semi-structured interviews for six months. The interview guide consisted of open-ended questions based on subcategories of predisposing, enabling, and reinforcing of the PRECEDE framework [14]. The interviews continued until data saturation and were recorded, transcribed, reviewed, coded, and immediately analyzed using NVivo 10. Ethical approval was obtained from the Ethics Committee of Shahid Sadoughi University of Medical Sciences. All patients who participated in the study were informed about the research objectives, and informed written consent was obtained from all of them. The participants were reassured about the confidentiality and anonymity of their information.

The important statements were underlined to identify the initial codes in the interview text to carry out the directed content analysis. In the next phase, these initial codes were placed into subcategories of the PRECEDE model and then into its three main categories, including; predisposing (personal) factors, enabling (structural), and reinforcing (social) factors. Placing the codes in subcategories was based on the PRECEDE model's ecological and educational diagnosis phase [14]. For considering rigor, prolonged engagement in the field from September to the end of March 2014 provided an opportunity to collect the data. To ensure that the analysis reveals the patients' perceptions, member checking was performed during the data collection. To confirm the dependability and conformability of the data, the initial codes were placed into the subcategories and categories of the educational phase of the PRECEDE model, and four experts in the field of health education checked its accuracy. The authors of this article, who were expertise in health education and familiar with the PRECEDE model, investigated the external check of the data. In addition, correspondence with Professor Green, the designer of PRECEDE model, was done to investigate the external check. Peer checked were also carried out by two experts in health education who had previous experience with the PRECEDE model. Maximum variation of sampling also confirmed the conformability and credibility of the data. In the predisposing part, patients were asked how they understood the importance of healthy eating in controlling their disease. What were their tendencies towards healthy eating? How much did they consider themselves at risk for their disease complications, or did they take their disease complications seriously and follow healthy eating? Obstacles and benefits of healthy eating were asked and finally asked how much was their ability to follow healthy eating despite the existing obstacles? In the reinforcing factors part, the role and importance of supportive people in following healthy eating and patients' feelings after following healthy eating were asked. In the enabling factors section, they were asked about the skills, facilities, and the availability and accessibility of services for adhering to healthy eating.

#### The Quantitative Phase

The participants were selected through mixed-method sampling; the Karaj city was divided into three regions: north, central, and south, representing high, medium, and low socioeconomic status. Through a list of the diabetes centers, two centers were randomly selected from each region. In total, six diabetes centers were selected. The sample size was also calculated based on Waltz *et al.*; they suggested 3-10 subjects per item of the questionnaire [15]. Five subjects were selected for each item of the questionnaire, and a total of 450 patients participated.

A researcher-made questionnaire generated from the qualitative phase was used to assess the relationship between predisposing, enabling, and reinforcing factors with healthy eating behaviors. The reliability of the items was assessed by internal consistency and test-retest. The score of face validity was computed based on each item's impact score, and a score equal to or greater than 1.5 was considered reasonable [15] by ten patients. Ten experts in health education and nutrition also investigated the content validity index (CVI) and content validity ratio (CVR). The score of CVI was calculated based on the simplicity/clarification and relevancy of each item, and a score equal to or higher than 0.79 indicated an appropriate content validity [15].

Moreover, the score of CVR was computed based on the necessity of each item, and a CVR score equal to or higher than 0.52 was envisaged a good content validity [15]. The construct validity of the questionnaire was conducted via exploratory factor analysis and confirmatory factor analysis [15]. Varimax rotation was used for factor analysis, and three factors, including predisposing, reinforcing, and enabling, were confirmed for the questionnaire. Cronbach's Alpha coefficient (0.7) indicated a good internal consistency for this questionnaire. Also, Spearman Brown's correlation coefficient (0.76) showed good test-retest reliability. Second, the questionnaire included three sections; demographic characteristics, clinical outcomes, predisposing, enabling, reinforcing factors and eating behaviors were created. The questionnaire of Isfahan Cardiovascular Center used for measuring eating behaviors and for scoring the behaviors, world food index (GDI), fat consumption index (FCI), and meat consumption index (MCI) were used [16].

All participants were justified about the research method, confidentiality, and goals, and informed written consent was obtained from them. Patients completed the self-report questionnaires.

The data analyzed by using SPSS 17, and the structural equation model was applied using AMOS 18 software.

## Findings

### Qualitative Findings

The mean age of participants in this phase was  $46.5 \pm 5.97$  years. All interviews were analyzed, and 176 codes were placed into subcategories and three main categories of the PRECEDE model.

#### *Predisposing (personal) factors*

**Knowledge:** Most participants found out that their unhealthy eating habits could result in health problems such as diabetes, obesity, dyslipidemia, and hypertension. They realized the benefits of having a sensible eating plan and its importance in controlling their health problem. Most participants were unaware of healthy and unhealthy foods. The existence of dietitians at the diabetic centers helped them to increase their understanding of healthy

foods. "I did not know how to control my lipid level using diet. Since I attended the Diabetic Center, the dietitian improved my awareness". (Female- 43 Aged- metabolic syndrome).

**Attitude:** Most participants had a positive attitude towards unhealthy foods. For example, they would prefer fried and fatty foods to boiled and steamed ones. Also, they tended to excessive use of salt and sugar. Some participants, especially women, preferred to use fat instead of oil for cooking. They believed that oil would stick to coronary arteries and could be harmful to their health. E.g., "I am always taking fat for cooking because oil sticks to the oven, and it is hard to clean it. On the other hand, fat can be cleaned easier when it shed gas. (Female, 47-years-old, prediabetes and hyperlipidemia)".

**Susceptibility and severity perceived:** The people with diabetes and metabolic syndrome were more worried about complications related to diabetes such as lower limb amputation, blindness, and kidney failure compared with other participants. If people with diabetes saw these complications in their surroundings, they would perceive more risk and adhere to healthy eating. "I am mainly worried about my diabetes as my father also had diabetes; he suffered a lot and lost his legs and went blind, and died from it, so I try to adhere the healthy diet forever" (Male – diabetic and hyperlipidemia)

**Perceived benefits:** Most participants believed that adhering to healthy eating behaviors controlled their health problem, prevented or reduced medication use, managed their weight, prevented or decreased complications associated with their illness, reduced the cost of health care. "I think that being on a diet leads to low fat and blood sugar, low blood pressure, losing weight properly, and being fit when I was overweight, it caused high fat and blood sugar. When I heard that I am a diabetic, I do not eat sugar, eat more vegetables, and eat red meat and fatty foods less; sometimes, I eat barley bread. (Female, 43-years-old, Metabolic Syndrome)".

**Perceived barriers:** Many participants found out the reasons for poor adherence to healthy eating, such as the dietary difference between patient and family, diet fatigue, feeling weak when dieting, tight schedules, laziness, psychological problems such as depression, stress, and anxiety. In addition, most interviewees believed that they were exposed to contradictory nutrition messages associated with ambiguity about nutrition recommendations. "When I cook for my family, I cannot resist not eating; it is a little hard to cook two different types of food at the same time forever. (Female, 43-years-old, Metabolic Syndrome)".

**Self-efficacy:** The people with diabetes, metabolic syndrome, hypertension, and hyperlipidemia declared more self-efficacy for adhering to healthy eating than those who had prediabetes, prehypertension, and low blood cholesterol or triglyceride. Indeed, the diabetes patients, due to fear

of complications related to their illness, had more self-efficacy. However, most patients stated low self-efficacy and adherence to healthy eating at social events, parties, and traveling. Some participants believed that they indulged in foods under pressure and when they were alone at home. "Unfortunately, the party itself is a problem, and you are a force to eat. On the one hand, stress makes me eat more; the food which my wife prepares for themselves and puts on the table was just too tempting; when I am at home and have nothing to do, I need to eat and be full. A sometimes, when I am so hungry, I overeat (Male, 49-year-old, metabolic syndrome)". Moreover, most participants believed that they could not maintain dietary adherence regularly. "When my doctor says that my blood sugar and lipid is normal, so I am not going to maintain my regular diet because I think my illness is improved, and I do not have any problem so that I can eat everything (Male 49-years-old, Metabolic Syndrome)".

**Enabling (structural) factors**

**Availability and Accessibility to Resources:** The majority of interviewees believed that having access to a dietitian at the diabetes center was very helpful to increase their knowledge about healthy foods. In addition, most of them stated the lack of educational materials such as a booklet or brochure about healthy foods. They said that at the diabetes centers, the dietitian only gave them a sheet of healthy foods that did not include enough information. Some women or their husbands mentioned the lack of healthy cooking workshops to prepare healthy food. "The screening program at the Diabetes Center is so good, if this is not, I have no idea that my blood lipid and sugar is high, the free diet consultation which the dietitian gave it to the patients is so good and give us more information, but if the instructions become like a booklet, I was most interested in reading them. (Female, 52 years old, diabetes, and hyperlipidemia)".

**New skills:** Although many participants benefited from necessary awareness to choose healthy foods, they could not read food labels and calculate their daily calorie needs. Moreover, some claimed that they did not have the essential skills to plan healthy regimes regularly. Some women or their husbands said that they did not know how to prepare healthy meals, or they indulged in cooking and served plenty of food for the family members. "One problem is that in the house my wife cooks too much food, she inherited it from her mother, and she serves too much food for all of the family members, and we will eat all of them, this is a very bad habit. (Male, 37 years old, hyperlipidemia)".

**Rules and Policies:** The high price of healthy food was one of the main contributing factors for not adhering to healthy eating. "If someone wants to follow his diet should have a good financial situation, for example, the dietitian told me to eat white meat, but I cannot purchase them regularly, the cost of fish,

sesame oil, and canola oil are too high. (Female, 43 years old, diabetes)". Furthermore, most respondents believed that there were fatty foods, soft drinks, and sweets at parties and celebrations. So, they could not adhere to a healthy regime at these events. They also believed that there were overly processed foods and fast foods in society, especially young families willing to consume them. In addition, some participants stated that places, which have sold healthy foods such as low-fat dairy products, healthy bread, all kinds of fresh vegetables, were not easily accessible and had to commute a long distance to purchase healthy foods. "Unfortunately, the party itself is a problem, Fried and fatty foods, all kinds of jellies, drinks, were found in these parties, you cannot be on a diet and do not eat in these situations (Male, 49-year-old, diabetes)".

Moreover, some interviewees believed that one of the main reasons for their health problems was the low quality of foods in markets. They believed that the use of artificial fertilizers, consumption of processed foods and additives, the use of hormones in food production, and fake foods had increased their chances of getting metabolic diseases. Many participants also felt that the authorities did not usually control the safety and quality of foods. "Nowadays, all type of foods has chemicals additives, even potato, fruits, and wheat. In old times, there were no chemical additives, one of these diseases, such as fat and diabetes, were not existing, now when you eat rice, you will get diabetes (Male, 45 years-old Metabolic Syndrome)".

**Reinforcing (social) factors**

**Social support:** Most participants stated that the dietitians, family members, and peers encouraged them to adhere to healthy eating. They said when the family members such as wife/husband, children, and parents did not support them to adhere to healthy eating, their motivation has diminished. The majority of interviewees stated that their family only advised them to follow healthy eating, but they did not accompany their patients. "My children are very closely asking me to be on a diet, my husband eats the diet foods, but the problem is: my children never eat it, they say that we do not like boiled foods. (Female, 54 years old, diabetes, and hyperlipidemia)".

**Behavioral outcomes:** The patients with adhering dietary regimes experienced positive outcomes such as weight loss, control of blood sugar, blood lipid, and blood pressure, feeling of pleasure, and reducing of the symptoms related to their health problems. Therefore, experiencing the positive results stimulated them to follow healthy eating behaviors. "The experience that I earn, e.g., I will diet for one month then I see their blood sugar or blood lipid becomes low, or I lose weight, my enthusiasm increases" (Man, aged 49, metabolic syndrome).

**Quantitative Findings**

The mean age of the participants in this study was 51.43±7.44. Among 450 people, 329 were female

(73.1%), and 121 were male (26.9%). The characteristics of participants' health problems showed in Table 1.

**Table 1)** Characteristics of the participants' health problems

| Variable              | Level | Percentage |
|-----------------------|-------|------------|
| <b>Cholesterol</b>    |       |            |
| Desirable             | 170   | 37.9       |
| High                  | 278   | 62.1       |
| <b>Triglycerides</b>  |       |            |
| Desirable             | 122   | 27.3       |
| Border                | 104   | 23.3       |
| High                  | 221   | 49.4       |
| <b>LDL</b>            |       |            |
| Desirable             | 249   | 63.2       |
| Border                | 96    | 24.4       |
| High                  | 49    | 12.4       |
| <b>HDL</b>            |       |            |
| Low                   | 96    | 21         |
| Good                  | 248   | 55.4       |
| Desirable             | 106   | 23.7       |
| <b>FBS</b>            |       |            |
| Normal                | 28    | 6.2        |
| Prediabetes           | 125   | 27.9       |
| Diabetes              | 295   | 65.8       |
| <b>Blood Pressure</b> |       |            |
| Normal                | 163   | 36.5       |
| Pre-hypertension      | 206   | 46.1       |
| High Hypertension     | 78    | 17.4       |

The mean±SD of the healthy eating behaviors were 6.45±2.20; That means approximately 51.7% of the participants adhered to healthy eating behaviors (Table 2).

**Table2)** The Mean±SD score of subcategories of predisposing, reinforcing, and enabling factors

| Variable                                    | Score range | Mean±SD    | Average score percentage |
|---|-------------|------------|--------------------------|
| <b>Predisposing</b>                         |             |            |                          |
| Perceived susceptibility                    | 3-15        | 9.66±3.15  | 55.5                     |
| Perceived severity                          | 4-20        | 17.75±2.23 | 85.93                    |
| Knowledge                                   | 0-17        | 13.29±2.66 | 87.17                    |
| Attitude                                    | 10-50       | 29.18±6.67 | 47.95                    |
| Perceived benefits                          | 8-40        | 37.10±3.36 | 90.93                    |
| Perceived barriers                          | 7-35        | 22.26±5.48 | 54.5                     |
| Self-efficacy                               | 4-40        | 24.63±7.94 | 48.76                    |
| <b>Enabling</b>                             |             |            |                          |
| New skills                                  | 0-8         | 4.37±2.55  | 31.87                    |
| Availability and Accessibility to Resources | 0-6         | 3.98±2.11  | 66.3                     |
| Rules and Policies                          | 0-8         | 3.06±2.21  | 38.25                    |
| <b>Reinforcing</b>                          |             |            |                          |
| Social support                              | 5-25        | 18.33±4.31 | 66.65                    |
| Behavioral outcomes                         | 0-12        | 9.70±3.07  | 80.83                    |
| <b>Motivation to comply</b>                 | 4-20        | 14.79±3.83 | 67.43                    |
| <b>Healthy eating behaviors</b>             | 0-13        | 6.45±2.20  | 51.07                    |

Structural equation modeling was used to investigate the relationships between categories and subcategories of the PRECEDE model with healthy eating behaviors. Structural equation modeling showed a significant relationship between predisposing (β=1.00; p=0.001) and reinforcing (β=0.67; p=0.001) with healthy eating behaviors, and the size of their effect was large and moderate. In the predisposing categories, the determinants of knowledge (β=0.14; p=0.005), attitude (β=0.26;

$p < 0.001$ ), perceived severity ( $\beta = 0.30$ ;  $p = 0.001$ ), perceived barriers ( $\beta = -0.33$ ;  $p = 0.001$ ) and self-efficacy ( $\beta = 0.49$ ;  $p = 0.001$ ) were significant. However, the perceived barriers and self-efficacy were the strongest predictors of healthy eating. In the enabling categories, the laws and policies ( $\beta = 0.36$ ;  $p = 0.01$ ) and new skills ( $\beta = 0.58$ ;  $p = 0.001$ ) were significant determinants.

In the reinforcing category, social support ( $\beta = 0.72$ ;  $p = 0.001$ ) and behavioral outcomes ( $\beta = 0.17$ ;  $p = 0.005$ ) were significant determinants, and social support was the strongest predictor.

The index of Chi-squared was less than 5, which confirmed the fit of the model. Also, GFI, AGFI, NFI, NNFI, RFI, IFI, and CFI fit indices greater than 0.9, RMSEA equal or less than 0.08, confirmed the validity of this model. As a result, this model has achieved a relatively good level of fit.

## Discussion

This study aimed to investigate the factors associated with dietary adherence among people with cardiovascular metabolic risk factors based on the PRECEDE framework. First, predisposing or personal factors were major contributors to dietary adherence. In this study, the predisposing category was the most dominant predictor of healthy eating, and its effect size was large. Among predisposing factors, knowledge was not the main predictor of adherence to healthy eating. Although there was a significant relationship, its effect size was small. Indeed, most participants knew what foods were beneficial and harmful for their health, but only half of them followed healthy eating behaviors. The studies [17-19] indicated that despite knowing healthy foods, the participants did not follow healthy eating behaviors regularly. The participants who had higher awareness; they perceived the importance of healthy eating in controlling their health problem and were stimulated to adhere dietary behaviors. Andric & Vuletic [20] supported health literacy as the main factor in adhering to health-related behaviors. Therefore, awareness cannot solely guarantee that behavior change will occur. In addition, attitude as a substantial component of behavior is defined in people's overall evaluations of performing behavior [10]. While most participants believed that adhering healthy eating behaviors was good and useful for their health, they had a positive attitude towards unhealthy foods. Indeed, they believed that fried foods, sugar, carbohydrate, and fast foods were more delusions than healthy foods. However, most of them declared that their health problem was the main motivation to follow healthy eating behaviors. This study indicated attitude as a significant determinant of healthy eating, but its effect size was small. As a result, the participants who had a positive attitude toward healthy eating behaviors were more likely to adhere to those behaviors [21].

Furthermore, susceptibility refers to the perception of vulnerability to a health problem and its complications, and severity is the perception of a health problem as a serious illness. In the current study, people with diabetes and metabolic syndrome, due to fear of complications related to their illness, considered their health problems more serious and followed healthy eating behaviors. This study showed that susceptibility was not an important determinant of healthy eating, whereas perceived severity was a significant predictor. In the study by Adejoh [22], perceived severity had a significant relationship with dietary adherence in patients with diabetes. Additionally, in the current study, while almost all participants benefited from following healthy eating behaviors, the perceived benefit was not a significant predictor of healthy eating. The research [23, 24] also confirmed that perceived benefit was not an important predictor of self-care among diabetic patients. Consequently, the perceived benefit construct is often high, but the score of behavior is relatively poor. It may be due to the inductive effect of the perceived benefits questions. Although most participants benefited from following healthy eating behaviors, they reported some obstacles to adhering to healthy eating behaviors. These barriers were confirmed by other studies [17, 18, 25-28]. Ard *et al.* [28] showed that despite knowledge and beliefs and the low value of perceived barriers to eating healthy foods and high value of perceived benefits, acculturation was an important factor in consuming fruits, vegetables, and the amount of fat intake. This is important because culture influences food preferences. In this study, the perceived barrier was a significant predictor of healthy eating behaviors, but its relationship was negative. According to some articles [27, 29], healthier eating behaviors can conclude the fewer barriers. Finally, the role of self-efficacy in starting and maintaining dietary adherence has been demonstrated by several studies [30, 31]. According to Bandura [10], self-efficacy is defined as one's belief in one's ability to succeed in specific situations or accomplish a task. The current study indicated self-efficacy as a significant predictor and moderate effect size for adhering to healthy eating behaviors. In some articles [32, 33], self-efficacy was also the strongest predictor of self-care behaviors in diabetes patients. It means individuals who have high self-efficacy to adhere healthy behaviors; they more perform that desired behaviors. Environmental factors were another main contributor that influenced dietary adherence. The environmental factors in the current study were the enabling and the reinforcing factors. In the qualitative phase, while most participants stated that structural or enabling factor was an important cause of dietary adherence, it was not a significant contributing factor in the quantitative phase, and its effect size was small. However, among enabling factors, the laws/policies related to food and skills

associated with healthy eating were significant predictors of dietary adherence. Many participants reported a lack of skills such as meal planning, reading food labels, calculating daily caloric intake, and preparing healthy foods. They also criticized policies and laws related to food, such as a lack of access to healthy foods, the high price of healthy foods, and poor safe food supervision—the high price of healthy foods lines with other studies [18, 34, 35]. Furthermore, according to research [35-38], the inappropriate structural environment was another barrier to healthy eating. Although access to resources such as the diabetes centers was not a significant predictor of healthy eating behaviors in the quantitative phase, most participants were perceived as a considerable factor in adhering to healthy eating in the qualitative phase.

In addition to enabling factor, reinforcing or social factor was a significant determinant of dietary adherence. Among reinforcing factors, social support by family members, dietitians, and general physicians was a significant and great predictor of dietary adherence. In the study by Goetz *et al.* [38], the role of social support by nurses and general physicians to change healthy diets among diabetes patients was reported. The study by Story *et al.* [37] reported that the social factors, including the interaction with family members, friends, peers, and others in the community, affected food choices through mechanisms such as; imitation, social support, and social norms. According to Klomegah [40], if most family members, friends, and acquaintances followed a healthy diet, dietary adherence would be easy for them.

Moreover, the behavioral outcome was another significant determinant of dietary adherence, though its effect size was small. Behavioral outcomes are positive or negative results following as a consequence of a behavior and strengthen the motivation for a behavior [14]. In current study, most patients by following eating behaviors experienced positive results on physiological indexes such as weight, blood sugar, blood lipid and blood pressure. As a result, the behavioral outcome was an internal motivator that encouraged most patients to adhere to healthy eating.

The qualitative study findings provided a deep understanding of the factors associated with healthy eating behaviors, a point of view that is not accessible in the quantitative research. The findings of a qualitative study belong to this population, and it lacks generalization, but this limitation was compensated with the quantitative part of the study. On the other hand, one of the challenges of mixed-method studies is integrating theory into mixed-method research. Another limitation in the current study was detection bias because the factors related to healthy eating behaviors and dietary behaviors were measured by using the questionnaire. These measures were based on the patient-reported

outcomes and were more likely to increase cognitive measures bias.

## Conclusion

In the qualitative phase, most interviewees believed that predisposing (personal) and enabling (structural) factors were important determinants of dietary adherence. On the other hand, the findings of the quantitative phase showed that personal factors, especially self-efficacy and perceived barriers and social factors, particularly social support, were the most dominant predictors of dietary adherence. This mixed-method study indicated that personal factors were the most important determinants of dietary adherence. However, social and structural factors should be considered in designing educational interventions to enhance dietary adherence. Identifying factors related to dietary adherence based on a psychological theory can help planners apply the most appropriate interventions to modify those factors and enhance healthy eating behaviors.

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