

# Factors associated with diet barriers in patients with poorly controlled type 2 diabetes

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**Background:** The study was conducted to investigate the diet barriers perceived by patients with poorly controlled type 2 diabetes and examine the associations between diet barriers and sociodemographic characteristics, medical condition, and patient-centered variables.

**Methods:** Secondary subgroup analyses were conducted based on the responses of 246 adults with poorly controlled type 2 diabetes from a multicenter, cross-sectional study. Diet barriers were captured by the Diet Barriers subscale of the Personal Diabetes Questionnaire. Participants also completed validated measures of diet knowledge, empowerment level, and appraisal of diabetes. Multiple regression techniques were used for model building, with a hierarchical block design to determine the separate contribution of sociodemographic characteristics, medical condition, and patient-centered variables to diet barriers.

**Results:** Diet barriers were moderately evident ( $2.23 \pm 0.86$ ) among Chinese patients with poorly controlled type 2 diabetes. The feeling of deprivation as a result of complying with a diet was the most recognized diet barrier ( $3.24 \pm 1.98$ ), followed by "eating away from home" ( $2.79 \pm 1.82$ ). Significantly higher levels of diet barriers were observed among those with lower levels of diet knowledge ( $\beta = -0.282$ ,  $P < 0.001$ ) and empowerment ( $\beta = -0.190$ ,  $P = 0.015$ ), and more negative appraisal ( $\beta = 0.225$ ,  $P = 0.003$ ).

**Conclusion:** Culturally tailored, patient-centered intervention programs that acknowledge individuals' preferences and allow for flexibility in diet management should be launched. Interventions programs that could enhance diet knowledge, promote positive appraisal, and improve empowerment level might effectively address diet barriers perceived by patients with poorly controlled type 2 diabetes.

**Keywords:** diabetes, diet barriers, knowledge, appraisal, empowerment

## Introduction

Despite the advances in treatment and self-management education, poor glycemic control is an evident issue among patients with type 2 diabetes.<sup>1</sup> A recent multinational, cross-sectional study estimated that nearly 60% of patients with type 2 diabetes suffered from poor glycemic control worldwide.<sup>2</sup> Mounting evidence demonstrates that such patients are at increased risk of developing irreversible micro- and macrovascular complications.<sup>2,3</sup> Optimization of glycemic control in this vulnerable population is a high priority for diabetes care.<sup>3</sup>

The poor glycemic control in patients with type 2 diabetes is due to multiple factors. As indicated by the Health Promotion Model and Patient Empowerment Model, perceived barriers are among the key factors that predict sustained behavioral change.<sup>4,5</sup> Diet barriers often lead to undesirable diet management (ie, behavioral dysregulation and lapse), which attributes mostly to poor glycemic control.<sup>6,7</sup> Recognizing and addressing diet barriers have been prioritized as a crucial step in providing patient-centered care to patients with poorly controlled diabetes.<sup>8-11</sup>

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Previous research indicated that patients with poorly controlled diabetes perceived more diet barriers compared with subjects with good glycemic control.<sup>12</sup> Given the variance in experiences and concerns for different metabolic conditions, diet barriers perceived by patients with poor glycemic control might be different from those perceived by subjects with good glycemic control.<sup>13</sup> Few studies have investigated the diet barriers perceived by underserved adults with type 2 diabetes and all glycemic control levels using validated instruments.<sup>7,14,15</sup> None of these studies mentioned any attempt to report diet barriers perceived by patients with poor glycemic control via subgroup analysis. The needs and characteristics of patients with poorly controlled diabetes thereby remain unclear. Although diet barriers have been the focus of self-management research and clinical care efforts, the existing self-management interventions may not adequately address the concerns of patients with poor glycemic control.<sup>16</sup>

Building a culture of patient-centeredness requires identification of key factors that account for diet barriers.<sup>17</sup> Consistent evidence showed that deficiencies in diet knowledge were associated with increased diet barriers.<sup>16</sup> The Transactional Model of Stress and Coping and results from the recent Diabetes Attitudes Wishes and Needs 2 study indicated that negative appraisal of diabetes consisted of barriers to adequate diet management.<sup>18,19</sup> Previous reviews supported that the empowerment level predicts the extent of an individual's active engagement in overcoming self-management barriers.<sup>5,20,21</sup> Of note is that a paucity of published studies simultaneously examined the independent effects of socio-demographic characteristics, medical condition, and patient-centered variables on diet barriers among patients with poorly controlled type 2 diabetes. A comprehensive understanding of diet barriers would facilitate the conceptualization of a design for tailored, patient-centered intervention programs for patients with poor glycemic control.

Building on the available evidence, in this study, we aimed to 1) examine diet barriers specifically perceived by patients with poor glycemic control; and 2) explore the associations between diet barriers and sociodemographic characteristics, medical condition, and patient-centered variables.

## Methods

Data presented here are secondary analyses from a multi-center, cross-sectional study with an overall goal to examine the psychometric properties of the Chinese version of the Personal Diabetes Questionnaire (PDQ).<sup>22</sup> The study was carried out between February and October in 2012. Potential

participants were recruited from four tertiary university-affiliated hospitals in Xi'an, People's Republic of China. This study was approved by the Institutional Review Boards, including Xi'an Jiaotong University and each study site.

## Participants

To be eligible, participants were adults with type 2 diabetes, with intact cognitive function with the Abbreviated Mental Test more than 7, had no psychiatric illness, and were able to provide written informed consent. Patients who had cancer or severe complications, end-stage illnesses, or were unwilling to participate in the study were excluded. In total, 361 eligible patients were approached; 346 of them gave their informed consent to participate in the study (response rate=95%). This analysis only included subjects with poor glycemic control ( $n=246$ ), as defined by patients with glycated hemoglobin ( $HbA_{1c}$ ) values greater than 7.5% advocated by the International Diabetes Federation.<sup>1</sup>

## Measures

### Outcome variables: diet barriers

Perceived diet barriers were measured by the Diet Barriers subscale of the PDQ which was a seven-item, patient-centered, self-report questionnaire. Participants were asked questions such as "In the past three months have you had problems eating because you feel discouraged due to lack of results?". Each item was scored based on a six-Likert scale, with a possible range of 1 (never) to 6 (one or more times per day). Scores were calculated by averaging the participants' response. A higher score indicates higher levels of perceived barriers in diet management.<sup>22</sup> In the current study, the Chinese version of the Diet Barriers subscale of the PDQ demonstrated adequate internal consistency (Cronbach's  $\alpha=0.705$ ) and test-retest reliability ( $r=0.990$ ). The Diet Barriers subscale also displayed significant associations with  $HbA_{1c}$  ( $r=0.697$ ,  $P<0.001$ ), supporting satisfactory criterion validity.

### Independent variables

Sociodemographic data included sex, age, educational level, and monthly income level. Medical condition data included exposure to diabetes education talk (yes/no), diabetes duration, the number of complications, and insulin use (yes/no).

### Patient-centered variables

#### Diet knowledge

Diet knowledge was measured by the Diet Knowledge subscale of the PDQ, using items such as "Use the information

about the number of calories in food to make decisions about what to eat?".<sup>13</sup> The participants responded to each item using a six-point Likert scale with a possible range of 1 to 6. A higher score indicated better knowledge in diet management. The Chinese version of the Diet Knowledge subscale demonstrated satisfactory internal consistency (Cronbach's  $\alpha=0.73$ ) and significant association with HbA<sub>1c</sub> ( $r=-0.66$ ,  $P<0.001$ ).<sup>22</sup>

#### Appraisal of diabetes: Appraisal of Diabetes Scale

The Appraisal of Diabetes Scale (ADS) is a seven-item instrument designed to capture individuals' appraisal of his or her diabetes.<sup>23</sup> Responses for each item range from 1 to 5. The average mean rating of the scale is used, with a higher score indicating more negative appraisal of diabetes. The psychometric properties of the Chinese version of the ADS were established with acceptable internal consistency (Cronbach's  $\alpha=0.810$ ) and excellent test-retest reliability (intraclass correlation coefficient =0.94).<sup>24</sup> The significant correlation between ADS and HbA<sub>1c</sub> also supported the appropriate criterion validity ( $r=0.556$ ,  $P<0.001$ ).<sup>24</sup>

#### Empowerment level: Diabetes Empowerment Scale-Short Form

The eight-item Diabetes Empowerment Scale-Short Form (DES-SF) was used to measure the empowerment level of people with diabetes.<sup>25</sup> A five-point Likert scale was employed and the scoring is performed by averaging participants' response. A higher score is interpreted as a higher level of empowerment. The Chinese version of DES-SF demonstrated good internal consistency (Cronbach's  $\alpha=0.848$ ) and test-retest reliability ( $r=0.817$ ). In addition, the score of DES-SF was positively correlated with general self-efficacy ( $r=0.556$ ,  $P<0.01$ ), giving evidence of acceptable convergent validity.<sup>26</sup>

#### Procedure

Eligible patients were approached and provided with information sheets. After obtaining the consents, face-to-face structured interviews were conducted to collect participants' information on sociodemographic characteristics and patient-centered variables by a trained research nurse. Data regarding medical condition were collected through the health system computerized medical records.

#### Statistical analysis

Data analysis was performed using IBM SPSS Statistics for Windows, Version 22.0: Armonk, New York, NY, USA.

Sociodemographic characteristics, medical condition, and patient-centered variables of participants were reported as frequency (percentage) and mean  $\pm$  standard deviation (SD) for categorical and continuous variables, respectively. Imputation was used to deal with the missing data: mean value substitution was used for continuous variables, and non-ignorable models were used for categorical missing values.<sup>27</sup>

Multiple regression techniques were used for model building, with a hierarchical block design to determine the separate contribution of sociodemographic characteristics, medical condition, and patient-centered variables to diet barriers. The first step of hierarchical regression included sociodemographic characteristics in the first block; this was followed by the addition of medical condition in the second block; and the third step added patient-centered variables into the third block. All statistical tests were two-sided and differences were accepted as significant at  $P<0.05$ .

## Results

### Characteristics of the study sample

Table 1 shows the sociodemographic characteristics, medical condition, and patient-centered variables of the participants. Overall, the mean age was  $58.90\pm 10.85$  years; the mean diabetes duration was  $9.68\pm 6.22$  years, and the mean HbA<sub>1c</sub> level was  $10.47\pm 2.29\%$ . Patients with poor glycemic control had a low level of diet knowledge ( $2.33\pm 0.85$ ) and empowerment ( $2.72\pm 0.84$ ), and a high level of negative appraisal ( $3.04\pm 0.75$ ).

Table 2 displays the barriers perceived by patients with poor glycemic control. "Feeling deprived due to attempts to follow a diet" was the most highly endorsed diet barriers perceived by patients with poorly controlled type 2 diabetes ( $3.24\pm 1.98$ ), followed by "Eating away from home" ( $2.79\pm 1.82$ ).

### Factors associated with diet barriers

Results of the hierarchical regression analyses are shown in Table 3. The final model (Model 3) was considered the best-competing model, as indicated by significantly increasing values of adjusted  $R^2$ . The inclusion of the three patient-centered variables increased the magnitude of variance explained by 23.1%. The results of Model 3 revealed that higher levels of diet barriers were associated with lower levels of diet knowledge ( $\beta=-0.282$ , 95% CI:  $[-0.341, -0.120]$ ,  $P<0.001$ ) and empowerment ( $\beta=-0.190$ , 95% CI:  $[-0.317, -0.035]$ ,  $P=0.015$ ), and more negative appraisal ( $\beta=0.225$ , 95% CI:  $[0.093, 0.443]$ ,  $P=0.003$ ). In addition, male subjects and younger subjects were more likely to report increased diet

**Table 1** Sociodemographics characteristics, medical condition, and patient-centered variables of patients with poor glycemic control (n=246)

Variables	Poor glycemic control (n=246)
Sociodemographics characteristics	
Male, n (%)	141 (57.32)
Age, M (SD)	58.90 (10.85)
Educational level, n (%)	
Primary school	113 (45.93)
Senior high school	77 (31.30)
College or above	56 (22.77)
Monthly income, n (%)	
<1,000 RMB	56 (22.76)
(1,000–3,000) RMB	133 (54.07)
>3,000 RMB	57 (23.17)
Medical condition	
Experience of diabetes education talk, n (%)	
Yes	118 (47.97)
No	128 (52.03)
Duration, M (SD)	9.68 (6.22)
Numbers of complications, n (%)	
0	11 (4.47)
1–2	94 (38.21)
>2	141 (57.32)
Insulin use, n (%)	
Yes	121 (49.19)
No	125 (50.81)
Patient-centered variables	
Diet knowledge, M (SD)	2.33 (0.85)
Appraisal of diabetes, M (SD)	3.04 (0.75)
Empowerment, M (SD)	2.72 (0.84)

**Note:** Patients with poor glycemic control refers to patients with HbA<sub>1c</sub> more than 7.5%.

**Abbreviations:** SD, standard deviation; M, mean; HbA<sub>1c</sub>, glycated hemoglobin.

barriers, as shown in the first and second steps of hierarchical regression analyses. However, after adding patient-centered variables into the model, neither sex nor age was significantly associated with the magnitude of diet barriers.

## Discussion

Our findings suggested that diet barriers were moderately evident among patients with poor glycemic control. The feeling

of deprivation due to complying with a diet was the most frequently cited diet barrier perceived by patients with poorly controlled type 2 diabetes. Subjects with lower levels of diet knowledge and empowerment and those with a more negative appraisal of diabetes were more likely to report higher levels of diet barriers.

From the patients' perspective, healthy eating is a complex and demanding decision-making process.<sup>5</sup> Our study confirmed that patients with poor glycemic control faced an array of diet barriers, including psychological-dimension and situational-dimension barriers.<sup>28</sup> In our study, "Feeling deprived due to attempts to follow a diet" was the frequently cited diet barrier, followed by "Eating away from home". The feeling of food deprivation as an important diet barrier perceived by patients with poor glycemic control has been reported by other diabetes populations.<sup>29–32</sup> The feeling of deprivation is often accompanied by the restrictive attitudes and loss of pleasure in eating and autonomy, which in turn led to increased susceptibility to disordered eating behaviors.<sup>31–34</sup> One possible reason for the feeling of food deprivation is that diet recommendations are either too general, idealistic, or not culture-specific.<sup>5,35</sup> With limited clear and practical dietary advice, patients are more likely to strictly and passively follow the instructions, thereby inducing the feeling of food deprivation. To decrease the levels of diet barriers perceived by patients with poor glycemic control, effective diet management intervention programs that provide concrete, practical, and culturally specific diet information (including portion control, meal planning, and food shopping) should be launched. Individuals' preferences should be acknowledged, and flexibility in diet management should be allowed. A flexible restrained approach has been suggested as an advantageous approach to foster healthy eating habit in the long term.<sup>32</sup>

All the patient-centered variables, including diet knowledge, diabetes appraisal, and empowerment, are significantly associated with diet barriers in the final hierarchical regression model.

**Table 2** Diet barriers perceived by patients with poor glycemic control (n=246)

Eating problems when	Mean ± SD
... when feeling stressed, anxious, depressed, angry, or bored	1.28±0.92
... because of hunger or food cravings	2.19±1.63
... because family or friends tempt you or are not very supportive of your efforts to eat right	2.01±1.21
... when eating away from home (such as fast food, in restaurants, with relatives, or potluck meals)	2.79±1.82
... because you feel deprived due to trying to follow a diet	3.24±1.98
... because you feel discouraged due to lack of results (such as no weight loss, or high blood sugars)	2.02±1.38
... because you are too busy with family, work, or other responsibilities	2.05±1.70
Total	2.23±0.86

**Abbreviation:** SD, standard deviation.

**Table 3** Factors associated with diet barriers among patients with poor glycemic control

Variable	Model 1 adjusted coefficients (95% CI)	Model 2 adjusted coefficients (95% CI)	Model 3 adjusted coefficients (95% CI)
Sociodemographic characteristics			
Sex (male as reference group)	-0.155* (-3.858, -0.090)	-0.156* (-3.839, -0.113)	-0.122 (-3.164, 0.065)
Age	-0.270*** (-0.248, -0.074)	-0.169* (-0.198, -0.003)	-0.071 (-0.128, 0.044)
Educational level	-0.127 (-1.597, 0.182)	-0.127 (-1.595, 0.173)	-0.087 (-1.250, 0.283)
Income level	-0.008 (-0.935, 0.844)	0.005 (-0.853, 0.908)	0.132 (-0.046, 1.548)
Medical condition			
Experience of diabetes education talk (reference is yes)	-	-0.137 (-3.533, 0.113)	-0.031 (-1.990, 1.222)
Diabetes duration	-	-0.168 (-0.332, 0.000)	-0.126 (-0.273, 0.023)
Numbers of complication	-	0.012 (-0.617, 0.722)	-0.017 (-0.654, 0.512)
Insulin use (insulin use as reference group)	-	0.016 (-1.669, 2.057)	0.023 (-1.347, 1.926)
Patient-centered variables			
Diet knowledge	-	-	-0.282*** (-0.341, -0.120)
Appraisal of diabetes	-	-	0.225** (0.093, 0.443)
Empowerment level	-	-	-0.190* (-0.317, -0.035)
Adjusted R <sup>2</sup>	0.083	0.108	0.338
R <sup>2</sup> change	0.104	0.045	0.231
F-test, df	5.017, 4	3.691, 8	9.227, 11
P-value	0.001	0.001	<0.001

Notes: \* $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.001$ .

Abbreviations: CI, confidence interval; df, degree of freedom.

After standardizing the coefficients, we found the strongest association between diet knowledge and diet barriers, suggesting that knowledgeable individuals are more likely to perceive a lower level of diet barriers. This point of view is in agreement with results of previous reviews, which assert that subjects who lack diet knowledge perceived more diet barriers, thereby increasing the likelihood of poor adherence in diet management.<sup>16,36</sup> Johnson and colleagues demonstrated that knowledgeable individuals were likely to gain awareness of their self-regulatory capacity to address diet barriers.<sup>32</sup> Individuals with more diet knowledge are more competent in making informed decisions that are flexibly suited to their goals, priorities, and lifestyle.<sup>37</sup> Patients with poorly controlled diabetes might particularly benefit from the development of intervention programs that can fill the gaps in knowledge required to achieve the goal of healthy eating. However, diet knowledge alone does not necessarily lead to decreased levels of perceived diet barriers.<sup>36</sup> Future works should establish effective ways to facilitate the transferability of diet knowledge within individuals' social and cultural networks.

Negative appraisal of diabetes is positively associated with perceived barriers in diet management. This finding is in agreement with results of previous research, which showed the deleterious effect of negative appraisal on self-management barriers.<sup>38-40</sup> Several reasons may account for the relationship between diabetes appraisal and perceived barriers. Appraisal of diabetes affects the likelihood

of adoption of a given behavior.<sup>41</sup> The Transactional Model of Stress and Coping supported the declaration that patients with negative appraisal may use "avoidance or passive resignation" instead of problem-focused and meaning-focused methods as potential coping strategies.<sup>42,43</sup> Patients with negative appraisal may consider diabetes as a condition that is beyond their own control and passively engage in problem-solving activities; these patients may perceive higher levels of diet barriers when complying with healthy eating recommendations.<sup>5,44</sup> Moreover, negative appraisal of diabetes was evidenced by increased vulnerability to psychological distress.<sup>40,45</sup> Psychological distress could cognitively distract patients and impede their autonomy and decision-making skills. Thus, psychological distress poses a great challenge in overcoming barriers.<sup>16,43,46</sup> Hence, the negative appraisal is a medically meaningful component that would likely contribute to the diet barriers perceived by patients with poor glycemic control. The current findings suggest that an assessment of diabetes appraisal could provide valuable clues on the identification of individuals with increased levels of diet barriers. Intervention programs that promote a more positive and adaptive appraisal may decrease the diet barriers perceived by patients with poor glycemic control.

The association between the empowerment level and diet barriers indicates that diet barriers are disproportionately challenging for those with lower empowerment level. This finding corroborated the theoretical assertions in Patient Empowerment Model and Empowerment Process Model,

which state that empowerment as a psychological self-efficacy could determine the commitment and perseverance of self-management efforts in the presence of barriers.<sup>20,47,48</sup> The negative association of diet barriers with empowerment has been detected in previous integrative literature reviews.<sup>5,21</sup> Empowerment has been linked to active roles in decision making in diet management.<sup>49,50</sup> Patients with a higher level of empowerment are more self-motivated to have a dynamic perception of diet knowledge and take meaningful behaviors accordingly.<sup>51–55</sup> A patient-centered approach to enhance empowerment may potentially be effective in addressing diet barriers. However, assessment of the effectiveness of such intervention programs in patients with poor glycemic control is beyond the scope of the current study.

We found two variables are significantly associated with diet barriers in the first and second steps of the hierarchical regression analyses, namely, male and age. Male subjects and younger subjects were more likely to report more diet barriers. However, the relationships between sex, age and diet barriers became nonsignificant, when patient-centered variables were added into the model. One potential explanation for the loss of significant statistical association between being a male and diet barriers might be the sex differences in use of diabetes education.<sup>56</sup> Studies in diverse populations showed that male patients reported a lower diabetes education attendance rate and exhibited a lower level of diet knowledge, compared with female subjects.<sup>57–61</sup> Thus, sex may confound the effect of diet knowledge on predicting the levels of diet barriers. Moreover, younger patients were found to be more sensitive to diabetes-related stigma (such as blaming, shaming, negative stereotyping, discrimination, and lost opportunities), thereby leading to increased psychological burden and negative appraisal of diabetes.<sup>62,63</sup> Such negative emotional and cognitive reactions may “wash out” the association between younger age and diet barriers.

## Limitations

Our results should be interpreted within the context of our design and methods. First, this study is cross-sectional in nature. Therefore, firm conclusions cannot be made on the causal effects of sociodemographic characteristics, medical condition, and patient-centered variables on diet barriers. Population-based and longitudinal studies are needed to gain more insight into the associations indicated by the current study. Second, the diet knowledge, diabetes appraisal, empowerment level, and diet barriers were assessed using self-report instruments; thus, responses may be biased. Nevertheless, self-report is the only feasible and cost-effective

method known for collecting such data.<sup>64</sup> Finally, our study only recruited participants from tertiary university-affiliated hospitals, which place limits on the generalizability of our exploratory results. Nevertheless, in the People’s Republic of China, most of the patients will be followed up at the clinics after diagnosis. Due to the uneven development of hospital and primary care, patients with poor glycemic control have a tendency to consult health care professionals in tertiary hospitals. Further studies that recruit a larger sample size of patients with poorly controlled type 2 diabetes in the community are warranted.

## Implications

Although causality cannot be obtained, the results of the investigation still have great potential to provide information for clinical practice. Diet barriers appeared to be challenging for patients with poor glycemic control. The exploration of the correlates confirms the significance of diet knowledge and emphasizes the roles of diabetes appraisal and empowerment in this vulnerable diabetes subgroup. The mechanisms underlying these associations are not clear and need to be elucidated in future studies.

Health care professionals need to consider subjects with low levels of diet knowledge, empowerment, and positive appraisal as an “at-risk” group among patients with poor glycemic control. It is imperative to evaluate these patient-centered variables as parts of routine practice to detect patients who need interventions. Culturally tailored intervention programs that aim to improve diet knowledge and facilitate knowledge transferability should be prioritized for patients with poor glycemic control. Further research is needed to develop effective intervention programs to promote positive appraisal and empowerment for individuals with poor glycemic control.

## Conclusion

Diet barriers are moderately evident among Chinese patients with poorly controlled type 2 diabetes. Culturally tailored, patient-centered intervention programs that acknowledge individuals’ preferences and allow for flexibility in diet management should be launched. Intervention programs that enhance diet knowledge, promote positive appraisal, and improve empowerment level might effectively address diet barriers among patients with poorly controlled type 2 diabetes.

## Disclosure

The authors report no conflicts of interest in this work.

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