Title

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Journal

BMJ Open, 13(11)

ISSN

2044-6055

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Publication Date

2023-11-01

DOI

10.1136/bmjopen-2023-076464

Peer reviewed

BMJ Open

Relationship between diabetic knowledge, attitudes and practices among patients with diabetes in China: a structural equation model

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To cite: Zhu W, Liang D, Petersen JD, *et al*. Relationship between diabetic knowledge, attitudes and practices among patients with diabetes in China: a structural equation model. *BMJ Open* 2023;**13**:e076464. doi:10.1136/bmjopen-2023-076464

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2023-076464).

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Received 08 June 2023
Accepted 03 November 2023

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ABSTRACT

Objectives Whether the routine delivery of diabetes-related knowledge can change patients' attitudes and hence influence their self-management activities remains unknown in primary healthcare settings in China. Thus, this study aims to explore the complex transformation process between knowledge, attitude and practice (KAP) among patients with diabetes in a city in China.

Design A cross-sectional study.

Setting Yuhuan City, Zhejiang Province, China.

Participants A total of 803 patients with diabetes were invited to attend a questionnaire survey and 782 patients with type 2 diabetes completed the survey. The average age of participants was 58.47 years old, 48.21% of whom only attended primary school or below.

Primary and secondary outcome measures A questionnaire based on existing scales and expert consultation was applied to assess patients' socio-demographic information (SI), disease progression risk and diabetes-related KAP. A structural equation model was built to analyse the relationships between patients' characteristics and KAP.

Results No significant association was found between patients' knowledge and attitude (β=0.01, p=0.43). Better knowledge and attitude were both found to be associated with better diet and physical activities (β=0.58, p<0.001; β=0.46, p=0.01). However, patients with a more positive attitude toward diabetic care showed worse foot care practice (β=−0.13, p=0.02), while better knowledge was associated with better foot care practice (β=0.29, p<0.001). In addition, patients with higher SI (β=0.88, p<0.001) and/or disease progression risk (β=0.42, p<0.001) tended to present higher levels of disease knowledge.

Conclusions While successful KAP transformation has been achieved in practice for diet and physical activities, there is a need to improve foot care practice. Health education should also prioritise the prevention, detection and care of diabetic foot. Also, appropriate methods should be adopted to deliver health education to vulnerable patients, such as the elderly, those living in rural areas, those with minimal education, the unemployed and low-income patients.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The structural equation model has been used to explore the complex relationships between knowledge, attitudes and practices (KAP) of patients with diabetes.
⇒ The transformation processes between KAP, including direct effect and indirect effect, were investigated in order to find out the transformation gaps.
⇒ This study used a cross-sectional design, so the relationship between assumed cause and effect might be reversed.
⇒ Convenience sampling was applied in the study, which would weaken the representativeness of the sample.

INTRODUCTION

Health education has been shown to be effective in improving patients' health literacy and health behaviours.[1–4] Health education is particularly crucial for patients with diabetes, since their condition relies predominantly on self-management, with only a small part of their time spent contacting healthcare providers.[5] Health education on diabetes is typically delivered by nurses, physicians and/or dietitians, through various strategies, including face-to-face, remote education, written materials and mixed methods.[6–9] The educational content mainly covers topics such as diet, exercise, blood glucose control, medication adherence, risk factors and psychosocial issues.[6]

In China, most health education on diabetes is delivered by primary healthcare providers as part of the National Essential Public Health Service Package (NEPHSP). Under the NEPHSP, primary care providers (PCPs) are expected to provide health education to all patients in their catchment area who have been diagnosed with diabetes and/or hypertension. However, there is concern that health education provided by PCPs has not been successful in achieving the diabetes management goal. Unhealthy lifestyles continue to pose a significant obstacle

in diabetes management. The prevalence of inadequate physical activities, excessive red meat intake, overweight and obesity increased in Chinese adults from 2013 to 2018.[10] Additionally, only 50.1% of patients receiving treatment achieved the glycaemic control target in 2018.[10] While many diabetic health education programmes have also been implemented in China to improve patients' disease-related knowledge, self-management behaviour and clinical outcome,[11 12] these programme-based interventions only cover a fraction of patients with diabetes and have limited implications for population health.

Improving the effectiveness of health education on diabetes provided by PCPs remains a challenge. It is uncertain to what extent the knowledge delivered by PCPs can change patients' attitudes and, consequently, modify their self-management behaviour. Although several studies have evaluated patients' knowledge, attitude and practice (KAP) toward diabetes in China, these studies either only reported the level of KAP and their predictors,[13–15] or barely explored the connection between constructs, such as knowledge and practice.[15] In other words, these analyses cannot fully explain the complex transformation process that occurs from patients' knowledge, to their attitudes and ultimately to their behaviours.

To address the knowledge gap, this study aims to examine the complex relationships between KAP among patients with diabetes in primary healthcare settings. According to the KAP model, acquiring knowledge can help patients to change attitudes and positive attitudes can urge patients to improve daily practice.[16 17] Based on this, we made three hypotheses: (1) Socio-demographic information (SI) and disease progression risk can affect patients' KAP; (2) knowledge can affect patients' attitudes and practices; (3) attitudes can affect patients' practices. The findings will provide insights and recommendations for diabetes health education in primary healthcare settings in China.

METHODS

Study setting

A cross-sectional study was conducted in Yuhuan city, Zhejiang province, China. Yuhuan city lies in the southeast part of Zhejiang province, comprised of 1 main island, 1 peninsula and 135 small islands. In 2020, of 644 000 residents, the gross domestic product (GDP) per capita of Yuhuan was ¥98 377,[18] higher than the GDP per capita of China (¥71 999).[19] Yuhuan has 2 secondary hospitals and 11 primary healthcare centres (PHCs), among which 1 secondary hospital and 5 PHCs were selected as our study sites by convenience sampling.

The secondary hospital and PHCs were chosen because they both serve a significant number of patients with diabetes. In 2021, these institutions managed approximately 12 000 patients with diabetes. As part of the NEPHSP, each PHC is responsible for providing diabetes management for local patients in the township where the PHC is located. PCPs undertake most of the diabetes management work in PHCs, including providing both curative and preventive care. In each follow-up, PCPs would monitor patients' blood glucose levels, adjust their treatment plans and provide health education. PCPs usually consist of licensed doctors and nurses working in township/community health centres, as well as village doctors who are either licensed doctors or community health workers, depending on local regulations. Many of them only attend vocational high school or 3-year college. Despite the availability of NEPHSP, some patients still chose to visit the outpatient endocrinology clinic at the secondary hospital for diabetes management, where health education and follow-up services were also provided. This is because China did not implement a strict gate-keeping mechanism.

Participants

From July 2021 to July 2022, patients with diabetes mellitus were invited to complete a questionnaire on diabetes-related KAP at the endocrinology clinic or the clinic for chronic disease management in the study sites through convenience sampling. To ensure every patient fully understood each question and provided answers based on their own opinion, a mix of face-to-face and telephone investigations were conducted. However, patients with newly-diagnosed diabetes (diabetes duration ≤0.5 months) were excluded as they did not establish a full view of their illness.

Measures and data collection

The questionnaire used to measure diabetes-related knowledge was adapted based on the Audit of Diabetes Knowledge.[20] The final version of our questionnaire's knowledge section primarily covered five domains: complications, hypoglycaemia, diet, alcohol and physical activities and foot. Each domain included two to four questions, and we tested whether patients could answer those questions correctly. Each correct answer was awarded one point, and the total score for each domain was calculated accordingly.

The questionnaire used to measure patients' attitudes toward diabetic care was adapted based on the Diabetes Treatment Satisfaction Questionnaire.[21] The final version of our questionnaire's attitude section consisted of three 5-point Likert questions to evaluate patients' opinions about treatment convenience, their recommendation of the treatment, as well as their understanding of the disease.

The questionnaire used to measure patients' self-care behaviours for diabetes was adapted based on the summary of diabetes self-care activities measure.[22] In the final version of our questionnaire's practice section, patients were asked about their daily diet, physical activities and foot care practice. They were asked to recall the number of days on which they engaged in self-care behaviour in the last 7 days. Therefore, the score for each question ranges from 0 to 7.

The original scales of all three sections of the KAP questionnaire have been widely tested and validated for measuring patients' diabetes-related KAP.[23–25] Overall, a higher score for each part represents greater knowledge, a more positive attitude and better practice for a patient. The internal consistency reliabilities of KAP parts were middle to high, as Cronbach's alpha for each part was 0.82, 0.63 and 0.58.[26] In addition, the results of Bartlett sphericity were statistically significant (p<0.001), which demonstrated that the construct validity of each part can be assessed by explanatory factor analysis.[27] And the results of factor analysis showed that the structure of each part was consistent with the originally designed domain.

Patients' SI and disease progression risk were also self-reported through the questionnaire. SI included age, sex, residence, education level, type of social medical insurance and annual household income. In China, inhabitants are covered by two types of social medical insurance: basic medical insurance for urban employees (UE) and basic medical insurance for urban and rural residents (URR). The former covers all employees, including those who are self-employed, while the latter covers the remaining residents. Commonly, people with UE have a relatively higher socioeconomic status (SES) than those with URR, as they are employed.

The disease progression risk was measured by the duration of diabetes, treatment plan and diabetic complications. For the last variable, we assessed whether patients had one or more of the following complications at the time of the survey: cardiovascular disease, cerebrovascular disease, peripheral vascular disease, neuropathy, nephropathy, retinopathy and foot ulcer.

The questionnaire has been revised by several diabetes experts. Thereafter, a pilot test was conducted on 10 patients with diabetes to adjust the words of the questionnaire for better patient understanding. The detailed questionnaire is presented in online supplemental table 1.

Statistical analysis

Descriptive analyses were applied to present patients' SI, disease progression risk and diabetes-related KAP using Stata V.16.0 (StataCorp, USA). In order to find the relationship between patients' KAP, a structural equation model (SEM) was built using LISREL V.8.51 (Scientific Software International, USA).

The SEM is a method that can help to assess the complex relationships between KAP. Compared with logistic regression, SEM can estimate a set of possible relationships between several analytical variables simultaneously and does not require split analysis.[28] It contains variables that not only are predicted by other variables, but also subsequently predict additional variables.[29] SEM can also investigate the mediated relationships between variables by calculating indirect effects.[30] Thus, it is a suitable method to explore the transformation process and gap between KAP. Another advantage of SEM is that it estimates the relations among error-free latent variables and controls for measurement error.[31] Commonly, the measurement of KAP is based on self-reported questionnaires, so the measurement error (eg, recall bias) has a big influence on results quality. Therefore, SEM is also suitable considering the nature of the data source.

Under the hypotheses mentioned above, five latent variables were identified and the measurements of each latent variable are displayed in table 1. Among them, a higher score for the SI variable represented that a patient was younger, tended to be male and/or had a higher SES, while a higher score for the disease progression risk variable meant that the disease risk for this patient was higher. And the scores of KAP variables were positively associated with a patient's KAP level.

A confirmatory factor analysis (CFA) was first applied to assess whether observed variables can adequately represent latent variables. Then, an SEM was built which specified the dependence relationships between latent variables based on the study's hypotheses. Online supplemental figure 1 illustrates the basic structure of SEM. The SI and disease progression risk were set as exogenous latent variables, while KAP were set as endogenous latent variables.

In the model, the one-way path (X→Y) means that X influences Y, while the two-way path (X↔Y) means that X correlates with Y.[32] Standardised coefficients for each path are reported, including factor loadings and factor coefficients. Factor loadings point to the associations between latent and observed variables, and factor coefficients describe the direct effects between adjacent latent variables. Indirect effects were also calculated to present the associations between latent variables that were not adjacent (ie, path 'X→Y→Z' means that X has a direct effect on Y, and an indirect effect on Z). These coefficients range from 0 to 1, and a higher coefficient represents a stronger relationship between the two variables. A path would be deleted if its coefficient was insignificant in order to improve the goodness-of-fit of the model.

The CFA and SEM models were both fitted using maximum likelihood estimation. Several indicators were adopted to assess the goodness-of-fit of the model, including χ^2/df (χ^2/df), root mean square error of approximation (RMSEA), Non-Normed Fit Index (NNFI) and Comparative Fit Index (CFI).[33] χ^2/df<5, RMSEA<0.08, NNFI>0.9 and CFI>0.9 were regarded as a good fit. Results were considered statistically significant if p<0.05.

Sample size

In order to perform SEM, a minimum sample size should be 5–20 times the number of estimated parameters.[34] Based on our original SEM, 50 parameters need to be estimated. Considering a 10% invalid response rate and the investigation ability, the final sample size of the study was set to 800 patients.

Table 1 The latent and observed variables used in the structural equation model

Latent variables	Observed variables	Value
SI	Age (years)	1=≥70, 2=60–69, 3=50–59, 4=40–49, 5=≤39
	Sex	1=female, 2=male
	Residence	1=rural, 2=urban
	Education level	1=primary school or below, 2=middle school, 3=high school, 4=3-year college, 5=bachelor or above
	Types of medical insurance purchased	1=none, 2=URR, 3=UE
	Annual household income (¥10 000)	1=≤3, 2=3.1–10, 3=10.1–30, 4=≥30.1
Disease progression risk	Duration of diabetes (years)	1=≤5, 2=5.1–10, 3=10.1–20, 4=≥20.1
	Treatment plan	1=no medication, 2=oral hypoglycaemic medications only, 3=insulin/GLP-1 only, 4=both oral hypoglycaemic medications and insulin/GLP-1.
	Diabetic complications	1=do not have, 2=have
Knowledge	Complications	0–4 points
	Hypoglycaemia	0–4 points
	Diet	0–3 points
	Alcohol	0–2 points
	Physical activities and foot	0–3 points
Attitude	How convenient have you been finding your treatment to be recently?	5-point Likert scale, ranging from 1 'very inconvenience' to 5 'very convenience'.
	Would you recommend this form of treatment to someone else with your kind of diabetes?	5-point Likert scale, ranging from 1 'strongly not recommend' to 5 'strongly recommend'.
	How satisfied are you with your understanding of your diabetes?	5-point Likert scale, ranging from 1 'very dissatisfied' to 5 'very satisfied'.
Practice	How many of the last 7 days have you followed a healthful eating plan?	0–7 days
	On how many of the last 7 days did you participate in at least 30 min of physical activity?	0–7 days
	On how many of the last 7 days did you check your feet?	0–7 days
	On how many of the last 7 days did you inspect the inside of your shoes?	0–7 days

GLP-1, glucagon-like peptide-1; SI, socio-demographic information; UE, basic medical insurance for urban employees; URR, basic medical insurance for urban and rural residents.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS

Patients' characteristics

A total of 803 patients answered the questionnaire, and among them, 782 patients with type 2 diabetes (56.27% were men) completed the questionnaire with no missing data and were included in the analysis. The average age for participants was 58.47 years old (SD: 11.89). The majority of patients lived in the urban area (63.55%), attended primary school or below only (48.21%), were covered by URR (53.84%) and had an annual household income of ¥30 000 to ¥100 000 (44.25%).

In terms of disease progression risk, 49.49% of patients had diabetes for less than 5 years and 69.44% of patients only used oral medications to control blood glucose. Nearly half of the patients (47.70%) had at least one diabetes-related complication. The detailed patients' characteristics are summarised in table 2.

Patients' diabetes-related KAP

The results of patients' diabetes-related KAP are shown in table 3. In terms of knowledge part, patients' average scores (mean (SD)) for complications, hypoglycaemia, diet, alcohol and physical activities and foot knowledge were 2.69 (1.49), 1.79 (1.52), 1.55 (1.02), 0.40 (0.65) and

Table 2 The detailed characteristics of included patients (n=782)

Characteristic	Category	N (%)
Age (years)	≤39	41 (5.24)
	40–49	138 (17.65)
	50–59	226 (28.90)
	60–69	238 (30.43)
	≥70	139 (17.77)
sex	Female	342 (43.73)
	Male	440 (56.27)
Residence	Urban	497 (63.55)
	Rural	285 (36.45)
Education level	Primary school or below	377 (48.21)
	Middle school	203 (25.96)
	High school	96 (12.28)
	Three-year college	62 (7.93)
	Bachelor or above	44 (5.63)
Medical insurance	UE	351 (44.88)
	URR	421 (53.84)
	None	10 (1.28)
Annual household income (¥10 000)	≤3	66 (8.44)
	3.1–10	346 (44.25)
	10.1–30	326 (41.69)
	≥30.1	44 (5.63)
Duration of diabetes (years)	≤5	387 (49.49)
	5.1–10	187 (23.91)
	10.1–20	172 (21.99)
	≥20.1	36 (4.60)
Treatment plan	No medication	33 (4.22)
	Oral hypoglycaemic medications only	543 (69.44)
	Insulin/GLP-1 only	55 (7.03)
	Both oral hypoglycaemic medications and insulin/GLP-1	151 (19.31)
Diabetic complications	Do not have	409 (52.30)
	Have	373 (47.70)

GLP-1, glucagon-like peptide-1; UE, basic medical insurance for urban employees; URR, basic medical insurance for urban and rural residents.

1.86 (1.01), respectively. Considering the attitude part, the reported average scores for treatment convenience, treatment recommendation and understanding of diabetes domains were 3.31 (0.94), 3.86 (0.51) and 3.66 (0.83), separately. And for the practice part, the average number of days that patients obeyed healthy diet, physical activities, feet check and shoe inspection rules were 4.35 (2.86), 3.58 (3.15), 0.96 (2.19) and 0.34 (1.42) days weekly.

Table 3 The diabetes-related KAP of included patients

Part	Domain	Score range	Mean (SD)
Knowledge	Complications	0–4	2.69 (1.49)
	Hypoglycaemia	0–4	1.79 (1.52)
	Diet	0–3	1.55 (1.02)
	Alcohol	0–2	0.40 (0.65)
	Physical activities and foot	0–3	1.86 (1.01)
Attitude	Treatment convenience	0–5	3.31 (0.94)
	Treatment recommendation	0–5	3.86 (0.51)
	Understanding of diabetes	0–5	3.66 (0.83)
Practice	Healthy diet	0–7	4.35 (2.86)
	Physical activities	0–7	3.58 (3.15)
	Feet check	0–7	0.96 (2.19)
	Shoe inspection	0–7	0.34 (1.42)

The relationships between KAP

Confirmatory factor analysis

The original model (see online supplemental figure 1), which only specified the paths between observed variables and latent variables, was first fitted using CFA. Then the structure of the model was adjusted according to fitting results. The results demonstrated that the heterogeneity between diet and physical activities and foot care practice was strong, so the practice was separated into two independent latent variables. Also, the observed variable 'sex' did not significantly affect the latent variable 'SI', so this observed variable was deleted in the final model. After adjustment, all standardised factor loadings for the measurement model were positive and statistically significant ($p<0.05$), ranging from 0.21 to 0.98. And it reached a good fit to the data which allowed the next step of SEM construction (χ^2/df=3.12, RMSEA=0.05, NNFI=0.90, CFI=0.92).

Structural equation model

Based on CFA results, the paths between each latent variable were added to the model. And SEM was conducted to test the relationships between latent variables. The final path diagram and standardised path coefficients for SEM are displayed in figure 1. Compared with the original model, the associations between SI/disease progression risk and attitude/practice were insignificant, so the paths between those latent variables were deleted. The goodness-of-fit of the final model was satisfactory, as each of the fitting indicators met the threshold standards (χ^2/df=3.08, RMSEA=0.05, NNFI=0.91, CFI=0.92).

All observed variables had significant factor loadings, ranging from 0.21 to 0.98 (online supplemental table 2).

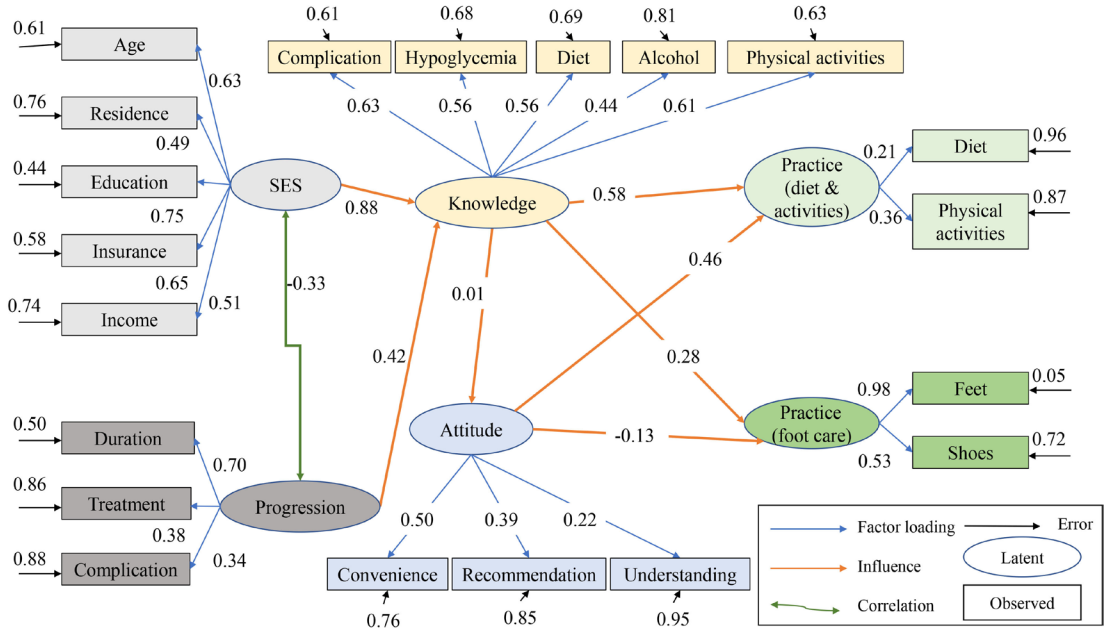

Figure 1 The final structure of the structural equation model. It contains six latent variables. The one-way path (X→Y) means that X influences Y, while the two-way path (X↔Y) means that X correlates with Y. SI, socio-demographic information.

Worse SI was found to be correlated with a higher risk of disease progression (β=−0.33, p<0.001). In respect of influence, the direct, indirect and total effects among latent variables are shown in table 4. As to direct effects, patients with better SI and a higher risk of disease progression had better diabetes-related knowledge (β=0.88, p<0.001; β=0.42, p<0.001). There was no significant association between patients' diabetes-related knowledge and their treatment attitude (β=0.01, p=0.43). However, knowledge had a direct and positive effect on both diet and physical activities (β=0.58, p<0.001) and foot care practice (β=0.29, p<0.001). Regarding attitude, a more positive attitude toward diabetic care was associated with better diet and physical activities (β=0.46, p=0.01), but worse foot care practice (β=−0.13, p=0.02).

In terms of indirect effects, better SI was associated with better diet and physical activities (β=0.51, p<0.001) and foot care practice (β=0.25, p<0.001) among patients. Disease progression risk also significantly affected patient's diet and physical activities (β=0.24, p<0.001) and foot care practice (β=0.12, p<0.001). That is, patients

Table 4 The direct, indirect and total effects of each path

Path	Direct effects	P value	Indirect effects	P value	Total effects	P value
SI → Knowledge	0.88	<0.001	—		0.88	<0.001
SI → Attitude	—		0.01	0.43	0.01	0.43
SI → Practice (diet and physical activities)	—		0.51	<0.001	0.51	<0.001
SI → Practice (foot care)	—		0.25	<0.001	0.25	<0.001
Progression → Knowledge	0.42	<0.001	—		0.42	<0.001
Progression → Attitude	—		0.01	0.43	0.01	0.43
Progression → Practice (diet and physical activities)	—		0.24	<0.001	0.24	<0.001
Progression → Practice (foot care)	—		0.12	<0.001	0.12	<0.001
Knowledge → Attitude	0.01	0.43	—		0.01	0.43
Knowledge → Practice (diet and physical activities)	0.58	<0.001	0.01	0.43	0.58	<0.001
Knowledge → Practice (foot care)	0.29	<0.001	−0.002	0.43	0.28	<0.001
Attitude → Practice (diet and physical activities)	0.46	0.01	—		0.46	0.01
Attitude → Practice (foot care)	−0.13	0.02	—		−0.13	0.02

SI, socio-demographic information.

with higher disease risks tended to have higher levels of self-management practice.

DISCUSSION

Summary of main findings

The current study established an SEM to explore the complicated relationships between KAP among patients with diabetes in Yuhuan city. Consistent with our hypotheses, patients' knowledge had a direct and positive association with their practice. However, the study results did not indicate a significant relationship between patients' knowledge and treatment attitude as hypothesised. Furthermore, patients' attitudes toward treatment presented contradictory associations with patients' practice: positive with regard to diet and physical activities, but negative regarding foot care practice. Lastly, SI and disease progression risk directly affected patients' diabetes-related knowledge and indirectly affected their self-management practice.

Lack of foot care practice

One important finding is that foot care practice was quite inadequate among patients with diabetes in China, which is in line with previous studies.[35 36] Also, patients' attitude was negatively linked with their foot care practice. A possible explanation for this might be that while some patients held positive attitudes toward diabetes treatment, they always neglected the importance of foot care and did not realise that they should be careful about feet injury.[37] In addition, about half of the participants in our study only had diabetes for less than 5 years. They may consider diabetic foot ulcers would only happen to acute and severe patients, and think of foot care as a low priority.[38] This explanation was also supported by the positive association between knowledge and foot care practice—when patients know the risk and prevention method for foot ulcers, they will practice foot care.

Another interesting finding is that not only diabetes-related knowledge but also attitudes toward treatment had positive associations with patients' diet and physical activities. These results indicated that health education toward diabetic diet and physical activities has promoted a successful transformation—a higher level of knowledge and a more positive attitude have led to the improvement of patients' daily behaviour. This may relate to the fact that diet and physical activities have always been and still are the core contents of diabetic health education and lifestyle intervention.[4 39] Patients have received relevant information adequately, which can also be supported by the evidence that patients' knowledge levels on diet and physical activities were relatively high in our study.

Knowledge inequalities

In addition, the current study found that there were positive relationships between patients' SI and their diabetes-related knowledge and self-management practice. In other words, patients who were younger, lived in the urban area, attended better education, were employed and had a higher income would get more diabetes information than others and control their daily behaviour more rigorously. This finding is consistent with many earlier studies.[40 41] A potential explanation for this was that the vulnerable group might have fewer opportunities to receive health education, and they may have difficulty understanding disease-related information.[42] And this could cause knowledge inequalities and disparities.

Recommendations

In summary, two major problems existed regarding patients with diabetes KAP in our study population, including the lack of foot care practice and the knowledge inequalities. These findings indicate some suggestions for health education design. First of all, health education in China should pay more attention to foot care practices. The International Working Group on the Diabetic Foot advises that patients and their families should be told how to protect their feet, recognise foot ulcers and pre-ulcerative signs, and handle the arising problems.[43] A systematic review also found that foot-care education can significantly improve patients' foot-care knowledge and self-care behaviour.[44] Second, health education should focus more on vulnerable groups, including elderly patients, individuals living in rural areas, those with minimal education, the unemployed and those with low incomes. Previous studies suggested that community health workers would be suitable people to deliver health information to vulnerable groups. This is because community health workers share similar cultural backgrounds, living environments and life experiences with their target groups and they know how to teach and persuade people in the same community.[45] In addition, it is also critical to assess whether the vulnerable patients understand the message and adhere to the recommendations after a period of health education.[43]

Moreover, our findings could be helpful to establish structured health education in the primary healthcare system in China. To avoid overloaded information, recent evidence has suggested that structured education, such as attending a structured course, could be efficient for patients with diabetes.[1] To cope with this, the National Institute for Health and Care Excellence in the UK recommends that structured group education delivered by trained educators should be offered to all patients with diabetes.[46] The American Diabetes Association also suggests that self-management education should use a curriculum to guide evidence-based message delivery.[47] Structured education programmes for patients with diabetes have also been implemented in China in recent years, but mostly in tertiary hospitals or big cities.[48 49] The KAP transformation gap that we found in our study can contribute to the design of such programmes in primary healthcare settings, which manage most patients with diabetes in China.

Limitations

This study has the following limitations. First, this study used a cross-sectional design. Hence, the causal relationship between KAP cannot be proven in our study, and the relationship between assumed cause and effect might be reversed and subject to residual confounding. Second, our study used a self-reported questionnaire for data collection, which may suffer from recall bias. However, the investigators were trained to minimise the bias. SEM also contained measurement errors in the model and controlled it in the analysis, which could also help to reduce the influence of recall bias. Third, the generalisability of this study should be interpreted with caution. This study used convenience sampling, which would weaken the representativeness of the sample. Patients who were willing to participate in the survey may be more interested in the study and have a higher level of disease awareness than those who refused to participate. Also, as participants were recruited from the healthcare settings, these findings may not be generalisability to patients with undiagnosed diabetes. Furthermore, the study was conducted in the primary healthcare settings of Yuhuan city, and most of our participants had diabetes for less than 5 years and only used oral hypoglycaemic medications. Thus, the results might only be extrapolated to patients with mild or moderate illnesses in primary healthcare settings, but not to critically ill patients in hospital settings. Thus, future studies are warranted to further explore the complex relationships between KAP in critically ill patients. Also, longitudinal studies with random sampling are needed and can help to verify our results.

CONCLUSION

Patients with higher SI and/or disease progression risk had higher levels of diabetes-related knowledge, which subsequently affected patients' daily practice positively. Holding a positive treatment attitude was also associated with a better diet and physical activities. In contrast, the attitude was inversely associated with foot care practice, and most participants did not obey the foot care recommendations in our study. Therefore, for economically marginalised groups, tailored strategies should be developed to reduce health disparities. And a key health education priority should be integrated with foot care practice.

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Acknowledgements We appreciate Dr Yiwen Cao for her valuable comments and suggestions on SEM methods implementation.

Contributors WZhu and DL contributed to this manuscript equally. WZhu, DL and JH designed the study. WZhu conducted the questionnaire investigation, performed the statistical analysis and wrote the first draft. DL extensively revised the first draft. JDP, WZhang, JH and YD reviewed the draft and provided advice. All authors agree to submit and be accountable for the content of the work. JH is responsible for the overall content as the guarantor.

Funding This article is supported by Grants from the Major Program of National Social Science Fund (No. 20VMG027).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by Medical Research Ethics Committee, School of Public Health, Fudan University (IRB#2021-TYSQ-04-122). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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