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Preferences of patients with depression for exercises: a discrete choice experiment

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Abstract

Background Exercise brings great benefits to patients with depression and is recommended as adjunct treatment for depressive disorder. The low compliance to exercise makes the effective management of depression a serious challenge. Preferences for exercise are important for promoting intrinsic motivation, enjoyment, and behavior maintenance. This study quantified the exercise preferences of patients with depression by a discrete choice experiment (DCE), which provided references for the development of intervention programs, so as to improve the physical activity level of patients with depression and promote the effective management of depressive symptoms.

Methods The six attributes (Professional guidance, Interestingness, Type, Special venue, Frequency, and Safety) and their levels were developed through a literature review, in-depth interviews, and focus group discussions. The software Ngene 1.2 was used to generate 36 choice sets, which were divided into 4 blocks. A survey instrument was developed adhering to the design-principles of DCE. A mixed logit model was used to estimate the preferences of patients with depression. The choice probability of exercise scenarios were predicted.

Results The preferences of 323 depressed patients were analyzed. High level of interestingness was the most important attribute level (coefficient = 0.84, $P < 0.01$), followed by high safety (coefficient = 0.79, $P < 0.01$). There is a gender-based and daily steps-based difference in preference. The optimal exercise strategy should be fun and safe, exercise 3–4 times a week, venue without restrictions, professional guidance, and a combination of teams and individuals.

Conclusion Based on the findings, patients with depression in this target population prefer exercises with attributes such as intrerestingness, safety, while considering gender-based and daily steps-based deference in preferences.

Keywords Depressive disorder, Depression, Adherence, Preference, Discrete choice experiment, Exercise, DCE, Physical activity

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Background

The high prevalence of depression establishes it as one of the most commonly occurring mental disorders globally, affecting approximately 350 million individuals, and China has the highest number of patients with depression, with 95 million cases [1, 2]. Depression's impact on health is profound, as it ranks among the top five causes of disability and stands as the leading cause of all-cause mortality worldwide [3]. Individuals diagnosed with depression exhibit a reduced life expectancy compared to the general population [4], primarily due to concurrent cardiovascular disease and suicide [5–8]. Furthermore, those suffering from depression face a substantially elevated risk of developing type 2 diabetes [9], hypertension [10] and metabolic syndrome [11]. The economic burden imposed by depression on both families and societies is substantial, with anxiety and depression collectively estimated to result in an annual global productivity loss of approximately US $1.15 trillion [12]. Projections indicate that by 2030, depression will ascend to the top rank in terms of global disease burden [13]. Addressing the escalating burden of mental disorders, particularly depression, has emerged as a paramount priority in global public health [14].

The first-line treatment options for depression typically involve oral antidepressants and psychotherapy. Nevertheless, the current effectiveness of these interventions remains unsatisfactory. There is evidence that only approximately half of patients receiving antidepressant treatment achieve significant clinical symptom relief [15]. The efficacy of antidepressants compared to placebo increases with the severity of depressive symptoms, but may be minimal or absent in patients with mild to moderate symptoms [16]. Furthermore, a considerable proportion (50-70%) of individuals suffering from depression exhibit poor medication adherence [17, 18], significantly elevating the challenges associated with depression management [19]. The worldwide shortage of psychotherapists also restricts access to psychotherapy [20]. Therefore, there is an urgent need to explore alternative interventions that offer high compliance and excellent accessibility.

There is a guideline advocating that adults engage in at least 150 min of moderate-to-vigorous physical activity per week, which translates to an average daily step count ranging from 6,000 to 8,000 steps. Adhering to the recommended level of physical activity brings great benefits for patients with depression, including significantly reducing the recurrence of depression [8, 21], alleviating depressive symptoms [22–24], mitigating suicidal ideation [25], enhancing the quality of life among patients with depression [26, 27], and decreasing the risk of cardiovascular disease-related mortality in individuals suffering from depression [28, 29]. Different types of exercise have different effects [30]. Compared with other exercises, jogging, yoga, and strength training have better therapeutic effects on depression and are well tolerated by patients [23, 31]. In contrast, relaxation therapy was most effective in reducing perinatal depression [32]. In addition, there may be a dose-response relationship between exercise and depression. Mild, moderate, and high intensity exercise can all reduce depressive symptoms [33]. It is worth noting that the effect of exercise intensity varies across different populations. For instance, both moderate and vigorous walking exercise can improve clinical symptoms in elderly patients with depression [34], low - and moderate-intensity exercise is beneficial to improve the severity of depression in women with postpartum depression [35], while vigorous exercise is the most effective intervention for treating depression and stress in college students [36]. It has been suggested that the effect of exercise on reducing depressive symptoms appears to depend on exercise frequency [37]. Simultaneously, exercise has a favorable effect on depression regardless of exercise duration and recovery period [38]. Although effects of varying types, intensities, and frequencies of exercise are different, exercises exhibit comparable efficacy to psychotherapy and antidepressants [39–41], and are recommended by various guidelines as adjunct treatment option for depression [42, 43].

The level of physical activity in patients with depression remains conspicuously low [44]. A substantial proportion of these patients fail to attain the recommended exercise intensity thresholds [45], and 34.8% even lack physical activity [46]. The primary obstacle to engaging in exercise for patients with depression is a lack of motivation [47]. Preferences are crucial for enhancing individual motivation and thus promoting behavior change and maintenance [48]. Strategies that incorporate personal preferences can effectively boost motivation [49], while strategies developed with clients to increase motivation can promote behavior change and retention in the long term [50]. For example, preference-based interventions that focus on health motivation may help to promote physical activity behavior in adults [51], while interventions that do not consider individual preferences may lead to poor maintenance of physical activity [52]. Furthermore, research has indicated that interventions exhibit limited efficacy when subjects display low compliance and insufficient participation [53]. Symptoms such as diminished interest and reduced volitional behavior frequently result in poor adherence to various treatment protocols among patients with depression. Considering individual needs and preferences is an important strategy to ensure that an exercise intervention is compatible with the target audience, which can affect the effectiveness of the intervention [54]. Moreover, tailoring interventions based on patient needs and preferences has the

potential to enhance patient compliance and augment the intervention's efficacy [55]. However, to date, no study has explored the exercise preferences of patients with depression.

Contingent valuation method (CVM) and Discrete choice experiment (DCE) are the predominant preference measurement methods in contemporary research [56]. However, CVM is constrained by limitations such as single-scenario settings, starting-point bias, and strategic bias. In contrast, DCE integrates consumer demand theory, econometric analysis, and random utility theory, thereby effectively addressing these biases. DCE enables the comparison and analysis of multiple attribute levels, evaluates preference intensities, optimizes resource allocation, provides a foundation for policy or intervention programs, and supports economic evaluation and decision-making [57]. Therefore, we conducted a DCE to investigate exercise preferences among patients with depression, aiming to inform the development of intervention programs that can enhance physical activity levels and promote effective symptom management.

Methods

The study, conducted from September 1, 2023, to August 31, 2024 in Sichuan province, was approved by the the Ethics Committee of Deyang People's Hospital (the ethics number: 2023-04-073-K01). It adhered the principles of discrete choice experimental design. A DCE typically consists of three stages: identification of attributes and levels, experimental design and questionnaire development, and questionnaire investigation and data analysis. The key stages for developing a DCE are illustrated in Fig. 1. Our study followed the checklist established by the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) for best practices in DCE within healthcare settings [58].

Identification of attributes and levels

Attributes and levels were identified through literature review, in-depth interviews, and focus group discussions. A literature search was conducted in Pubmed, Web of science, Embase, China National Knowledge Infrastructure (CNKI) and Wanfang Database. The search strategy is as follows: ("Depress*" OR "Depressive Disorder"[MESH] OR "Dysthymic Disorder[MESH]" OR "MDD") AND ("Exercise"[MESH] OR "Physical active*") AND ("Patient Satisfaction"[Mesh] OR "Patient Preference"[Mesh] OR "incentive" OR "motivation" OR "intention" OR "attitude" "barrier"). The snowball method was employed to obtain more pertinent literature. The retrieved results were reviewed, relevant impact factors were extracted, and potential attributes was developed. Subsequently, in-depth interviews were developed and conducted with patients with depression to further explore and refine attributes and levels (The interview outline was presented in Appendix A). The in-depth interviews mainly focused on the following topic: (1) the cognition and attitude towards physical activity; (2) influencing factors of physical activity in patients with depression; (3) the needs and preferences for physical activity; and (4) opinions of patients with depression and expectations on exercise. In addition, five patients with depression and three psychiatric professionals were invited to participate in focus group discussions. Based on feedback from these discussions, 11 potential attributes were identified, and the definition and final levels of each attribute were determined. Some researchers have suggested that when the task becomes overly complex, respondents may not make

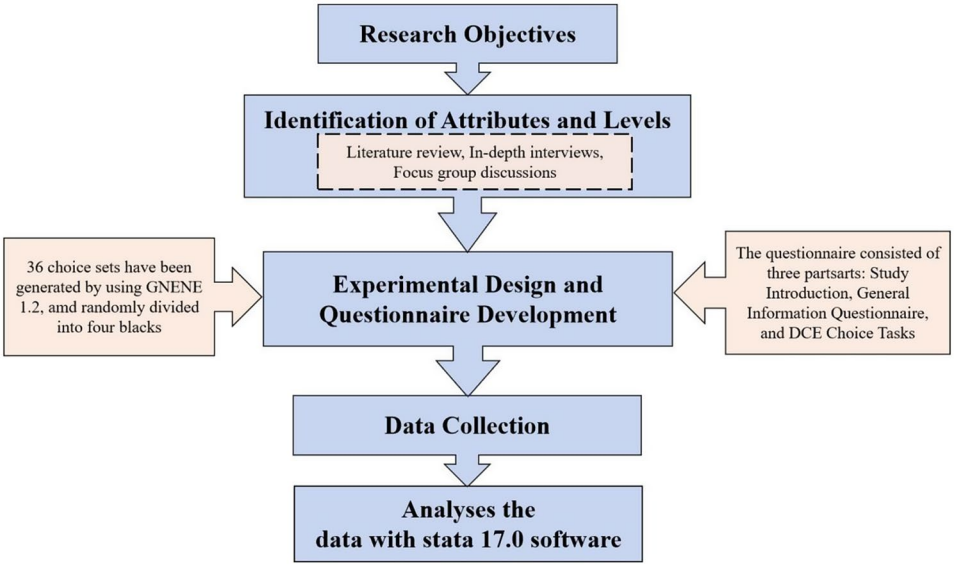

Fig. 1 The key stages for developing a DCE

trade-offs and instead adopt other decision heuristics or lexicographic decision rules [59]. Referring to a DCE to assess adherence-related motivation, 15 participants who did not participate in in-depth interviews and focus group discussions were asked to vote for each attribute with "most important", "somewhat important" and "least important" [60], and according to the number of "most important" votes, the attributes were sorted. In DCE studies, the typical range for the number of attributes is between 4 and 8 [61]. Research has also indicated that six attributes are optimal for a DCE [62]. Therefore, according to the ranking results, six attributes were included in our study. Detailed information on the attributes and their levels is provided in Table 1.

Table 1 List of attribute and levels

Attribute	Level	Description
Professional guidance	Yes	Professional guidance is provided during exercise.
	No	No professional guidance is provided during exercise.
Interestingness	Low	Sports are less interesting and may make people feel bored.
	Medium	The interest of sports is not high, but it will not make people feel bored.
	High	Sports are very interesting and may bring a lot of joy.
Type	Individual exercises	This type of exercises can be performed without a partner.
	Team exercises	This type of exercises can not be performed without a partner.
	Alternate between individual exercises & team exercises	If you play an individual exercises this time, play a team exercises next time, and so on.
Special venue	Need	This type of sport requires special venues or equipment to carry out.
	No need	This type of sport does not require special venues or equipment to carry out.
Frequency	≤ 2/week	The frequency of exercise was not more than twice per week.
	3–4/week	The frequency of exercise was 3–4 times per week.
	≥ 5/week	Exercise at least 5 times a week on average.
Safety	Low	The possibility of physical injury during exercises is relatively high.
	Medium	The body is not easy to be injured during exercises.
	High	It is almost impossible to be injured during exercises.

Experimental design and questionnaire development

The D-efficiency design was performed using Ngene1.2 version, resulting in 36 choice sets. To reduce the cognitive burden on respondents, these choice sets were divided into four blocks, each comprising nine tasks. Participants were subsequently randomly assigned to one of the four blocks.

The questionnaire mainly contains three parts: the Study Introduction, the General Information Questionnaire, and the Discrete Choice Experiment (DCE) Choice Tasks. Please see Appendix B for details of questionnaire.

Study Introduction: This section elucidates the objectives of the study and outlines the necessary precautions for completing the questionnaire.

General Information Questionnaire: This part mainly includes social demographics characteristics, such as gender, age, income, and education level, to explore how this information may affect preferences.

Choice Set Tasks: In this part, exercise-related attributes and levels were initially described to ensure clarity for participants. This was followed by a practice task as a "warm-up" to familiarize the respondent with the subsequent choice tasks. In addition to the nine choice set tasks, the third choice task was repeated into the tenth choice task, which was not included in the statistical analysis, to test for response consistency. All choice tasks were non-mandatory, that is, respondents could choice-opt option, which would avoid overestimation of participation rates. The example of choice set is provided in Appendix C.

Participants and data collection

The survey subjects of this study are patients with depression, and the inclusion criteria are as follows: (1) Patients who have been diagnosed with depression by certified psychiatrists (including depressive mood and depressive state); (2) Participants must be at least 18 years of age; and (3) Individuals must possess the ability to comprehend textual information and complete the questionnaire independently. The exclusion criteria are as follows: (1) Patients unwilling to participate in the survey; (2) Patients with comorbid psychiatric disorders or substance use issues; and (3) Patients with other medical conditions that preclude physical activity, such as severe cardiovascular disease or malignant tumors. To guarantee the representativeness of the sample within the population, patients with depression were recruited from six psychiatric wards and outpatient departments in Sichuan province. Based on rule of thumb to determine the sample size [63, 64], the formula is as follows: $N > 500c/(t \times a)$. Where 500 is a fixed variable, a represents the number of alternatives in each choice set (the 'opt-out item' is not included), c represents the maximum number of levels of any attribute, t represents the number of choice sets in each questionnaire (excluding the repeatedly included choice sets). In our study, $a = 2$, $t = 9$, $C = 3$, and the number of samples for each version is calculated according to this formula to be 84.

Data were collected from September 1, 2023, to August 31, 2024. Trained investigators conducted face-to-face data collection at the recruitment sites. To ensure an adequate sample size and minimize bias due to variations in the number of questionnaires per version, we had planned to collect 100 questionnaires in each version. Participants were randomly assigned to four groups using a random number generator, and each group was investigated with version 1, version 2, version 3 and version 4 of the questionnaire, respectively. Questionnaires were excluded from the final analysis if they met either of the following criteria: (1) The consistency test failed: that is, respondents gave different answers to repeated choice tasks; and (2) Were submitted within 120 s, as pilot testing indicated a minimum completion time of 130 s.

Data analysis

Descriptive statistics were performed to analyze the sociodemographic characteristics of patients with depression, and the mixed logit model and conditional logit model in Stata 17.0 were used to assess the preferences of patients with depression. Model selection was based on likelihood ratio tests, Akaike Information Criteria (AIC), and Bayesian Information Criteria (BIC). Subsequently, subgroup analyses were conducted and optimal exercise scenario predictions were made based on the selected model. The attribute levels were encoded as dummy variables, with the average coefficient value representing the depressed patient's average preference for a specific attribute level. The sign of the coefficient indicates the direction of preference: a positive (negative) sign suggests that the patients with depression preferred (not preferred) the specific attribute level compared to the reference attribute level. Given the difference in the incidence and mortality of depression between men and women [65], as well as established gender differences in individual preferences [66], we conducted a subgroup analysis of participants based on gender to explore the differences in preferences of people with depression by gender. In addition, a subgroup analysis of participants based on daily steps was conducted. The preference score (Vj), also known as the indirect utility score, is calculated as the sum of the model coefficients for each combination of attribute levels. The Pj represents the probability that a given combination of attribute levels is the most preferred scenario, and it is calculated using the following formula:

$$P_j = \frac{\exp(V_{j)}}{\sum_{k=1}^{J} \exp(V_k)}$$

where $j = 1..$ j. In this article, only the top five scenarios with the highest rankings are considered.

Results

Characteristics of respondents

A total of 400 patients with depression, who met both the inclusion and exclusion criteria, were invited to participate. Among them, 31 failed to complete the questionnaire, 27 did not pass the consistency test, and 19 submitted the questionnaire within 120 s. Consequently, a final sample of 323 participants was included in the analysis. Of the 323 participants, 181 (56.04%) were female. Participants under the age of 40 accounted for 52.9% of the sample, with those aged 18–29 years comprising 31.3% and those aged 30–39 years comprising 21.7%. The participants with monthly income of 6000–10,000 were the most, accounting for 45.82%. A total of 123 participants were employed full-time, and the majority (52.94%) of the participants were from Metro/city. The details of respondents' characteristics is reported in Table 2.

Overall results

The results for all respondents are presented in Table 3. The results from mixed logit mode indicate that, in comparison to the reference level, depressed patients exhibited a more preferred level for each attribute, which proved that the attribute level identified in this study was a key factor affecting exercise participation in depressed patients. The attribute level most valued by depressed patients was 'interestingness-high' (Coefficient = 0.84, $p < 0.01$), followed by 'safety-high'(Coefficient = 0.79, $p < 0.01$). Although providing professional guidance in exercise was valued by people with depression(Coefficient = 0.15, p = 0.03), it was valued much less than at the levels of other attributes. Notably, participants with depression were more likely to participate in medium-frequency (3–4 times/week) exercise(Coefficient = 0.21, p = 0.03) than high-frequency (≥ 5 times/week) exercise, and the difference in preference between low(≤ 2/week) and high frequency exercise was not significant(p = 0.12). Heterogeneity in preferences was observed across all attribute levels for depressed patients, except for 'interestingness-medium' and 'safety-high'. The results from the conditional logit model are consistent with those of the mixed logit model. The attribute level most valued by depressed patients was 'interestingness-high' (Coefficient = 0.65, $p < 0.01$), followed by 'safety-high' (Coefficient = 0.62, $p < 0.01$).

Assessment of model fit

The results of the model fit assessment are presented in Table 4. There was little difference in log-likelihood (LL) values between the two models. For the mixed logit model, AIC and BIC values are 5510.12 and 5580.85, respectively. In contrast, the conditional logit model yields AIC and BIC values are 5547.50 and 5618.23,

Table 2 Characteristics of respondents

Characteristics	Respondents (*N* = 323)	
	N	%
Gender		
Male	142	43.96
Female	181	56.04
Age, years		
18–29	101	31.27
30–39	70	21.67
40–49	49	15.17
50–59	33	10.22
60–69	66	20.43
≥ 70	4	1.24
Highest level of education		
Primary school and below	23	7.12
Junior high school	97	30.03
Senior high school	96	29.72
College degree and above	107	33.13
Daily average steps		
<5000	82	25.39
5000–7500	130	40.25
7500–10,000	65	20.12
≥ 10,000	46	13.24
Monthly income		
<2000	23	7.12
2000–6000	81	25.08
6000–10,000	148	45.82
≥ 10,000	71	21.98
Occupational status		
Working full-time	123	38.08
Working part-time	44	13.62
Working casual	47	14.55
Not working	21	6.51
Home duties and/or caring responsibilities	19	5.88
Retired	69	21.36
Area of residence		
Metro/city	171	52.94
Regional	101	31.27
Rural	51	15.79

respectively. Lower AIC and BIC values indicate a more accurate and parsimonious model. Therefore, based on these criteria, the mixed logit model was selected for analysis, and subsequent subgroup analyses were conducted using this model.

Results of subgroup analyses

Table 5 reports the results of the subgroup analyses. The results of subgroup analysis based on gender showed that, for male patients, the most important attribute level was 'frequency-3-4/week'(Coefficient = 0.71, $p < 0.01$), followed by 'interestingness-high'(Coefficient = 0.69, $p < 0.01$). Conversely, the attribute level most valued by female patients was 'safety-high'(Coefficient = 0.85, $p < 0.01$). Compared with attribute level 'safety-low', female patients prefer 'safety-high'(Coefficient = 0.85, $p < 0.01$), while male patients' preference for higher safety has no significant difference($p = 0.78$). Female depressed patients preferred team exercise more than individual exercise(Coefficient = 0.47, $p < 0.01$), and male patients did not differ significantly in their preference for team exercise($p = 0.50$). In the results of subgroup analysis based daily average steps, for the patients with fewer 7500 daily steps, the most important attribute level was 'interestingness-high'(Coefficient = 0.91, $p < 0.01$), while for the patients with more than 7500 daily steps, this was 'special venue-no need' (Coefficient = 0.81, $p < 0.01$). Preference for 'professional guidance-yes' was significant for patients with fewer than 7500 daily steps ($p < 0.01$), whereas preference for it was insignificant for patients with more than 7500 daily steps ($p = 0.19$).

Predicting choice probability

To elucidate the respondent's preference for a combination of factors, the five most valuable exercise scenarios are presented in Table 6. All of these scenarios feature professional guidance and medium frequency. Additionally, the optimal exercise scenarios should combine high levels of interest and safety, not require specialized venues, and integrate both team and individual sports(Preference score = 2.74, Probability = 0.21).

Discussion

Individual preferences for exercise play a crucial role in fostering intrinsic motivation, enhancing enjoyment, and ensuring sustained behavior [48]. Although some studies have investigated the exercise preferences of patients with depression [67–70], While some studies have examined the exercise preferences of patients with depression, they have not quantified the strength of these preferences or explored the trade-offs between influencing factors. Our study utilized a DCE to quantify exercise preferences among patients with depression, analyze gender-based and daily steps-based differences in these preferences, and predict the acceptance probability of various exercise scenarios. Our study identified modifiable exercise management characteristics relevant to clinical practice and health education, clarifying which exercise attributes are most significant for patients with depression within the framework of patient-centered medicine. This provides valuable insights for formulating and optimizing exercise intervention programs aimed at improving physical activity levels and effectively managing depressive symptoms.

Patients with depression place significant value on the engaging nature of exercise. A lack of motivation is a major barrier to exercise individuals with depression [47]. Due to the influence of the disease, patients with depression usually exhibit symptoms such as diminished

Table 3 The results for all respondents ($N = 323$)

A. Mixed Logit Mode Estimates								
Attribute levels (reference level)	**Coefficient (s.e)**	***p***	**95%CI**		**SD (s.e)**	***p***	**95% CI**	
Professional guidance (No)								
Yes	0.15(0.07)	0.03	0.0166822	0.2838884	1.23(0.13)	< 0.01	0.9812041	1.472975
Interestingness (Low)								
Medium	0.53(0.10)	< 0.01	0.3356907	0.7206956	0.20(0.26)	0.45	-0.3081536	0.6996564
High	0.84(0.08)	< 0.01	0.6818403	0.9940637	0.88(0.13)	< 0.01	0.6250876	1.133947
Type (Individual exercises)								
Team exercises	0.18(0.07)	0.02	0.0331827	0.3187127	1.11(0.14)	< 0.01	0.8383903	1.376064
Alternate between individual exercises & team exercises	0.51(0.15)	< 0.01	0.2258233	0.788915	1.12(0.12)	< 0.01	0.9573861	1.441776
Special venue (Need)								
No need	0.25(0.08)	0.01	0.0902156	0.4124775	0.58(0.17)	0.01	0.2517856	0.9108769
Frequency (≥ 5/week)								
3–4/week	0.21(0.09)	0.03	0.0207608	0.3890212	0.82(0.14)	< 0.01	0.554253	1.086632
≤ 2/week	0.20 (0.13)	0.12	-0.0557767	0.4619111	0.99(0.14)	< 0.01	0.7210182	1.259552
Safety (Low)								
Medium	0.24(0.11)	0.03	0.0231328	0.4487649	0.64(0.16)	< 0.01	0.324607	0.9574771
High	0.79(0.09)	< 0.01	0.615995	0.4487649	0.29(0.24)	0.22	0.1748078	0.7503307
B. Conditional Logit Mode Estimates								
Attribute levels (reference level)	**Coefficient (s.e)**	***p***	**95%CI**					
Professional guidance (No)								
Yes	0.15 (0.06)	0.01	0.0413445	0.2684709				
Interestingness (Low)								
Medium	0.25 (0.10)	0.01	0.0527899	0.43842				
High	0.65 (0.10)	< 0.01	0.4526637	0.8528021				
Type (Individual exercises)								
Team exercises	0.51 (0.10)	< 0.01	0.316188	0.7115677				
Alternate between individual exercises & team exercises	0.55 (0.07)	< 0.01	0.4159216	0.6852963				
Special venue (Need)								
No need	0.32 (0.08)	< 0.01	0.1711737	0.4719911				
Frequency (≥ 5/week)								
3–4/week	0.26 (0.08)	0.01	0.0989089	0.4173527				
≤ 2/week	0.11 (0.09)	0.26	-0.0786793	0.2919655				
Safety (Low)								
Medium	0.47 (0.08)	< 0.01	0.3064403	0.6330175				
High	0.62 (0.09)	< 0.01	0.447028	0.7884793				

Table 4 The result of assessing of model fit

Item	Mixed Logit Mode	Conditional Logit Mode
LL	−2745.06	−2763.75
AIC	5510.12	5547.50
BIC	5580.85	5618.23

interest and reduced volitional behavior. Introducing interesting exercise interventions holds promise in enhancing patient motivation. Gamification, which applies game design elements in non-game contexts, has emerged as a promising approach due to its high level of engagement and ability to boost individual motivation and participation [71]. Common gamification elements include goal setting, game points, leaderboards, and levels, all of which stimulate individual interest and enhance feelings of value and enjoyment [54]. Moreover, getting extrinsic incentives through gaming mechanisms can also influence individual behavior [72]. Numerous studies have confirmed the effectiveness of gamification interventions. For instance, Maher used gamification to enhance the physical activity level and motivation of adults [73]. Patel, drawing insights from behavioral economics, combined gamification elements such as grades and points with social incentives to significantly increase the number of daily steps of individuals [74]. Therefore, integrating highly interesting gamification elements into exercise can cater to the preferences of patients with depression and improve their adherence to exercise.

Consistent with previous findings [67], patients with depression in this study preferred to exercise 3–4 times per week. Lethargy is a common symptom among individuals with depression, which can make it difficult to meet the recommended 150 min of moderate to vigorous aerobic exercise per week [75]. Consequently,

Table 5 Results of subgroup analysis

Attribute levels (reference level)	Male ($n=142$)				Female ($n=181$)			
	Coefficient (s.e)	*p*	SD (s.e)	*p*	Coefficient (s.e)	*p*	SD (s.e)	*p*
A. Based on gender								
Professional guidance (No)								
Yes	0.41(0.14)	< 0.01	0.40 (0.26)	0.13	0.49 (0.09)	< 0.01	0.68 (0.21)	0.74
Interestingness (Low)								
Medium	0.36 (0.21)	0.09	0.90 (0.24)	< 0.01	0.52 (0.17)	< 0.01	1.97 (0.44)	< 0.01
High	0.69 (0.12)	< 0.01	1.13 (0.37)	< 0.01	0.58 (0.15)	< 0.01	1.76 (0.44)	< 0.01
Type (Individual exercises)								
Team exercises	0.14 (0.21)	0.50	0.65 (0.22)	< 0.01	0.47 (0.09)	< 0.01	0.28 (0.21)	0.18
Alternate between individual exercises & team exercises	0.33 (0.14)	0.02	1.12 (0.29)	< 0.01	0.10(0.07)	0.41	0.28 (0.18)	0.11
Special venue (Need)								
No need	0.45 (0.08)	< 0.01	0.65 (0.16)	< 0.01	0.29 (0.14)	0.05	0.34 (0.20)	0.09
Frequency (≥ 5/week)								
3–4/week	0.71 (0.07)	< 0.01	0.72 (0.24)	0.76	0.53 (0.13)	< 0.01	0.15 (0.24)	0.52
≤ 2/week	0.38 (0.13)	0.04	0.52 (0.23)	0.02	0.11 (0.13)	0.55	1.27 (0.45)	0.01
Safety (Low)								
Medium	0.07 (0.25)	0.78	0.18 (0.17)	0.30	0.74 (0.13)	< 0.01	1.49 (0.49)	< 0.01
High	0.39 (0.23)	0.78	0.62 (0.26)	0.02	0.85 (0.17)	< 0.01	0.86 (0.21)	0.97
B. Based on daily average steps								
Attribute levels (reference level)	**< 7500 ($n=212$)**				**≥ 7500 ($n=111$)**			
Professional guidance (No)								
Yes	0.53(0.16)	< 0.01	0.62 (0.24)	0.01	0.13 (0.10)	0.19	0.36 (0.17)	0.02
Interestingness (Low)								
Medium	0.36 (0.19)	0.06	0.62 (0.29)	0.03	0.40 (0.10)	< 0.01	0.79(0.09)	< 0.01
High	0.91 (0.13)	< 0.01	0.70 (0.21)	< 0.01	0.59 (0.10)	< 0.01	0.28 (0.11)	0.01
Type (Individual exercises)								
Team exercises	0.90 (0.16)	< 0.01	0.05 (0.22)	0.83	0.21 (0.07)	0.01	0.37 (0.09)	< 0.01
Alternate between individual exercises & team exercises	0.31 (0.19)	0.10	0.35 (0.17)	0.04	0.54(0.09)	< 0.01	0.36 (0.09)	< 0.01
Special venue (Need)								
No need	0.68 (0.19)	< 0.01	0.85 (0.55)	0.80	0.81 (0.09)	< 0.01	0.13 (0.12)	0.28
Frequency (≥ 5/week)								
3–4/week	0.12 (0.25)	0.64	0.19 (0.22)	0.39	0.42 (0.10)	< 0.01	0.66 (0.10)	< 0.01
≤ 2/week	0.14 (0.20)	0.49	0.56 (0.22)	0.01	0.19 (0.13)	0.12	0.45 (0.10)	< 0.01
Safety (Low)								
Medium	0.54 (0.14)	< 0.01	0.74 (0.31)	0.02	0.22 (0.10)	0.02	1.49 (0.29)	< 0.01
High	0.71 (0.17)	< 0.01	0.42 (0.24)	0.08	0.47 (0.11)	< 0.01	0.85 (0.21)	0.96

Table 6 Preference scores within the top 5 exercise programs

Professional guidance	Interestingness	Type	Special venue	Frequency	Safety	Preference score	Probability	Rank
Yes	High	Alternate between individual exercises & team exercises	No need	Medium	High	2.74	0.21	1
Yes	Medium	Alternate between individual exercises & team exercises	No need	Medium	High	2.43	0.16	2
Yes	High	team exercises	No need	Medium	High	2.41	0.15	3
Yes	High	Alternate between individual exercises & team exercises	No need	Medium	Medium	2.19	0.12	4
Yes	Medium	team exercises	No need	Medium	High	2.10	0.11	5

patients with depression may opt for a more manageable exercise, which could explain their preference for exercising 3–4 times a week. One study has demonstrated that lower doses of physical activity also had significant benefits for mental health [76]. The benefit of engaging in physical exercise 3–4 times per week for patients with depression has been substantiated by numerous studies. For instance, Nyström advocates a minimum of

30 min of regular physical activity three times weekly [77], while Stanton recommends engaging in exercise for 30 to 40 min three to four times weekly [78]. Exercise intensity should not be ignored. There are evidences suggest that adherence rates are significantly higher when the required weekly physical activity for improving mental health [79] and reducing symptoms of mental illness is reduced, as well as at lower levels of physical activity [80]. The greatest improvements in positive effects after physical activity occurred for the lowest-intensity activity, with benefits twice as large as those from moderate-intensity physical activity (MVPA) [81]. Similarly, Ekkekakis' study found that mild physical activity was associated with higher levels of positive effects than vigorous physical activity [82]. Low level of physical activity is a global problem, and the physical activity level of Chinese residents is far lower than that of other developed countries [83, 84]. High doses of exercise present a significant challenge for Chinese residents. As the country with the largest number of patients with depression, gradually increasing the dose of exercise from low dose is more in line with the needs of patients with depression in developing countries such as China. Consequently, low-intensity exercise 3–4 times per week may be more effective in mobilizing exercise motivation in patients with depression.

There are notable gender differences in individual preferences [66]. And there is a significant gender difference in the preference for exercise among patients with depression [67], which is confirmed by our research findings. A study has confirmed that women generally report lower levels of perceived security compared to men [85]. Safe services can enhance women's sense of reassurance and security [86]. At the same time, young girls are taught not to show anger or engage in arguments, and thus may feel less capable than the average male to stand up for themselves and meet their needs independently [87]. This explains why female patients with depression tend to prefer exercise with higher safety. Conversely, men tend to favor more stimulating and challenging activities [88], which could account for their lesser preference for safer forms of exercise.

Notably, in Busch's research [67], conducted in the United States, both men and women preferred individual sports. In contrast, our study revealed that female depressed patients preferred team sports over individual sports, and male patients preferred a combination of team and individual sports. We speculate that these differences may be attributed to variations in economic development levels and cultural distinctions between the United States and China. An Italian case-control study showed that both people with mental disorders and community non-mental disorder individuals preferred group activities [70]. However, this study encompassed patients with various types of mental disorders and which diverges from our focus on depression, thereby limiting its direct compare to our findings. Informal group and team physical activities have been found to be negatively associated with depressive symptoms [89]. Given that social isolation is one of the most common effects of depression, team sports, characterized by social interactions, can help mitigate this condition to some extent [90]. During team exercises, the process of building relationships with others through participation may fulfill an individual's need for a sense of belonging [91]. This may be the reason why female patients with depression prefer team exercises. Indeed, the effects of physical activity on well-being are mediated by increases in health and social functioning [92]. Consistent with this, it has been proposed that the benefits of exercise on depression are generally attributed to physical and social influences, and that any exercise involving social contact is positive and motivating for people with depression [93]. Thus, providing team sport interventions for women and a combination of team and individual sport interventions for men, and enjoyable physical activity that promotes positive social interactions may be the best option for alleviating depressive symptoms, improving mental health, and promoting long-term maintenance.

Our study provides preliminary information on the development of exercise strategies for patients with depression, emphasizing which motor characteristics are most important for these individuals within the framework of patient-centered medicine. The optimal exercise program should be guided by professional expertise. This validates a previous study showing that the preferences of patients with depression for exercise program is with coaching [67]. However, the limited availability of mental health professionals in China restricts access to such guidance [94]. Daily step count significantly influenced patient preferences; notably, professional guidance was particularly important for patients with fewer daily activities but less so for those with higher step counts. It is a promising approach to provide mental health-related professional guidance to fitness coaches and family members, so that they can play an important role in the exercise guidance of patients with depression with fewer than 7500 daily steps. While the guidance methods are diverse, the specific preferences of depressed patients for these methods remain unclear, suggesting a potential direction for future research. Although the optimal exercise program should be fun and safe, location-independent, and combine team and individual sports, moderate levels of fun or participation in team sports can still achieve similar benefits when conditions do not permit.

Not all types of exercise offer the same benefits in terms of alleviating depressive symptoms, fostering well-being, and optimizing mental health. While swimming

is often regarded as an optimal aerobic exercise, its site-specific requirements and the necessity of possessing swimming skills may limit its accessibility for individuals with depression. Patients with depression preferred attribute-level 'specialized venues-not need'. Many sports without venue restrictions have brought many benefits to patients with depression. For example, yoga offers both physical and psychological benefits [95], positively impacting chronic stress in depressed patients [96], and is well-received by this population [67, 68]. However, due to its relatively high entry threshold and significant gender preference differences, it may not be universally suitable. Engaging in physical activity through transportation modes, such as walking and cycling to work, has been shown to enhance mental health outcomes [97]. Family-oriented physical activity, including gardening, contribute positively to individual well-being [98]. Leisure-time physical activity (LTPA), such as hiking, exhibits a stronger associated with mental health and mental illness outcomes due to the element of choice, the distraction from stressors, and the enhancement of self-esteem and self-efficacy [97]. Walking can be carried out without specific equipment or venues, making it the most preferred form of exercise for individuals with mental disorders [67–69]. Engaging in outdoor activities within natural settings can yield additional positive effects on mental health that are not observed when performing similar activities indoors [99]. Based on our study findings and the preceding discussion, we recommend the following exercise strategies for patients with depression:

1) Participate in outdoor walking and incorporate gamification elements via mobile applications to enhance the enjoyment of walking;
2) Considering the impact of individual differences on preferences, group walking exercises or peer support programs may be beneficial for female patients with depression;
3) Tailor the frequency and provide professional guidance according to the patient's daily physical activity level.

Limitation

There are several limitations in our study that warrant acknowledgment. Firstly, the DCE focused exclusively on the stated preferences of patients with depression, thereby precluding an exploration of the consistency between stated and revealed preferences. Secondly, the sample size for participants aged 60 and above was relatively small, and no specific investigation was conducted regarding participants' medication use or severity of depression. This may introduce selection bias and limit our ability to fully interpret the results, particularly concerning the influence of age, substance use, and severity of depression on preferences. Thirdly, significant differences in safety preferences were observed between males and females, which may be influenced by subjective factors such as personal experiences or societal norms. Fourthly, as the data were collected via self-report, there is a potential for social desirability bias, where respondents may provide answers they believe are socially acceptable rather than truthful. Lastly, the convenience sampling method used in this study, while easy to implement and cost-effective, may compromise the representativeness of the sample. Additionally, the study was conducted in a single province, which may limit the generalizability of the findings. Future research could benefit from multi-center studies with stratified random sampling and inclusion of additional attributes.

Conclusion

Based on the findings, patients with depression in this target population prefer exercise strategies that were fun and safe, did not require a dedicated venue, had professional guidance, and combined team and individual exercise. Exercise preferences differ between men and women, suggesting that exercise regimens need to be tailored to the individual characteristics of depressed patients. The results of this study can provide valuable evidence for clinicians or health educators in southwest China and have important implications for developing countries. This study can guide future research, such as exploring the specific reasons behind the exercise preference of patients with depression through qualitative research, or conducting intervention research to verify the effects of exercise programs based on individual preferences on the exercise level and exercise compliance of patients.

Abbreviations

DCE	Discrete choice experiment
LL	Log-likelihood
AIC	Akaike Information Criteria
BIC	Bayesian Information Criteria

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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Author contributions

LHQ wrote the main manuscript text and designed this study. XP, JWX and HY collected, analyzed and interpreted data. GSW and JS designed this study and revised critically the manuscript. All authors reviewed the manuscript.

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Data availability
The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
This study complied with the Declaration of Helsinki and was approved by the the Ethics Committee of Deyang People's Hospital (the ethics number: 2023-04-073-K01). All respondents signed informed consent before participating in the survey.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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