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The effect of positive mental well-being on patient reported outcome (PRO): finding from a cross-sectional multi-disease study in China

Zhihao Yang^{1,2}, Nan Luo³ and Yanming Hong^{4*}¹⁰

Abstract

Purpose This study aims to investigate the potential impact of positive mental well-being on responses of patient-reported outcome measures (PROMs), such as EQ-5D-5L.

Methods This study utilized the data collected in a cross-sectional study in a sample consisted of individuals with different health conditions. Spearman's rank correlations were employed to investigate the relationship between the responses to the dimensions of EQ-5D-5L and the Short Warwick-Edinburgh Mental Well-being Scale (SWEMWBS). A binary logistic regression analysis and ordered logistic multivariable regression were utilized to examine how SWEMWBS scores could impact the responses to EQ-5D-5L dimensions, while controlling for variables such as age, gender, education level, health conditions, caring experience, and data collection methods. The effects of SWEMWBS on EQ-VAS and utility values were also examined.

Results One thousand nine individuals participated in the survey. Spearman's rank correlation revealed that all dimensions of EQ-5D-5L, except for the anxiety/depression dimension, exhibited weak correlations with all dimensions of SWEMWBS. Binary logistic regression and ordered logistic multivariable regression indicated that age, SWEMWBS scores, gender, health conditions, data collection methods, and caring experience significantly influenced the likelihood of reporting problems in EQ-5D-5L responses. Notably, better SWEMWBS outcomes increased the likelihood of reporting no or fewer problems across all EQ-5D-5L dimensions. Spearman's rank correlation suggested a moderate or strong positive correlation between SWEMWBS scores and EQ-5D-5L utility values and EQ-VAS. The results of multiple linear regression analysis revealed that SWEMWBS scores, health conditions, caring experience, and data collection methods were significantly associated with EQ-5D utility values and EQ-VAS.

Conclusions Individuals with better positive mental well-being results are more likely to report better results in PROMs like EQ-5D-5L. Future study is needed to understand the thought process and to explore strategies to cope with the response heterogeneity that led by the status of mental well-being.

Keywords Patient reported outcomes (PROs), Patient reported outcome measures (PROMs), Positive mental wellbeing, SWEMWBS, EQ-5D-5L

*Correspondence: Yanming Hong hym18370966170@163.com Full list of author information is available at the end of the article



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Introduction

Traditional clinical measures like morbidity, mortality, and physiological outcomes illustrate the physiological benefits of treatment. The patient perspective provides a more comprehensive interpretation and assessment of the benefits of treatment under investigation [1, 2]. Patient-reported outcomes (PROs) are outcomes that are reported directly by patients, without any interpretation by clinicians or others [3]. These outcomes can range from simple symptoms such as fatigue, anxiety, and pain, to more complex concepts like health-related quality of life (HRQoL) and its related domains [4]. The utilization of PROs serves various purposes, including assessing intervention effectiveness, evaluating treatment outcomes, monitoring disease progression, and facilitating shared decision-making between patients and healthcare providers [1, 5-8], etc. PROs are often measured in absolute terms, such as a patient's rating of the severity of pain. The instruments used to measure PROs are referred to patient-reported outcome measures (PROMs). These measures can be used to obtain data on various aspects of a patient's condition, such as physiological functional status, HRQoL or health utility, caring experience, and symptoms arising from the patient's condition or therapy for it [1, 9]. The use of PROMs has become increasingly important with the shift towards a patient-centered, holistic approach to healthcare [10]. PROMs provide unique information on the effect of the disease and treatment from the patients' perspective, which can supplement conventional clinical measures like blood tests, functional tests, and imaging [11]. Moreover, PROMs have been increasingly used as primary or secondary endpoints in clinical studies [12-15].

Although PROMs have shown success in both clinical research and practice, there are certain limitations that hinder their widespread application. One of the main reasons for this is their susceptibility to subjective factors, making it uncertain how they produce varying levels and scores [5]. PROMs primarily rely on patients' selfassessments, which can be influenced by their personal perspectives, emotions, subjective awareness, etc., which lead to variation in the PROM results. When physicians utilize PROM results to monitor patients' conditions and treatment effectiveness, this variation can bias their judgment [16]. Previous studies have indicated that PROMs can potentially hinder patient-clinician relationships and lack clinically meaningful information [17–19]. These negative perceptions can undermine the potential of utilizing PRO data to support clinical decision-making and enhance patient-centered care [16]. Therefore, it is crucial to comprehend the factors that may influence how patients respond to PROMs.

As one of the factors that may influence the outcome of PROMs, positive mental well-being encompasses an optimal state of psychological functioning and an overall sense of wellness [20]. It involves experiencing positive emotions, including emotional stability, optimism, confidence, and more. Furthermore, it encompasses actively engaging in life, nurturing healthy relationships, achieving personal growth, and feeling in control of one's own life [21, 22]. Positive mental well-being surpasses the mere absence of mental health issues and instead signifies the presence of positive psychological functioning. This state empowers individuals to effectively handle daily stressors, maintain fulfilling relationships, and thrive in society. It may influence the responses to PROMs in several ways including improving subjective experiences [23], enhancing disease prognosis [24], increasing treatment adherence, and improving quality of life directly [23, 25–28]. Individuals with positive mental well-being tend to report higher satisfaction with their overall health conditions and experience a better quality of life. Conversely, patients with poor mental health may exhibit lower PROM scores due to factors such as reduced ability to cope with symptoms or treatment side effects. Yet, there lacks studies that systematically examine how positive mental well-being could affect the response of PROM. Short Warwick-Edinburgh Mental Well-Being Scale (SWEMWBS) is the only available PROM, which has been translated in simplified Chinese and validated in China, that measures positive mental well-being. EQ-5D-5L has been widely validated and used in China and other countries. In this study, we aimed to examine the relationship between positive mental well-being and EQ-5D-5L, which has been widely used as a PROM in different settings [29]. We quantitatively analyzed the effect of SWEMWBS scores on responding to EQ-5D-5L responses after controlling for other demographic factors. We hypothesized that respondents with better positive mental well-being are more likely to report better results for PROMs like EQ-5D-5L. We also explored the influence of demographic factors including health conditions, caring experience, and data collection methods on PROMs like EQ-5D-5L.

Methods

Study design and participants

This study utilized the data collected in a cross-sectional online survey and face-to-face survey in China. The online survey data was obtained from the E-QALY project conducted in China [30, 31]. The goal of the E-QALY project is to develop a new quality-of-life measure. A sample of 500 individuals with different health conditions (including asthma, arthritis, heart conditions, stroke, emphysema, thyroid disorder, bronchitis, liver, cancer, diabetes, epilepsy, blood pressure, Irritable Bowel Syndrome (IBS), Chronic Hepatitis B (CHB), HIV/ AIDS, disability, depression, generalized anxiety disorder (GAD), and healthy individuals (defined as a visual analog score on health of > 80)) were recruited between April and July 2019 through Accent, a UK-based online survey company. All participants were aged 18 years or older and consented to complete the survey. The study was approved by the Ethics Committee of the University of Sheffield, United Kingdom (Approval letter number 025524), and the IRB of Jinan University, China (Approval letter number JNUKY-2020-001). Written informed consent was obtained from all participants prior to their participation in the online survey. Participants were first provided with an overview of the research purpose and asked to report their health condition. Eligible participants also provided background information such as age, gender, education level, and whether they were carers (carers were defined as those who provided care for friends or family members because they were sick, disabled, or elderly). Subsequently, participants were asked to complete the core survey, which included the E-QALY candidate items, EQ-5D descriptive systems (including EQ-5D-3L and EQ-5D-5L), EQ-VAS (completed once), and SWEMWBS. This study utilized the background information, EQ-5D-5L, EQ-VAS, and SWEMWBS data collected in the psychometric survey in China. The order in which participants completed the EQ-5D-5L and SWEMWBS was randomized, with half of the sample starting with SWEMWBS and the other half starting with EQ-5D-5L. All of 500 participants were included in this study: 231 individuals reported themselves with one or more physical conditions (including asthma, arthritis, heart conditions, stroke, emphysema, thyroid disorder, bronchitis, liver, cancer, diabetes, epilepsy, blood pressure, IBS, CHB, HIV/AIDS, disability, and other physical condition), 21 individuals with one or two mental condition (depression and GAD), 108 individuals with both physical and mental conditions, 140 individuals being healthy. No missing data was allowed in the online survey and all data were kept for analysis.

The face-to-face survey replicated the online survey setting except that participants were recruited in person and one version of the questionnaire was used with a fixed order of E-QALY candidate items, SWEMWBS, and EQ-5D-5L (including EQ-VAS). 550 patients with lung cancer, diabetes, depression, and schizophrenia were recruited from the Provincial Hospital of Guizhou, the No.2 Hospital affiliated with Guizhou University of Traditional Chinese Medicine, Yuqing Caring Psychiatric Hospital and Fenggang Caring Psychiatric Hospital. Healthy participants were recruited in different counties of Guizhou Province. The survey was conducted using a paper and pencil by 10 trained undergraduate students from Guizhou Medical University. The face-to-face data was collected between December 2021 and September 2022. All respondents were encouraged to complete the survey independently. Interviewers were instructed not to interpret the items for the respondents. Respondents were informed that they could skip questions they did not understand or preferred not to answer. The face-to-face study was approved by the Ethics Committee of Guizhou Medical University (Approval letter number 2021-101). Written informed consent was obtained from all participants before administering the survey. Respondents without reporting specific illnesses, yet who reported themselves not being healthy (n=15), or missing EQ-5D-5L data (n=4), SWEMWBS data (n=18), and carer status (n=4), were excluded. A total of 509 participants were included in this study: 101 individuals reported themselves with depression, 118 individuals with diabetes, 81 individuals with lung cancer, 112 individuals with schizophrenia, and 97 individuals were healthy.

Since both surveys were self-reported, we combined them for analysis. Patients with certain condition that met our inclusion criteria were recruited and, in the survey, a question about their other health condition was asked. Notably, we merged the disease groups into three categories: with physical conditions (including asthma, arthritis, heart conditions, stroke, emphysema, thyroid disorder, bronchitis, liver, cancer, diabetes, epilepsy, blood pressure, IBS, CHB, HIV/AIDS, disability, and other physical condition), with mental conditions (including GAD, depression, and schizophrenia), and with both mental and physical conditions.

Instruments

The EQ-5D-5L is a widely used generic PROM [32], which consists of a five-item health descriptive system and a visual analog scale (EQ-VAS) [33, 34]. The descriptive system contains five dimensions: mobility, self-care, usual activities, pain/discomfort, anxiety/depression, and five response levels in each dimension: 1= no problems, 2= slight problems, 3= moderate problems, 4= severe problems, and 5= unable/extreme problems. The EQ-VAS is a 20-cm-long vertical health thermometer recording the current self-rated health of respondents that ranges from 0 ('The worst health state you can imagine') to 100 ('The best health state'). We applied the value set of China developed by Luo et al. to calculate EQ-5D-5L utility values [35].

SWEMWBS is a widely used tool for monitoring mental well-being in populations, offering the advantage of robust measurement properties and brevity [36, 37]. In

comparison to the 14-item Warwick-Edinburgh Well-Being Scale (WEMWBS), SWEMWBS provides superior interval scaling [36-38]. The Simplified Chinese translation of SWEMWBS was derived from the developer of WEMWBS and translated by Dong et al. [39]. It has been utilized in the Chinese general population as well as in hospitalized patients with mental illness [40-42]. SWEMWBS is a self-report instrument consisting of seven questions, each representing a specific aspect of mental well-being: feeling optimistic about the future, feeling useful, feeling relaxed, dealing with problems well, thinking clearly, feeling close to other people, and being able to make up one's mind about things. Each question offers five response options: 1=none of the time, 2 =rarely, 3 =some of the time, 4 =often, and 5 =all of the time [37]. The raw level summary score is transformed into metric total scores using the SWEMWBS conversion Table [37].

Notably, the response levels reversed between SWEM-WBS and EQ-5D-5L on item level, with a lower response indicating worse results for SWEMWBS but better results for EQ-5D-5L. On an aggregate level, a higher score suggests better results for both EQ-5D-5L utility values, EQ-VAS, and SWEMWBS overall score. In addition, the recall periods differed as EQ-5D-5L uses 'today' and SWEMWBS uses 'over the past two weeks'.

Statistical analyses

Data were analyzed using SPSS Version 22.0. We first described the sample characteristics and reported the distributions of the EQ-5D-5L dimension responses, SWEMWBS dimension responses, SWEMWBS scores, EQ-5D-5L utility values, and EQ-VAS. Means and standard deviations (SD) were used for describing continuous variables, while frequencies and percentages were used for describing categorical variables. The internal consistency of EQ-5D-5L and SWEMWBS was assessed using Cronbach's alpha [43], for which a value > 0.70 was considered acceptable [41, 43]. Further, the corrected item-total correlation (correlations between a specific item and the total score recalculated after omitting the specific item) were calculated by the Spearman's rank correlation coefficient, with a value of > 0.4 being considered good consistency [44]. The Spearman's rank correlations also were used to examine the correlation between the responses of EQ-5D-5L and SWEMWBS dimensions. Correlations were deemed as weak (0.10-0.29), moderate (0.30-0.49), and strong (≥ 0.5) [45–47]. Next, the binary logistic regression analysis (0=no problem, 1=slight/moderate/severe/unable/extreme problems) and ordered logistic multivariable regression were used to explore the association between SWEMWBS scores and EQ-5D-5L dimension responses controlling for age, gender, education level, health conditions, caring experience, and data collection methods. Next, the correlation between SWEMWBS scores and EQ-5D-5L utility values and EQ-VAS were also examined by the Spearman's rank correlations as their distributions were not normally distributed. The multiple linear regression analysis was used to analyze the influence of age, SWEMWBS scores, gender, education level, health conditions, caring experience, and data collection methods on EQ-5D-5L utility values and EQ-VAS. In the appendix, we supplemented the results of the ordered logistic multivariable regression analysis and the multiple linear regression analysis when the data from online survey and face-to-face survey were analyzed separately. Furthermore, we conducted an additional analysis exploring the associations between mental well-being, as measured by the SWEMWBS, and sociodemographic characteristics to verify the robustness of the results.

Results

The total sample consisted of 1,009 individuals, with 529 (52.2%) being female. Our study sample was evenly distributed across four age groups, with a mean age of 41.5 ± 14.82 years old. More than half of the participants had a college degree or higher education, accounting for 544 (53.7%) individuals. The participants encompassed four different health condition subgroups. This included 237 (23.4%) healthy individuals, 430 (42.4%) individuals with physical conditions, 234 (23.1%) with mental conditions. Out of the total sample, 692 (68.3%) participants had no previous experience with caregiving. A summary of the characteristics of the entire sample can be found in Table 1.

The distributions of the EQ-5D-5L dimensions and SWEMWBS dimensions are depicted in Fig. 1. Regarding the EQ-5D-5L, the majority of respondents indicated 'no problems' in the dimensions of mobility, self-care, and usual activities, accounting for 73.6%, 79.4%, and 71.7% respectively. Levels 4 and 5 of the EQ-5D-5L had comparatively fewer responses. On the other hand, the SWEMWBS exhibited responses across all levels, with the highest percentage of respondents reporting 'often' in each dimension. In contrast, the 'none of the time' level was the least reported in each dimension.

Figure 2 displays the distributions of the SWEMWBS scores, EQ-5D-5L utility values, and EQ-VAS. All of them showed a skewed distribution. Regarding the SWEMWBS scores, the mean score was 24.73±5.71, ranging from 7.0 to 35.0. In addition, 10.7% of participants scored the

Table 1	Sample	charac	teristics
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Characteristics	n	%
Gender		
Male	480	47.6%
Female	529	52.4%
Age group		
≤30 years	248	24.6%
31 ~ 40 years	287	28.4%
41 ~ 50 years	223	22.1%
>50 years	251	24.9%
Education level		
Primary School or Below	137	13.6%
Middle or high school	328	32.5%
College graduate or above	544	53.9%
Health conditions		
Healthy	237	23.5%
Physical conditions	430	42.6%
Mental conditions	234	23.2%
Both physical and mental conditions	108	10.7%
Carers		
Yes	317	31.4%
No	692	68.6%
Data collection methods		
Online survey	500	49.6%
Face-to-face survey	509	50.4%

highest possible score, 35 points. The mean of EQ-5D-5L utility was 0.86 ± 0.17 . The utility values were greater than 0 except for one participant (utility value = -0.305) and 31.2% of participants had a utility value of 1. As for EQ-VAS, the mean score was 76.52 ± 18.96 , ranging from 0 to 100. The majority of participants scored in the range of 68.10 to 90.00.

Good internal consistency was found for both instruments, as indicated by the high Cronbach's α values (0.811 for EQ-5D-5L and 0.922 for SWEMWBS). The corrected item-total correlations were strong, ranging from 0.475 (anxiety/depression dimension) to 0.735 (usual activities dimension) for EQ-5D-5L, and from 0.737 (relaxed dimension) to 0.792 (problems dimension) for SWEMWBS (Table 2). For SWEMWBS, removing any single item did not result in a Cronbach's α value higher than the overall α of 0.922, indicating good internal consistency across all dimensions. In contrast, for EQ-5D-5L, deleting the anxiety/depression dimension increased the overall Cronbach's α , suggesting that this dimension may have lower internal consistency compared to other dimensions.

Table 3 presents Spearman's rank correlation coefficients between the EQ-5D-5L and SWEMWBS dimensions.

The four dimensions of the EQ-5D-5L (mobility, self-care, usual activities, and pain/discomfort) exhibited weak correlations with all dimensions of the SWEMWBS, with correlation coefficients ranging from -0.297 to -0.001. The anxiety/depression dimension of the EQ-5D-5L showed a moderate correlation with several dimensions of the SWEMWBS: optimistic (ρ =-0.495), useful (ρ =-0.439), relaxed (ρ =-0.493), problems (ρ =-0.389), clearly (ρ =-0.336), close (ρ =-0.415), and mind (ρ =0.392), respectively.

The results of the binary logistic regression analysis are presented in Table 4. Among all controlled variables, education level had no effect over the likelihood of reporting problems for EQ-5D-5L dimensions except for the anxiety/depression dimension, other variables showed moderate to large effects. Specifically, older participants were found to have a higher likelihood of reporting problems in the mobility dimension (OR: 1.034; 95% CI: 1.017, 1.051), self-care dimension (OR: 1.051; 95%CI: 1.031, 1.072), and pain/discomfort (OR: 1.014; 95% CI: 1.000, 1.027). Male participants were more likely to report no problems than females in five dimensions of the EQ-5D-5L. Individuals with physical and/ or mental conditions were more likely to report problems across all dimensions of the EQ-5D-5L compared to healthy individuals. The usual activities of the EQ-5D-5L exhibited the highest likelihood of problems (OR: 5.752 to 11.482), while the anxiety/depression dimension displayed the lowest likelihood of problems (OR: 3.875 to 10.594). Those with no prior caregiving experience and participants who underwent online interviews were more likely to report problems across all dimensions of the EQ-5D-5L compared to carers and participants interviewed face-to-face. Particularly, participants with higher SWEMWBS scores demonstrated a greater likelihood of reporting no problems across all dimensions of the EQ-5D-5L. The OR ranged from 0.837 (95%CI: 0.809, 0.866) for the anxiety/depression dimension to 0.920 (95%CI: 0.887, 0.955) for the self-care dimension of the EQ-5D-5L.

In general, the results of the ordered logistic regression model (Table 5) were similar to the results of the binary logistic regression model (Table 4). Age, gender, health conditions, data collection methods, and caring experience showed significant effects on the likelihood of reporting problems for EQ-5D-5L responses. Among which, health conditions have the most obvious effect. Specifically, participants with physical and/or mental conditions reported more severe problems across all dimensions of the EQ-5D-5L, e.g., the OR ranged between 5.680 and 10.740 for the usual activities dimension and ranged between 4.007 and 6.567 for the anxiety/





Fig. 1 Response distributions of EQ-5D-5L dimensions and SWEMWBS dimensions

depression dimension. In terms of the SWEMWBS scores, a significant, negative association was observed between SWEMWBS scores and EQ-5D-5L responses, that is, the higher the SWEMWBS score, the less

likelihood of reporting problems for EQ-5D-5L, with an OR ranging between 0.807 (95%CI: 0.782, 0.831) for the anxiety/depression dimension and 0.910 (95%CI: 0.878, 0.944) for the self-care dimension. When the data from



Fig. 2 Distributions of SWEMWBS scores, EQ-5D-5L utilities, and EQ-VAS

Table 2 The internal consistency of EQ 3D 3E and SWEIMWD.	Table 2	The internal	consistency	of EQ-5D-5L	and SWEMWBS
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Items	Corrected item-total correlation ^a	Cronbach's alpha if item deleted
EQ-5D-5L		
Mobility	0.683	0.754
Self-care	0.638	0.769
Usual activities	0.735	0.736
Pain/discomfort	0.575	0.782
Anxiety/depression	0.475	0.834
SWEMWBS		
Optimistic	0.754	0.910
Useful	0.760	0.910
Relaxed	0.737	0.912
Problems	0.792	0.906
Clearly	0.761	0.910
Close	0.740	0.912
Mind	0.752	0.910

^a Values greater than 0.4 are considered suitable; Spearman's rank correlation coefficient (*p*<0.001 for all correlations)

online survey and face-to-face survey are analyzed separately, the effect of SWEMWBS scores on responses to EQ-5D-5L dimension responses is consistent (Appendix Table 7).

The relationship between the SWEMWBS scores and EQ-5D-5L utility values and EQ-VAS is shown in Fig. 3. The Spearman's rank correlation coefficients between the SWEMWBS scores and EQ-5D-5L utility values and EQ-VAS were 0.412 (P<0.01) and 0.515 (P<0.01), respectively, suggesting a moderate or strong positive correlation. Table 6 shows the results of multiple linear regression analysis. Age is not significantly associated with EQ-5D utility values and EQ-VAS; in contrast, gender, education level, SWEMWBS scores, health conditions, caring experience, and data collection methods were associated with the values. Males had a weak positive correlation with EQ-5D-5L utility values (β : 0.035; 95%CI: 0.017, 0.053); The SWEMWBS scores had a

significant positive correlation with EQ-5D-5L utility values (β: 0.011; 95%CI: 0.010, 0.013) and EQ-VAS (β: 1.583; 95%CI: 1.391, 1.775). Appendix Table 8 shows a similar result with a positive correlation between SWEMWBS scores and utility values and EQ-VAS when the data from online survey and face-to-face survey are analyzed separately. The physical and/or mental conditions had a weak negative correlation with EQ-5D-5L utility values (β: -0.110; 95%CI: -0.135, -0.086; β: -0.096; 95%CI: -0.124, -0.067; β: -0.124; 95%CI: -0.159, -0.088; respectively) and had a stronger negative correlation with EQ-VAS (β: -7.433; 95%CI: -10.216, -4.650; β: -9.424; 95%CI: -12.664, -6.183;β: -8.724; 95%CI: -12.746, -4.703; respectively). The data collection methods had a weak positive correlation with EQ-5D-5L utility scores (β : -0.047; 95%CI: -0.076, -0.017), while caring experience had a stronger positive correlation with EQ-VAS (β: 2.854; 95%CI: 0.499, 5.209). The associations between SWEMWBS scores and sociodemographic characteristics is shown in appendix Table 9. Age, gender and caring experience had a positive correlation with SWEMWBS scores, while health conditions and data collection methods were negatively associated with SWEMWBS scores.

Discussion

PROMs have gained growing popularity in randomized clinical trials and clinical practice due to their noninvasive nature, patient-centered approach, and ease of accessibility [8, 48, 49]. Despite its increasing use and importance, there is a lack of understanding regarding the impact of participants' psychological factors on their responses to commonly used PROMs like EQ-5D-5L. By conducting a quantitative analysis to examine the effect of SWEMWBS scores on responses to EQ-5D-5L dimension responses, utility values, and EQ-VAS in a large sample with different health conditions after accounting for other demographic factors, we found that SWEMWBS score was statistically significant associated with EQ-5D-5L outcomes.

Table 3 Spearman correlation coefficients between domain responses for the EQ-5D-5L and SWEMWBS

EQ-5D-5L	SWEMWBS						
	Optimistic	Useful	Relaxed	Problems	Clearly	Close	Mind
Mobility	-0.237 ^a	-0.207 ^a	-0.175 ^a	-0.044	-0.017	-0.135 ^a	-0.085 ^a
Self-care	-0.139 ^a	-0.180 ^a	-0.123 ^a	-0.038	-0.001	-0.105 ^a	-0.089 ^a
Usual activities	-0.263 ^a	-0.257 ^a	-0.245 ^a	-0.136 ^a	-0.114 ^a	-0.186 ^a	-0.167 ^a
Pain/discomfort	-0.283 ^a	-0.265 ^a	-0.297 ^a	-0.235 ^a	-0.229 ^a	-0.243 ^a	-0.228 ^a
Anxiety/depression	-0.495 ^a	-0.439 ^a	-0.493 ^a	-0.389 ^a	-0.336 ^a	-0.415 ^a	-0.392 ^a

Correlation: 0.10–0.29 = small; 0.30–0.49 = medium; > 0.50 = large

^a Correlation is significant at the 0.01 level (2-tailed)

Table 4 Binary logistic regression	analysis with EQ-5D-	5L dimer	nsions as dependent	variable	S					
Variables	Mobility		Self-care		Usual activities		Pain/discomfort		Anxiety/depression	
	OR(95%Cl)	٩	OR(95%Cl)	٩	OR(95%CI)	٩	OR(95%Cl)	٩	OR(95%Cl)	٩
Age	1.034(1.017, 1.051)	< 0.001	1.051(1.031, 1.072)	< 0.001	1.013(0.997, 1.029)	0.108	1.014(1.000, 1.027)	0.043	0.993(0.979, 1.006)	0.290
SWEMWBS scores	0.902(0.872, 0.934)	< 0.001	0.920(0.887, 0.955)	< 0.001	0.884(0.853, 0.915)	< 0.001	0.882(0.856, 0.910)	< 0.001	0.837(0.809, 0.866)	< 0.001
Male (Ref: Female)	0.562(0.400, 0.791)	0.001	0.681(0.468, 0.989)	0.044	0.484(0.344, 0.680)	< 0.001	0.596(0.444,0.801)	0.001	0.525(0.383, 0.720)	< 0.001
Education level (Ref: College graduate or above)		0.743		0.107		0.153		0.178		0.011
Primary School or Below	0.913(0.446, 1.868)	0.803	1.064(0.470, 2.407)	0.882	0.724(0.361, 1.451)	0.363	0.628(0.357, 1.105)	0.107	0.661(0.362, 1.206)	0.177
Middle or high school	0.813(0.472, 1.401)	0.457	0.574(0.304, 1.085)	0.087	0.595(0.351, 1.008)	0.054	0.957(0.623, 1.470)	0.842	0.499(0.316, 0.790)	0.003
Health conditions (Ref: Healthy)		< 0.001		< 0.001		< 0.001		< 0.001		< 0.001
Physical conditions	10.041(5.481, 18.396)	< 0.001	7.495(3.864, 14.537)	< 0.001	11.238(6.156, 20.516)	< 0.001	5.721(3.811, 8.588)	< 0.001	3.875(2.521, 5.957)	< 0.001
Mental conditions	4.384(2.092, 9.189)	< 0.001	5.260(2.249, 12.302)	< 0.001	5.752(2.822, 11.724)	< 0.001	2.331(1.458, 3.726)	< 0.001	3.949(2.382, 6.547)	< 0.001
Both conditions	7.765(3.775, 15.972)	< 0.001	7.069(3.250, 15.376)	< 0.001	11.482(5.611, 23.495)	< 0.001	10.585(5.205, 21.525)	< 0.001	10.594(4.817, 23.300)	< 0.001
Carers (Ref: Yes)	2.257(1.505, 3.386)	< 0.001	2.336(1.507, 3.623)	< 0.001	2.292(1.528, 3.439)	< 0.001	0.825(0.583, 1.166)	0.275	0.898(0.622, 1.298)	0.568
Online survey (Ref: Face-to-face survey)	5.297(2.861, 9.805)	< 0.001	11.112(5.263, 23.459)	< 0.001	3.495(1.952, 6.258)	< 0.001	1.757(1.091, 2.830)	0.021	2.359(1.434, 3.881)	0.001
Intercept	0.056	< 0.001	0.008	< 0.001	0.313	0.070	6.024	< 0.001	49.185	< 0.001
OR odds ratio, Cl confidence interval										

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Variables	Mobility		Self-care		Usual activities		Pain/discomfort		Anxiety/depression	_
	OR(95%Cl)	٩	OR(95%Cl)	٩	OR(95%Cl)	ط	OR(95%Cl)	٩	OR(95%CI)	Р
Age	1.038(1.021, 1.053)	< 0.001	1.051(1.031, 1.071)	< 0.001	1.014(0.999, 1.029)	0.073	1.012(1.001, 1.024)	0.041	0.987(0.974, 0.999)	0.037
SWEMWBS scores	0.890(0.860, 0.919)	< 0.001	0.910(0.878, 0.944)	< 0.001	0.877(0.849, 0.907)	< 0.001	0.881(0.857, 0.904)	< 0.001	0.807(0.782, 0.831)	< 0.001
Male (Ref: Female)	0.583(0.419, 0.811)	0.001	0.702(0.488, 1.01)	0.057	0.528(0.382, 0.732)	< 0.001	0.646(0.498, 0.839)	0.001	0.605(0.461, 0.794)	< 0.001
Education level (Ref: College	graduate or above)									
Primary School or Below	0.852(0.424, 1.713)	0.653	1.016(0.458, 2.255)	0.968	0.749(0.379, 1.48)	0.405	0.553(0.325, 0.938)	0.028	0.504(0.286, 0.889)	0.018
Middle or high school	0.776(0.458, 1.314)	0.345	0.555(0.297, 1.036)	0.064	0.614(0.367, 1.026)	0.063	0.829(0.559, 1.231)	0.354	0.488(0.322, 0.742)	0.001
Health conditions (Ref: Healt	hy)									
Physical conditions	8.732(4.797, 15.879)	< 0.001	6.801(3.518, 13.158)	< 0.001	9.855(5.452, 17.814)	< 0.001	5.018(3.418, 7.367)	< 0.001	4.007(2.670, 6.013)	< 0.001
Mental conditions	4.595(2.232, 9.459)	< 0.001	5.140(2.234, 11.822)	< 0.001	5.680(2.838, 11.359)	< 0.001	2.770(1.781, 4.306)	< 0.001	6.567(4.121, 10.465)	< 0.001
Both conditions	6.746(3.333, 13.667)	< 0.001	6.586(3.062, 14.168)	< 0.001	10.740(5.387, 21.392)	< 0.001	7.135(4.229, 12.037)	< 0.001	5.447(3.228, 9.18)	< 0.001
Carer (Ref: Yes)	1.808(1.232, 2.651)	0.002	1.988(1.303, 3.031)	0.001	1.919(1.314, 2.804)	0.001	0.826(0.611, 1.116)	0.214	0.849(0.624, 1.156)	0.298
Online survey (Ref: Face- to-face survey)	4.716(2.601, 8.551)	< 0.001	9.384(4.549, 19.337)	< 0.001	3.177(1.808, 5.585)	< 0.001	1.305(0.846, 2.014)	0.229	2.028(1.296, 3.177)	0.002
OR odds ratio, Cl confidence int	erval									

 Table 5
 Ordered logistic multivariable regression analysis with EQ-5D-5L dimensions as dependent variables

 Variables
 Mobility

92 0. 01 -C 11 0. 35 0.	5%Cl .632~0.752 0.001~<0.001 .010~0.013	P <0.001 0.075 <0.001	β 41.516 -0.004	95%Cl 34.657~48.376 -0.093~0.085	P < 0.001
92 0. 01 -C 11 0. 35 0.	.632~0.752).001~<0.001 .010~0.013	<0.001 0.075 <0.001	41.516 -0.004	34.657~48.376 -0.093~0.085	< 0.001
01 -C 11 0. 35 0.	0.001~<0.001 .010~0.013	0.075 < 0.001	-0.004	-0.093~0.085	
11 0. 35 0.	.010~0.013	< 0.001			0.924
35 0.		101001	1.583	1.391~1.775	< 0.001
	.017~0.053	< 0.001	0.169	-1.842~2.180	0.869
e graduate or above)					
36 0.	.001~0.071	0.046	-5.142	-9.140~-1.145	0.012
24 -C	0.003~0.051	0.084	-0.708	-3.766~2.351	0.650
lthy)					
10 -C	0.135~-0.086	< 0.001	-7.433	-10.216~-4.650	< 0.001
96 -0	0.124~-0.067	< 0.001	-9.424	-12.664~-6.183	< 0.001
24 -0	0.159~-0.088	< 0.001	-8.724	-12.746~-4.703	< 0.001
-04	0.024~0.017	0.721	2.854	0.499~5.209	0.018
47 -C	0.076~-0.017	0.002	2.449	-0.886~5.785	0.150
e 3 1 1 2 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1	5 0 graduate or above) 6 0 4 -(24 -	5 0.017~0.053 9 graduate or above) 6 6 0.001~0.071 4 -0.003~0.051 1:hy) 10 10 -0.135~-0.086 26 -0.124~-0.067 24 -0.159~-0.088 04 -0.024~0.017 47 -0.076~-0.017	1 0.010~0.013 < 0.001	1 0.010×0.013 < 0.001	1 0.010~0.013 <0.001

Table 6 Multiple linear regression analysis with EQ-5D-5L Utilities and EQ-VAS as dependent variables

β Beta, Cl confidence interval

As we hypothesized, our finding suggests that positive mental well-being can indeed influence PROM results. The following mechanisms may explain the results. Firstly, positive mental well-being can impact how individuals perceive and report their health-related experiences and outcomes. Previous studies have reported that individuals with higher levels of positive mental well-being are more likely to report better overall health, improved quality of life, and greater satisfaction with their health outcomes [23, 26, 50-53]. In comparison, individuals with poor positive mental well-being may pay excessive attention to their bodily discomfort or symptoms, leading them to the report of more negative health outcomes, lower quality of life, and reduced satisfaction with their health [54, 55]. Secondly, positive mental wellbeing can also affect individuals' decision-making and execution of health behaviors, and further influence the assessment of health-related experiences and outcomes. Previous studies suggested that people with positive mental health are more likely to adopt positive health behaviors such as regular exercise, healthy eating, smoking cessation, and being more involved in a variety of social, etc. [56], while those with poor mental health are more likely to adopt unhealthy behaviors such as drinking, smoking, irregular eating habits, and abuse of drugs and alcohol [57-59]. Additionally, positive mental wellbeing may influence physiology directly, perhaps by protecting against ill health and risk of disease. For example, studies have shown that positive mental well-being can consistently protect individuals against cardiovascular disease, and alter the time course of disease processes such as atherosclerosis [24, 28, 51, 60-62]. This direct effect on health may directly affect their responses to PROM results. These studies offer a comprehensive perspective on how mental health impacts health across multiple dimensions. However, while previous studies have widely discussed the benefits of positive mental well-being on health, direct validation of the relationship between specific PROMs (such as EQ-5D-5L) and positive mental well-being is scarce. Our study specifically focuses on how positive mental well-being influences patient-reported outcome measures (PROMs). Our study supports the positive correlation between SWEMWBS scores and EQ-5D-5L assessment results through concrete data, providing more specific guidance for clinical and public health practices. Moreover, Our research further reveals how positive well-being impacts the outcome of physical dimensions in PROMs, offering a more nuanced understanding.

Understanding the influence of mental well-being on PROM results is essential for accurately assessing and interpreting patient-reported data. Researchers and healthcare professionals can consider mental well-being as a potential confounding or moderating factor when analyzing PROs and make appropriate adjustments in their analyses to account for its impact. In our previous study, the anxiety/depression dimension of EQ-5D-5L loads on the same factor as all dimensions of the SWEMWBS [63]. Jan R Böhnke et al. also found overlap between the anxiety/depression dimension of EQ-5D-5L



Fig. 3 The correlation between SWEMWBS scores and quality of life (EQ-5D-5L utilities and EQ-VAS)

and the SWEMWBS [64], suggesting that they measure the same underlying structure. Notably, although the structure they measure is similar, they involve two different aspects. In EQ-5D, the anxiety/depression dimension focuses on negative emotions, where the best state "1" only indicates the absence of negative emotions, and cannot assess positive emotional states. On the other hand, the SWEMWBS focuses on primarily the positive aspects of well-being [65], assessing the degree of positive emotions. This encourages to explore the effect of the anxiety/depression dimension on the other four dimensions of EQ-5D. In other words, when persons exhibit more problems on the anxiety/depression dimension, it is also likely that they will report more severe problems in the other four dimensions of physical health. By understanding how negative mental health like anxiety/ depression impacts the outcome of physical dimensions in PROMs, we can gain more comprehensive and valuable insights into response patterns for PROMs. Traditionally, medical interventions have primarily focused on the treatment and rehabilitation of physical illnesses, while mental health has often been overlooked. If the results are indeed true, then interventions that promote mental well-being could also improve the outcome of physical dimensions measured by PROMs, even though physical health may not be improved. This finding provides new perspectives and strategies for medical practice. For example, by providing psychological support, cognitive-behavioral therapy, psycho-education, and other interventions, we can help patients establish a positive mental state that improves the outcome of physical dimensions in PROMs. This is important for improving the overall health and quality of life of patients. Particularly, while our study shows the impact of mental wellbeing on EQ-5D, it does not directly generalize to all types of PROMs. In other words, it may not be a relevant confounding factor for all PROs. We will further explore its impact on other PROMs in future studies.

Another influential factor in our results is the method of data collection. Interestingly, participants in our online survey were expected to report fewer issues across EQ-5D-5L dimensions compared to those engaging in faceto-face survey, primarily due to the younger age of the former group. However, contrary to this expectation, our findings indicated the opposite; participants from the online survey reported more problems across all EQ-5D-5L dimensions. We hypothesized that the primary reasons for this outcome are twofold. First, there might be a selection bias. It can be argued that patients willing to complete a face-to-face survey are likely to have a relatively better state of health. Severe health conditions might render it nearly impossible for a study to collect PROM data from such individuals. Secondly, the presence of interviewers and the assistance they provide during face-to-face data collection could lead to socially desirable responses.

In addition to the factors that we explored in this study, various other factors could contribute to the variations of responses in PROMs, including demographic factors (such as age, gender, ethnicity, education level, and socioeconomic status), health literacy, clinical considerations (including disease severity, comorbidities, and treatment history), language barriers, and cultural beliefs. For example, individuals with lower health literacy might encounter challenges comprehending and responding to PROMs, which potentially influence their responses [66]. Patients from distinct cultural backgrounds could hold varying health-related beliefs and values [67], thereby impacting their PROMs responses. This also suggests that the findings of this study may not be generalizable to other populations. Furthermore, patients might offer responses they perceive as socially favorable, rather than accurately reflecting their genuine experiences or sentiments. These factors collectively contribute to the variability in response heterogeneity observed in PROM results.

Coping with response heterogeneity in patientreported outcome (PRO) studies can be challenging. Nevertheless, there exist several strategies for addressing this response heterogeneity. These strategies could be implemented either during the data collection phase, e.g., the use of multiple measurement methods; the data analysis phase, such as the utilization of statistical analysis techniques, such as item response theory (IRT) or latent class analysis (LCA), as well as approaches like subgroup analysis, sensitivity analyses, and stratification and adjustment; and other strategies like qualitative research methods, sample size considerations, and interpretation and reporting [68–70]. In particular, we propose that some strategies could be employed to handle response heterogeneity stemming from variations in mental well-being results, in addition to the aforementioned methods. In the data collection process, the incorporation of multiple measurement methods (e.g., the use of Proxy, interviewer administered, and self-report modes) could offer diverse perspectives on patients' symptoms and psychological states, mitigating the impact of psychological factors; consistent measurement could aid in monitoring changes in patients' symptoms and psychological states, enabling prompt identification and rectification of psychological factor influence. In addition, building a trusting rapport, when using interviewer-assisted surveys, for example, can reduce anxiety and enhance response accuracy. However, this may introduce social desirability bias, where respondents give socially acceptable answers. To minimize this, emphasize anonymity, use neutral language, and pilot test different modes of administration. During data analysis, strategies like LCA can identify distinct subgroups with unique response patterns, and IRT can detect differential item functioning to see if specific items are more influenced by mental well-being. Including mental well-being as a covariate in regression models or conducting sensitivity analyses by excluding extreme cases can further control for this variability. While the strategies may focus on mental well-being response heterogeneity, they are not limited to this domain. In fact, many of the principles and techniques outlined here can be applied to address other forms of response heterogeneity. For example, the strategies for building trust and reducing bias in data collection can be adapted to assess physical health, quality of life, or other patient-reported outcome. Similarly, the quantitative strategies for data analysis can be tailored to the specific research question and data collected. Future studies should explore other strategies.

There are some limitations that need to be addressed. First, our data collection followed an international study protocol which did not require us to note down the sampling procedures in terms of, for example, the number of participants being approached, and number of participants refused to participate. In addition, we could not verify the disease status of the online participants. All the information has been self-reported. Also, a typical problem of using online survey, which we cannot verify in this study is that the responses could come from the caregiver instead of the patients themselves [71]. Conversely, for the face-to-face survey, the data might be subjected to socially desirable bias due to the presence of interviewers. Secondly, our study only considered a limited number of control variables, potentially overlooking other significant factors such as socioeconomic variables (e.g., income, occupation, social status), lifestyle elements (e.g., diet, exercise, smoking, alcohol consumption), and treatment-related factors (such as treatment plans and medication dosages), which could impact the outcomes. Most importantly, due to the cross-sectional nature of the study, we cannot definitively confirm the causal relationship between positive mental well-being and EQ-5D-5L results. In other words, the observed association between positive mental well-being and EQ-5D-5L responses can also be interpreted the other way around, meaning that better HRQoL captured by EQ-5D-5L could lead to better mental well-being measured by SWEMWBS. Or, both of these effects could coexist, and it is impossible to disentangle them in this study. For future research, employing qualitative methods could help establish a causal relationship between these two outcomes.

While our findings contribute to the understanding of the relationship between mental well-being and PRO responses, they are based on a single-country dataset using the EQ-5D-5L and SWEMWBS. As such, the results should not be considered generalizable to other contexts or PROMs. Future studies should explore these associations using different instruments and in diverse cultural settings to validate and extend our findings.

Conclusion

Better SWEMWBS scores could lead to better EQ-5D-5L results, highlighting the effect of positive mental wellbeing on the responses of PROMs like EQ-5D-5L. More research is needed to better understand the mechanism of mental well-being on PRO.

Appendix

See Table 7, Table 8 and Table 9.

Table 7 Ordered logistic multivariable regression analysis with EQ-5D-5L dimensions as dependent variables when the data from online survey and face-to-face survey are analyzed separately

Variables	Mobility		Self-care		Usual activities		Pain/ discomfort		Anxiety/ depression	
	OR(95%Cl)	Ρ	OR(95%Cl)	Ρ	OR(95%Cl)	Ρ	OR(95%Cl)	Ρ	OR(95%Cl)	Ρ
Online sur	vey									
Age	1.076(1.044, 1.110)	< 0.001	1.085(1.053, 1.119)	< 0.001	1.047(1.018, 1.077)	0.001	1.042(1.016, 1.069)	0.002	1.016(0.992, 1.041)	0.195
SWEM- WBS scores	0.914(0.873, 0.958)	< 0.001	0.924(0.882, 0.969)	0.001	0.895(0.856, 0.937)	< 0.001	0.853(0.816, 0.891)	< 0.001	0.798(0.763, 0.834)	< 0.001
Male (Ref: Female)	0.467(0.291, 0.751)	0.002	0.642(0.399, 1.031)	0.067	0.413(0.263, 0.648)	< 0.001	0.647(0.430, 0.974)	0.037	0.742(0.506, 1.088)	0.126
College graduate or Below (Ref: College graduate or above)	0.230(0.082, 0.641)	0.005	0.293(0.106, 0.811)	0.018	0.529(0.223, 1.251)	0.147	0.978(0.482, 1.986)	0.951	0.525(0.266, 1.036)	0.063
Health state	us (Ref: Healthy)									
Physical condition	26.95(9.412, 77.169)	< 0.001	11.508(4.716, 28.106)	< 0.001	11.554(5.507, 24.216)	< 0.001	5.906(3.469, 10.064)	< 0.001	3.912(2.340, 6.54)	< 0.001
Mental condition	14.541(3.442, 61.375)	< 0.001	8.628(2.237, 33.315)	0.002	7.085(2.234, 22.488)	0.001	2.044(0.744, 5.618)	0.166	17.904(6.890, 46.479)	< 0.001
Both condi- tions	22.624(7.367, 69.408)	< 0.001	11.212(4.204, 29.934)	< 0.001	15.441(6.807, 35.023)	< 0.001	9.244(4.894, 17.462)	< 0.001	6.945(3.796, 12.705)	< 0.001
Carer (Ref: Yes)	1.937(1.200, 3.127)	0.007	1.82(1.120, 2.959)	0.016	1.992(1.260, 3.146)	0.003	0.634(0.416, 0.969)	0.035	0.872(0.586, 1.297)	0.498
Face-to-fa	ce survey									
Age	1.031(1.011, 1.051)	< 0.001	1.034(1.009, 1.059)	0.006	1.009(0.990, 1.027)	0.364	1.005(0.991, 1.019)	0.476	0.977(0.962, 0.992)	0.003
SWEM- WBS scores	0.852(0.809, 0.897)	< 0.001	0.876(0.824, 0.932)	< 0.001	0.845(0.802, 0.89)	< 0.001	0.895(0.865, 0.927)	< 0.001	0.814(0.780, 0.85)	< 0.001
Male (Ref: Female)	0.773(0.459, 1.303)	0.335	0.732(0.381, 1.406)	0.349	0.686(0.409, 1.149)	0.152	0.587(0.409, 0.841)	0.004	0.450(0.299, 0.678)	< 0.001
Education l (Ref: Colleg	evel Je graduate or a	bove)								
Primary School or Below	1.522(0.620, 3.732)	0.359	1.454(0.524, 4.039)	0.473	0.870(0.401, 1.889)	0.725	0.572(0.323, 1.012)	0.055	0.619(0.330, 1.158)	0.133
Middle or high school	1.547(0.691, 3.463)	0.289	0.878(0.334, 2.309)	0.792	0.644(0.328, 1.264)	0.201	0.759(0.472, 1.221)	0.256	0.496(0.291, 0.843)	0.010
Health state	us (Ref: Healthy)									
Physical condition	1.502(0.663, 3.404)	0.330	1.537(0.541, 4.367)	0.420	3.695(1.380, 9.885)	0.009	4.191(2.282, 7.698)	< 0.001	4.166(2.002, 8.662)	< 0.001
Mental condition	0.924(0.411, 2.077)	0.848	0.980(0.344, 2.795)	0.970	2.111(0.827, 5.382)	0.118	2.316(1.319, 4.067)	0.003	4.345(2.284, 8.256)	< 0.001
Carer (Ref: Yes)	1.347(0.654, 2.773)	0.418	3.469(1.009, 11.929)	0.048	1.492(0.720, 3.089)	0.282	1.1(0.682, 1.774)	0.696	0.899(0.528, 1.530)	0.694

OR odds ratio, Cl confidence interval

Table 8 Multiple linear regression analysis with EQ-5D-5L Utility

 scores and EQ-VAS as dependent variables when the data from
 online survey and face-to-face survey are analyzed separately

Variables	EQ-5D U	Jtility		EQ-VAS		
	β	95%Cl	Р	β	95%Cl	Р
Online survey	,					
Intercept	0.714	0.628~0.8	< 0.001	25.102	16.457~33.748	< 0.001
Age	-0.003	-0.005~-0.001	< 0.001	0.106	-0.07~0.281	0.238
SWEMWBS scores	0.012	0.01~0.015	< 0.001	2.047	1.766~2.328	< 0.001
Male (Ref: Female)	0.03	0.002~0.058	0.035	-0.18	-2.992~2.633	0.900
College graduate or Below (Ref: College graduate or above)	0.02	-0.003~0.044	0.093	-0.248	-2.632~2.135	0.838
Health status (I	Ref: Health	ny)				
Physical condition	-0.122	-0.158~-0.086	< 0.001	-3.219	-6.842~0.403	0.081
Mental condition	-0.143	-0.214~-0.071	< 0.001	-12.7	-19.928~-5.472	0.001
Both conditions	-0.128	-0.171~-0.085	< 0.001	-3.969	-8.304~0.365	0.073
Carer (Ref: Yes)	0.001	-0.029~0.03	0.963	4.918	1.966~7.869	0.001
Face-to-face	urvey					
Intercept	0.678	0.611~0.746	< 0.001	53.913	45.502~62.325	< 0.001
Age	< 0.001	-0.001~0.001	0.964	0.047	-0.059~0.153	0.382
SWEMWBS scores	0.01	0.008~0.012	< 0.001	1.245	0.989~1.501	< 0.001
Male (Ref: Female)	0.042	0.019~0.065	< 0.001	1.884	-0.948~4.717	0.192
Education leve (Ref: College g	l raduate oi	r above)				
Primary School or Below	0.025	-0.011~0.061	0.180	-5.227	-9.726~-0.728	0.023
Middle or high school	0.013	-0.018~0.044	0.415	-0.373	-4.238~3.493	0.850
Health status (I	Ref: Health	ny)				
Physical condition	-0.073	-0.108~-0.038	< 0.001	-13.944	-18.279~-9.608	< 0.001
Mental condition	-0.058	-0.09~-0.026	< 0.001	-12.306	-16.285~-8.327	< 0.001
Carer (Ref: Yes)	-0.019	-0.049~0.01	0.200	-1.429	-5.149~2.291	0.451

 β Beta, Cl confidence interval

 Table 9
 Multiple lineal regression analysis with SWEMWBS scores as dependent variables

Variables	SWEM	WBS scores	
	β	95%Cl	Ρ
Intercept	21.854	20.098~23.61	< 0.001
Age	0.093	0.065~0.121	< 0.001
Male (Ref: Female)	0.679	0.03~1.328	0.040
Education level (Ref: College graduate c	or above)		
Primary School or Below	-0.315	-1.608~0.978	0.632
Middle or high school	-0.555	-1.544~0.434	0.271

ariables SWEMWBS scores			
	β	95%Cl	Р
Health status (Ref: Healthy)			
Physical condition	-0.369	-1.269~0.532	0.422
Mental condition	-3.652	-4.675~-2.628	< 0.001
Both conditions	-2.649	-3.94~-1.359	< 0.001
Carer (Ref: Yes)	1.283	0.525~2.04	0.001
Online survey (Ref: Face-to-face interview)	-1.366	-2.441 ~-0.29	0.013

 β Beta, *Cl* confidence interval

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Authors' contributions

Zhihao Yang, Nan Luo, and Yanming Hong contributed to data acquisition. Zhihao Yang and Yanming Hong analyzed the data and draft the manuscript. Nan Luo revised the manuscript critically for important intellectual content. Zhihao Yang and Yanming Hong contributed to the conception, design, and the interpretation of the results. All authors reviewed and approved the final version. Zhihao Yang and Yanming Hong is the study guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Funding

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Data availability

Data are available from the corresponding author (hym18370966170@163. com) on reasonable request.

Declarations

Ethics approval and consent to participate

The online survey was approved by the Ethics Committee of the University of Sheffield, United Kingdom (Approval letter number 025524), and the IRB of Jinan University, China (Approval letter number JNUKY-2020–001). The face-to-face study was approved by the Ethics Committee of Guizhou Medical University (Approval letter number 2021–101). Written informed consent was obtained from all participants.

Consent for publication

Manuscript is approved by all authors for publication.

Competing interests

The authors declare no competing interests.

Author details

¹Health Services Management School, Guizhou Medical University, Guiyang 550002, People's Republic of China. ²Medical Psychiatry and Psychotherapy, Erasmus Medical Center, Rotterdam 3015CN, the Netherlands. ³Saw Swee Hock School of Public Health, National University of Singapore, Singapore, Singapore. ⁴The Third Affiliated Hospital of Sun Yat-Sen University, The Third Affiliated Hospital of Sun Yat-Sen University, 600, Tianhe RoadTianhe District, Guangzhou 510630, People's Republic of China.

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