

The underlying dimensions of major depressive symptoms in a sample of Chinese earthquake survivor

Yajie Bi

Institute of Psychology, Chinese Academy of Sciences

Li Wang (✉ wangli1@psych.ac.cn)

Chengqi Cao

Institute of Psychology, Chinese Academy of Sciences

Ruojiao Fang

Institute of Psychology, Chinese Academy of Sciences

Gen Li

Institute of Psychology, Chinese Academy of Sciences

Ping Liu

Peoples Hospital of Deyang City

Shu Luo

Peoples Hospital of Deyang City

Brian Hall

University of Macau

Haibo Yang

Tianjin Normal University

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Abstract

Background: Experiencing natural disasters is associated with common mental disorders including major depressive disorder (MDD). However, the latent structure of MDD is widely debated, and few studies examined the structure of MDD in Chinese natural disaster survivors. Therefore, this study aimed to evaluate the factorial validity of the Patient Health Questionnaire-9 (PHQ-9) for DSM-5 major depressive disorder (MDD) symptoms in Chinese earthquake survivors.

Method: Participants were 1058 Chinese earthquake survivors. Self-reported measures included the PHQ-9 and the Short-Form Health Survey (SF-36). Confirmatory factor analysis (CFA) and structural equation modelling (SEM) was used to examine the latent structure of MDD and the associations between latent factors of MDD and different aspects of health-related quality of life, respectively.

Results: The model comprised of somatic and non-somatic factors demonstrated significantly better fit than the other competing MDD models in the current sample. Further structural equation modeling analyses indicated that the non-somatic factor was significantly associated with both physical and psychosocial health-related quality of life, while the somatic factor was a uniquely predictor of physical health-related quality of life. Furthermore, the somatic factor was found to partially mediate the relationship between the non-somatic factor and physical health-related quality of life.

Conclusions: The MDD symptoms was best captured by a two-factor model comprised of somatic and non-somatic factors in Chinese natural disaster survivors. The two MDD factors were differentially associated with physical and psychosocial health-related quality of life, and the non-somatic factor associated physical health-related quality of life partially through the somatic factor. The current findings add to extant knowledge of latent structure of MDD symptoms, and carry implications for assessment and intervention of post-disaster mental health problems.

Introduction

Due to urbanization, environmental degradation, climate change and other factors, the frequency of natural disasters has increased dramatically in recent years [1]. Natural disasters not only cause economic loss, injuries and deaths [2], but also cause severe psychological distress and psychiatric disorders [3]. Major depressive disorder (MDD) is one of the most common psychiatric disorders in natural disaster-exposed populations [4], and MDD symptoms increase with time among natural disaster-exposed individuals [5].

Compared to the prevalence of MDD in general population of 4.7% [6], natural disaster-exposed populations range from 10.0%-17.6% [7, 8, 9, 10]. Therefore, it is important to develop accurate assessment that guides effective prevention and intervention for MDD after natural disaster. Exploring the factor structure of MDD symptoms could not only benefit our understanding of psychopathological and biological mechanisms, but is also important for the development of more sophisticated clinical assessment and effective treatment programs for this disorder.

The Patient Health Questionnaire-9 (PHQ-9) is a self-reported instrument and maps onto the criteria of MDD in DSM-5 [11]. The reliability and validity of PHQ-9 have been evaluated in numerous populations globally [12, 13]. The PHQ-9 is one of the most validated and commonly used depression measures [14], however, the structure of MDD measured by PHQ-9 is debated.

Several alternative models of MDD symptoms has been proposed and validated in previous studies [13, 15, 16, 17], see Table 1 for item mapping for alternative models). Model 1 is the unidimensional model, with nine items loading on one “depression” factor. This model was based on PCA/CFA studies of primary care patients[18, 19] and spinal cord injury patients [20]. A number of studies in varies samples (such as Chinese adults and adolescents, Mexican women, American college students) have found robust evidence for the single factor-model that underlies the PHQ-9 [13, 21], and many of them excluded two-factor models for the high correlation between the two factors of MDD [22, 23, 24]. Other competitive models are similar and comprised of 2 factors: a somatic factor and a non-somatic factor (cognitive/affective factor). Model 2a was proposed by Krause in CFA Studies of spinal cord injury patients measured depression at an average of 50 days post-injury [15, 25]. This finding was confirmed by a longitudinal study of palliative care patients [26]. Model 2b moved “psychomotor agitations/retardation” item from the non-somatic factor to the somatic factor, while other symptoms were retained. This model was based on a CFA study of coronary heart disease patients [16]. In model 2c the “concentration difficulties” symptom was transferred to the somatic factor. This model was proposed by Richardson and Richards (2008) and Krause et al., (2010) for patients with spinal cord injury in EFA and CFA studies [25, 27], and was confirmed by the CFA studies in soldiers [17], primary care patients in Germany [28], Filipino female domestic workers in China [29], mental health patients[30] and university students in Colombia [31]. Model 2d moved the “anhedonia” symptom to a somatic factor along with the previously classified somatic items in Model 2c. This model was first described by Krause et al., (2010) in the sample of patients with spinal cord injury at 30 months post injury [25]. Notably, Model 2b has been confirmed in more studies than the other competing models [17, 28, 29], and this may be attributed to type of populations, demographics, health condition, and history of trauma exposure [29].

Many studies have explored the factor structure of MDD, while few of them clarified the different functional roles of MDD symptom clusters. Simms (2002) suggested that external measures of psychopathology should be examined to shed light on this issue [32]. As highlighted by several studies, MDD is tightly associated to poor health-related quality of life [33], and quality of life is an important consideration of treatment-outcome assessment in MDD patients [34]. Previous studies suggested that somatic symptoms (i.e., sleep disturbance, fatigue and appetite changed) were uniquely associated with reduced physical health [35, 36]. Furthermore, some non-somatic symptoms such as feeling worthless and suicidal ideas might be related closely to poor psychosocial functioning [37, 38], and could reduce physical health [39]. Therefore, the discriminant validity of the best fitting model can be examined by estimating the correlations between factors of MDD and external measures of health-related quality of life.

Previous studies revealed that people who suffer from MDD often had physical problems [40, 41], and some psychotherapies (e.g., cognitive therapy) have positive effects on the physical problems of MDD patients [42]. Therefore, investigations are needed that document the association between MDD symptoms and physical health-related quality of life. However, few studies discussed this issue. Non-somatic and somatic depression factors might be related to physical health-related quality of life.

Within traditional Chinese culture, people are reluctant to express their emotions and psychological distress. They tend to attribute psychological problems to physical or external origins [43]. Therefore, non-somatic (cognitive/affective) symptoms of MDD might be expressed through somatic symptoms in Chinese samples, which may in turn affect physical health-related quality of life.

In the current study, our first aim was to find the best fitting latent structural model of MDD; our second aim was to evaluate whether the somatic factor mediates the relationship between non-somatic factor and physical health-related quality of life. Based on prior studies as outlined above, we hypothesized that: (1) the model comprised of a somatic factor and a non-somatic factor would fit the data better than competing models; (2) the non-somatic factor would be associated with psychosocial health and physical health. Relatedly, we expected the somatic factor would correlate with physical health only; and, (3) the non-somatic factor would affect physical health-related quality of life through the somatic factor.

Methods

Participants

A destructive earthquake measuring 8.0 on the Richter scale occurred in Sichuan Province on May 12, 2008. About 69,227 people were killed and 374,643 injured, while 17,923 were missing and approximately 4.8 million were homeless.

For the purposes of accessing disaster-related mental health problems, the sample was collected from 5 rebuilt communities of Hanwang town, Mianzhu City. The town was completely destroyed by the earthquake, and about 5000 people were killed. This survey was conducted in July, 2017, more than 9 years after the earthquake. The procedures were as follows: (1) Selecting one family member randomly in each household as participants; (2) making sure that all participants were aged from 16 to 65 and experienced the 2008 earthquake; (3) excluding individuals with psychosis (e.g. schizophrenia and organic mental disorders). The survey was conducted by well-trained clinical psychologists, psychology undergraduates, and post-graduate students. Investigators explained the aim of the study before the participants completed self-reported questionnaires.

A total of 1072 people participated in this study. People with missing data (> 20% items) were excluded (n = 14), leaving 347 (32.7%) men and 711 (67.3%) women with a mean age of 51.1 (SD = 10.0), 911 (86.2%) were married, and 146 (13.8) were unmarried (never married, divorced, widowed). 1042 (98.6%) were Han people, and 5 (0.4%) were members of other ethnic groups (including Zang, Qiang and Hui). In

terms of educational level, 732 (69.2%) did not complete high school, 240 (22.7%) completed high school, and 85 (8.0%) completed college.

Measures

MDD symptoms were assessed using the Patient Health Questionnaire-9 (PHQ-9), which is a nine-item instrument from the Primary Care Evaluation of Mental Disorders (PRIME-MD). PHQ-9 is a short, easily administered self-report questionnaire designed to capture MDD symptoms. Each item is rated on a 4-point scale using anchors ranging from 0 (not at all) to 3 (extremely), reflecting the extent which symptom bothers a participant in the past two weeks. The reliability and validity of the PHQ-9 have been well-documented in a previous study [14]. The PHQ-9 has been translated to more than 80 languages and is used worldwide. Adequate levels of internal consistency reliability (Cronbach's alpha above 0.86) and test-retest reliability (2 weeks interval, 0.86) for the Chinese version have been reported (Wang et al., 2014). Associations with other depression measures including the Hamilton Depression Inventory (HAM-D-17) and the Beck Depression Inventory (BDI) have demonstrated convergent and discriminant validity of the Chinese version [12]. Cronbach's α for PHQ-9 was 0.89 in the current sample.

The Short-Form Health Survey (SF-36) was used to assess health-related quality of life. There are 8 subscales in this instrument, 4 reflect Physical health-related quality of life (consisting of physical functioning, role-physical, bodily pain and general health), and 4 reflect Psychological quality of life (including role-emotional, social functioning, mental health and fatigue). Each subscale's score ranging from 0 to 100, and higher score indicates better health. Regarding the Chinese version of SF-36, it has been validated and widely used in Chinese populations [44]. Wang (2014) identified that the PHQ-9 total score correlated negatively with all subscales scores of the SF-36 [12]. We select scales of SF-36 because their content can explicitly address psychosocial functioning. Mental health and Fatigue subscales were excluded for the observation of spurious relationship with the MDD measures.

Data Analysis

All descriptive analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 20 for Windows. Of 1058 participants, 36 were missing one PHQ-9 item, 284 were missing one to three SF-36 items and 6 were missing four to six SF-36 items. We used full information maximum likelihood (ML) procedures to estimate missing values on the PHQ-9. According to the scoring procedures of the SF-36, the missing values on the SF-36 were estimated with the average score of the same subscales.

To evaluate the best-fitting factor model, five alternative CFA models (see Table 1) previously identified were tested in the current study. According to previous studies, items should be treated as categorical variables when measures contain fewer than five options, and Weighted Least Squares Estimation with a mean and variance adjusted (WLSMV) should also be used [45]. Therefore, all measurement models were evaluated using CFA and WLSMV in Mplus 7.0. In all of models estimated, error covariances were fixed to zero, and factors were allowed to correlate. Overall model fit was evaluated with three indices, including

the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root-mean square error of approximation (RMSEA). For these indices, an excellent fit is indicated by CFI and TLI of 0.95 and above, RMSEA of 0.06 or less, and an acceptable fit is indicated by CFI and TLI of 0.90 and above, RMSEA of 0.08 or less [46]. Chi-square difference tests were conducted to compare nested models using the DIFFTEST function in Mplus. The Bayesian information criterion (BIC) were used to compare non-nested models. A BIC difference of 6–10 provides strong support and a difference greater than 10 indicates very strong support for the model with the lower BIC value [47]. However, the BIC can only be generated by ML, therefore, we use maximum likelihood estimation with robust standard (MLR) to compute this index.

We subsequently incorporated two structural equation models to evaluate the associations between each of the PTSD factors and health-related quality of life. In the first model, physical health was measured by the physical functioning, role-physical, bodily pain, and general health subscales of SF-36 subscales, and was set as the dependent latent variable. In the second model, psychosocial quality of life was measured by the role-emotional and social functioning, and was set as the dependent latent variable. In both models, the somatic factor, non-somatic factor of the best fitting MDD model and covariates (age, gender, educational level and marital status) were simultaneously included in the equation as predictors. The models were tested by the structural equation model (SEM), and regression coefficients were calculated to examine the relative importance of each MDD factor in predicting physical health-related quality and psychosocial quality of life.

To assess MDD's somatic factor as a mediator between MDD's non-somatic factor and physical health-related quality of life, we used 1000 bootstrapped samples to estimate standard errors. Direct effects in the current study include the relationship between MDD's somatic and non-somatic factors, between MDD's somatic factors and physical health, and between MDD's non-somatic factors and physical health. Indirect effects included the effect of MDD's non-somatic factor on physical health through MDD's somatic factor.

Results

Descriptive statistics

Descriptive statistics for the PHQ-9 and SF-36 total scores were estimated at first. Mean PHQ-9 score was 6.2 (SD = 5.0, range: 0–27), and based on the diagnostic algorithm of using a cutoff score of 10 or higher, 236 (22.2%) participants were identified as probable MDD cases.

Mean scores on the SF-36 subscales were as follows: “Physical Functioning” was 79.2 (SD = 24.2, range: 0–100), “Role limitations due to physical health” was 64.4 (SD = 41.0, range: 0–100), “Bodily Pain” was 76.4 (SD = 22.3, range: 0–100), “General Health” was 60.7 (SD = 21.2, range: 0–100), “Social Functioning” was 79.6 (SD = 21.4, range: 0–100), and the “Role limitations due to emotional problems” was 60.3 (SD = 41.6, range: 0–100).

Confirmatory factor analyses

Table 2 presents goodness of fit indices for alternative models. According to the aforementioned criteria, only Model 2a yielded acceptable fit, while other models were rejected due to large RMSEA values. The Mplus DIFFTEST indicated that only Model 2a was superior to model 1 ($\Delta\chi^2(1) = 45.653, p < 0.001$). In terms of comparisons of non-nested models, the BIC value for model 2a was lower than the other models, and all Δ BIC were lower than 6 except the Δ BIC between Model 2a and other models (Δ BIC = 39.536). For these reasons, the Model 2a was the best fitting model (see Table 2). Figure 1 presents the standardized factor loadings and factor intercorrelations of Model 2a.

Relationship to health-related quality of life

Both models demonstrated adequate fit. Fit statistics were $\chi^2(110, N = 1058) = 218.08, CFI = 0.99, TLI = 0.99, RMSEA = 0.03$ (90% CI: 0.03–0.04) for the model with physical health-related quality of life as dependent variable, and $\chi^2(81, N = 1058) = 243.98, CFI = 0.99, TLI = 0.98, RMSEA = 0.04$ (90% CI: 0.04 ~ 0.05) for the model with psychosocial health-related quality of life as a dependent variable. Table 3 summarizes the associations between the two MDD factors and physical and psychosocial health-related quality of life. After controlling for all the other factors, the somatic factor was a unique predictor for physical health-related quality of life ($\beta = -0.336, p < .01$), and the non-somatic factor was a significant predictor for both physical health-related quality of life ($\beta = -0.362, p < .01$) and psychosocial health-related quality of life ($\beta = -0.773, p < .01$).

3.4. The mediating effect of the somatic factor

The indirect effect of the non-somatic factor on physical health-related quality of life was significant ($\beta = -0.296, p < .05$) (see Fig. 2). Results indicated significant effects of the non-somatic factor on the somatic factor ($\beta_1 = 0.922, SE = 0.016, p < .05$) and the somatic factor on physical health-related quality of life ($\beta_2 = -0.321, SE = 0.153, p < .05$). The path from non-somatic to physical health-related quality of life was also significant ($\beta_3 = -0.383, SE = 0.149, p < .05$). After 1000 bootstrapped tests, the somatic factor still significantly mediated the relationship (95% CI of β_1 : 0.894 ~ 0.957; 95% CI of β_2 : -0.645 ~ -0.061; 95% CI of β_3 : -0.629 ~ -0.082; 95% CI of indirect effect: -0.581 ~ -0.057).

Discussion

The present study investigated the underlying dimensionality of DSM-5 MDD symptoms in a sample of Chinese natural disaster survivors. Using CFA we tested five competitive models, and found the Model 2a which was comprised of somatic and non-somatic factors best fit the data in this sample. Examination of convergent and discriminant validity with external measures of health-quality of life, suggested that psychosocial health-related quality of life was uniquely predicted by the non-somatic factor, and the physical health-related quality of life was predicted by both the somatic factor and the non-somatic factor. We further tested whether the somatic factor mediated the relationship between the non-somatic factor and physical health-related quality of life, and the result revealed that the somatic factor partially mediating the relationship.

The two-factor model was the best fitting model, and this is consistent with results of many recent cross-sectional EFA studies [27, 48], CFA studies [17, 28, 29, 31] and longitudinal studies [26, 30]. The findings of this study support separating the MDD into a somatic factor and non-somatic factor, and suggest that the MDD diagnosis needs to consider these two factors separately.

To further verify the distinction of the two MDD's factors, the current study used health-related quality of life (HRQoL) as an external measure, and found that HRQoL displayed distinct associations with two factors of MDD. Previous studies also had similar findings. The results of Mordeno et al., (2018)'s study have revealed that two-factor MDD model was the best fitting model, and the somatic disorder (measured by PHQ-15) was more related to the somatic factor than non-somatic factor [29]. Elhai et al. (2011) also found that in the sample of Canadian military veterans measured by Center for Epidemiologic Studies-Depression Scale (CES-D), depression's somatic items were more related to some factors of posttraumatic stress disorder (PTSD) than non-somatic items [49]. Finally, another study has demonstrated that the Australian and UK samples measured by the Gotland Scale of Male Depression (GSMD) were best represented by a two-factor (affective and somatic) MDD model [50]. The results supported our hypotheses, and illustrated that the distinct factors of MDD might play different functional roles in the health-related quality of life of people with depression and provided further robust support for two-factor MDD model.

Furthermore, we tested whether the somatic factor mediates the relationship between the non-somatic factor and physical health-related quality of life. Results indicated that the somatic factor partially mediated the relationship between the non-somatic factor and physical health-related quality of life, and this finding was consistent with our hypothesis. This may have a cultural explanation. For example, expressing psychological distress is considered a dilemma in Chinese culture. People who experience psychological problems tend to attribute these problems to physical or external origins [43]. This might be the reason that psychological problems were often expressed in the form of physical illness in Eastern populations. Our findings partially clarified the pattern of MDD's non-somatic factor influencing the physical health-related quality of life in the Chinese natural disaster survivors.

The current findings have several clinical implications. First, according to the best fitting two-factor MDD model, we could better establish more useful assessment systems. This would guide more effective intervention and treatment for MDD patients. Second, findings of the present study informed the different functional roles that distinct factors of MDD played in health-related quality of life. This would be helpful to structure and establish treatment which aims to improve the health-related quality of life of people with depression. Third, our findings benefit our understanding of the psychopathological process of MDD symptoms affecting physical health related quality of life. Findings of the current study illustrated that for Chinese people with significant somatic symptoms, their psychological problems need also to be recognized.

There are several study limitations that need to be recognized. First, the generalizability of the findings may be somewhat limited because of our utilization of a earthquake-exposed sample. Thus, additional

replications with samples exposed to other types of traumatic events are warranted. Second, the limitation of self-reported symptoms has been acknowledged [51]. Therefore, the findings need to be further replicated in samples using clinical-administered MDD measures. Third, external variables adopted to evaluate the convergent and discriminant validity in the present study was limited. There should be more variables (e.g., psychological, biological, and behavioral) which theoretically and empirically related to MDD to evaluate the external validity of this MDD model in the future studies.

Conclusion

Our findings indicate that MDD is best represented by the two-factor model in Chinese natural disaster survivors, and the MDD somatic factor partially mediates the relationship between the MDD non-somatic factor and physical related health of life. These findings not only provide support for the MDD model proposed by Krause (2008, 2010), but also reveal that non-somatic factor of MDD negatively relates to the physical related health quality of life through the somatic factor of MDD. For people with depressive symptoms who report somatic symptoms, their non-somatic symptoms should also be considered noteworthy.

Abbreviations

MDD

Major Depressive Disorder

PHQ-9

Patient Health Questionnaire-9

SF-36

Short-Form Health Survey

CFA

Confirmatory Factor Analysis

SEM

Structural Equation Modelling

HRQoL

Health-related Quality of life

CES-D

Center for Epidemiologic Studies-Depression Scale

PTSD

Posttraumatic Stress Disorder

GSMD

Gotland Scale of Male Depression

Declarations

Availability of data and materials

The datasets used and/or analyzed in the current study are available from the corresponding author upon reasonable request.

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Author information

Affiliations

Laboratory for Traumatic Stress Studies, CAS Key Laboratory of Mental Health, Institute of Psychology, Chinese Academy of Sciences, Beijing, China

Yajie Bi, Li Wang, Chengqi Cao, Ruoqiao Fang & Gen Li.

Department of Psychology, University of Chinese Academy of Sciences, Beijing, China

Yajie Bi, Li Wang, Ruoqiao Fang & Gen Li.

Shenzhen Key Laboratory of Affective and Social Cognitive Science, Shenzhen University, Shenzhen, China

Chengqi Cao

People's Hospital of Deyang City, Deyang, Shichuan, China

Ping Liu & Shu Luo.

Global and Community Mental Health Research Group, Department of Psychology, Faculty of Social Sciences, University of Macau, Avenida da Universidade, E21-3040, Taipa, Macau (SAR), China

Brian J. Hall

Department of Health, Behavior and Society, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

Brian J. Hall

Haibo Yang

Contributions

LW designed the current study. PL, SL, RJF, YJB and GL oversaw data collection. YJB supervised data analysis and drafted the manuscript. LW, CQC, RJF, GL, BJH and HBY read the manuscript and provided critical revision for it.

Corresponding author

Correspondence to Li Wang.

Ethics declarations

Ethics approval and consent to participate

The survey protocol was reviewed and approved by the Institutional Review Board of the Institute of Psychology, Chinese Academy of Sciences, and we obtained written informed consent from all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1 Item mapping for confirmatory factor analysis

PHQ-9 Items	Model 1	Model 2a	Model 2b	Model 2c	Model 2d
Anhedonia	Depression	Non-somatic	Non-somatic	Non-somatic	Somatic
Depressed mood	Depression	Non-somatic	Non-somatic	Non-somatic	Non-somatic
Sleep difficulties	Depression	Somatic	Somatic	Somatic	Somatic
Fatigue	Depression	Somatic	Somatic	Somatic	Somatic
Appetite changed	Depression	Somatic	Somatic	Somatic	Somatic
Feeling of worthless	Depression	Non-somatic	Non-somatic	Non-somatic	Non-somatic
Concentration difficulties	Depression	Non-somatic	Non-somatic	Somatic	Somatic
Psychomotor agitations/retardation	Depression	Non-somatic	Somatic	Somatic	Somatic
Thoughts of death	Depression	Non-somatic	Non-somatic	Non-somatic	Non-somatic

Note. Model 1 posits that a single one-dimension factor underlies the PHQ-9; Model 2a: Krause et al. (2010), Krause et al. (2008), Chilcot et al., (2012); Model 2b: de jonge et al. (2007); Model 2c: Krause et al., (2010), Richardson & Richards, (2008), Elhai et al., (2012), Petersen et al., (2014), Mordeno et al., (2018), Guo et al., (2017), Miranda & Scoppetta, (2018). Model 2d: Krause et al. (2010).

Table 2. Model goodness of fit indices

Model	Chi-square	df	CFI	TLI	RMSEA	RMSEA 90% CI
Model 1	239.38	27	0.980	0.974	0.086	0.076-0.096
Model 2a	173.89	26	0.986	0.981	0.073	0.063-0.084
Model 2b	233.96	26	0.981	0.974	0.087	0.077-0.097
Model 2c	235.07	26	0.981	0.973	0.087	0.077-0.098
Model2d	237.65	26	0.981	0.973	0.088	0.077-0.098

Note. N = 1058. CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval.

Table 3. Relationship between MDD factors and health related quality of life

Dependent variables	Predictor	r	B	β
Physical health-related quality of life	Somatic	-0.674	-5.637*	-0.336*
	Non-somatic	-0.678	-5.687*	-0.362*
Psychosocial quality of life	Somatic	-0.691	0.795	0.036
	Non-somatic	-0.741	-14.955*	-0.733*

Note. N=1058.

*p<0.01

Figures

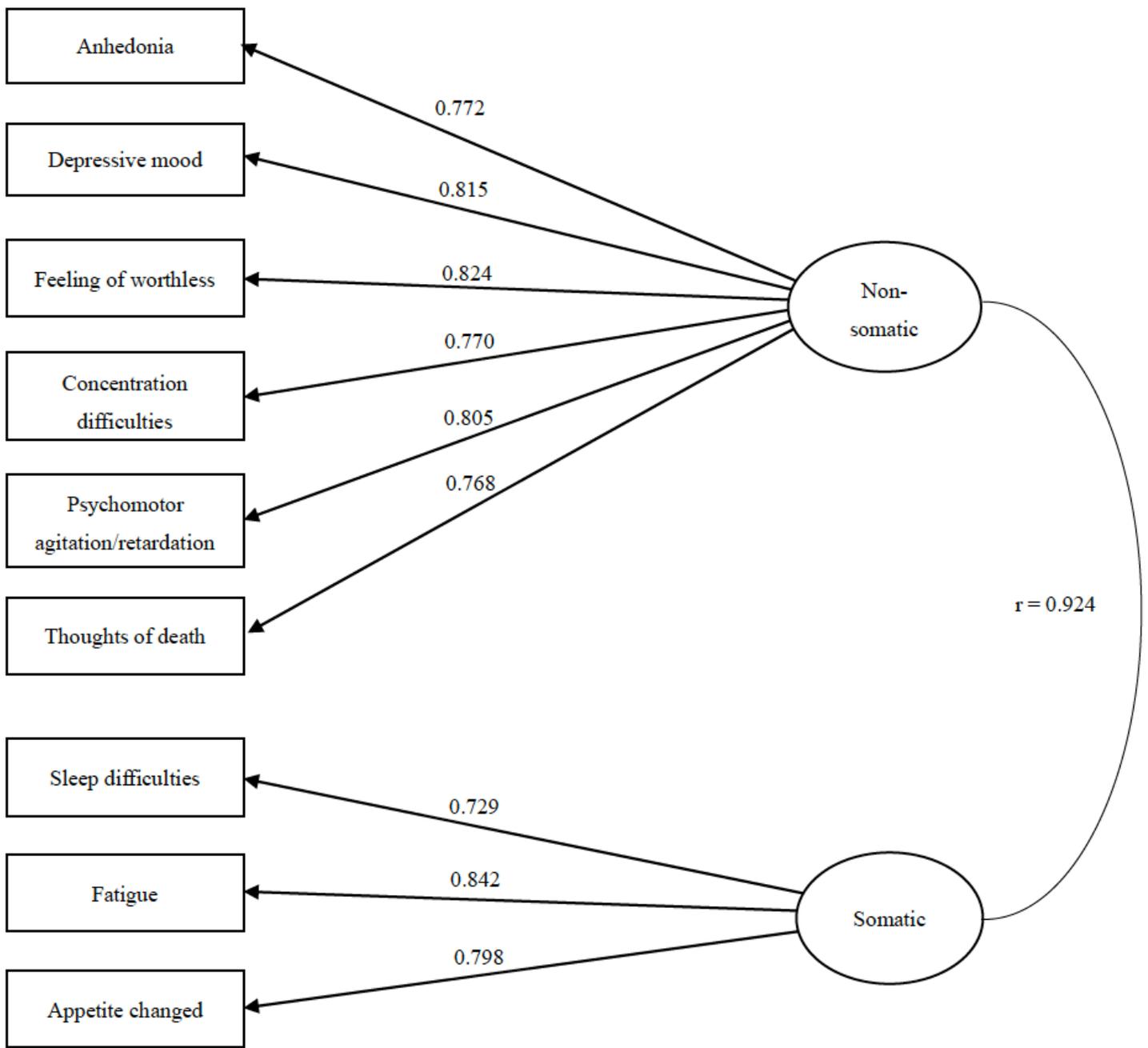


Figure 1

Structure of the MDD model comprising two factors Note. N=1058.

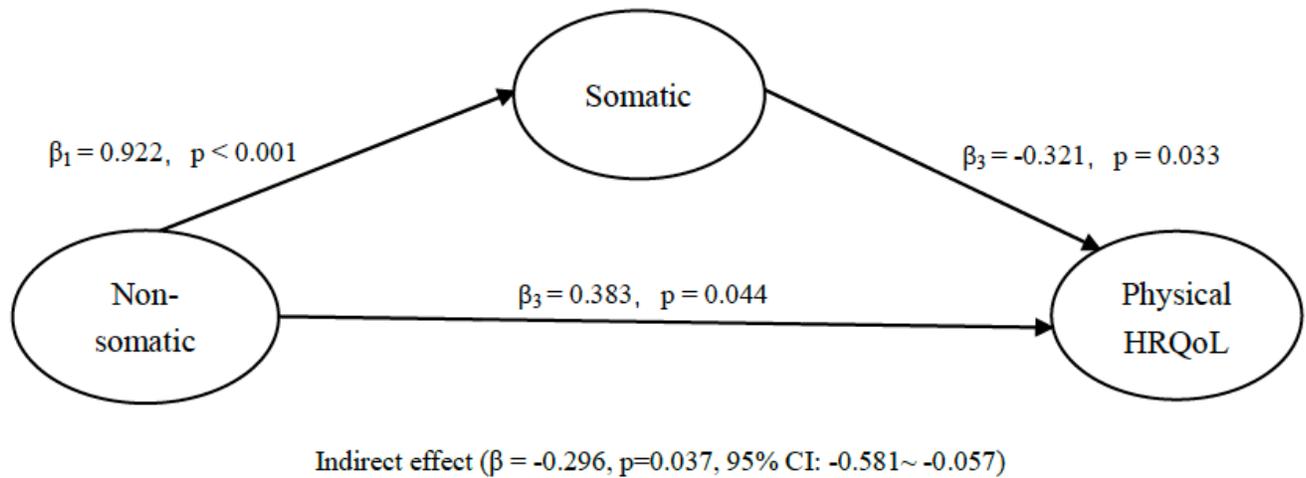


Figure 2

Mediating effect of MDD's somatic factor in the relationship between MDD's non-somatic and physical health-related quality of life Note. N=1058. HRQoL, health-related quality of life