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Psychometric properties of the Sport Mental Health Continuum – Short Form scale (Sport MHC-SF): cross-cultural validation and measurement invariance of the Chinese adaptation

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Abstract

Background Sport Mental Health Continuum – Short Form (Sport MHC-SF) is an adaptation of the Mental Health Continuum-Short Form for athletes. Although validated in Western contexts, its applicability to the Chinese population remains unexplored. This study aims to validate the Chinese adaptation of the Sport MHC-SF in Chinese university athletes, evaluate its reliability and validity, and confirm its factorial structure.

Methods A total of 1,025 Chinese university athletes (65% male, mean age 20 ± 1.54 years) were included in this study. Confirmatory factor analysis (CFA) and multi-group CFA (MGCFA) were conducted using Mplus 8.0 to evaluate the factorial structure and assess measurement invariance across sports levels.

Results Both the three-factor and second-order models demonstrated a good fit for the Chinese adaptation of the Sport MHC-SF. Chi-square values were 262.704 (74) and 262.705 (74), respectively, with a comparative fit index (CFI) of 0.968, a Tucker-Lewis index (TLI) of 0.961, a standardized root mean square residual (SRMR) of 0.027, and a root mean square error of approximation (RMSEA) of 0.050 (90% CI: 0.043–0.056). Measurement invariance across ranked and non-ranked athletes was confirmed, with minimal changes in fit indices (ΔCFI $\leq$ 0.01, ΔTLI $\leq$ 0.01, ΔRMSEA $\leq$ 0.015) from configural to strict invariance.

Conclusion The Chinese adaptation of the Sport MHC-SF scale has strong construct validity, reliability, and measurement invariance, making it a reliable tool for future research on the well-being of Chinese athletes. This study fills a critical gap in cross-cultural validation, offering a foundation for future research and practical applications in sports psychology among Chinese athletes.

Keywords Confirmatory factor analysis (CFA), Mental health and well-being, University athletes

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Introduction

Athletes face multiple psychological hurdles in their quest for excellence, including self-doubt driven by an intense focus on competitive success, psychological distress during career transitions, and mental exhaustion or emotional burnout resulting from prolonged training and competition [1, 2]. These challenges can profoundly affect their mental health and athletic performance [3, 4]. Well-being, as an essential component of mental health, plays a crucial role in mitigating these challenges [3, 5]. It promotes a positive mindset, reduces competition-related anxiety, and enhances psychological resilience [6]. Positive emotions associated with well-being regulate stress, boost immunity, and speed recovery from fatigue, mitigating the effects of injuries [7, 8]. Furthermore, well-being fosters intrinsic motivation, encouraging athletes to enjoy their sport and maintain self-motivation [9, 10].

The mental health and well-being of athletes are shaped by various factors, including competitive experiences, motivation, relationships with coaches, and support from parents or peers. Recent years have seen an expansion of psychometric tools designed to assess these factors, validated across diverse cultural and sports contexts [11, 12]. For instance, to better understand athletes' psychological needs, Alexe et al. validated the Interpersonal Behaviors Questionnaire and the Need Satisfaction and Frustration Scale in Romanian athletes, providing a scientific basis for measuring need satisfaction and frustration in sports contexts [13, 14]. Similarly, the Sport Climate Questionnaire, studied by Balaguer et al. [15], highlighted the critical role of sports climates in maintaining athletes' mental health. Additionally, Chu and Zhang [16] emphasized the key role of coaches, peers, and parents in meeting athletes' psychological needs, further demonstrating the necessity of scientific tools to capture the multidimensionality of mental health. These studies not only validated the value of these tools but also provided empirical support for the theoretical frameworks of well-being, aligning closely with Keyes' Mental Health Continuum theory [3, 17].

Keyes' Mental Health Continuum integrates emotional, social, and psychological well-being into a comprehensive framework to conceptualize mental health. Emotional well-being (EWB) evaluates an individual's positive emotions and life satisfaction, psychological well-being (PWB) emphasises self-acceptance and personal development, while social well-being (SWB) examines social integration and personal growth in a community-based environment [18, 19]. In sports contexts, these dimensions manifest as satisfaction with competitive success (EWB), growth through overcoming challenges (PWB), and the importance of support from coaches and a sense of team belonging (SWB).

The Mental Health Continuum – Short Form (MHC-SF) has been widely applied across diverse populations. Foster and Chow adapted the MHC-SF for sports contexts, developing the Sport Mental Health Continuum – Short Form (Sport MHC-SF) [17]. This adaptation tailored the questionnaire items for athletic settings, such as modifying "During the past month, how often did you feel happy?" to "During the past month, how often did your sports participation make you feel happy?" While the Sport MHC-SF has been validated among athletes in Italy [20], Canada [21], and the United States [2], its applicability to Chinese athletes remains unexplored.

Psychometric tools are typically developed within specific cultural contexts, which may restrict their cross-cultural applicability [22, 23]. Western cultures, for instance, place greater emphasis on individual achievement and autonomy, where athletes' well-being is often derived from intrinsic motivation and competitive success. In contrast, collectivist cultures such as China emphasize group harmony and social responsibility, with athletes' well-being more dependent on teamwork and social recognition [24–26]. These cultural differences highlight the importance of adapting and validating the Sport MHC-SF for the Chinese context. Additionally, the psychological structure of well-being may differ across athletes of varying competition levels [27, 28]. Athletes at higher levels often derive well-being from achievements and team support, while those at lower levels prioritize intrinsic enjoyment.

To comprehensively evaluate well-being, this study draws on prior research on the Mental Health Continuum framework. The research examines multiple models of well-being in the Chinese university athletic population. Specifically, the following models are examined: (1) a single-factor model, where mental health is represented by a single overarching factor; (2) a two-factor model, dividing well-being into hedonic well-being (EWB) and eudaimonic well-being (PWB and SWB); (3) a three-factor model, treating EWB, PWB, and SWB as independent but interrelated dimensions; and (4) a second-order model, positing that the three first-order dimensions load onto an overarching higher-order mental health factor [17, 29]. These theoretical models broaden perspectives on well-being research in sports and provide a multidimensional framework for tool development.

Building on these considerations, this study aims to translate and cross-culturally validate the Sport MHC-SF, with a systematic evaluation of its psychometric properties among Chinese university athletes. Furthermore, this study compares the fit of four theoretical models of well-being to investigate the factorial structure of well-being in sports contexts. Finally, measurement invariance across sports levels is assessed to ensure the scale's accuracy and cultural adaptability for diverse subgroups. This contributes to the refinement of mental health and well-being theories while providing practical guidance for application in the Chinese context.

Methodology

Participants

Data from 1,025 Chinese university athletes were included in the study. The inclusion criteria were as follows: (1) participants were aged 18 years or older; (2) officially registered as active members of a university sports team; (3) engaged in regular training sessions with their respective teams; and (4) eligible to represent their universities in competitions at or above the intercollegiate level. Exclusion criteria included (1) individuals who were not officially registered as team members and (2) those who were absent from any team training sessions within the past six months, regardless of the reason.

Participants were involved in various sports, categorized into team sports and individual sports. Team sports included basketball, volleyball, and soccer, comprising 393 (38%) participants. Individual sports, such as badminton, table tennis, tennis, aerobics, track and field, martial arts, taekwondo, and dragon and lion dance, accounted for 632 (62%) participants.

Instrument of measures

The descriptive statistics of sociodemographic analysis

The sociodemographic analysis and sports activities data were reported as mean (SD) or as frequencies and percentages. Age, gender, grade, height, weight, sports participation, sports disciplines and weekly training hours were among the data that were collected for the descriptive analyses.

The Sports Mental Health Continuum—Short Form (Sports MHC-SF) scale

The Sports MHC-SF scale was developed by Foster and Chow based on the original MHC-SF scale. This scale comprises 14 items, encompassing three dimensions of well-being: emotional (EWB; 1–3 items), social (SWB; 4–8 items), and psychological (PWB; 9–14 items). The frequency of encountering specific emotions during their engagement in sports over the past month was the respondents. Responses were scored on a 6-point Likert scale, with responses ranging from 0 (never) to 5 (every day).

Questionnaire translation

The authors of the original scale were contacted via email, and their permission was obtained to translate and adapt the scale into the Chinese language, following the Brislin forward and backward questionnaire translation procedure principle [30]. Initially, a bilingual author, familiar with the content performed the forward translation (from English to Chinese), followed by another bilingual expert conducting the reverse translation (from Chinese to English). Subsequently, a panel comprising five experts fluent in both languages, including psychologists, sports psychologists, coaches, linguists, and psychometricians, reviewed the Chinese translation from English and the English translation from Chinese. They meticulously compared each item with its counterpart in the original English version. Furthermore, the experts were tasked with scrutinising the content of the Sport MHC-SF scale to verify its cultural appropriateness to fit the Chinese university athlete population. The panel evaluated the scale's content relevance, conceptual consistency, and practical applicability, ensuring alignment with Chinese cultural norms while preserving the integrity of the original constructs. The final Chinese version of the Sport MHC-SF scale was pretested with 10 university athletes, who provided positive feedback on its clarity and wording. No revisions were necessary, and the finalized version was adopted for the study.

Data collection

A cross-sectional research design was employed to investigate the self-reported Chinese adaptation of the Sport MHC-SF (hereafter referred to as C-Sport MHC-SF). Before data collection, ethical approval was obtained from the USM Human Research Ethics Committee (USM/JEPeM/KK/23030250), and the study strictly followed all protocols stated by the Declaration of Helsinki.

To ensure effective data collection and accurate participant instructions, a research team was established. The team comprised the first and second authors and was responsible for coordinating with university sports management centres, supervising the data collection process, and addressing participants' queries to maintain consistency and reliability.

Data collection consisted of two phases: offline and online. In the first phase, paper-based questionnaires were distributed. After coordinating with the sports management centres of 13 universities in Zhengzhou, Henan Province, we visited the sports teams. During their training breaks, with the coaches' introduction, the research team provided detailed explanations regarding the purpose, content, and procedures of the study to ensure that participants fully understood the research requirements. University athletes voluntarily completed the questionnaires, and their participation was considered informed consent. Participants who completed the paper-based questionnaire used pens provided by the research team. After completing the survey, these low-cost pens were given to them as a token of appreciation and were not collected back. However, the offline data collection process was slow, and the sample size did not meet the initial expectations. To increase the sample size, the second phase involved distributing anonymous online questionnaires via the Sojump platform. The link to the electronic questionnaire was shared with team coaches via email and WeChat groups, and the coaches then passed the link to their athletes. The first page of the electronic questionnaire included a brief informed consent form, the inclusion and exclusion criteria, and a note explicitly stating that individuals who had completed the offline questionnaire should not participate again. After reading the informed consent form, participants were required to click the "Agree" button to proceed with the questionnaire. To ensure data completeness, the questionnaire was set up to require full completion before submission.

The C-Sport MHC-SF scale was administered once during data collection, conducted from August to October 2023, a non-competitive off-season period without provincial or higher-level events. In total, 1,053 questionnaires were collected across both phases. During data cleaning, 28 questionnaires were excluded due to incomplete responses or abnormally short completion times, resulting in a final dataset of 1,025 valid and complete questionnaires for analysis.

Statistical analysis

Data analysis was conducted using the Mplus 8.0 software. Data were screened for missing values before analysis. Firstly, a multivariate normality test was used to evaluate the data distribution. Significant Mardia's multivariate skewness ($p < 0.001$) and kurtosis ($p < 0.001$) indicated non-normally distributed data. To address this, we used the robust maximum likelihood estimator (MLR) in the confirmatory factor analysis (CFA), as it effectively handles non-normal data and enhances parameter robustness.

We validated one-factor, two-factor, three-factor, and second-order models and compared them using fit indices to determine the best model. Hair et al. [31] suggest that multiple fit indices should be reported for a comprehensive assessment. We used the comparative fit index (CFI) and Tucker-Lewis index (TLI), both with values > 0.90; root mean square error of approximation (RMSEA) < 0.08, with an upper limit of the confidence interval < 0.10; and standardised root mean square residual (SRMR) < 0.08. These indices were used collectively to evaluate model fit [32].

Items with factor loadings > 0.40 were retained in the initial analysis [33]. All retained items showed significant factor loadings ($p < 0.05$), and modification indices (MI) were used to optimise model fit. Construct validity was assessed using CFA, including convergent and discriminant validity. Convergent validity was evaluated using composite reliability (CR) and average variance extracted (AVE), with CR ≥ 0.70 and AVE > 0.50 to ensure high shared variance among items within each factor [31].

Discriminant validity was assessed by comparing correlations between factors. Correlation coefficients below 0.85 indicated good discriminant validity [34]. The chi-square statistic (χ^2) and its degrees of freedom (df) were also reported, though other fit indices were primarily used due to the chi-square's sensitivity to large sample sizes. Internal consistency was assessed by calculating Cronbach's alpha (α). Values of α ≥ 0.70 indicated good internal consistency [32].

Subsequently, multi-group CFA (MGCFA) tested the measurement invariance of C-Sport MHC-SF in university athletes with different ranks in sports. Measurement invariance encompasses four aspects of equivalence. Increasingly restrictive models of invariance, including configural, metric, scalar, and strict invariance. Measurement invariance was assessed using ΔCFI, ΔTLI, and ΔRMSEA for validation. If ΔCFI and ΔTLI were ≤ 0.01, and ΔRMSEA was less than 0.015, measurement invariance was considered acceptable [35–37]. Finally, after establishing measurement invariance, independent samples t-tests were used to compare differences in specific variable scores between groups, further exploring the impact of group characteristics on the study results.

Results

Characteristics of participants

The mean age of the study participants was 20 (SD = 1.54) years, the mean of their body mass index (BMI) was 21.5 (SD = 3.16), the mean of their weekly training time was 10 (SD = 6.14) hours, and the mean of their athletic experience was 4.8 (SD = 2.69) years. Other descriptive statistical analyses are presented in Table 1.

Descriptive statistics of the C-Sport MHC-SF

Table 2 presents the descriptive statistics of the C-Sport MHC-SF scale, including the mean, standard deviation, skewness, and kurtosis for each item (N = 1025). The means of the items range from 3.11 to 3.36, with SDs between 1.14 and 1.25, indicating a consistent distribution of responses across the 6-point Likert scale. The skewness values range from −1.02 to −0.72, suggesting negative skewness, which implies that many participants scored relatively high on each item. The kurtosis values range from 0.14 to 0.89, which were close to zero, indicating that the distribution of each item was approximately normal [32].

Table 1 Description of the distribution of sample characteristics

Variables	Type	*n*	%
Gender	Male	668	65
	Female	357	35
Grade	First Year	280	27
	Second Year	415	41
	Third year	196	19
	Fourth-year	99	10
	Graduate Students	35	3
Sports level	Ranked	464	45
	Non-Ranked	561	55
Type of institution	Sports Universities	188	18
	Non-Sports Universities	837	82
The main field of study	Sports-related Majors	542	53
	Not Sport Majors	483	47

n represents the number for the categories and % represents the percentage

Table 2 Means, SDs, skewness, and kurtosis ($N = 1025$)

Item	Mean	SD	Skewness	Kurtosis
EWB1	3.25	1.16	−1.02	0.83
EWB2	3.32	1.14	−0.99	0.89
EWB3	3.27	1.15	−0.94	0.71
SWB1	3.11	1.21	−0.77	0.19
SWB2	3.28	1.22	−0.85	0.37
SWB3	3.31	1.20	−0.83	0.43
SWB4	3.36	1.17	−0.96	0.78
SWB5	3.33	1.18	−0.91	0.65
PWB1	3.28	1.18	−0.95	0.69
PWB2	3.18	1.25	−0.72	0.14
PWB3	3.33	1.17	−0.97	0.81
PWB4	3.32	1.16	−0.94	0.82
PWB5	3.30	1.17	−0.94	0.79
PWB6	3.33	1.17	−0.94	0.73

EWB emotional well-being, *SWB* social well-being, *PWB* psychological well-being

Table 3 Fit indices for different measurement models

Model	χ2 (df)	CFI	TLI	SRMR	RMSEA (90% CI)
Single factor	1857.548/77	0.701	0.647	0.096	0.150 (0.144–0.156)
Two-factor	1244.422/76	0.804	0.765	0.078	0.122 (0.117–0.129)
Three-factor	262.704/74	0.968	0.961	0.027	0.050 (0.043–0.056)
Second-order	262.705/74	0.968	0.961	0.027	0.050 (0.043–0.056)

Two factor EWB loads on one factor, and SWB and PWB load on the second factor, *χ2* chi-square test, *df* degrees of freedom, *CFI* comparative fit index, *TLI* Tucker-Lewis index, *SRMR* standardised root mean square residual, *RMSEA* root mean square error of approximation

Measurement models of C-Sport MHC-SF

Table 3 presents the fit indices for the different measurement models. The single-factor model demonstrated poor fit, while the two-factor model showed a slight improvement, but still failed to reach the acceptable levels. In contrast, both the three-factor and second-order models exhibited good fit indices, with χ^2 (df) = 262.704 (74) and 262.705 (74), respectively, CFI = 0.968, TLI = 0.961, SRMR = 0.027, and RMSEA = 0.050 (90% CI: 0.043–0.056). These results indicate that the three-factor and second-order models presented a significantly better fit to the data compared to the single-factor and two-factor models.

Structural analysis and reliability evaluation of the three-factor model

Figure 1 illustrates the structure of the three-factor model, comprising three latent variables (EWB, SWB, PWB) and 14 observed items. All factor loadings of the items were significant (> 0.4), indicating that the observed variables were measured with high precision for their respective latent constructs.

The reliability of the three-factor model was assessed using CR, AVE, and Cronbach's alpha (α). The CR values all exceed the recommended threshold of 0.70, indicating good internal consistency. The AVE values are all above 0.50, suggesting sufficient variance explained by each factor, thus supporting convergent validity. The Cronbach's alpha (α) values for all factors and the overall model exceeded 0.70, thus, demonstrating strong reliability across the model. The correlations between latent variables were below the recommended threshold of 0.85, indicating strong discriminant validity. Detailed results are presented in Table 4.

Structural analysis and reliability evaluation of the second-order model

Figure 2 illustrates the second-order model, comprising one second-order factor, three first-order factors (EWB, SWB, PWB), and 14 observed variables. The second-order factor influences the observed items through the first-order factors, with standardised loadings of 0.704, 0.777, and 0.776, indicating an effective explanation of the variance in each first-order factor.

The CR of the second-order factor is 0.797, higher than the recommended threshold of 0.70. The AVE is 0.567, exceeding the recommended value of 0.50, indicating sufficient convergent validity. Overall, although the CR is slightly below the ideal value, the AVE meets the standard, suggesting that the second-order factor has adequate reliability and validity.

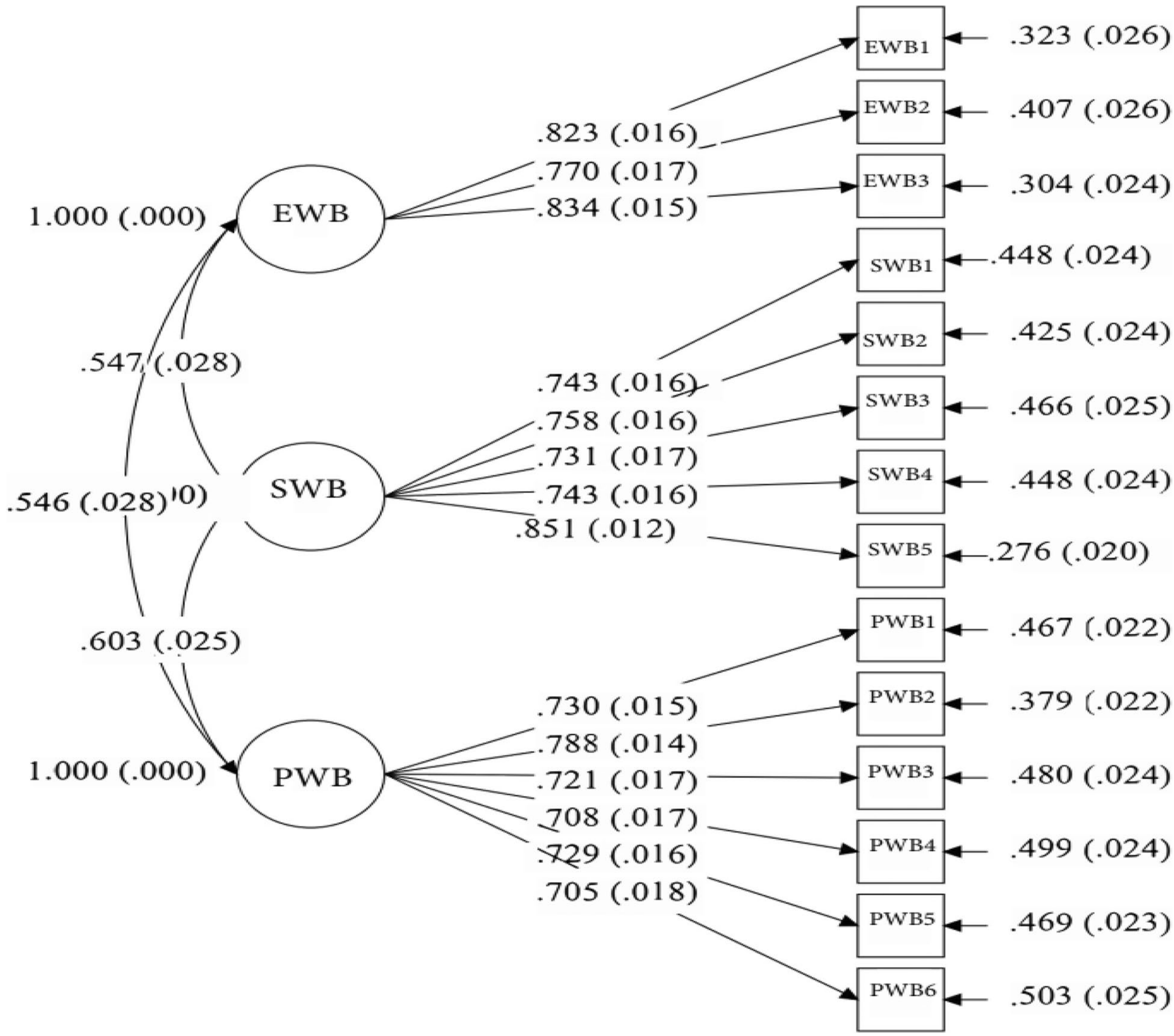

Fig. 1 C-Sport MHC-SF three-factor model

Table 4 Cronbach's alpha, CR, AVE and the factor correlation of the C-Sport MHC-SF three-factor model

Variables	Cronbach's Alpha (α)	CR	AVE	EWB	SWB	PWB
EWB	0.85	0.851	0.655	1	0.547**	0.603**
SWB	0.875	0.876	0.587	-	1	0.546**
PWB	0.873	0.873	0.534	-	-	1
Overall	0.906	-	-	-	-	-

EWB emotional well-being, *SWB* social well-being, *PWB* psychological well-being, *CR* composite reliability, *AVE* Average variance extracted

** $p<0.01$ (two-tailed)

Measurement invariance

To further confirm the measurement invariance of the three-factor C-Sport MHC-SF model between RUA and NRUA groups, a series of tests was conducted. Table 5 shows the baseline model fit indices and invariance testing results for the C-Sport MHC-SF.

All models (M1 to M6) have a CFI and TLI greater than 0.90, indicating a good model fit. In invariance testing, as

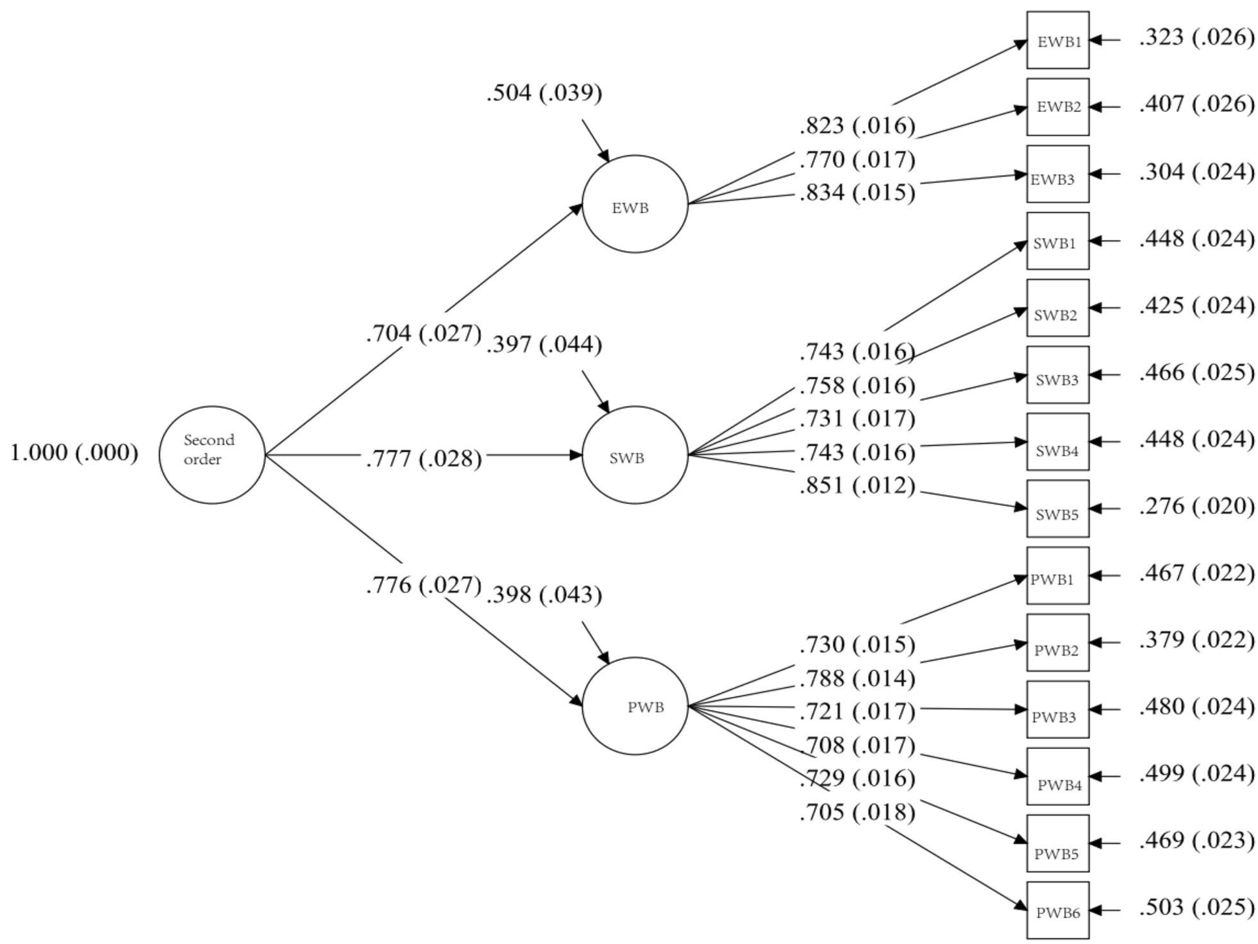

Fig. 2 C-Sport MHC-SF second-order model

Table 5 C-Sport MHC baseline model fit results and tests of invariance across sport ranked

Model	χ^2 (df)	CFI	TLI	SRMR	RMSEA (90% CI)	Compari-sons	ΔCFI	ΔTLI	ΔRMSEA
M1. RUA	180.077 (74)	0.961	0.952	0.033	0.056 (0.045–0.066)				
M2. NRUA	155.872 (74)	0.975	0.969	0.028	0.044 (0.035–0.054)				
M3. Configural	335.559 (148)	0.969	0.961	0.03	0.050 (0.043–0.057)				
M4. Metric	355.9 (159)	0.967	0.962	0.039	0.049 (0.042–0.056)	M4-M3	−0.002	0.001	−0.001
M5. Scalar	370.067 (170)	0.966	0.964	0.041	0.048 (0.041- 0.055)	M5-M4	−0.001	0.002	−0.001
M6. Strict	391.383 (184)	0.965	0.966	0.053	0.047 (0.040–0.053)	M6-M5	−0.001	0.002	−0.001

RUA ranked university athletes, *NRUA* non-ranked university athletes, χ^2 chi-square goodness of fit, *df* degrees of freedom, *CFI* comparative fit index, *TLI* Tucker–Lewis index, *RMSEA* root mean square error of approximation, *90% CI* 90% confidence intervals, *ΔCFI* CFI difference, *ΔTLI* TLI difference, *ΔRMSEA* RMSEA difference

constraints increased from configural to strict, both CFI and TLI decreased slightly, but the changes were minimal. For example, comparing Model M4 (Metric) to M3 (Configural), ΔCFI was −0.002 and ΔTLI was −0.001, indicating acceptable metric invariance. Comparing M5 (Scalar) to M4, ΔCFI was −0.001 and ΔTLI was 0.002, supporting scalar invariance. Comparing M6 (Strict) to M5, ΔCFI was −0.001 and ΔTLI was −0.002, showing that strict invariance was still acceptable.

Moreover, all models displayed RMSEA values below 0.08, and SRMR remained within acceptable limits. The ΔRMSEA values were small across models (e.g., ΔRMSEA for M6-M5 was −0.001), indicating a stable fit. In conclusion, Table 4 shows that the C-Sport MHC-SF scale demonstrates good measurement invariance between RUA and NRUA groups. The changes in ΔCFI, ΔTLI, and ΔRMSEA are all within acceptable ranges (ΔCFI ≤ 0.01, ΔTLI ≤ 0.01, and ΔRMSEA ≤ 0.015), supporting the consistent use of the scale across these groups.

Comparison of C-Sport MHC-SF between university athletes with different sports ranks

Differences in C-Sport MHC-SF scores between RUA and NRUA groups were examined, with results shown in Table 6. For overall scores, RUA had a significantly higher score (Mean ± SD = 47.33 ± 10.55) compared to NRUA (mean ± SD = 44.82 ± 11.40), *t*-statistic = 3.66, $p < 0.01$, 95% CI (1.17–3.86).

Item-level scores indicated that the RUA group scored significantly higher on several items compared to the NRUA group. However, for some items (e.g., EWB2, EWB3, and SWB3), highlighting differences between the two groups was not significant ($p > 0.05$), indicating no substantial differences in those items.

Discussion

Cultural differences in mental health and well-being perceptions necessitate the cross-cultural adaptation and validation of psychological scales to ensure their relevance and accuracy in diverse contexts [11, 38]. This study represents the first attempt to translate the Sport MHC-SF into Chinese, aiming to validate its applicability among Chinese athletes and assess its measurement invariance across different sports levels. The findings enhance well-being research by introducing a new cultural perspective and offer important insights for the implementation of sports psychology.

CFA results show that the C-Sport MHC-SF has strong construct validity and reliability among Chinese university athletes. Both the three-factor and second-order models demonstrated good fit indices: χ^2 (df) = 262.704 (74) and 262.705 (74), CFI = 0.968, TLI = 0.961, SRMR = 0.027, and RMSEA = 0.050 (90% CI: 0.043–0.056). Factor loadings, composite reliability (CR), and average variance extracted (AVE) for both models met the required standards. This indicates that emotional, social, and psychological well-being can be considered as distinct but related dimensions (three-factor model) or as components of a higher-order well-being construct (second-order model). The selection of a model is contingent upon the theoretical focus of the study, which may pertain to the interaction of the dimensions or the overall structure of well-being. In contrast, the single- and two-factor models showed poor fit, underscoring the need for

Table 6 Different sports ranked in the item and total scores of C-Sport MHC-SF

Items	RUA (*n* = 464)	NRUA (*n* = 561)	*t*	*p*	95% CI	
EWB1	3.31 (1.14)	3.19 (1.17)	1.63	0.10	−0.02	0.26
EWB2	3.44 (1.07)	3.22 (1.19)	0.07	0.00	0.08	0.36
EWB3	3.33 (1.12)	3.23 (1.17)	1.41	0.16	−0.04	0.24
SWB1	3.21 (1.15)	3.02 (1.25)	2.51	0.01	0.04	0.34
SWB2	3.41 (1.14)	3.16 (1.27)	3.23	0.00	0.10	0.39
SWB3	3.37 (1.21)	3.26 (1.20)	1.39	0.17	−0.04	0.25
SWB4	3.45 (1.13)	3.28 (1.20)	2.40	0.02	0.03	0.32
SWB5	3.41 (1.11)	3.26 (1.23)	2.05	0.04	0.01	0.30
PWB1	3.37 (1.21)	3.20 (1.16)	2.23	0.03	0.02	0.31
PWB2	3.33 (1.15)	3.06 (1.32)	3.46	0.00	0.12	0.42
PWB3	3.42 (1.17)	3.25 (1.16)	2.34	0.02	0.03	0.32
PWB4	3.43 (1.05)	3.23 (1.24)	2.74	0.01	0.06	0.34
PWB5	3.39 (1.14)	3.23 (1.18)	2.29	0.02	0.02	0.31
PWB6	3.46 (1.13)	3.22 (1.19)	3.28	0.00	0.10	0.38
Total score	47.33(10.55)	44.82(11.40)	3.66	0.00	1.17	3.86

EWB emotional well-being, *SWB* social well-being, *PWB* psychological well-being, *RUA* ranked university athletes, *NRUA* non-ranked university athletes, *t* *t*-statistic, *95% CI* 95% confidence intervals a multidimensional approach to accurately assess well-being as a complex construct.

The results support the measurement invariance of the C-Sport MHC-SF scale across athletes with different sports ranks. Measurement invariance was confirmed across ranked and non-ranked athletes, with minimal changes in fit indices (ΔCFI $\leq$ 0.01, ΔTLI $\leq$ 0.01, and ΔRMSEA $\leq$ 0.015) from configural to strict invariance levels, all within acceptable ranges [36]. This suggests that the C-MHC-SF scale maintains high stability and applicability across different athlete groups, enabling meaningful comparisons between the ranked and non-ranked athletes. These results add to our understanding of how different sports backgrounds may impact athletes' well-being and provide a theoretical foundation for developing targeted interventions.

The comparison of well-being scores between athletes with different sports ranks revealed that ranked athletes reported significantly higher overall well-being scores ($p < 0.01$). This aligns with previous research, indicating that higher sports ranks may be associated with enhanced well-being [39, 40]. The potential explanation is that higher-ranked athletes may experience a greater sense of achievement and social support through their involvement in sports, which contributes positively to their well-being. However, some item-level differences were not significant (e.g., EWB2, EWB3, and SWB3), suggesting that specific aspects of well-being may be influenced by other factors, such as individual sports experience or personality traits [3, 41, 42].

This study rigorously validated the measurement model and conducted thorough multi-group invariance testing for the Chinese adaptation of the Sport MHC-SF scale, providing strong evidence for its applicability among Chinese university athletes. However, several limitations should be acknowledged. Firstly, the sample consisted primarily of university athletes, which may limit the generalisability of the findings to professional athletes or the general population. Second, the use of self-reported data may introduce biased inputs, as respondents could be influenced by personal perceptions or social desirability, leading to responses that may not accurately reflect their true well-being. To address this, combining self-reports with objective measures, such as physiological indicators or behavioural observations, could further enhance the validity of the findings. For example, using physiological indicators (such as heart rate or body mass index) or behavioural observation (such as tracking physical activity through wearable devices) can provide an objective complement to self-reports. This approach allows for a more comprehensive understanding of well-being, as it enables researchers to compare subjective experiences with objective realities. Additionally, incorporating qualitative methods, such as interviews or focus group discussions, alongside quantitative self-reports can help mitigate biases. In future studies, by exploring participants' experiences and perceptions in greater depth, researchers can uncover nuanced insights that may not be captured through standardised questionnaires. This strategy allows for the identification of discrepancies between self-reported feelings and actual behaviours or conditions.

This study used different data collection methods: offline participants received pens for completing paper-based questionnaires, while online participants did not receive tokens. Although ethically appropriate, this discrepancy may have slightly influenced participant engagement. Future studies should standardize procedures for consistency. Additionally, the cross-sectional design limits the ability to establish causal relationships. Future research should consider employing more diverse samples, including professional athletes and the general population, and adopt longitudinal or experimental designs with varied data collection approaches to further validate the scale's reliability and applicability.

The results demonstrate that the scale possesses strong construct validity, reliability, and measurement invariance, establishing it as a reliable tool for future research on the well-being of Chinese university athletes. Future studies could expand on these findings by exploring well-being characteristics in diverse populations, including professional athletes and the general public, to enhance the scale's generalizability. Moreover, employing longitudinal or experimental designs could help uncover causal relationships and further refine the theoretical framework for well-being research, paving the way for the development of targeted psychological interventions.

Implications for practice

The C-Sport MHC-SF holds significant potential as a practical tool for monitoring athletes' mental health and evaluating the effectiveness of psychological interventions. Regular assessments using this scale can help coaches and sports psychologists identify mental health issues early and implement timely interventions. Longitudinal measurements at multiple time points can bolster the reliability and validity of the scale, allowing for a deeper understanding of how well-being evolves over time.

Beyond university athletes, the scale's applicability could extend to individuals who regularly engage in physical activity, including recreational athletes and the general public. This broader application may facilitate assessments of mental health and well-being related to sports participation in diverse populations. Future research should explore the scale's relevance in non-athlete populations, providing a fuller picture of mental health in the context of physical activity, and inform the development of targeted interventions that promote healthy body image and overall well-being among adolescents and adults alike.

Conclusion

The Sport MHC-SF serves as a comprehensive tool for evaluating well-being in sports contexts, capturing emotional, social, and psychological dimensions connected to mental health and life satisfaction. This study provides substantial evidence for the reliability, validity, and measurement invariance of the Chinese adaptation of the Sport MHC-SF among university athletes. These findings fill a critical gap in cross-cultural research and establish the C-Sport MHC-SF as a valuable tool for assessing athlete well-being. This tool offers insights into the significant potential for practical applications in sports psychology and targeted psychological interventions.

Abbreviations

Sport MHC-SF	Sport Mental Health Continuum – Short Form Scale
C-Sport MHC-SF	Chinese adaptation of the Sport MHC-SF
EWB	Emotional well-being
SWB	Social well-being
PWB	Psychological well-being
MGCFA	Multi-group confirmatory factor analysis
RUA	Ranked University Athletes
NRUA	Non-Ranked University Athletes
CFA	Confirmatory factor analysis
BMI	Body Mass Index
SD	Standard deviation
ILSI	International Life Science Institute
MLR	Robust maximum likelihood estimator
RMSEA	Root mean square error of approximation
SRMR	Standardized root mean square
CFI	Comparative fit index
TLI	Tucker-Lewis index
CR	Composite reliability
AVE	Average variance extracted

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40359-025-02487-5.

Supplementary Material 1.

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Authors' contributions

XW and GK made substantial contributions to the conception or design of the work and drafted the work. XW, ZY, LL, YCK, LX, and GK made substantial contributions to the conception or design of the work and revised the work critically for important intellectual content. All authors read, revised, and approved the final manuscript.

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Data availability

The datasets used during the current study are available upon reasonable request from XW and GK.

Declarations

Ethics approval and consent to participate

The ethical approval was obtained from the USM Human Research Ethics Committee (USM/JEPeM/KK/23030250). It is in line with the Declaration of Helsinki, and informed consents were obtained from the participants. Implied consent was obtained from participants who voluntarily returned the completed surveys to the researchers. Implied consent refers to an agreement that is not explicitly stated but is inferred from the participant's actions.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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