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Reliability and validity of the Healthy Fitness Measurement Scale Version 1.0 (HFMS V1.0) in Chinese people

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ABSTRACT

Objective To investigate the reliability and validity of Healthy Fitness Measurement Scale Version 1.0 (HFMS V1.0) for different population cohorts in the city of Guangzhou, Guangdong, China and to provide evidence and tools for further evaluation of healthy fitness of Chinese population and related factors.

Design Cross-sectional study.

Setting Urban neighbourhood and Medical University.

Participants Elderly people (n=393; mean age 68.27±6.38 years; 53.18% male), university students (n=390; mean age 19.29±1.29 years; 38.21% male) and urban residents (n=393; mean age 32.23±9.41 years; 44.78% male).

Primary and secondary outcome measures The primary outcomes were evaluated the reliability and validity of HFMS V1.0 by internal consistency evaluation, split-half reliability, test–retest reliability, convergent and discriminant construct validity, and factor analysis.

Results The Cronbach's α coefficients for HFMS V1.0 were all greater than 0.85 for overall scale of total samples and three individual groups, and the split-half reliability and intragroup correlation coefficients were both greater than 0.70 (p<0.01). The correlation of each item, dimension and subscales ranged from 0.52 to 0.91 ($p < 0.01$). A total of 10 factors were screened by exploratory factor analysis with the cumulative contribution rate of 61.40%, basically consistent with the theoretical structure of scale. The confirmatory factor analysis indicated good fit: CMIN/DF=3.45, root mean square error of approximation=0.05, GFI=0.91, AGFI=0.90, IFI=0.90, comparative fit index=0.90.

Conclusion HFMS V1.0 showed acceptable reliability and validity in the test of healthy fitness of general population in Guangzhou. This scale could be a reliable measurement tool for evaluation of healthy fitness and potential risk factors.

Strengths and limitations of this study

- The main strength of this study was the evaluation of the reliability and validity of Healthy Fitness Measurement Scale V.1.0 (HFMS V.1.0) through three different population cohorts.
- This study provides the first representative analysis of the reliability and validity data on the Chinese version of HFMS V.1.0, which evaluates the level of Healthy Fitness, including health-related physical fitness, mental fitness and social fitness.
- The study compares the three subscales of HFMS V.1.0 with a mature scale of health-related physical fitness, mental fitness and social fitness, respectively, increasing its strength in reliability.
- This study was limited by its small sample size of 1176 participants.
- The participants were recruited from Guangzhou city in China, which might limit the generalisability of the findings.

INTRODUCTION

Adaptation is defined as a process where individual unconsciously or consciously responds to internal and external environmental stimuli and integrates with environment; also a process to promote physical, psychological and social integrity.[1 2] With the rapid development of society, one of the most important skills is keeping the balance between the individual environment, and internal and external environment, namely fitness.[3] Fitness is one's ability to learn and adjust, with which an individual effectively adapts to changing environments based on his own approaches, including physical fitness (PF), mental fitness (MF) and social fitness (SF).[4 5] Studies have revealed that a healthy body better adapts to the natural environment and resists against diseases.[6 7] Fitness enables people to deal with the internal and external events and to restore to a balanced state through stress reaction and adjustments, thereby achieving health promotion and disease prevention. This indicates that fitness is complementary to the bodily health.

Fitness is made up of PF, MF and SF. PF was initiated by the USA and gradually accepted in the medical health field, but it has various definitions by different scholars. According to the definition proposed by the WHO, physical health is the ability to cope with daily work without undue fatigue, and with ample energy to enjoy leisure and respond to emergencies.[8]

Caspersen *et al* have deemed that physical health is composed of a series of individual's attributes in different dimensions.[9] A study by Corbin and Masurier has pointed out that PF is one's capacity to perform daily activities and to function efficiently and effectively in work and leisure activities.[10] PF is also implicated as a comprehensive indicator to reflect the body function required for regular physical activities and sports.[11] Of note, it is a changeable factor. PF is important for disease prevention, reducing the risk of depression and cardiovascular disease[12]; it is related to children's healthy brain development,[13 14] and also serves as an indicator for adolescent health,[11 15] such as the risk of having cardiovascular disease.[16] Meanwhile, enhancement of fitness in the population has valuable social and health benefits, such as a decrease in medical costs.[17–20] According to different population cohorts, PF is grouped into two main categories, competitive PF and health-related PF.[21 22] Health-related PF refers to the ability to adapt to the internal and external environment and a state of well-being with prominent impacts on daily life, work, disease prevention and physical activity.[23–25] Health-related PF is indicated as an important indicator for controlling chronic disease risks and improving functional health in most European countries and American.[26] It is made of body composition, cardiorespiratory endurance, muscle strength and muscle endurance, speed, balance and flexibility.[13 15 27 28] MF, a kind of emotional agility to cope with pressure, is defined as an individual's ability to flexibly respond to challenges or disadvantages to meet psychological demands.[29] Actually, it is not a new concept. In 1964, MF had been proposed by McKinsey, explaining the Knudsen's concept of positive mental health and the process of achieving optimalfunctioning.[29] Evidence supports that a high level of MF help alleviate symptoms of anxiety and depression.[30] As for the factors for assessing MF, Robinson *et al*[29] has proposed a framework for MF based on the framework for PF, that is, strength (self-efficacy, positive affect ratio, social support and emotional management), flexibility (mindfulness, acceptance and psychological flexibility) and endurance (resilience, meaning, purpose and hope). Wesemann *et al*[5] have evaluated MF of the soldiers deployed in Afghanistan using a questionnaire from the perspectives of resilience, sense of coherence, quality of life, mental disorders and post-traumatic growth.

Henderson has pointed out that SF refers to the transformation of individuals from social withdrawal, and negative self-perception into active social participation with initiative, and empathy, a physical, emotional, psychological and behavioural adaption.[31 32] It is a key component of achieving harmony between individuals and society. Besides, SF is considered as the expectation of courtesy, respect, consideration and self-discipline.[33] The Chinese most representative Chinese study on SF is the 'three-factor theory' in which SF is defined as the adaptation to learning, interpersonal relationships and the social environment.[34] High level of SF tends to elicit social support and a sense of belonging,[35] thereby receiving greater respect and inducing confidence and pride, while individuals with low SF exhibit shyness, low self-esteem, social anxiety and fear. Evaluation of SF shall consider individual's self-care ability, labour ability, occupational ability, social ability, handling ability and self-discipline.[31] Lan *et al* revealed that SF hinges on the social connectivity and the health of leadership, family relationships, friendships, work relationships and financial health, as the emphasis varies based on the specific population cohort.[36]

Most studies have focused on single-dimensional fitness. However, the biomedical model has evolved to the bio-psycho-social model and investigators have made significant progress into health and health-related PF. A single-dimensional fitness assessment or a superposition of several fitness assessments cannot accurately and scientifically reflect individual fitness, hardly meeting people's demand of the comprehensive fitness assessment. Therefore, the evaluation of fitness for general population shall be improved from one-dimension to multidimension. Psychological fitness and SF shall be integrated into the evaluation, in addition to PF. Therefore, our previous study has proposed the concept of 'healthy fitness' based on the definition of health by the WHO and health-related PF, namely the optimum physical, mental and SF to changes in internal and external environments.[37] Further, we have established the Healthy Fitness Measurement Scale Version 1.0 (HFMS V1.0) involving physical, mental and SF based on the Chinese culture and existing health-related PF scales (the International Fitness Scale,[38] Self-Reported PF Survey,[39] MF scale (Adolescence Psychological Adaptability Scale,[40] Symptom Check List-90,[41] Self-Rating Anxiety Scale[42] and SF scales (Vineland Adaptive Behaviour Scale,[43] Adaptive Behaviour Assessment System,[44] Social Adaptation Self-evaluation Scale.[45] In this study, we carried out an on-site testing of the healthy fitness of the general population (the elderly, urban residents and university students) in the city of Guangzhou, Guangdong, China to explore the reliability and validity of HFMS V1.0 for the Chinese population. This evidence might underpin a theoretical and practical basis for further investigation of the healthy fitness level of the Chinese population and potential influencing factors.

Subjects and methods

Study design

This cross-sectional survey was conducted using a random sampling technique with three stages from August 2019 to August 2020 in randomly selected urban neighbourhoods and one randomly selected university from Guangzhou city. We enroled 400 elderly people, 400 university students and 400 urban residents, considering the sample size being 5–20 times the number of items on the scale, and the expulsion rate. A quarter of the participants (n=100, each cohort) received retest within 24 hours to 1 week after the first test. Subjects with mental illness, communication problem and cognitive deficits or unable to understand the content of questionnaires were excluded. All participants that volunteered provided their

verbal consent prior to data collection and were given the option to cease from participating anytime. All data were kept strictly confidential.

As for investigation for the elderly and urban residents, in the first stage, we chose four administrative districts within Guangzhou from which 1–3 streets were chosen in the second stage. The final stage involved sampling of committee members from 1~2 neighbourhood's committees. For the university subjects, the first stage was random sampling of one university within Guangzhou. In the second stage, one school was selected from the selected university. The final stage involved sampling of three majors from the school and 2–4 classes from the selected majors. Questionnaires were administered to all students of these classes.

HFMS v1.0 questionnaire

The HFMS V1.0 used for healthy fitness assessment in this study was developed by Jun Xu *et al* and it consists of demographic factors and healthy fitness rating scale, conforming to medical model transformation and combining Chinese social culture.[37] HFMS V1.0 is composed of three subscales—health-related PF, MF and SF—and 9 dimensions with 38 items in total (HF1-HF38). All items were assessed using Likert's five-level scoring, ranging from 1 (very poor) to 5 (very good). Forward scoring was adopted for the item HF1-HF5, HF16-HF17, HF28-HF36 with the score equal to the original score. Reverse scoring (6-original score) was adopted for the items HF6-HF14, HF18-HF26 and items 15, 27, 37 and 38 were the overall evaluation items and not taken into account. For better analysis, comparison and popularisation, the raw scores were converted to percentile value using the formula[46] = (Original score − Theoretical Minimum) *100/ (Theoretical Maximum- Theoretical Minimum). The higher the conversion score, the higher the fitness level.

Statistical analysis

All data were entered by double entry using Epidata V.3.02 and processed by IBM SPSS V.20.0 and AMOS V.22.0. The missing value was replaced by the average value of the dimension items. In case of straightlining or a completion rate below 80%, the invalid questionnaires were eliminated. The analytical methods included the Spearman's correlation analysis exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) with bilateral α=0.05 as significance.

Reliability

Reliability refers to the stability and consistency of the scale and is usually determined by evaluation of internal consistency, test-retest, and split-half reliability. As Cronbach's α coefficient reflects internal consistency of HFMS V1.0, α-level over 0.80 with subscales' α-level greater than 0.60 indicates almost perfect agreement.[47] The intraclass correlation coefficient (ICC) between first test and the 1week retest was calculated for evaluating test-retest reliability, and ICC ≥0.50 indicates acceptable reliability.[48] Split-half reliability assessed the internal consistency of a test by comparing the results of two halves of all items, with its coefficient over 0.70 considered satisfactory.[49]

Validity

Validity refers to the accuracy of scale and is assessed with convergent validity and discriminant validity. The validity of HFMS V1.0 was evaluated by the Spearman's correlation coefficient between items, dimensions and subscales and factor analysis. Correlation value of correlation coefficient ≥0.40 was considered satisfactory.[50] Applicability of EFA was detected by the Kaiser-Meyer-Olkin (KMO) test. The factors with eigenvalue over 0.85 were extracted after rotation with the maximum variance. CFA assesses the scale's fitness with indexes such as χ^2 (χ^2/DF), root mean square error of approximation (RMSEA) and comparative fit index (CFI). The X^2/df <3.00, RMSEA <0.08, and CFI >0.90 suggests a good fit.[51]

Results

Demographic characteristics

A total of 400 elderly people, 400 university students and 400 rural residents were identified by this random sampling; 1176 (98.00%) completed the questionnaires, including 393 elderly people (98.25%), with a mean age of 68.27±6.38 years; 390 university students (97.50%), with a mean age of 19.29±1.29 years and 393 urban residents (98.25%), with a mean age of 32.23±9.41 years. A sample of 85 (85.00%) elderly people, 95 (95.00%) university students and 97 (97.0%) urban residents were readministered the questionnaire a week after the first administration with a recovery rate of 92.33%. All participants included 534 males (45.41%), 629 females (53.49%), and 13 missing (1.11%) with a mean age of 39.99±21.77 years.

Reliability analysis

Internal consistency reliability

The internal consistency of the HFMS V1.0 scale and three subscales showed that the Cronbach's α Coefficients were 0.89 in HFMS V1.0 and 0.79, 0.85 and 0.79 in the PF, MF and SF subscales, respectively. As for the elderly, the Cronbach's α for the overall scale was 0.90 and for three subscales was 0.84, 0.84 and 0.78, respectively. For university students, the Cronbach's alpha was calculated as 0.90 for overall scale, and 0.75, 0.84 and 0.81 for three subscales, respectively. For urban residents, the Cronbach's α coefficients of the overall scale and three subscales were 0.89, 0.77, 0.87 and 0.78, respectively.

Split-half reliability

The split-half reliability of 34 items of HFMS V1.0 in three cohorts demonstrated that the Spearman-Brown Coefficient for all participants was 0.72. The Guttman coefficients for the elderly, university students, and urban residents were 0.70, 0.73 and 0.76, respectively.

Table 1 Correlation coefficient between items and dimensions in HFMS V.1.0

Item	Organ function	Motor function	Physical adaptive capacity	Psychological cognition	Resilience	Stress response	Role adaptation	Resource and social support
HF1	0.56**	0.28**	0.13**	0.24**	0.23**	0.12**	0.21**	0.12**
HF2	0.52**	0.04	0.12**	0.19**	0.13**	0.19**	0.11**	0.01
HF3	0.58**	0.30**	0.28**	0.33**	0.30**	0.17**	0.32**	0.21**
HF4	0.61**	0.26**	0.34**	0.27**	0.25**	0.35**	0.25**	0.06*
HF5	0.60**	0.27**	0.29**	0.23**	0.25**	0.41**	0.30**	0.09**
HF6	0.35**	0.77**	0.32**	0.26**	0.31**	0.11**	0.25**	0.16**
HF7	0.33**	0.77**	0.31**	0.21**	0.30**	0.13**	0.29**	0.18**
HF8	0.15**	0.66**	0.17**	0.13**	0.17**	0.03	0.12**	0.11**
HF9	0.33**	0.73**	0.35**	0.29**	0.35**	0.18**	0.35**	0.21**
HF10	0.31**	0.72**	0.35**	0.27**	0.29**	0.11**	0.22**	0.16**
HF11	0.28**	0.34**	0.73**	0.25**	0.31**	0.24**	0.24**	0.13**
HF12	0.20**	0.13**	0.63**	0.19**	0.23**	0.32**	0.20**	0.09**
HF13	0.28**	0.31**	0.71**	0.26**	0.31**	0.24**	0.28**	0.14**
HF14	0.35**	0.35**	0.63**	0.27**	0.33**	0.29**	0.35**	0.20**
HF16	0.34**	0.24**	0.26**	0.81**	0.41**	0.27**	0.38**	0.21**
HF17	0.36**	0.27**	0.30**	0.83**	0.34**	0.30**	0.29**	0.18**
HF18	0.28**	0.35**	0.29**	0.34**	0.71**	0.20**	0.39**	0.31**
HF19	0.23**	0.23**	0.28**	0.29**	0.72**	0.30**	0.32**	0.18**
HF20	0.33**	0.37**	0.33**	0.37**	0.79**	0.34**	0.48**	0.36**
HF21	0.30**	0.16**	0.33**	0.33**	0.70**	0.51**	0.39**	0.14**
HF22	0.29**	0.07*	0.30**	0.26**	0.40**	0.75**	0.39**	0.24**
HF23	0.33**	0.15**	0.29**	0.23**	0.35**	0.77**	0.36**	0.17**
HF24	0.31**	0.09**	0.29**	0.29**	0.37**	0.77**	0.31**	0.16**
HF25	0.35**	0.15**	0.32**	0.31**	0.36**	0.80**	0.37**	0.20**
HF26	0.31**	0.10**	0.31**	0.25**	0.30**	0.76**	0.32**	0.15**
HF28	0.22**	0.22**	0.21**	0.19**	0.32**	0.24**	0.69**	0.37**
HF29	0.33**	0.26**	0.35**	0.35**	0.45**	0.42**	0.71**	0.29**
HF30	0.33**	0.26**	0.33**	0.34**	0.42**	0.39**	0.77**	0.29**
HF31	0.28**	0.22**	0.22**	0.33**	0.38**	0.28**	0.69**	0.29**
HF32	0.12**	0.13**	0.17**	0.20**	0.28**	0.25**	0.34**	0.67**
HF33	0.13**	0.24**	0.12**	0.16**	0.21**	0.11**	0.32**	0.65**
HF34	0.04	0.11**	0.03	0.11**	0.13**	−0.02	0.12**	0.60**
HF35	0.12**	0.15**	0.15**	0.18**	0.26**	0.21**	0.33**	0.79**
HF36	0.18**	0.16**	0.22**	0.21**	0.30**	0.27**	0.39**	0.77**

Note: Statistical analysis was conducted by Spearman.
** $p < 0.01$
HFMS, Healthy Fitness Measurement Scale.

Test–retest reliability

The ICC between first test and the retest of three groups was calculated as 0.90 for HFMS V1.0 scale and 0.83, 0.83, and 0.80 for three subscales. The ICC of university students for the overall scale was 0.92 and that for the subscales was 0.86, 0.87, and 0.86 (p<0.01), respectively. The ICC of the elderly for the overall scale and three subscales were 0.78, 0.67, 0.72, 0.63, respectively (p<0.01). The group of urban residents was calculated as 0.94 for overall scale, and 0.86, 0.87 and 0.83 for subscales (p<0.01).

Validity analysis

Convergent and discriminant validity

To verify the structural validity of the HFMS V1.0, we conducted the Spearman's correlation analysis between each item and dimensions in the overall scales and subscales. The correlation coefficient of all subjects between items and corresponding dimensions in HFMS V1.0 ranged from 0.52 to 0.83, significantly greater than the coefficient between the item and other dimensions (-0.02–0.51) (p<0.01), as shown in table 1. Besides, the

Table 2 Spearman's correlation between dimensions and subscales

	PF	MF	SF
Organ function	0.72**	0.50**	0.29**
Motor function	0.84**	0.31**	0.30**
Physical adaptive capacity	0.71**	0.48**	0.30**
Psychological cognition	0.44**	0.61**	0.35**
Resilience	0.49**	0.79**	0.46**
Stress response	0.37**	0.86**	0.37**
Role adaptation	0.46**	0.58**	0.74**
Social resource and social support	0.25**	0.33**	0.91**
HFMS V1.0	0.83**	0.83**	0.72**

Note: Statistical analysis was conducted by Spearman.
**$p < 0.01$.
HFMS, Healthy Fitness Measurement Scale; MF, mental fitness; PF, physical fitness; SF, social fitness.

correlation coefficient between a dimension and corresponding subscale (0.61–0.91) significantly surpassed the coefficient the dimension and other subscales (0.25–0.58) (p<0.01) (table 2). The correlation coefficients between HFMS V1.0 and PF, MF and SF subscales were 0.83, 0.83 and 0.72 (p<0.01) (table 2).

Exploratory factor analysis

The data of high KMO value (0.91) and Bartlett test (p<0.01) demonstrated that the scale was applicable in factor analysis.[52] In the principal components analysis (PCA), on varimax rotation, 10 factors with characteristic root greater than 0.85 were extracted, and the cumulative contribution rate reached 61.40%, consistent with the theoretical construct. This study only listed the factor coefficient with the factor load greater than 0.4. According to the maximum factor load of each item and the research design, the items were divided into eight categories (factor 1: stress response, factor 2: motor function, factor 3 and 8: social resource and social support, factor 4: role adaptation, factor 5: resilience, factor 6: physical adaptive capacity, factor 7 and 10: organic function, factor 9: psychological cognition) (table 3).

Confirmatory factor analysis

Combined with the secondary structure of the HFMS V1.0, a second order CFA structure was modelled using the analysis of moment structure (AMOS), as shown in figure 1. The correlation coefficients among the three subscales of PF, MF and SF were 0.68, 0.86 and 0.87, respectively. The standardised path coefficients between dimensions and subscales ranged from 0.54 to 0.97, and the coefficients between items and dimensions ranged from 0.23 to 0.83, indicating great path association. The initial model was not well fitted with the minimum discrepancy per degree of freedom (CMIN/DF) was 3.97, root mean-square error of approximation (RMSEA) was 0.05, goodness-of-fit index (GFI) was 0.89, adjusted goodness-of-fit index (AGFI) was 0.88, incremental fit index (IFI) was 0.87, and comparative fit index (CFI) was 0.87. On amendment, the model showed a good fit with CMIN/DF=3.45, RMSEA=0.05, GFI=0.91, AGFI=0.90, IFI=0.90 and CFI=0.90.

DISCUSSION

The HFMS V1.0 by Jun Xu *et al* was established based on the definition of healthy fitness and Chinese culture of self-tested health, and it consisted of indicators from PF, MF and SF. In this study, a total of 1176 subjects in three cohorts of the elderly, university students and urban residents were administered epidemiological investigation to evaluate the reliability and validity of HFMS V1.0. The data demonstrated that the Cronbach's α Coefficients of total samples and three individual groups were all greater than 0.80 for the total HFMS V1.0 scale and those were also greater than 0.75 for the three subscales, indicating great internal consistency of the HFMS V1.0. Split-half reliability and ICC of total samples or each group (>0.70) depicts the sufficient stability over time of the scale. Additionally, compared with the International Fitness Scale, a well-known measure of physical health, on school students in Bogota, the HFMS V1.0 PF subcale on three cohorts exhibited consistent internal consistency and retest reliability.[53] The fitness level of the PF subscale achieves the above-average level in the International Fitness Scale summarised by Pereira *et al*.[54] The MF subscale of total samples and three cohorts are also consistent with the results of an Adolescent Psychological Adaptability Scale for primary school students in Shanxi Province and university students in Tianjin City, China.[40] Besides, the SF subscale is also consistent with the social adaptation self-evaluation scale on the Japanese patients with depression from psychiatric outpatient of the Hospital of the University of Occupational and Environmental Health.[55] Collectively, the evidence has confirmed that HFMS V1.0 has good reliability in different cohorts and the general population.

In this study, each item of HFMS V1.0 in the total samples revealed a strong correlation with the corresponding dimension, and a weak correlation with other dimensions. Each of the dimension was strongly correlated with corresponding HFMS V1.0 subscale and weakly correlated with other subscales. This indicates that HFMS V1.0 items and corresponding scale dimensions, and each dimension and corresponding subscale have great discriminating validity and aggregation validity. In the EFA, 10 common factors with characteristic roots over 0.85 were screened, consistent with the theoretical structure of the scale, and the cumulative contribution rate reached 61.40%. But the item HF21 in the dimension of resilience (Will you be discouraged by a failure) was also included in the stress response due to the fact that the negative response is positively correlated with psychological stress response.[56] Meanwhile, we set up a second-order CFA model in which the standardised

Table 3 EFA analysis of HFMS V1.0 scale

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10
HF1										0.62
HF2										0.80
HF3							0.53			
HF4							0.60			
HF5							0.69			
HF6		0.73								
HF7		0.73								
HF8		0.67								
HF9		0.65								
HF10		0.69								
HF11						0.74				
HF12						0.46				
HF13						0.72				
HF14						0.52				
HF16									0.64	
HF17									0.70	
HF18					0.66					
HF19					0.71					
HF20					0.65					
HF21	0.44				0.54					
HF22	0.61									
HF23	0.73									
HF24	0.75									
HF25	0.80									
HF26	0.78									
HF28				0.41						
HF29				0.65						
HF30				0.73						
HF31				0.72						
HF32			0.62							
HF33								0.62		
HF34			0.45					0.58		
HF35			0.81							
HF36			0.81							

1, PCA was performed. 2, Varimax rotation. 3. Factor load >0.40.
EFA, exploratory factor analysis; HF, Healthy Fitness; HFMS, Healthy Fitness Measurement Scale; PCA, principal components analysis.

path coefficient between the first and second order factors ranged from 0.54 to 0.97 with most factor load greater than 0.5, suggesting great path association. As for the amendment of the model using revised index, a covariance of error was set up between the item HF4 and HF5 of 'Organ function' dimension, which might be related to head discomfort such as dizziness, headache accompanied with the symptoms of palpitations, like autonomic dysfunction.[57] The covariance between item HF21 of the 'Resilience' dimension and the items of the 'Stress response' dimension was consistent with the results of EFA. It could be seen that both psychological resilience and stress response affect the individual's negative coping response.[56] The attitude of family members, colleagues or friends towards help-seeking behaviours directly affects the willingness of individuals to seek help,[58] which might be responsible for the covariance of the errors between items HF33 and HF34 of 'Social resource and support'. After amendment, HFMS V1.0 scale indicated good fit as demonstrated by CMIN/

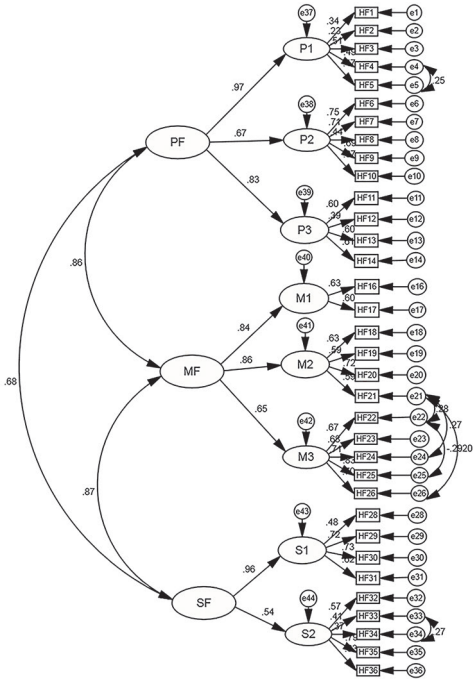

Figure 1 Path of CFA for HFMS V1.0. P1=Organic function; P2=Motor function; P3=Physical adaptive capacity; M1=Psychological cognition; M2=Resilience; M3=Stress response; S1=Role adaptation; S2=Social resource and social support. CFA, confirmatory factor analysis; HFMS, Healthy Fitness Measurement Scale; MF, mental fitness; PF, physical fitness; SF, social fitness.

DF=3.45, RMSEA=0.05, GFI=0.91, AGFI=0.90, IFI=0.90 and CFI=0.90.

Self-rated outcomes have been proven as the most reliable source of information for subjective feelings, reflecting people's feelings timely and effectively. The self-rate has became an international research hotspot in recent years. Previous studies often conducted field experiments, which is limited by assessors, instrumentation, and location and has the disadvantages of high cost and poor operability. To facilitate the large-scale health promotion in the general population, this study developed the HFMS V1.0 using a self-rated measure. For better evaluating PF, the HFMS V1.0 combined the elements of PF (body composition, cardiorespiratory fitness, muscle strength, flexibility, etc) with the comprehensible indicators related to individual daily life. For example, the item HF1 'Do you think you are well proportioned?' reflects the elements of body composition; the item HF8 'Is it difficult for you to bend down and touch your toes with your hands without bending your legs?' reflects the elements of flexibility; the item HF5 'Do you feel nervousness and palpitation when you are quiet?' and the item HF6 'Do you have any difficulty climbing the third to fifth floors?' reflects the elements of cardiopulmonary fitness; the item HF9 'Do you have any difficulty in taking on daily housework?' and the item HF10 'Do you have difficulty in participating in energy intensive activities (such as strenuous physical exercise, moving heavy objects, etc)?' reflect the elements of muscle strength and endurance. Additionally, in the early stage, our team analysed the results of HFMS V1.0 and found that the calibration validity of the PF subscale of university students was 0.59. [59]

This study conducted field tests on the healthy fitness for the elderly, university students and urban residents in Guangzhou City, Guangdong, China. The data suggest that HFMS V1.0 has acceptable reliability and validity for evaluating the healthy fitness of Chinese resident. This scale could be an effective and reliable tool for comprehensive assessment of Chinese residents' healthy fitness.

Conclusion

The self-assessment HFMS V1.0 based on operational definition of healthy fitness, integrates the PF, MF and SF, and exhibits the advantages of operability, scientificity, effectiveness and easy promotion. Through epidemiological data analysis HFMS V1.0 is indicated to have high reliability and validity. These results provide scientific basis and a practical tool for the following large-scale studies on evaluation of healthy fitness of the Chinese population and investigation of influencing factors.

Limitations

This study has certain limitations. First, the self-rated method was adopted when the participants made an evaluation of their healthy fitness in the past month, but there may be a recall bias. Second, as a preliminary verification of the reliability and validity of HFMS V1.0, a small sample size of 1176 participants met the requirement that the sample size was 5–20 times the number of items on the scale. However, as a country with a large population in China, the sample size of this study is not representative enough. Further research will be carried out using a random sampling technique with several stages from five administrative divisions in China (North, Northeast, Central South, Southwest, and Northwest).

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Data are available on reasonable request. Readers can contact JX (drugstat@163.com) to submit raw data access requirements.

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