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Research article

Reliability and validity tests of the Chinese version of the Geriatric Locomotive Function Scale (GLFS-25) in tumor survivors

Yu-Ling Yang, Hui-Hong Wang, Hui Su, Hui Lu, Hui Yu, Jing Wang, Yu-Qing Zhou, Ling Li, Ying Chen *

Department of Oncology, Affiliated Hospital of Jiangnan University, 1000 Hefeng Road, Wuxi, 214122, Jiangsu Province, China

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ABSTRACT

Objective: To evaluate the reliability and validity of the Chinese-translated Geriatric Locomotive Function Scale (GLFS-25) for the assessment of locomotive syndrome (LS) in individuals surviving malignancies.

Methods: 393 tumor survivors at a general hospital in China were recruited. The Chinese version of GLFS-25 was utilized to conduct a cross-sectional survey to ascertain the tool's efficacy in measuring LS in this cohort. The scale's validity was examined through content, structural and discriminant validity assessments, while its reliability was investigated by determining the internal consistency (via Cronbach's α coefficient) and test-retest reliability (via intragroup correlation coefficient, ICC).

Results: The Chinese-adapted GLFS-25 demonstrated a robust scale-level content validity index of 0.94, while item-level content validity indices ranged from 0.83 to 1.00 across individual items. The suitability of the scale for structural validity assessment was confirmed via exploratory factor analysis, yielding a Kaiser-Meyer-Olkin measure of 0.930 and a significant Bartlett's test of sphericity ($\chi^2 = 3217.714$, df = 300, $P < 0.001$). Subsequent confirmatory factor analysis (CFA) extracted four distinct factors: Social Activity Engagement, Daily Living Ability, Pain Experience and Physical Mobility. These factors accounted for 72.668 % of the variance, indicating substantial construct validity for measuring LS among this population. CFA supported the model's fit with the following indices: χ^2/df = 1.559, RMSEA = 0.077, GFI = 0.924, CFI = 0.941, NFI = 0.919, and TLI = 0.933. The factor loadings for the four factors ranged from 0.771 to 0.931, indicating the items corresponding to the four factors effectively represented the constructs they were designed to measure. The correlation coefficients among the four factors were between 0.306 and 0.469, all lower than the square roots of the respective AVEs (0.838–0.867). This suggests a moderate correlation among the four factors and a distinct differentiation between them, indicating the Chinese version of the GLFS-25 exhibits strong discriminant validity in Chinese tumor survivors. Reliability testing revealed a high Cronbach's α coefficient for the overall scale at 0.961, with the subscales yielding coefficients of 0.751, 0.836, 0.930, and 0.952. The overall ICC was determined to be 0.935, with subscale ICCs ranging from 0.857 to 0.941, reinforcing the scale's reliability in this context.

* Corresponding author.
E-mail addresses: yulingzxc@163.com (Y.-L. Yang), zhszyqxj@163.com (H.-H. Wang), 435431137@qq.com (H. Su), 2225882902@qq.com (H. Lu), 53582900@qq.com (H. Yu), Wangjing0990@163.com (J. Wang), zhouyuqingprc@163.com (Y.-Q. Zhou), 582704909@qq.com (L. Li), yingchenyycc@163.com (Y. Chen).

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Conclusions: The Chinese version of the GLFS-25 exhibits strong reliability and validity for the assessment of LS in tumor survivors. It may serve as a diagnostic tool for LS, contributing to the prevention and management of musculoskeletal disorders and enhancing the prognosis for this patient population.

1. Introduction

Malignant tumors constitute a significant public health issue globally, with both incidence and mortality rates escalating annually, thereby posing substantial risks to human life, health, and quality of life (QoL). The International Agency for Research on Cancer (IARC) under the aegis of the World Health Organization reported approximately 20 million new instances of malignant neoplasms and 10 million attributable fatalities worldwide in 2020 [1]. These neoplasms remain a leading cause of mortality, occupying the first or second place in over half of the countries globally, and are expected to increasingly burden the healthcare system due to shifts in lifestyle and demographic trends towards an older population [2]. The Chinese government realizes that it is essential to keep abreast of the current status of limb function in patients with tumors, and that appropriate intervention is preferable to remedial treatment when limb function has not deteriorated to a serious degree. Within the Chinese healthcare framework, amidst the push for national health advancement and in light of an aging populace, the focus of oncologic care extends beyond the prognosis of survivors to also encompass the enhancement of their QoL [3]. A critical element in elevating QoL is the preservation and augmentation of musculoskeletal function (MF) among survivors, to ensure their capability in performing basic activities of daily living (ADL) [4].

The Japanese Orthopaedic Association (JOA) introduced the concept of Locomotive Syndrome (LS) to emphasize the significance of MF, aiming to prevent and manage musculoskeletal disorders efficiently and reduce the incidence of locomotor disabilities [5–7]. LS is defined as a condition marked by diminished MF due to the impairment or degeneration of the locomotor system, affecting individuals' ability to perform daily activities and has garnered significant international attention [5]. The musculoskeletal system, implicated in LS, comprises bones, joints and intervertebral discs, and muscles and nerves [8]. The progression of LS symptoms can lead to osteoporosis and related fractures, osteoarthritis and spondylosis, and sarcopenia and neurological disorders, resulting in pain, limited joint mobility, poor posture, and balance issues. These symptoms contribute to difficulties in standing and walking, a decline in MF, ADL, QoL, and eventually necessitate dependence on others for care [9,10].

Unlike sarcopenia or muscular weakness, LS offers a more holistic assessment of the body's overall MF [11]. The insidious degradation of locomotor components, particularly the musculoskeletal system, often escapes early detection. Among tumor survivors whose Eastern Cooperative Oncology Group Performance Status (ECOG-PS) was "Fully Active", 29.7 % were diagnosed with LS, despite the absence of overt sarcopenia or muscular weakness [12]. Masahiro argues that LS acts as a more sensitive barometer for assessing MF impairment, and its timely diagnosis enables preemptive interventions, thereby preserving ADL and QoL [13].

Vulnerability to LS is especially pronounced among tumor survivors. Oncological conditions can necessitate prolonged periods of being bedridden, leading to muscle disuse atrophy, secondary osteoporosis, and radiation or surgery-induced lymphedema, among others—each acting as a potential catalyst for LS development [14]. Proactive screening for LS among tumor survivors offers significant potential for early-stage interventions to maintain or improve ADL and QoL.

In response to the current situation, there is a pressing need for a tool that can effectively assess the basic body functions of tumor survivors. Existing methods for measuring MF are predominantly instrumental, requiring a substantial array of specialized equipment and personnel. Furthermore, due to the complicated nature of the measurement process, many patients are averse to investing significant time and resources in MF screening. This reluctance can lead to the unnoticed progressive deterioration of the musculoskeletal system, missing critical opportunities for intervention and potentially impacting the prognosis of the cancer.

The JOA has introduced the Geriatric Locomotive Function Scale (GLFS-25) as a screening tool for LS. Initially aimed at the elderly, it has since been broadly applied across various age groups for LS detection [15–17]. The GLFS-25 emerges as a straightforward and user-friendly method for assessing body function, boasting accuracy and efficiency without necessitating extensive equipment or significant manpower, and aligns well with the current demands of China's public health initiatives [18]. Currently, the GLFS-25 is widely recognized in Japan, Iran, Brazil, China, and other countries for LS screening across different societal age groups [18–20]. It is increasingly being used for LS screening among hospital orthopedic patients, individuals with rheumatoid arthritis, intensive care unit patients, and those experiencing debilitation [21–23]. In Japan, the GLFS-25 has been employed as a comprehensive tool for MF assessment, providing early warnings about MF issues [24]. However, the reliability of the Chinese version of GLFS-25 has so far been confirmed only among the elderly Chinese population [25]. Its applicability in Chinese tumor survivors is not known, and no independent studies have been conducted on this topic. In practice, given the cultural differences and unique characteristics of populations in different countries, its suitability for tumor survivors in China needs further investigation before implementing the GLFS-25 for LS screening among this group. Therefore, this study aims to validate the reliability of the Chinese GLFS-25 among tumor survivors and determine its effectiveness for LS assessment within this segment of the Chinese population. The aim of this study is to draw the attention of the Chinese public to musculoskeletal disorders, to prevent and treat musculoskeletal disorders in a timely manner, to reduce the rate of motor disability among tumor survivors, and to maintain their independence as much as possible, thus further reducing the burden of care on the family and society.

2. Materials and methods

This study employed a cross-sectional study design. Participant voluntarily participated in the study and signed the consent. The study was approved by the Ethics Committee of the Affiliated Hospital of Jiangnan University (No. LS2023101) and completed the Chinese Clinical Trial Registration (No. ChiCTR2400079958). Written informed consent was obtained from all the subjects for the participation and publication of this study. This study conformed to the standards of the Declaration of Helsinki.

2.1. Subjects

Participants were recruited through convenience sampling for a cross-sectional survey, which took place from June to October 2023, at the Cancer Center of the Affiliated Hospital of Jiangnan University, Wuxi, Jiangsu Province, China. Individuals were selected from those attending outpatient appointments.

Inclusion criteria incorporated: (1) a confirmed diagnosis of malignant tumors; (2) completion of primary treatments including surgery, radiotherapy, or chemotherapy (active treatment, not palliative care); (3) stable vital signs and clinical condition; (4) cognitive clarity enabling questionnaire comprehension and response; (5) the ability for self-care; (6) absence of MF attributable to primary orthopedic conditions; (7) informed consent provided and voluntary study participation.

Exclusion criteria entailed: (1) cognitive impairment or unconscious states precluding questionnaire completion; (2) any clinical condition contraindicating physical activity.

The ideal cohort for factor analysis, following factor analysis stipulations, is between 10 and 25 times the item count of the instrument in question. With the GLFS-25 containing 25 items, and factoring in potential sample attrition, data from 400 tumor survivors were eventually amassed for this study.

2.2. Research tools

2.2.1. General information questionnaire

Devised by the research team, drawing upon pertinent literature, the questionnaire collected data on: (1) Sociodemographic variables such as age, gender, exercise habit, type of previous occupation *etc*.; (2) Disease-specific information including tumor typology, disease course, instances of metastasis or recurrence, radiation exposure, and concurrent morbidities *etc.*

2.2.2. Chinese version of GLFS-25

The GLFS-25 serves as an empirical, quantifiable instrument for discerning the subtleties of locomotive syndrome (LS). It has gained international recognition as an authoritative tool for LS assessment [25,26]. Originally developed in Japanese, the scale comprises 25 items spanning four domains: pain, ADL, social activities, and mental health. Respondents are to reflect upon the past month in their evaluations. The scoring utilizes a 5-point Likert scale, with individual item scores from 0 (“no difficulty”) to 4 (“great difficulty”), culminating in a total possible score ranging from 0 to 100. Higher aggregate scores denote a more severe manifestation of LS [9]. The Cronbach’s α coefficient for the original scale is 0.961, demonstrating excellent internal consistency. The sinicized GLFS-25 version, adapted by a Chinese academic, has a Cronbach’s α of 0.927. This indicates robust reliability and validity, affirming the scale’s applicability for LS screening among the Chinese elderly population.

2.3. Test indicators

2.3.1. Validity tests

(1) **Content validity:** 13 oncologists and experts in scale development were solicited via email to appraise the relevance of each scale item. Utilizing a 4-point scale, “1” indicated no relevance and “4” denoted high relevance to the measured content. The scale-level content validity index (S-CVI) and item-level content validity index (I-CVI) were computed from these assessments. An S-CVI of $\geq$0.80 and an I-CVI of $\geq$0.70 were indicative of acceptable content validity.

(2) **Structural validity:** Structural validity was examined through exploratory and confirmatory factor analyses. Adequacy for factor extraction in exploratory factor analysis was determined by a Kaiser-Meyer-Olkin (KMO) measure >0.7 and a Bartlett’s test of sphericity p-value <0.001. Confirmatory factor analysis(CFA) assessed the fit of the model, with satisfactory construct validity indicated by $\chi^2/df < 2$, RM-SEA <0.08, GFI >0.90, CFI >0.90, NFI >0.90, and TLI> 0.90.

(3) **Discriminant Validity:** This was employed to compare the differences between the concepts represented by the different factors in the questionnaire. It was assessed by comparing the magnitude of AVE values to the square of the correlation coefficient between each factor.

2.3.2. Reliability tests

(1)**Internal consistency reliability:** The internal consistency of the scale was assessed using Cronbach’s α coefficient. Cronbach’s α coefficient$\geq$0.7 was considered indicative of good reliability.

(2)**Retest reliability:** A subset of 40 tumor survivors was re-evaluated using the scale two weeks post-initial survey. Test-retest reliability, assessing temporal stability, was determined by the intraclass correlation coefficient (ICC), with an ICC of ≥0.70 reflecting good reliability.

2.4. The research process

Consent for scale adaptation was procured from Dr. Seichi, the original creator of the GLFS-25, and Ning Zhang, developer of the Chinese version, in accordance with the protocols of Guillemin et al. and Beaton et al. [27,28]. Subsequent to this adaptation, a preliminary assessment with 20 tumor survivors was executed to gauge their comprehension of the content and directives of each scale item, ensuring clarity for inclusion in the official survey.

Following approval from the relevant department and hospital leadership, two investigators commenced formal data collection. Beforehand, both researchers aligned their interpretations of the scale's instructions and the significance of its items. Patients were contacted via telephone about a week before their appointment to inquire about their willingness to participate in this study. Those who agreed were informed of the exact time and location for participation. At their appointment one week later, the researcher administered the questionnaire to the participants in a private room. Before filling out the questionnaire, participants were required to sign an informed consent form and were thoroughly briefed on the questionnaire's guidelines and related concepts to ensure their understanding of the content and to facilitate accurate responses. The questionnaires were self-completed by the participants. To ensure the integrity and accuracy of the scale's primary data, researchers provided assistance to participants facing literacy challenges or difficulties with the questionnaire. Upon completion, the researcher collected the questionnaire and verified it for any missing

Table 1
General information of 393 tumor survivors.

Item	Classification	Number of people	
		N	%
Age (years)	<50	84	21.4
	50~70	219	55.7
	>70	90	22.9
Gender	Male	189	48.1
	Female	204	51.9
Exercise habit	None	258	65.6
	Yes	135	34.4
Type of previous occupation	Physical work	138	35.1
	Non-physical work	255	64.9
Tumor type	Gastrointestinal tumor	138	35.1
	Lung cancer	69	17.6
	Head and neck tumors	27	6.8
	Breast cancer	72	18.3
	Liver cancer	18	4.6
	Reproductive system tumors	60	15.3
	Hematologic malignancies	9	2.3
Number of concurrent chronic condition[a]	0	261	66.4
	1~2	126	32.1
	≥3	6	1.5
Tumor metastasis	None	201	51.1
	Yes	192	48.9
Osseous metastasis	None	375	95.4
	Yes	18	4.6
Surgeries	None	135	34.4
	Yes	258	65.6
Radiotherapy	None	306	77.9
	Yes	87	22.1
Chemotherapy	None	75	19.1
	Yes	318	80.9
Duration of disease (years)	≤1.0	168	42.7
	1.1–2.9	207	52.7
	≥3.0	18	4.6
Recurrence	None	327	83.2
	Yes	66	16.8
Fall	None	375	95.4
	Yes	18	4.6
Visual abnormality	None	357	90.8
	Yes	36	9.2
Auditory abnormality	None	372	94.7
	Yes	21	5.3
Somatosensory abnormality	None	330	84.0
	Yes	63	16.0

[a] :Including hypertension, diabetes mellitus, dyslipidemia, stroke and chronic respiratory diseases.

responses to maintain the study's quality.

2.5. Statistical methods

The One-sample Kolmogorov-Smirov Test was used to test whether the data conforms to a normal distribution. Descriptive statistics for normally distributed variables were expressed as mean ± standard deviation; for skewed distributions, median and quartiles were utilized; and for categorical variables, frequency and percentage were reported. Content and construct validity assessments were implemented to evaluate scale validity, while internal consistency and test-retest reliability were measured for reliability assessments. All statistical analyses were performed using IBM SPSS 26.0 software (Armonk, NY, USA) and AMOS 26.0 software, with a designated significance threshold at a *P*-value (two-tailed) of <0.05.

3. Results

3.1. Scale revision process

The requisite permissions for the utilization and modification of the GLFS-25 scale were secured from the original author in Japan and the developer of its Chinese iteration. Subsequently, a panel consisting of 13 specialists in medical oncology and scale development (including 3 chief physicians, 2 associate chief physicians, 2 associate chief nurses, 3 individuals with PhDs, and 3 professors) were convened to appraise the applicability of the scale items via the Delphi method across two evaluative sessions. First, during the initial round of expert consultation, the phraseology of the items was refined to better resonate with the cultural nuances of Chinese oncology patients. Second, the following round involved independent expert assessment of each item's relevance to life satisfaction (LS), with item revisions informed by this expert feedback. In the preliminary testing phase, 20 tumor survivors were queried on their comprehension and acceptance of the scale items' content and intent. Responses indicated a clear and facile understanding of the instructions and items, with noted relevance to the participants' health statuses. The average completion time recorded was approximately 4–5 min. Following this rigorous and methodical scale adaptation procedure, the finalized Chinese version of the GLFS-25 tailored for tumor survivors was established.

3.2. General information on tumor survivors

This investigation included 400 tumor survivors. Following the exclusion of invalid scales, the analysis incorporated data from 393 participants, yielding a scale retrieval rate of 98.3 %. The median age of the cohort was 60 years (interquartile range [IQR]: 51, 69), with a median disease duration of 1.0 year (IQR: 0.6, 2.1). These demographics and clinical details are elucidated in Table 1.

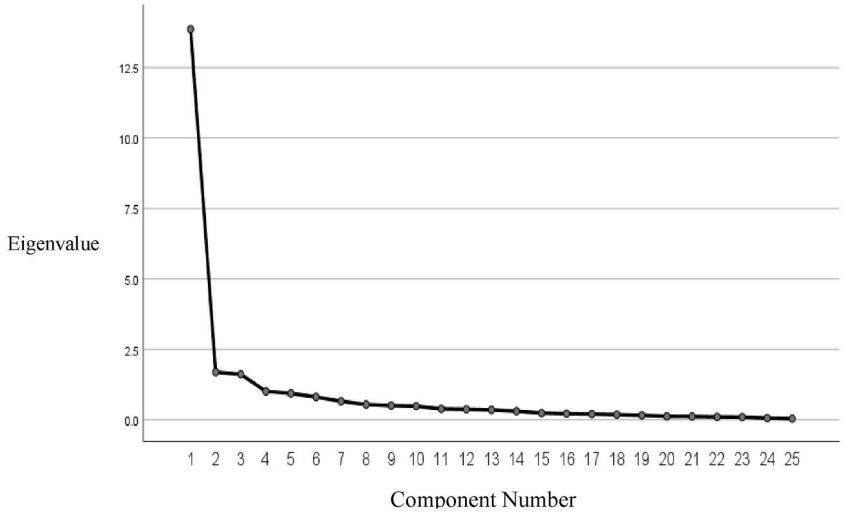

Fig. 1. Scree plot of the Chinese version of the GLFS-25 in tumor survivors
Fig. 1Scree Plot shows the number of favorable factors in the Chinese version of the GLFS-25 in tumor survivors. Twenty-five items of the questionnaire consisted of four factors.

3.3. Tests of reliability and validity

3.3.1. Validity test

(1) Content validity

Analysis of the scale's content validity yielded S-CVI of 0.94, and the I-CVI for individual items ranged from 0.86 to 1.00. These findings affirm that the scale has robust content validity, suitably reflecting the constructs intended to be measured.

(2)Structural validity

Structural validity was assessed using exploratory factor analysis, yielding a KMO measure of sampling adequacy at 0.930, with Bartlett's test of sphericity indicating significant suitability for factor analysis ($\chi^2 = 3217.714$, df = 300, $P < 0.001$). Principal component analysis was employed to extract eigenvalues >1, resulting in four factors. The percentage of variance explained by each rotated factor was 27.941 %, 26.423 %, 10.265 %, and 8.039 %, cumulatively accounting for 72.668 % of the total variance. This analysis allocated items 1 to 4 to factor 3, items 5 to 7 to factor 4, items 8 to 14 to factor 2, and items 15 to 24 to factor 1. Factor 1 predominantly corresponded to Social Activity Engagement, contributing 27.941 % to the variance; factor 2 corresponded to Daily Living Ability, contributing 26.423 %; factor 3 correlated with Pain Experience, contributing 10.265 %; and factor 4 related to Physical Mobility, contributing 8.039 %. Each item registered a significant loading within its designated factor, culminating in a collective variance contribution of 72.668 % across all factors.

CFA supported the model's fit with the following indices: $\chi^2/df = 1.559$, RMSEA = 0.077, GFI = 0.924, CFI = 0.941, NFI = 0.919, and TLI = 0.933. These metrics demonstrate a satisfactory fit for the model, thus validating the Chinese version of the GLFS-25 for use among tumor survivors. The factor loadings for the four factors ranged from 0.771 to 0.931, exceeding the 0.7 threshold, indicating that the items corresponding to the four factors effectively represented the constructs they were designed to measure. Fig. 1 and Table 2 listed the comprehensive data of the participants, detailed information of CFA Path Chart can be seen in Fig. 2.

(3) Discriminant Validity

The correlation coefficients among the four factors were between 0.306 and 0.469, which are lower than the square roots of the respective AVEs (0.838–0.867). This suggests a moderate correlation among the four factors and a distinct differentiation between them, indicating that the Chinese version of the GLFS-25 exhibits strong discriminant validity in Chinese tumor survivors. Details are provided in Table 4.

Table 2
Results of exploratory factor analysis of the Chinese version of the GLFS-25 in tumor survivors.

Items	Factor 1	Factor 2	Factor 3	Factor 4
1. Did you have any pain (including numbness) in your neck or upper limbs?	0.113	0.059	**0.700**[a]	0.214
2. Did you have any pain in your back, lower back or buttocks?	0.197	0.206	**0.724**[a]	0.173
3 Did you have any pain (including numbness) in your lower limbs?	0.250	0.420	**0.477**[a]	−0.380
4 To what extent has it been painful to move your body in daily life?	0.043	0.057	**0.765**[a]	−0.044
5 To what extent has it been difficult to get up from a bed or lie down?	0.285	0.276	0.217	**0.747**[a]
6 To what extent has it been difficult to stand up from a chair?	0.468	0.348	0.133	**0.500**[a]
7 To what extent has it been difficult to walk inside the house?	0.414	0.418	0.177	**0.685**[a]
8 To what extent has it been difficult to put on and take off shirts?	0.193	**0.872**[a]	0.129	0.058
9 To what extent has it been difficult to put on and take off trousers and pants?	0.287	**0.883**[a]	0.176	0.151
10 To what extent has it been difficult to use the toilet?	0.302	**0.870**[a]	0.163	0.095
11 To what extent has it been difficult to wash your body in the bath?	0.406	**0.794**[a]	0.137	0.124
12 To what extent has it been difficult to go up and down stairs?	0.562	**0.582**[a]	0.323	0.222
13 To what extent has it been difficult to walk briskly?	0.410	**0.495**[a]	0.380	0.192
14 To what extent has it been difficult to keep yourself neat?	0.290	**0.788**[a]	0.032	0.199
15 How far can you keep walking without rest? 0 = 2–3 km; 1 = 1 km; 2 = 300 m; 3 = 100 m; 4 = 10 m	**0.578**[a]	0.360	0.251	0.327
16 To what extent has it been difficult to go out to visit neighbors?	**0.596**[a]	0.516	0.233	0.348
17 To what extent has it been difficult to carry objects weighing 2 kg?	**0.638**[a]	0.481	0.184	0.184
18 To what extent has it been difficult to go out using public transportation?	**0.636**[a]	0.505	0.202	0.231
19 To what extent have simple tasks and housework been difficult?	**0.695**[a]	0.502	0.136	0.257
20 To what extent have load-bearing tasks and housework been difficult?	**0.803**[a]	0.192	0.059	0.131
21 To what extent has it been difficult to perform sports activities?	**0.827**[a]	0.144	0.211	0.037
22 Have you been restricted from meeting your friends?	**0.804**[a]	0.306	0.135	0.189
23 Have you been restricted from joining social activities?	**0.798**[a]	0.304	0.069	0.266
24 Have you ever felt anxious about falls in your house?	**0.631**[a]	0.482	0.071	0.138
25 Have you ever felt anxious about being unable to walk in the future?	**0.743**[a]	0.224	0.082	−0.045

[a] :Categorization factor.

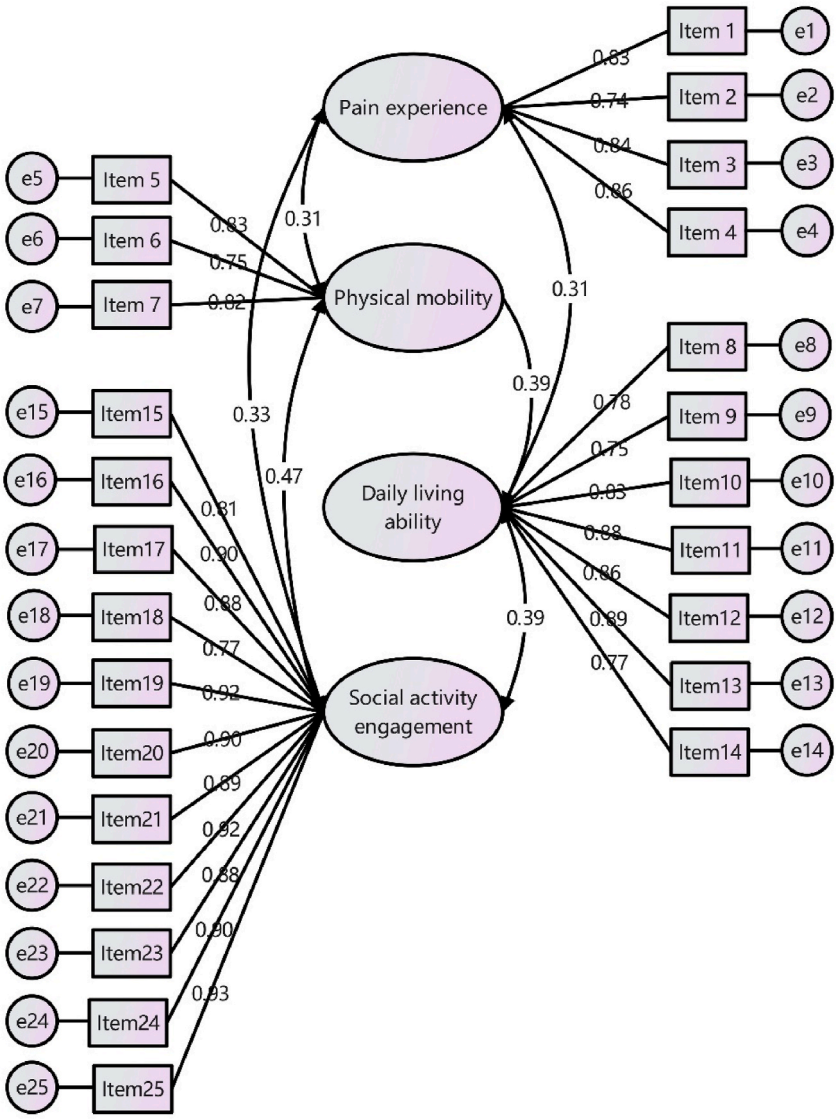

Fig. 2. Confirmatory factor analysis(CFA) Path Chart of the Chinese version of the GLFS-25 in tumor survivors

Fig. 2Confirmatory factor analysis Path Chart shows the number of favorable factors in the Chinese version of the GLFS-25 in tumor survivors. Twenty-five items of the questionnaire consisted of four factors: Social activity engagement, Daily living ability, Pain experience and Physical mobility.

Table 3
Results of the reliability test of the Chinese version of the GLFS-25 in tumor survivors.

Categorization	Cronbach's α coefficient	ICC
Internal scale	0.961	0.935
Factor 1	0.952	0.866
Factor 2	0.930	0.917
Factor 3	0.751	0.857
Factor 4	0.836	0.941

3.3.2. Reliability test

The Chinese version of the GLFS-25 demonstrated solid reliability within the cohort of tumor survivors, as detailed in Table 3. The Cronbach's α coefficients for the entire scale and for individual factors were ≥0.70. ICCs were also ≥0.70, substantiating the scale's reliability among this demographic.

Table 4
Results of discriminant validity of the Chinese version of the GLFS-25 in tumor survivors.

Categorization	Pain experience	Physical mobility	Daily living ability	Social activity engagement
Physical mobility	0.312			
Daily living ability	0.306	0.386		
Social activity engagement	0.328	0.469	0.385	
The root squares of the corresponding AVE	0.864	0.838	0.855	0.867

4. Discussion

4.1. The significance of the Chinese version of GLFS-25 applied to tumor survivors

The enactment of policies by the Chinese administration aimed at promoting health engagement has been noteworthy. Accurate assessment of MF within a population is crucial for the strategic enhancement of overall health status. The impact of tumors on physical capacity is demonstrably more severe than in populations without significant pathologies. Direct consequences encompass pain, paralysis, and fractures stemming from both bony and soft tissue involvement due to neoplasms; indirect consequences are attributed to protein depletion, inflammatory mediator elevation, and perturbed muscle metabolism, both anabolic and catabolic, coupled with systemic deterioration in individuals enduring metastasis and oncological therapies [29–31]. The imperative for robust and relevant tools to gauge locomotive syndrome (LS) in this cohort is therefore evident.

LS encompasses the interplay among musculoskeletal integrity, functional capacity, body composition, and health status, facilitating the identification of functional decline and associated risks, thereby enabling preventative and restorative interventions. The GLFS-25 serves as a potential screening instrument for LS. Utilization of its Chinese version in tumor survivors can heighten awareness of ADL and QoL, prompt early intervention for MF impairments, potentially extend the duration of autonomous living, and mitigate the caregiving load on families and society at large.

4.2. Validity and reliability analysis of the scale in Chinese tumor survivors

The Chinese version of the GLFS-25 demonstrated excellent content validity among tumor survivors. Expert evaluations throughout the validation process revealed no significant concerns regarding the scale's textual content. There was unanimous agreement on the relevance of each item to LS, confirming the scale's ability to accurately and comprehensively measure LS prevalence in tumor survivors. The study confirmed the internal consistency (Cronbach's α: 0.961) and test-retest reliability (ICC: 0.935) of the GLFS-25, both holistically and for its individual components. These metrics underscore strong internal consistency and reliability over time for the Chinese version of the GLFS-25 among tumor survivors.

In the initial scale production study, Seichi organized the GLFS-25 into five dimensions: Usual Care, Movement-related Difficulty, Cognitive, Social Activities, and Body Pain [16]. Wang, through CFA, found its structure to be more suitable for Japanese older adults when divided into three dimensions: Body Pain, Movement-related Difficulty, and Psycho-social Complications [32]. Upon revision in this research, it was proposed that for Chinese tumor survivors, the dimensions should be: Social Activity Engagement, Daily Living Ability, Pain Experience, and Physical Mobility. This approach aligns closely with findings from Chinese researchers, and the study made refinements to specific items based on these insights to better reflect the experiences of Chinese tumor survivors [25]. Despite differences in factor categorization from the original and other adapted versions, statistical analysis supported this structure as a more coherent framework for tumor survivors. The decision to adopt this configuration of factors was based on expert methodological advice and tailored to reflect the unique aspects of cancer pathologies.

5. Conclusion and limitations

The Chinese adaptation of the GLFS-25 has shown robust reliability and validity among tumor survivors. It proves to be an effective tool for identifying and managing locomotive syndrome, enabling early detection and intervention for musculoskeletal impairments. Its integration into LS screening processes for Chinese tumor survivors is recommended to facilitate prompt preventive strategies.

The data analysis method employed in this research encompasses a variety of reliability tests, including content validity, structural validity, exploratory factor analysis, confirmatory factor analysis, discriminant validity, Cronbach's α coefficient, and the ICC, all of which were subject to rigorous scientific analysis to confirm its applicability in clinical settings.

We also discovered that the GLFS-5, a more concise version of the GLFS-25, could further benefit our research [33]. As this is our first application of the scale to survey LS in the Chinese cancer population, employing the GLFS-25 appears to offer a more thorough and cautious approach. We anticipate that the GLFS-5 will significantly reduce research time and resources, and plan to incorporate the GLFS-5 into our study at a subsequent phase.

Also, because there is no'gold standard' scale to comprehensively assess LS in tumor survivors, the validity of the scale was not examined in this study. Moreover, since this study targeted tumor survivors with better ADL, it resulted in a smaller sample size. Furthermore, given the diversity of cancer types, the limb function of patients with different cancers and at various stages significantly differs; thus, we aim to enlarge the sample size to include patients with a wider range of cancer types and stages in our future research.

Data availability statement

The datasets used during the current study available from the corresponding author on reasonable request.

Ethics statement

Participant voluntarily participated in the study and signed the consent. The study was approved by the Ethics Committee of the Affiliated Hospital of Jiangnan University (No. LS2023101) and completed the Chinese Clinical Trial Registration (No. ChiCTR2400079958). Written informed consent was obtained from all the subjects for the participation and publication of this study. This study conformed to the standards of the Declaration of Helsinki. All are in compliance with the Heliyon expectations for authorship. I assure you that this manuscript has not been previously published and is not under consideration in any other publication.

Trial registration

The study was approved by the Ethics Committee of the Affiliated Hospital of Jiangnan University (No. LS2023101) and completed the Chinese Clinical Trial Registration (No. ChiCTR2400079958), all subjects signed an informed consent form. This study conformed to the standards of the Declaration of Helsinki.

CRediT authorship contribution statement

Yu-Ling Yang: Writing – review & editing. **Hui-Hong Wang:** Supervision, Conceptualization. **Hui Su:** Writing – original draft, Formal analysis, Data curation. **Hui Lu:** Methodology. **Hui Yu:** Writing – original draft, Formal analysis, Data curation. **Jing Wang:** Validation, Investigation. **Yu-Qing Zhou:** Validation, Investigation. **Ling Li:** Methodology. **Ying Chen:** Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] H. Sung, J. Ferlay, R.L. Siegel, et al., Global Cancer Statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries, CA A Cancer J. Clin. 71 (3) (2021) 209–249, https://doi.org/10.3322/caac.21660. PMID: 33538338.
[2] L.A. Torre, R.L. Siegel, E.M. Ward, et al., Global cancer incidence and mortality rates and trends–An update, Cancer Epidemiol. Biomarkers Prev. 25 (1) (Jan 2016) 16–27, https://doi.org/10.1158/1055-9965.EPI-15-0578. PMID: 26667886.
[3] J. Liu, L. Dong, Y. Zhu, et al., Prostate cancer treatment – China's perspective, Cancer Lett. 550 (2022 Dec 1) 215927, https://doi.org/10.1016/j.canlet.2022.215927. PMID: 36162714.
[4] J. Firkins, L. Hansen, M. Driessnack, et al., Quality of life in "chronic" cancer survivors: a meta-analysis, J Cancer Surviv 14 (4) (Aug 2020) 504–517, https://doi.org/10.1007/s11764-020-00869-9. PMID: 32162194.
[5] K. Hirano, S. Imagama, Y. Hasegawa, et al., The influence of locomotive syndrome on health-related quality of life in a community-living population, Mod. Rheumatol. 23 (5) (Sep 2013) 939–944, https://doi.org/10.1007/s10165-012-0770-2. PMID: 22996232.
[6] R. Tokida, S. Ikegami, J. Takahashi, et al., Association between musculoskeletal function deterioration and locomotive syndrome in the general elderly population: a Japanese cohort survey randomly sampled from a basic resident registry, BMC Musculoskelet Disord 21 (1) (Jul 3 2020) 431, https://doi.org/10.1186/s12891-020-03469-x. PMID: 32620119.
[7] T. Iwaya, T. Doi, A. Seichi, et al., Characteristics of disability in activity of daily living in elderly people associated with locomotive disorders, BMC Geriatr. 17 (1) (Jul 26 2017) 165, https://doi.org/10.1186/s12877-017-0543-z. PMID: 28747158.
[8] M. Akahane, A. Maeyashiki, Y. Tanaka, et al., The impact of musculoskeletal diseases on the presence of locomotive syndrome, Mod. Rheumatol. 29 (1) (2019 Jan) 151–156, https://doi.org/10.1080/14397595.2018.1452173. Epub 2018 Apr 9. PMID: 29529893.
[9] A. Nishizawa, J. Katsuhira, M. Watanabe, et al., Relationship between the locomotive syndrome and kinetic and kinematic parameters during static standing and level walking, Gait Posture 93 (2022 Mar) 146–152, https://doi.org/10.1016/j.gaitpost.2022.01.017. Epub 2022 Jan 22. PMID: 35151196.
[10] K. Hirano, S. Imagama, Y. Hasegawa, et al., Effect of back muscle strength and sagittal spinal imbalance on locomotive syndrome in Japanese men, Orthopedics 35 (7) (2012 Jul 1) e1073–e1078, https://doi.org/10.3928/01477447-20120621-25. PMID: 22784903.
[11] K. Nakamura, Locomotive syndrome: disability-free life expectancy and locomotive organ health in a "super-aged" society, J. Orthop. Sci. 14 (1) (2009 Jan) 1–2, https://doi.org/10.1007/s00776-008-1302-y. Epub 2009 Feb 13. PMID: 19214680.
[12] M. Hirahata, J. Imanishi, W. Fujinuma, et al., Cancer may accelerate locomotive syndrome and deteriorate quality of life: a single-centre cross-sectional study of locomotive syndrome in cancer patients, Int. J. Clin. Oncol. 28 (4) (2023 Apr) 603–609, https://doi.org/10.1007/s10147-023-02312-2. Epub 2023 Feb 19. PMID: 36806698.

[13] H. Kawano, M. Hirahata, J. Imanishi, Locomotive syndrome in cancer patients: a new role of orthopaedic surgeons as a part of comprehensive cancer care, Int. J. Clin. Oncol. 27 (8) (2022 Aug) 1233–1237, https://doi.org/10.1007/s10147-022-02194-w. Epub 2022 Jun 11. PMID: 35690700.
[14] N. Yoshimura, S. Muraki, K. Nakamura, et al., Epidemiology of the locomotive syndrome: the research on osteoarthritis/osteoporosis against disability study 2005-2015, Mod. Rheumatol. 27 (1) (2017 Jan) 1–7, https://doi.org/10.1080/14397595.2016.1226471. PMID: 27538793.
[15] K. Ide, Y. Yamato, T. Hasegawa, et al., Prospective nursing care certification using the 25-question geriatric locomotive function scale, Geriatr. Gerontol. Int. 21 (6) (Jun 2021) 492–497, https://doi.org/10.1111/ggi.14169. PMID: 33851499.
[16] A. Seichi, Y. Hoshino, T. Doi, et al., Development of a screening tool for risk of locomotive syndrome in the elderly: the 25-question Geriatric Locomotive Function Scale, J. Orthop. Sci. 17 (2) (Mar 2012) 163–172, https://doi.org/10.1007/s00776-011-0193-5. PMID: 22222445.
[17] A. Nishimura, M. Ohtsuki, T. Kato, et al., Locomotive syndrome testing in young and middle adulthood, Mod. Rheumatol. 30 (1) (Jan 2020) 178–183, https://doi.org/10.1080/14397595.2018.1551176. PMID: 30501428.
[18] H. Taghinejad, E. Mohammadyari, H. Tavan, et al., Investigating the validity and reliability of the GLFS-25 questionnaire by factor analysis in the elderly hospitalized at the intensive and cardiac care units, Heliyon 9 (7) (2023 Jul 11) e18111, https://doi.org/10.1016/j.heliyon.2023.e18111. PMID: 37519703.
[19] D.R. Tavares, F.C. Santos, Locomotive syndrome in the elderly: translation, cultural adaptation, and Brazilian validation of the tool 25-Question Geriatric Locomotive Function Scale, English, Portuguese, Rev Bras Reumatol Engl Ed. 57 (1) (2017) 56–63, https://doi.org/10.1016/j.rbre.2016.07.015. Epub 2016 Aug 1. PMID: 28137403.
[20] T. Kobayashi, T. Morimoto, C. Shimanoe, et al., The association of comorbidities with the 25-question geriatric locomotive function scale and the diagnosis of locomotive syndrome, J. Orthop. Sci. 28 (2) (2023 Mar) 453–459, https://doi.org/10.1016/j.jos.2021.11.021. Epub 2022 Jan 3. PMID: 34991939.
[21] Y. Sobue, M. Suzuki, Y. Ohashi, et al., Locomotive syndrome in rheumatoid arthritis patients during the COVID-19 pandemic, Nagoya J. Med. Sci. 84 (4) (Nov 2022) 799–812, https://doi.org/10.18999/nagjms.84.4.799. PMID: 36544599.
[22] Y. Gu, T. Ito, Y. Ito, et al., Factors Related to locomotive syndrome in school-aged children in Okazaki: a cross-sectional Study, 1~10, Healthcare (Basel) 9 (11) (Nov 20 2021), https://doi.org/10.3390/healthcare9111595. PMID: 34828640.
[23] Y. Ishihara, H. Ozaki, T. Nakagata, et al., Association between daily physical activity and locomotive syndrome in community-dwelling Japanese older adults: a cross-sectional study, Int. J. Environ. Res. Publ. Health 19 (13) (2022), https://doi.org/10.3390/ijerph19138164. PMID: 35805823.
[24] N. Yoshimura, T. Iidaka, C. Horii, et al., Correction to: epidemiology of locomotive syndrome using updated clinical decision limits: 6-year follow-ups of the ROAD study, J Bone Miner Metab 40 (5) (2022 Sep) 872, https://doi.org/10.1007/s00774-022-01349-z.Erratum.for. J Bone Miner Metab. 2022 Jul;40(4):623-635. PMID: 35699791.
[25] N. Zhang, R. Zhang, H. Li, Validity and reliability of the Chinese version of geriatric locomotive function scale, Clin J nurs. 51 (6) (2016) 747~751, https://doi.org/10.3761/j.issn.0254-1769.2016.06.024.
[26] S. Tanaka, K. Ando, K. Kobayashi, et al., Locomotive syndrome and the power spectral characteristics of body sway, Geriatr. Gerontol. Int. 20 (7) (2020 Jul) 691–696, https://doi.org/10.1111/ggi.13937. Epub 2020 Jun 1. PMID: 32483917.
[27] F. Guillemin, C. Bombardier, D. Beaton, Cross-cultural adaptation of health-related quality of life measures: literature review and proposed guidelines, J. Clin. Epidemiol. 46 (12) (1993) 1417–1432, https://doi.org/10.1016/0895-4356(93)90142-n. PMID: 8263569.
[28] D.E. Beaton, C. Bombardier, F. Guillemin, et al., Guidelines for the process of cross-cultural adaptation of self-report measures, Spine 25 (24) (2000) 3186–3191, https://doi.org/10.1097/00007632-200012150-00014. PMID: 11124735.
[29] M.F. Berger, E.R. Mardis, The emerging clinical relevance of genomics in cancer medicine, Nat. Rev. Clin. Oncol. 15 (6) (Jun 2018) 353–365, https://doi.org/10.1038/s41571-018-0002-6. PMID: 29599476.
[30] J.P. Bates, R. Derakhshandeh, L. Jones, et al., Mechanisms of immune evasion in breast cancer, BMC Cancer 18 (1) (May 11 2018) 556, https://doi.org/10.1186/s12885-018-4441-3. PMID: 29751789.
[31] F. Paredes, H.C. Williams, A. San Martin, Metabolic adaptation in hypoxia and cancer, Cancer Lett. 502 (Apr 1 2021) 133–142, https://doi.org/10.1016/j.canlet.2020.12.020. PMID: 33444690.
[32] C. Wang, T. Ikemoto, A. Hirasawa, et al., Assessment of locomotive syndrome among older individuals: a confirmatory factor analysis of the 25-question Geriatric Locomotive Function Scale, PeerJ 8 (2020 Apr 14) e9026, https://doi.org/10.7717/peerj.9026. PMID: 32328357.
[33] T. Kobayashi, T. Morimoto, C. Shimanoe, et al., Development of a simple screening tool based on the 5-question geriatric locomotive function scale for locomotive syndrome, J. Orthop. Sci. 27 (4) (2022 Jul) 913–920, https://doi.org/10.1016/j.jos.2021.05.001. PMID: 34090778.