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German translation and psychometric evaluation of the Mental Health Literacy Scale (MHLS-GER) in a general population sample and in patients with acute myocardial infarction

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ABSTRACT

Background: The Mental Health Literacy Scale (MHLS) is a scale-based measure with 35 items that assesses various aspects of mental health literacy. The original English version was developed in Australia and has been translated into several languages. The present study aimed to translate and culturally adapt the questionnaire for its use in Germany and to determine the psychometric properties of the German version of the MHLS (MHLS-GER) in two different samples.

Methods: After translation and cultural adaptation, the MHLS-GER was administered via an online survey in a general population sample and via a postal survey in patients with acute myocardial infarction (AMI). Exploratory factor analysis and confirmatory factor analysis were conducted to determine the dimensionality. Furthermore, internal consistency, known-groups-validity and measurement invariance were evaluated.

Results: Data of 517 participants of the general population sample and 786 participants of the AMI sample were analyzed. In both samples a four-factor structure yielded good model fit indices. The four subscales of the MHLS-GER including 31 items comprise the topics 'knowledge' (11 items), 'information seeking' (4 items), 'stigmatization' (9 items) and 'social distance' (7 items). All four subscales showed good internal consistency (Cronbach's alpha: 0.80 to 0.90, average inter-item correlation: 0.30–0.59) and were mostly invariant across the two samples. Participants with previous experience with mental disorders (personal or professional context) showed higher scores on the four subscales.

Conclusion: In contrast to the unidimensional structure of the original version, the MHLS-GER comprises four subscales. All subscales showed acceptable to good psychometric properties and can now be used to assess mental health literacy. Further validation studies to evaluate test-retest-reliability and responsiveness are required.

1. Introduction

Mental health literacy (MHL) plays an important role in coping with mental illness in daily life, in preventing the development of a mental disorder or providing help for others. MHL evolved from the concept of general health literacy which comprises the competences to access, understand, appraise, and apply health information in healthcare, disease prevention, and health promotion to improve quality of life (Sørensen et al., 2012). The concept of MHL was first described 1997 by Jorm et al. and includes several attributes: ability to recognize mental disorders, knowledge how to seek mental health information, knowledge of risk factors and causes, of self-help-strategies and professional help, and attitudes that promote recognition and help-seeking (Jorm et al., 1997).

Since mental illness represents a global burden for a large proportion of the population and the health care system, measuring and improving MHL is of great importance. The prevalence of any mental health disorder worldwide was around 12% in 2017, with depressive and anxiety disorders being the most frequent (GBD 2017 Disease and Injury Incidence and Prevalence Collaborators, 2018). In Germany the prevalence of depressive disorder was 20% in women and around 11% in men in 2017 (Steffen et al., 2020). Depressive disorders were one of the leading contributors to disability accounting for 14 % of all-age years lived with disability in 2017 (GBD 2017 Disease and Injury Incidence and

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Prevalence Collaborators, 2018). Mental disorders in general are among the most common causes of death worldwide (Walker et al., 2015) and are associated with decreased quality of life and work productivity (Alonso et al., 2004; Olatunji et al., 2007; Årdal et al., 2013).

Furthermore, mental illness cannot be considered in isolation from somatic illness. It has been shown that a non-negligible number of patients with serious somatic diseases, such as cardiovascular disease, struggle with mental illness as a co-morbidity. Around one third of patients with stroke develop a post stroke depression (Ayerbe et al., 2013; Towfighi et al., 2017). Similarly, after myocardial infarction, 28% of the patients show depressive symptoms and up to 38% show moderate to severe symptoms of anxiety (Feng et al., 2019; Lian et al., 2022). About one in five patients with pulmonary embolism report symptoms of depression or anxiety (Feehan et al., 2018; Fischer et al., 2023a).

Additionally, many people with mental disorders remain untreated. The discrepancy between the number of people receiving treatment and the actual prevalence has been reported to be over 50% for some disorders, depending on the region (Kohn et al., 2004; Lora et al., 2012). People's knowledge, understandings and beliefs about mental health can influence whether they seek for help or take preventive action. Managing one's own mental health problems can be complex. The stigma that still exists in the context of mental disorders adds to the burden (Schomerus et al., 2019; World Health Organization 2022).

In order to plan and evaluate interventions that aim to improve MHL it is necessary to have valid and reliable measurement instruments for MHL. Two reviews about existing MHL measures concluded that a majority of the instruments did not capture all components of MHL and often the psychometric properties were not properly tested and reported (O'Connor et al., 2014; Wei et al., 2015). Common measures used a diagnostic vignette approach, i.e. participants received a description of a person with a mental disorder and are then asked to identify the disorder. This approach is time-consuming, does not evaluate all components of MHL and may not detect improvements following an intervention (Kutcher et al., 2016). To fill this gap, O'Connor and Casey developed the Mental Health Literacy Scale (MHLS), a scale-based measure that assesses all attributes of MHL in line with the definition of Jorm et al. (Jorm et al., 1997; O'Connor and Casey 2015). The MHLS has been developed in English and was translated and validated in several languages: e.g. Arabic (Alshehri et al., 2021), Persian (Heizomi et al., 2020; Nejatian et al., 2021), Chinese (Chen et al., 2021), French (Montagni and González Caballero 2022), Portuguese (Neto et al., 2021), and Slovenian (Krohne et al., 2022). Positive correlations with measures of depression-related attitudes and literacy (Krohne et al., 2022), self-efficacy (Chen et al., 2021) or help seeking behavior (O'Connor and Casey 2015; Krohne et al., 2022) and negative correlations with stigma (Chen et al., 2021; Krohne et al., 2022) indicate good convergent validity of the MHLS. However, considering dimensionality, the original MHLS has an univariate structure with 35 items, whereas in validation studies of the non-English versions often a multifactorial structure, e.g. three, four, five, or six factors, seemed to be more appropriate. The final psychometric evaluation of the original MHLS was performed in a very specific sample of university students who undertake psychology courses and mental health professionals. Moreover, the item reduction process was primarily based on item content and Cronbach's alpha for a set of 51 items at that stage and the final factor structure was not confirmed by any goodness of fit indices. Therefore, dimensionality of the MHLS is unclear or at least no cross-cultural factor solution is available. Furthermore, internal consistency was reported with a Cronbach's alpha of 0.87 for the original MHLS but ranged from 0.34 to 0.89 depending on the items included in the single factors in other language versions.

A German version of the MHLS has not yet been developed. To overcome the previously mentioned issues, the aim of this study was first to perform a German translation and culturally adaptation and then to comprehensively evaluate the psychometric properties including exploratory and confirmatory factor analyses as well as internal consistency and known-groups-validity for the single factors, and measurement invariance in a general population sample and in a sample of patients with myocardial infarction.

2. Methods

The translation, cultural adaptation and evaluation of psychometric properties was performed according to the COSMIN (Consensus Based Standards for the Selection of Health Measurement Instruments) study design checklist for patient-reported outcome measurement instruments (Mokkink et al., 2019).

2.1. Measure

The MHLS comprises 35 items with 4-point and 5-point Likert scales as a response format. Twelve items (item 10, 12, 15 and items 20 to 28) are reversely scored. A summary score is calculated with lowest score 35 and highest score 160. Higher values indicate higher levels of MHL. The questions cover the following topics: ability to recognize disorders, knowledge of where to seek information, knowledge of risk factors and causes, knowledge of self-treatment, knowledge of professional help available, and attitudes that promote recognition or appropriate help-seeking behavior (O'Connor and Casey 2015).

2.2. Translation process

We performed a forward and backward translation. Two native German speakers, one a psychologist and researcher with 30 years of professional experience in the field of patient-reported outcomes and one a nurse and health scientist, independently translated the original questionnaire into German. The two versions were combined by resolving differences through discussion. This version was then back-translated by a native English speaker and compared with the original English version. As recommended in the COSMIN study design checklist, the back translator had no specific expertise in mental health topics. Any differences were inspected and resolved again by discussion between the three researchers. The initial version was then tested for face validity in seven persons with no psychological background which led to a minimal adjustment of the wording of some items. Remaining ambiguities were clarified directly by e-mail contact with the author of the original version. Finally, the translation was compared with a version developed by another German research team (Prof. Michèle Wessa and colleagues, University of Mainz) who concurrently worked on a translation of the MHLS. The two versions were discussed and combined to one final German version. The joint German version contained all 35 items of the original English version.

2.3. General population sample

The participants of the general population sample were recruited via an online-access-panel in March 2023. The distributions of age and gender within the sample were the same distribution as reported for the general German population in the age range of 18–69 years. Participants were invited via e-mail to complete an online survey.

2.4. Patients with AMI

The sample consisted of patients with AMI who participated in a postal follow-up survey of the Myocardial Infarction Registry Augsburg, which was established as a part of the MONICA-project (Monitoring Trends and Determinants in Cardiovascular disease) in 1984. The study area covers the city of Augsburg, Germany, and the two adjacent counties, including a total of approximately 680,000 inhabitants. The registry continuously registers all cases of coronary death and non-fatal AMI of the study population older than 24 years. The registry was approved by the ethics committee of the Bavarian Medical Association (Bayerische Landesärztekammer) and the study was performed in

accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants. In April 2023, all survivors with incident or recurrent AMI admitted between 2017 and 2019 (n = 1712) were sent a questionnaire via post.

Both samples were requested to complete the translated German version of the MHLS and were asked for their gender, age, marital status and education level. In addition, participants were asked if they have experience with mental disorders due to a personal diagnosis or mental disorders in their family, friends or professional environment.

2.5. Sample characteristics

Overall, 517 panel members participated in the online population survey. Fifty percent were females with a mean age of 45 (±14), 44.7% were married and 33.8% were living alone. Thirty percent of the participants had a diagnosed mental disorder and 61.5% and 17.0% had experiences with mental disorders among friends or family or in the professional context, respectively.

A total of 855 (49.9%) of the 1712 patients with AMI who received a postal survey, returned the questionnaire. From the 857 non-responders, 67 patients had died, 104 had moved with unknown address, and 42 indicated that they are not willing or able to answer the questions. The remaining 644 persons received a postal reminder, but they did not respond.

Patients who completed less than 50% of the questions in the MHLS were excluded for further psychometric analyses, which lead to 786 patients in the final sample. Mean age was 71 (±10.9) years with 22.5% females. Seventy-one percent of the patients were married. Eleven percent reported a mental disorder diagnosis. Twenty-eight and eight percent had experience with mental disorders among family or friends or in professional context, respectively (Table 1).

2.6. Statistical analysis

In both sample data we applied multiple statistical approaches to examine the psychometric properties of the translated German Version of the MHLS. First, missing values and distribution of the responses were inspected. For all further psychometric analyses, we excluded cases with more than 50% missing values in the questions of the MHLS. The original unidimensional structure of the MHLS was tested using confirmatory factor analysis (CFA). Then, the factorial structure was further investigated using exploratory factor analyses (EFA). Bartlett's Test of Sphericity and Kaiser–Meyer–Olkin index (KMO) were used to determine the appropriateness of the sample for factor analysis (Watkins 2018). Parallel analyses and Empirical Kaiser Criterion (EKC) were used to examine the number of factors to be extracted. We used weighted least squares (WLS) estimation and different rotation methods for the EFA to find a suitable and interpretable number and allocation of factors with factor loadings >0.3 (Goretzko et al., 2021). Finally, we tested the multifactorial structure using a CFA again. We used several global goodness of fit indices to assess model fit: Chi-square test statistics (χ^2), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMR). For good (or acceptable) model fit, the chi-square test statistics should be non-significant and the ratio $\chi^2/df < 2$ (or at least <3), TLI and CFI ≥0.95 (or at least ≥0.90) (Hu and Bentler 1999), RMSEA ≤0.05 (or at least ≤0.08) and SRMR ≤0.05 (or at least ≤0.10) (Schermelleh-Engel et al., 2003). We used robust maximum likelihood (MLR) to handle not normally distributed data and full information maximum likelihood method to account for missing data. Modification indices were used to identify local dependencies which were modeled where necessary.

Summary scores for the subscales determined from the final factorial structure were calculated if at least 50% of the items in the scale were completed. Floor and ceiling effects (proportions of participants with minimal and maximal possible scores) of the subscales were examined and considered acceptable if they were <15% (Terwee et al., 2007). Internal consistency was measured by Cronbach's alpha, McDonald's omega, and average inter-item correlation. For known-groups-validity, it was tested (using Mann–Whitney U-tests and rank-biserial correlation as effect size (r < 0.3: small, r = 0.3–0.5: moderate, r > 0.5: large)) whether the scales distinguish between groups that are known to differ in MHL (Francis et al., 2016).

Finally, we tested measurement invariance of the model between the two samples. Measurement invariance assesses whether the construct has the same psychometric quality across groups and is an important prerequisite for an instrument used for comparison between groups (Putnick and Bornstein 2016). We tested configural (equivalence of model

Table 1
Sample characteristics.

	General population sample	AMI sample
	N = 517[a]	**N = 786**[1]
Age	46.0 (32.0, 58.0)	71.4 (63.2, 80.4)
Females	260 (50.3%)	177 (22.5%)
Marital status		
Married	231 (44.7%)	558 (71.0%)
Single	220 (42.6%)	58 (7.4%)
Divorced	54 (10.4%)	69 (8.8%)
Widowed	12 (2.3%)	98 (12.5%)
Missing	0 (0%)	3 (0.4%)
Education level		
≤9 years school education	58 (11.2%)	395 (50.1%)
10 years school education	170 (32.9%)	195 (24.8%)
≥12 years school education	34 (6.6%)	59 (7.5%)
University degree	100 (19.3%)	128 (16.3%)
Missing	0 (0%)	9 (1.1%)
Diagnosed mental disorder		
Yes	155 (30.0%)	90 (11.5%)
Missing	0 (0%)	9 (1.1%)
Experience with mental disorders among family or friends		
Yes	318 (61.5%)	226 (28.8%)
Missing	0 (0%)	6 (0.8%)
Experience with mental disorders in professional context		
Yes	88 (17.0%)	65 (8.3%)
Missing	0 (0%)	10 (1.3%)
Living alone	175.0 (33.8%)	–

[a] Median (Q_{25}, Q_{75}) or n (%).

structure), metric (equivalence of item loadings on the factor) and scalar (equivalence of item intercepts) invariance and considered a change in model fit of ΔCFI ≤0.01 and ΔRMSEA ≤0.01 as acceptable (Putnick and Bornstein 2016). If the cut-offs were exceeded, we tested for partial measurement invariance by releasing several model constraints.

All analyses were conducted using the statistical software R version 4.3.1 (R Core Team 2023) mainly with the packages "lavaan", "semTools", and "psych".

3. Results

3.1. Acceptability

In the sample of patients with AMI, missing values per item ranged from 7 to 18% (highest for item 5 and item 6 with 18% and 17% missing values, respectively) indicating low to moderate acceptability. There were no missing values in the general population sample, as the study was an online survey with mandatory fields. The mean summary score in the general population sample was 119 (SD: ±16, range: 74 to 155, median: 122) and 113 (SD: ±20 range: 37 to 159, median: 115) in patients with AMI.

3.2. Dimensionality

Bartlett's test and KMO confirmed the adequacy of each of the two samples for factor analysis (general population sample: $\chi2(595) = 8318.12$, $p < 0.001$ and KMO = 0.91; patients with AMI: $\chi2(595) = 11805.55$, $p < 0.001$ and KMO = 0.89). In both samples, a one factor solution which was proposed for the original English version of the MHLS did not show appropriate model fit indices in the CFA with high RMSEA (0.122, 0.116) and SRMR (0.136, 0.116) and very low CFI (0.454, 0.431) and TLI (0.420, 0.396).

For further investigations of the factorial structure EFAs were conducted. EKC indicated 4 and parallel analysis 5 factors to be extracted from the data. We tried 3 to 5 factors with different oblique rotation methods to identify the best interpretable solution (Supplementary Material, Tables 1–8). The theoretically most suitable and interpretable solution in both samples was seen with four factors using 'Promax' rotation and removing the four items 10, 11, 12 and 15. The only difference in EFA was that item 11 loaded on Factor 1 in the AMI sample but not in the general population sample (Supplementary Material, Tables 1–4). According to the EFA, the items 10, 12 and 15 were assigned to subscale 'stigmatization' but did not match with the content of the scale. These items are reversely scored which may explain the shared variance with items from subscale 'stigmatization' that are also reversely scored. Thus, based on their content, these remaining items could not be assigned to one of the four factors neither to another additional fifth factor.

In both samples the CFA with four factors yielded acceptable fit indices with few co-varied error terms on items 27 and 28, 18 and 19, 30 and 31 (Fig. 1, Table 2). The correlation of the latent factors ranged between 0.26 and 0.61 in the general population sample and between 0.20 and 0.42 in the AMI sample. In both samples the fit was acceptable with and without item 11. In the general population sample the factor loading of item 11 was lower compared to the rest of the items and did not load on any factor in the EFA. Therefore, we decided to exclude the item from the subscale for the final model. Factor loadings for both samples are shown in Table 3.

3.3. Internal consistency

Cronbach's alpha ranged from 0.80 for 'stigmatization' to 0.90 for 'social distance' and McDonald's omega from 0.78 for 'information seeking' to 0.90 for 'social distance' (Table 4). Together with an average inter-item correlation ranging from 0.30 for 'stigmatization' to 0.59 for 'social distance' these results indicate good internal consistency.

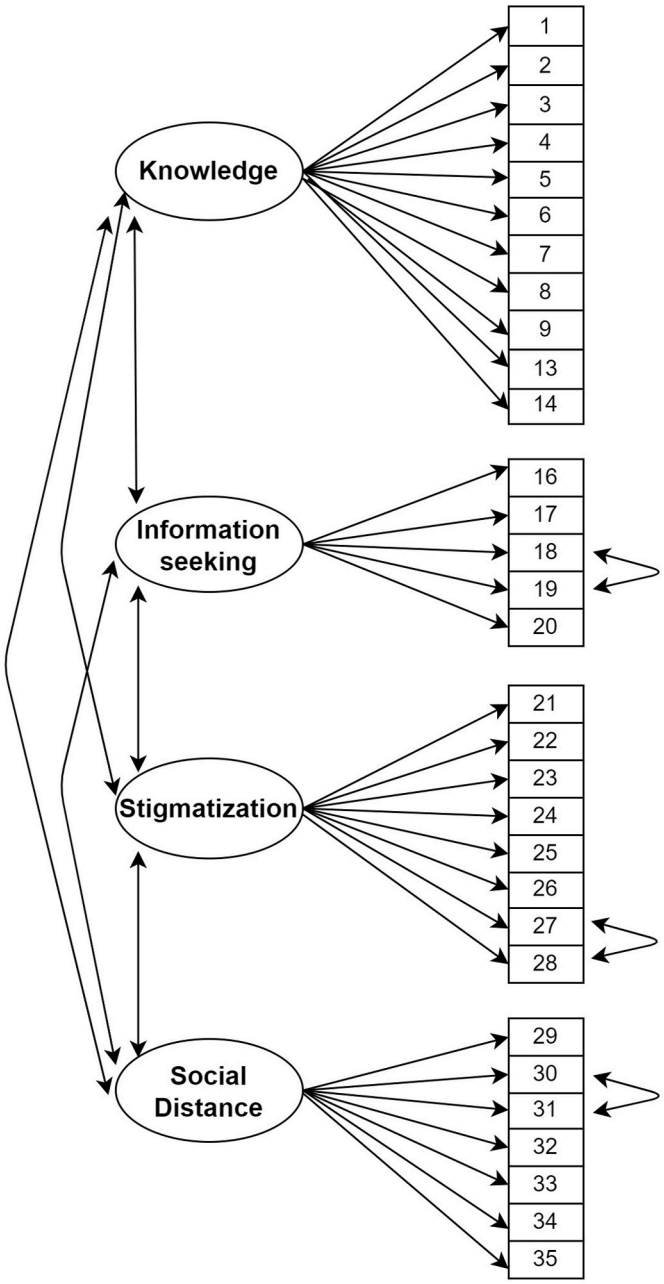

Fig. 1. CFA model with 31 items in four factors and three co-varied error terms (curved arrows).

Table 2
Global fit measures for the MLR-estimates of the confirmatory factor analysis.

	General population sample	AMI sample
n	517	786
χ^2	1040.064	1116.728
Df	425	425
χ^2/df	2.4	2.6
p-value (χ^2)	$p < 0.001$	$p < 0.001$
TLI	0.895	0.912
CFI	0.904	0.919
RMSEA (90% CI)	0.057 (0.053; 0.061)	0.049 (0.046; 0.053)
SRMR	0.064	0.054

Co-varied error terms on items 27 and 28, 18 and 19, 30 and 31.

Table 3
Item properties.

Item	General population sample				AMI sample			
	Mean	SD	CFA loading[a]	CFA R^2	Mean	SD	CFA loading[a]	CFA R^2
Knowledge								
Item 1	2.72	0.79	0.53	0.28	2.56	0.87	0.56	0.31
Item 2	2.92	0.79	0.64	0.41	2.68	0.95	0.37	0.14
Item 3	2.94	0.84	0.57	0.32	2.96	0.86	0.66	0.44
Item 4	3.20	0.87	0.73	0.54	3.15	0.86	0.71	0.51
Item 5	2.73	0.86	0.58	0.34	2.98	0.91	0.76	0.57
Item 6	2.71	0.86	0.51	0.26	2.94	0.93	0.77	0.59
Item 7	3.18	0.90	0.76	0.58	3.04	0.89	0.81	0.65
Item 8	3.06	0.89	0.68	0.46	3.01	0.88	0.77	0.59
Item 9	2.69	0.86	0.41	0.17	2.73	0.80	0.30	0.09
Item 13	3.06	0.67	0.55	0.31	3.09	0.75	0.56	0.32
Item 14	3.16	0.85	0.52	0.27	3.21	0.90	0.45	0.20
Information seeking								
Item 16	3.90	0.94	0.71	0.51	3.86	1.12	0.77	0.59
Item 17	4.08	0.89	0.76	0.58	3.92	1.20	0.78	0.62
Item 18	3.93	1.00	0.59	0.34	4.21	1.01	0.63	0.40
Item 19	4.09	0.89	0.81	0.65	4.24	0.99	0.74	0.55
Stigmatization								
Item 20	3.81	1.23	0.70	0.49	3.97	1.08	0.59	0.34
Item 21	4.14	1.18	0.85	0.72	4.32	1.05	0.72	0.52
Item 22	4.09	1.29	0.69	0.47	3.92	1.42	0.49	0.24
Item 23	3.38	1.03	0.57	0.33	3.50	1.15	0.53	0.28
Item 24	4.04	1.08	0.80	0.64	4.18	1.05	0.64	0.41
Item 25	3.43	1.14	0.42	0.18	3.55	1.21	0.38	0.14
Item 26	4.04	1.24	0.71	0.50	3.96	1.27	0.58	0.33
Item 27	3.92	1.23	0.59	0.35	4.14	1.14	0.51	0.26
Item 28	4.00	1.14	0.62	0.39	4.12	1.08	0.51	0.26
Social distance								
Item 29	3.77	0.99	0.81	0.65	3.74	0.99	0.72	0.51
Item 30	3.95	0.98	0.82	0.68	3.72	1.10	0.74	0.55
Item 31	3.82	0.98	0.85	0.73	3.52	1.09	0.81	0.65
Item 32	3.70	1.03	0.83	0.69	3.27	1.12	0.83	0.68
Item 33	3.51	1.07	0.78	0.62	3.01	1.20	0.76	0.58
Item 34	2.81	1.26	0.52	0.27	2.07	1.17	0.56	0.31
Item 35	3.23	1.11	0.72	0.52	2.83	1.19	0.73	0.54

[a] Standardized; all factor loadings were statistically significant with $p < 0.001$.

Table 4
Distribution of subscales and internal consistency.

Scale	Nr. of items	Min-Max	Median (Q_{25}, Q_{75})	Floor effects %	Ceiling effects %	Cronbach's alpha	McDonald's omega	Average inter-item correlation
AMI sample								
Knowledge	11	11–44	33 (28, 36)	2.0	1.3	0.87	0.87	0.35
Information seeking	4	4–20	17 (14, 19)	1.4	21.8	0.84	0.79	0.57
Stigmatization	9	9–45	36 (31, 41)	0.1	3.9	0.80	0.78	0.30
Social distance	7	7–35	22 (18, 27)	1.7	1.8	0.89	0.88	0.55
General population sample								
Knowledge			33 (30, 36)	1.4	0.6	0.85	0.86	0.40
Information seeking			16 (14, 19)	0.8	14.5	0.82	0.78	0.54
Stigmatization			37 (30, 41)	0.6	5.2	0.88	0.87	0.45
Social distance			25 (21, 29)	1.4	5.4	0.90	0.90	0.59

3.4. Floor and ceiling effects

No floor effects were detected in any of the four subscales in both samples. The subscales did also not show relevant ceiling effects with the exception of the subscale 'information seeking' in the AMI sample (Table 4).

3.5. Known-groups-validity

Differences between known groups were tested for age, gender, level of education and experience with mental disorders (personal, among family or friends and professional context).

In the general population sample differences were mainly found regarding experience with mental disorders. Almost all subscale scores were significantly higher in patients with previous experience in this context. Significantly higher scores were also found for females compared to males in subscales 'knowledge' and 'stigmatization'. Furthermore, the subscale scores of 'information seeking' and 'stigmatization' were significantly higher in participants older than 45 years compared with younger participants, and score of subscale 'knowledge' was significantly higher in the group with higher school education (≥10 years) compared with participants with school education <10 years. Effect sizes were small to moderate, ranging from 0.11 to 0.36 (Table 5).

Table 5
Known-groups validity in the general population sample.

	Groups		p-value[b]	|r|[c]
Age	<45 years	≥45 years		
Knowledge	33 (30, 36)[a]	33 (30, 36)	0.676	–
Information Seeking	16 (14, 18)	16 (15, 19)	**0.035**	0.11
Stigmatization	35 (27, 40)	37 (33, 41)	**<0.001**	0.24
Social distance	25 (21, 29)	25 (21, 29)	0.728	–
Gender	Female	Male		
Knowledge	33 (31, 37)	33 (29, 36)	**0.028**	0.11
Information Seeking	16 (15, 29)	16 (14, 18)	0.228	–
Stigmatization	38 (32, 41)	35 (28, 40)	**0.007**	0.14
Social distance	25 (21, 29)	25 (21, 29)	0.096	–
School education	<10 years	≥10 years		
Knowledge	32 (28, 35)	33 (31, 36)	**0.017**	0.20
Information Seeking	16 (13, 19)	16 (15, 18)	0.550	–
Stigmatization	35 (30, 41)	37 (31, 41)	0.313	–
Social distance	25 (21, 30)	25 (21, 28)	0.401	–
Mental disorder	Yes	No		
Knowledge	35 (32, 38)	33 (29, 35)	**<0.001**	0.33
Information Seeking	17 (15, 19)	16 (14, 18)	**0.018**	0.13
Stigmatization	39 (34, 42)	36 (29, 40)	**<0.001**	0.23
Social distance	27 (23, 31)	24 (21, 28)	**<0.001**	0.27
Mental disorders among family/friends	Yes	No		
Knowledge	34 (32, 37)	31 (27, 34)	**<0.001**	0.36
Information Seeking	16 (15, 19)	16 (13, 18)	**<0.001**	0.17
Stigmatization	37 (32, 41)	35 (28, 40)	**0.005**	0.15
Social distance	26 (22, 30)	23 (21, 27)	**<0.001**	0.25
Mental disorders in professional context	Yes	No		
Knowledge	34 (32, 38)	33 (30, 36)	**0.002**	0.20
Information Seeking	17 (15, 19)	16 (14, 18)	**0.038**	0.14
Stigmatization	37 (30, 42)	36 (30, 41)	0.374	–
Social distance	26 (22, 30)	25 (21, 29)	**0.023**	0.15

Bold font indicates statistical significance with alpha = 0.05.
[a] Median (Q_{25}, Q_{75}).
[b] Mann-Whitney-U-Test.
[c] Rank-biserial correlation.

In the sample of patients with AMI, younger participants (<65) with a higher educational level and more experience with mental disorders showed significantly higher scores compared with their counterparts in almost all subscales. No differences were found for gender except for subscale 'stigmatization'. Effect sizes were also small to moderate, ranging from 0.12 to 0.34 (Table 6).

3.6. Measurement invariance

The MHLS-GER is mostly invariant across the two samples. Model structure, loadings and most of the intercepts (except for the four items 5, 6, 29 and 34) are the same across the two samples. Comparison of model fit is depicted in Table 7.

4. Discussion

The investigation of the dimensionality revealed that for the German version the one factor solution is not appropriate. A four-factor structure showed acceptable fit indices. Since it has been reported that chi-square tests tend to over-rejection when using robust estimation methods (Li 2016), the fit was considered acceptable according to alternative fit indices. The four factors comprised the topics ability to recognize mental disorders and knowledge of risk factors and professional help ('knowledge', 11 items), knowledge of where to seek information about mental health ('information seeking', 4 items), general attitude towards mental illness and help-seeking behavior ('stigmatization', 9 items) and attitude to someone with mental illness ('social distance', 7 items).

A multi-factorial structure also makes sense from a theoretical point of view. In the validation studies of the Slovenian and the Arabic version an almost identical four-factor structure was identified as the most meaningful solution (Alshehri et al., 2021; Krohne et al., 2022). In other validation studies of the MHLS, different factor structures of three, five or six factors were found, but except for the Chinese version (Chen et al., 2021), none of them confirmed the original unidimensional structure.

Other questionnaires for the assessment of health literacy also have a multi-factorial structure, e.g. the Health Literacy Questionnaire (HLQ) comprising nine different subscales (Osborne et al., 2013), or the Health Literacy in Pulmonary Embolism (HeLP) questionnaire with four domains that measure disease-specific health literacy in patients with pulmonary embolism (Fischer et al., 2023b). It seems plausible that the multidimensional character of health literacy also applies to MHL. For instance, a person who is familiar with correctly recognizing mental disorders may still have a non-favorable attitude or stigma towards mentally ill persons.

To ensure cross-cultural comparability of results derived from the MHLS-GER we propose to use the 4 items that were not assigned to one of the four factors as additional descriptive information. We recommend using the four subscales for the German version of the MHLS which all yielded good psychometric properties. Another advantage of the four subscales is the possibility to only use one subscale if the research question is restricted to a specific topic which also reduces the time to complete the questionnaire.

Overall, good reliability and known-groups-validity of the four factors emphasize their appropriateness. Each of the four subscales showed good

Table 6
Known-groups validity in the AMI sample.

	Groups		p-value[b]	|r|[c]
Age	<65 years	≥65 years		
Knowledge	34 (30, 38)[a]	32 (26, 36)	**< 0.001**	0.25
Information Seeking	18 (16, 20)	16 (14, 19)	**< 0.001**	0.19
Stigmatization	39 (33, 42)	36 (30, 40)	**< 0.001**	0.23
Social distance	25 (21, 29)	21 (17, 25)	**< 0.001**	0.34
Gender	Female	Male		
Knowledge	33 (28, 37)	33 (28, 36)	0.405	–
Information Seeking	16 (14, 19)	17 (14, 19)	0.545	–
Stigmatization	38 (32, 42)	36 (31, 40)	**0.019**	0.12
Social distance	23 (19, 27)	22 (18, 27)	0.120	–
School education	<10 years	≥10 years		
Knowledge	31 (25, 35)	34 (30, 37)	**< 0.001**	0.29
Information Seeking	16 (14, 19)	17 (15, 20)	**0.002**	0.13
Stigmatization	35 (29, 39)	38 (33, 42)	**< 0.001**	0.22
Social distance	22 (17, 26)	23 (18, 27)	0.228	–
Mental disorder	Yes	No		
Knowledge	35 (30, 38)	33 (27, 36)	**< 0.001**	0.23
Information Seeking	17 (14, 19)	17 (14, 19)	0.846	–
Stigmatization	40 (34, 42)	36 (31, 40)	**< 0.001**	0.25
Social distance	26 (21, 29)	22 (18, 26)	**< 0.001**	0.28
Mental disorders among family/friends	Yes	No		
Knowledge	35 (30, 37)	32 (26, 36)	**< 0.001**	0.27
Information Seeking	16 (15, 19)	17 (14, 19)	0.998	–
Stigmatization	39 (34, 42)	35 (29, 40)	**< 0.001**	0.27
Social distance	23 (19, 28)	22 (17, 26)	**< 0.001**	0.17
Mental disorders in professional context	Yes	No		
Knowledge	36 (30, 38)	33 (28, 36)	**< 0.001**	0.29
Information Seeking	18 (15, 20)	17 (14, 19)	0.101	–
Stigmatization	39 (34, 43)	36 (31, 40)	**0.001**	0.24
Social distance	24 (19, 28)	22 (18, 26)	0.070	–

Bold font indicates statistical significance with alpha = 0.05.
[a] Median (Q_{25}, Q_{75}).
[b] Mann-Whitney-U-Test.
[c] Rank-biserial correlation.

Table 7
Measurement invariance across general population and AMI sample.

Model	χ^2 (df)	CFI	ΔCFI	RMSEA	ΔRMSEA	Released constraints	Decision
M1: Configural Invariance	2435.676 (850)	0.907	–	0.054	–	–	Accept
M2: Metric Invariance	2546.664 (877)	0.902	0.005	0.054	0	–	Accept
M3: Scalar Invariance	2929.117 (904)	0.881	0.021	0.059	0.005		Reject
M3a: Partial Scalar Invariance	2717.499 (900)	0.893	0.009	0.053	0.006	Items 5, 6, 29, 34	Accept

General population sample (n = 517); AMI sample (n = 786).

internal consistency and identified differences in groups in which differences in (mental) health literacy were expected. Especially participants with previous experience with mental disorders because of an own diagnosis or mental health problems among friends or family or in the professional context showed higher scores on the four subscales. This finding is in line with the differences found in the validation study of the original English MHLS version (O'Connor and Casey 2015), the Chinese validation study (Chen et al., 2021) and in another Iranian study that applied the MHLS (Noroozi et al., 2018). Differences in the MHLS scores between females and males with females having higher scores were found in the Chinese, Arabic and Portuguese validation studies (Alshehri et al., 2021; Chen et al., 2021; Neto et al., 2021). In the MHLS-GER, these findings were only confirmed for the subscale 'stigmatization' in both samples and the subscale 'knowledge' in the general population sample.

The MHLS-GER showed only low to moderate acceptability regarding the completeness of the questionnaire in the AMI sample with ≥10% missing values in about half of the items. The low level of acceptability could be associated with stigma and may be a further indication of the need to strengthen MHL to reduce aversion towards mental health topics especially in older people. All four subscales show left skewed distributions and may detect low levels of MHL but not distinguish between good and very good levels of MHL.

Having a higher MHL is associated with being more likely to recognize mental disorders, to choose appropriate treatment options (Wright et al., 2007; Jorm 2012) and with less stigmatizing attitude towards people with mental disorders and towards seeking professional help (Kitchener and Jorm 2004; Rüsch et al., 2011). Interventions that seek to improve MHL necessarily need appropriate measures to evaluate their effect. With this study, a newly adapted German version of the MHLS exists to be used in this context. In a clinical screening setting, it may be helpful to know the level of MHL in different domains to provide support in line with individual needs.

The MHLS-GER can be applied in the general population as well as in patients with AMI which is associated with frequent psychological

comorbidity. So far, little research has been conducted on MHL in patients with chronic somatic disease. Further studies on other cardiovascular diseases and severe somatic diseases, e.g. stroke or cancer, are needed to validate the use of the MHLS-GER in these samples and to explore whether adapted instruments are required to consider disease-specific challenges.

5. Strengths and limitations

The strength of the study are the two large samples that represent two different groups in which the measure can be applied. Previous studies often measured MHL in University students or health care workers. Furthermore, we conducted a comprehensive investigation of psychometric properties, e.g. factor analysis, internal consistency, and known-groups-validity, for the German MHLS. A fact that previously conducted validation studies on other measures on MHL were lacking and criticized for (O'Connor et al., 2014; Wei et al., 2015). However, test-retest-reliability and responsiveness were not investigated and should be complemented for the MHLS-GER in future studies. Although the number of participants represented the general population in terms of gender and age, they were all panel members who voluntarily participated in online surveys, which may have led to a selection bias. Furthermore, we cannot exclude a selection bias towards better MHL in the sample of patients with AMI available for the analysis compared with those persons, who were not willing or able to complete the questionnaire.

6. Conclusions

The MHLS fills the gap of psychometrical robust measures for MHL and a valid and reliable German version with four subscales is now available to be applied in further studies. The assessment of currently missing aspects of the concept MHL (e.g. knowledge about risk factors and self-help strategies) should be investigated and the instrument should be further developed. Moreover, validation studies to evaluate further psychometric properties such as test-retest-reliability and responsiveness are required.

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CRediT authorship contribution statement

Simone Fischer: Writing – original draft, Methodology, Formal analysis. **Timo Schmitz:** Writing – review & editing, Resources, Project administration. **Christine Meisinger:** Writing – review & editing, Supervision. **Jakob Linseisen:** Writing – review & editing, Supervision, Resources. **Inge Kirchberger:** Writing – review & editing, Methodology, Conceptualization.

Declaration of competing interest

None.

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Appendix A. Supplementary data

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