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ABSTRACT

Background: No Arabic validated scale is available to date to measure AI literacy. The current study aimed to evaluate the psychometric properties of a first Arabic translation of the Artificial Intelligence Literacy Scale (AILS) among university students from four Arab countries (i.e. Lebanon, Saudi Arabia, Morocco and Palestine).

Methods: Online cross-sectional data collection took place in July 2023 among university students ($N=1849$, mean age of 21.37 ± 3.84 years, 74.3% females).

Results: The Arabic version replicated the original four-factor structure of the AILS. Internal consistency reliability coefficients were excellent (Cronbach $\alpha = .92$). Moreover, scalar, metric and configural invariance was supported across sex and country. Finally, concurrent validity was established through significant negative correlations of the AILS scores with levels of fear of autonomous robots and artificial intelligence.

Conclusion: Making an Arabic version of the AILS available can guide course designs and development at the higher education system, to include AI in both curricula and assessment settings.

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1. Introduction

Artificial Intelligence (AI) is an emerging field of technology that has attracted increased attention from academia, the industrial sector, and even governmental bodies over recent years (Zhang & Lu, 2021). Recent advances in technology are induced by the multidisciplinary aspect of this technology. AI Watch, the European Commission’s knowledge service to monitor AI for Europe, defined AI systems as

‘software (also hardware) systems designed by humans. When given a complex goal, this system acts in physical or digital dimension, perceiving the environment through acquiring data, interpreting collected structured/unstructured data, reasoning on the knowledge or processing the information derived from this data, and deciding the best action to take to achieve this given goal’ (Samoili et al., 2020). Due to all these abilities, expedited development of

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AI-based technologies can be tracked in numbers. The annual growth rate of AI patents filed between 2015 and 2021 is recorded at 76.6%, on average (Zhang et al., 2021).

In case of any complex system, communication between user and interface is essential to ensure proper outcomes. For AI, this communication is termed AI literacy, which refers to the ability to “critically evaluate, use and effectively communicate with AI” (Yi, 2021), without necessarily developing AI models themselves (Long et al., 2021). Yi (2021) further defined AI literacy as the capacity to critically recognize varying cultures, and not simply being able to use AI. Thus, AI literacy allows users of AI to comprehend basic AI principles, helping them perceive possible biases and comprehend ethical implications (Wang et al., 2023). The term AI literacy was first introduced in a 2015 article online (Konishi, 2016). This term adds to the series of proposed literacies, aiming at understanding a specific technological construct (Laupichler et al., 2022). Young adults, mainly students enrolled in higher education programs, are considered as AI education’s target audience, as they require developing proper skills to efficiently handle AI throughout their careers (Southworth et al., 2023).

1.1. AI literacy across the world

In the field of education, AI is being adopted and used extensively throughout educational institutions, albeit in various forms (Chen et al., 2020). Despite initially taking the form of computer-related technology, AI transitioned to intelligent online and web-based education systems. Due to the use of these embedded computer systems with other technologies, humanoid robots were developed as well as web-based chatbots that assist in instructors’ and students’ assignments and functions, independently or along with these humans’ input (Chen et al., 2020). In recent years, some projects tried introducing AI to students attending college and university. These projects were designed for non-IT students, like medicine (Aulenkamp et al., 2021), teacher education (Vazhayil et al., 2019), or business administration (Xu & Babaian, 2021). Although AI education and AI literacy is a relatively young field, yet research around it increased over the past few years (Cetindamar et al., 2022). Nevertheless, only some attempts were made for instruments development, aimed at evaluating AI literacy of individuals (Laupichler et al., 2023). Given that work skills and adult education require a certain level of AI competencies, evaluation methods need

to be elaborated. Introducing AI systems is linked to a process of general change that must be acquired in a constructive manner (Carolus et al., 2023), hence the need to develop proper instruments to assess AI literacy and the gaps to be targeted. Several efforts are increasing worldwide to implement AI literacy in the past few years. The literature finds on the topic of AI literacy that the current research state reports 47 papers, an increase in publications from 2019 to 2023. In 2021, 11 publications are reported, marking an increased attention as compared to 2019 and 2020. This trendline continues in the next years, with 16 publications in 2022 and 18 publications until August 2023 (Almatrafi et al., 2024). AI literacy and applications vary across cultures. Such a variation depends on several factors such as the country’s technological level, the extent of AI application in the educational sector or marketplace and workplace, the infrastructure available, and whether it can sustain AI systems. It is valuable to evaluate AI literacy because the tools permit a detailed assessment of the knowledge level of a particular group or representative sample, as well as an evaluation of the effectiveness of implemented interventions (Almatrafi et al., 2024), enabling to track the progress of AI understanding and level across various timeframes. Assessing AI literacy at the level of Higher Education, such as in university students, permits an effective design of AI-related courses. Results can offer primary insights into the state of AI literacy in various students’ samples, serving as a starting ground for more targeted research (Hornberger et al., 2023).

The prevalence of AI literacy is projected to increase worldwide, due to the increase of AI technologies prevalence in societies. Bridging knowledge gaps in AI requires educational programs to increase overall AI literacy, allowing students to participate more efficiently with AI tech (Hornberger et al., 2023). However, gaps are present in the literature, particularly when addressing AI literacy prevalence. Among the UK medical students’ population, training opportunities in healthcare AI are limited, hence affecting the level and prevalence of AI literacy (Kimiifar et al., 2023). Studies focusing solely on the prevalence of AI literacy in the world are practically non-existent. Addressing these gaps leads to a better understanding of AI literacy, in statistical and empirical delimitations. Thus, providing solid grounds for using AI literacy data to enhance and adapt education- or workplace-related AI use throughout different cultures, based on AI literacy assessments from different countries and populations.

1.2. Measurement instruments of AI literacy

So far, some scales aiming to measure AI literacy have been reported in the literature. To date, the most recent systematic review of AI literacy scales published by Lintner in August 2024 was able to identify 22 studies across internationally published data (Lintner, 2024). Of these 22 publications, only 16 scales were validated. These AI literacy scales targeted various populations (e.g. general population, secondary education students, higher education students and teachers) (Lintner, 2024). An example of the measures validated is the General AI Literacy scale, which consists of 13 items assessing five dimensions: technology knowledge, human actors in AI knowledge, AI steps knowledge, AI usage and design experience (Pinski & Benlian, 2023). This scale was tested among people with programming knowledge, which might limit its use among non-experts in AI. Another scale is the 34-item Meta AI Literacy Scale, which assesses AI literacy, creation skills, self-efficacy and self-competency (Carolus et al., 2023). This scale extends beyond measuring AI literacy to evaluating participants' psychological competencies concerning AI. Laupichler et al. (2023) developed a 31-item scale, the Scale for the assessment on non-experts AI literacy, which yields three factors- technical understanding, critical appraisal and practical implication. The medical Artificial Intelligence readiness scale for medical students (MAIRS-MS) developed specifically for students in medicine (Karaca et al., 2021). Finally, Wang et al. (2023) developed a 12-item questionnaire, the Artificial Intelligence literacy scale (AILS), designed to assess AI literacy among high school students.

1.3. The AILS

The purpose behind developing the AILS was driven by the need for a reliable and validated standard scale, for measurement of participants' AI literacy. Its development followed the recommendations of Hinkin (1998), by incorporating these steps: generating item, validating content, administering the questionnaire, redacting an item, confirmatory factor analysis and testing for reliability and validity (Wang et al., 2023). The four key areas described above were identified as the primary core constructs of AI literacy (awareness, use, evaluation and ethics). For capturing these constructs, 65 items were generated, out of which retention was validated for 31 items. Further reduction of the number of items following reliability tests led to the 12-item instrument for

quantitative AI literacy measurement, known as AILS. The latter relates significantly to digital literacy, users' daily AI usage and attitude towards robots. Regression results showed that in AILS, awareness and evaluation are important to predict negative attitudes of users towards robots. Whereas results of correlation and regression proved that AILS and digital literacy are interrelated. Frequency, extent and variety of use of AI were correlated with AI literacy and the four constructs (with exception of ethics). AILS scale's Cronbach's alpha was 0.83, used to determine reliability and validity of construct. For the four constructs, alpha values were 0.73 for awareness, 0.75 for usage, 0.78 for evaluation and 0.73 for ethics (Wang et al., 2023). Literature reports AILS as the AI literacy scale having the most robust quality evidence, specifically if the study aims to assess general population (Wang et al., 2023). To the best of our knowledge, a Turkish validation was conducted for the AILS acknowledging the four-factor structure, with a good internal reliability ($\alpha = .85$) (Çelebi et al., 2023). However, no validation of any AI literacy scale is available in Arabic language throughout the literature; hence the need for an Arabic validation of a measure assessing AI literacy, adapted for the regional Arabic-speaking population.

1.4. Rationale and aim of the present study

The current study sought to add to the literature available on the topic of AI literacy worldwide by validating the AILS scale for use among Arabic-speaking people. As such, this study would be, to our knowledge, a pioneer for statistic validation of AILS in the Middle East and North Africa region. For validation purposes, young adults are a relevant target population, since the young generation reportedly uses AI most, as compared to older generations. In addition, published research focuses on AI literacy for the general population, so a selective number of studies assess literacy for a specific subpopulation exposed to AI at the highest rate. Because of the rising interest in the field of AI, a meticulous instrument is required to properly evaluate students' learning through their AI literacy phase of development. Mainly, validity and reliability must be carefully assessed (Ng et al., 2023). Hence the efforts to publish data related to the psychometric properties of the AILS in Arabic. The current study aimed to evaluate the psychometric properties of a first Arabic translation of the AILS among university students from different Arab countries. It is expected that the Arabic-language AILS will show good

validity, reliability, measurement invariance across sexes, and adequate concurrent validity.

2. Methods

2.1. Procedures

Throughout July 2023, a link via Google Form was shared to collect data for this study. The team's researchers contacted students at universities that are part of their social circle. Sampling through the snowball technique expanded data collection, by asking these students for link sharing with fellow students that they know. This method of recruitment was chosen since potential participants would be more willing to participate if they are referred to by someone they trust (Family member or friend) and it can be more cost-effective and quicker (especially in non-funded projects). Criteria for inclusion demanded participants to be above 18 years old, as well as being citizens and residents of Saudi Arabia/Lebanon/Morocco/Palestine. If participants do not fulfill the inclusion criteria, they were excluded from this study. The Google Form started with an introductory section shedding light on the study's objectives, while warranting confidential and anonymous responses from involved participants. After providing digital informed consent, participants filled the questionnaire's instruments, on a voluntary basis and in the absence of any remuneration. The Lebanese International University's School of Pharmacy, through its Ethics and Research Committee, provided approval for this study protocol (2023RC-022-LIUSOP).

2.2. Measures

2.2.1. Demographics

Participants were asked to provide their age and sex.

2.2.1.1. The artificial intelligence literacy scale (AILS). It is composed of 12 items, scored on a seven-point Likert scale ('strongly disagree to strongly agree'), with higher scores reflecting higher AI literacy (Wang et al., 2023). This scale was translated from English into Arabic by a bilingual translator, whose native language is Arabic and who is fluent in English. Next, an expert committee formed by healthcare professionals and a linguistics expert verified the translated Arabic version of the scale. Subsequently, the Arabic version of the scale was back-translated into English by an independent translator who is fluent in Arabic and English. The back-translated measure was returned to the expert committee, who compared both translations and

aimed to resolve any inconsistencies between versions. During the translation and adaptation processes of the scale, no changes were made or were deemed necessary. In particular, item wording was not altered and the type/number of anchor points were not revisited (see Appendix 1). The translated AILS was first tested on 30 participants, for primitive scores that ensure that all questions are clear.

2.2.1.2. The 4-item scale of fear of autonomous robots and Artificial Intelligence (FARAI). Validated in Arabic (Fekih-Romdhane et al.), participants were asked four questions scored on a 5-point Likert scale ranging from not afraid (1), slightly afraid (2), afraid (3), to very afraid (4). Higher scores indicate more fear of autonomous robots and AI.

2.3. Statistical analysis

No incomplete responses were included in the dataset. The AILS factor structure was studied using Confirmatory Factor Analysis (CFA), originating from the total sample's data and processed by SPSS software AMOS v.29. To conduct CFA, the sample size must at least range from 3 to 20 times the number of variables of the adopted scale (Mundfrom et al., 2005). Thus, a 36–240 range of participants was the minimum sample size regarded necessary to establish adequate statistical power. The purpose was evaluating the scale's four-factor model and second-order model. The maximum likelihood method derived parameter estimates. Fit indices were calculated, such as the Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR). Good fit of the model to the data is indicated by values $\geq .90$ for TLI and CFI, $\leq .08$ for RMSEA and $\leq .05$ for SRMR (Hu & Bentler, 1999). Multivariate normality was not confirmed upon initial verification (Bollen-Stine $p = .002$; critical ratio >5). Hence, the subsequent procedure application of non-parametric bootstrapping. Items with factor loading below 0.4 were removed since those items would indicate a weak relationship between the item and the underlying construct and they contribute less to the explanation of the construct variance. Therefore, removing these items can improve the model fit indices and make the model more robust.

2.3.1. Measurement invariance

By employing the total sample, a multi-group CFA was carried out to compute AILS scores' country and sex

invariance (Chen, 2007). Invariance of measurements was assessed at the scalar, metric and configural levels (Vadenberg & Lance, 2000). Evidence of invariance was approved for $\Delta CFI \leq .010$ and $\Delta SRMR \leq .010$ or $\Delta RMSEA \leq .015$ (Chen, 2007). These thresholds have emerged from methodological literature as reasonable benchmarks for evaluating measurement invariance. They create a balance between sensitivity to detect meaningful differences across groups and the practical need to maintain comparability of constructs.

Cronbach's α and McDonald's ω were used to evaluate composite reliability, whereby adequate composite reliability is indicated by values greater than .70. For each item in this scale, kurtosis and skewness values ranged from -1 to $+1$; hence verifying the normality of AILS subscales scores (Hair et al., 2021). Pearson test was used for testing the correlation between FARAI scores and AILS scores, to assess concurrent validity. The strength of correlation was deemed as weak, moderate or strong if the correlation coefficients were around 0.2, 0.5 and 0.8 respectively (Cohen, 1988). The Student's t -test was employed to conduct sex-based comparison, in cases of partial scalar or scalar invariance, while the ANOVA test was used to compare the AILS scores between the four countries. Bonferroni test was used to perform post-hoc analysis, to distinguish significant differences between countries, when compared two by two.

3. Results

A total of 1849 university students answered the survey, with a mean age of 21.37 ± 3.84 years and 74.3% females. The details by country are found in Table 1.

The fit indices of the different models tested deriving from the confirmatory factor analysis are summarized in Table 2. CFA indicated that fit of the

four-factor model of AILS scores was modest at first. We removed items 2, 5 and 12 since they had low loading factor (below 0.4). Consequently, we re-ran the CFA on the remaining items and that model showed excellent fit indices. The standardized estimates of factor loadings of this model were all adequate (Figure 1). The second-order CFA showed also good fit indices. The AVE value was satisfactory = .63. Internal reliability was excellent for the total score ($\omega = .92$; $\alpha = .92$). Convergent validity of the scale was good as shown by the average variance extracted value of .63 ($>.50$).

3.1. Measurement invariance

Indices suggested that configural, metric, and scalar invariance was supported across sexes and countries (Table 3). Higher AILS scores were significantly found in males compared to females (53.85 ± 12.48 vs. 52.07 ± 11.38 , $t(1837) = 2.73$, $p = .006$).

In terms of countries, a higher mean AILS score was found in Morocco (54.17 ± 11.45) compared to Palestine (52.72 ± 11.60), Saudi Arabia (51.83 ± 12.01) and Lebanon (51.56 ± 11.67), $F(3,1835) = 4.99$, $p = .002$, with a significant difference seen between Lebanon and Morocco ($p = .002$) and Morocco and Saudi Arabia ($p = .029$).

3.2. Concurrent validity

Higher FARAI scores were significantly but weakly associated with lower AILS scores ($r = -.05$; $p = .022$).

4. Discussion

This paper aimed at evaluating psychometric properties of an adapted Arabic translation of the AILS, for assessing the current state AI literacy among Arabic

Table 1. Description of the sample by country.

	Total (n=1849)	Saudi Arabia (n=348)	Morocco (n=469)	Lebanon (n=629)	Palestine (n=403)
Age (years)	21.37 ± 3.84 [min = 18; max = 40]	21.71 ± 4.26 [min = 18; max = 40]	21.45 ± 5.01 [min = 18; max = 40]	22.25 ± 2.86 [min = 18; max = 40]	19.59 ± 2.39 [min = 18 ; max = 40]
Sex					
Males	475 (25.7%)	48 (13.8%)	111 (23.7%)	235 (37.4%)	81 (20.1%)
Females	1374 (74.3%)	300 (86.2%)	358 (76.3%)	394 (62.6%)	322 (79.9%)
Household crowding index	1.39 ± .78	1.08 ± .46	1.84 ± 1.03	1.08 ± .47	1.64 ± .68
Living area					
Urban	1334 (72.1%)	340 (97.7%)	359 (76.5%)	404 (64.2%)	231 (57.3%)
Rural	515 (27.9%)	8 (2.3%)	110 (23.5%)	225 (35.8%)	172 (42.7%)
Prior use of AI					
Never	386 (20.9%)	49 (14.1%)	72 (15.4%)	170 (27.0%)	95 (23.6%)
Yes, rarely	368 (19.9%)	58 (16.7%)	83 (17.7%)	129 (20.5%)	98 (24.3%)
Yes, sometimes	590 (31.9%)	106 (30.5%)	166 (35.4%)	186 (29.6%)	132 (32.8%)
Yes, often	305 (16.5%)	70 (20.1%)	93 (19.8%)	90 (14.3%)	52 (12.9%)
Yes, always	200 (10.8%)	65 (18.7%)	55 (11.7%)	54 (8.6%)	26 (6.5%)

speaking university students from four countries. To the best of our knowledge, results are the first to report an Arabic translation of the AILS, with results reflecting AI literacy on a regional level, to Arabic-speaking university students. The findings offer primary insights into psychometric properties of the AI literacy scale among students in Arab universities, paving the way into regional and cross-country validation of this scale.

The Arabic version replicated the four-factor structure of the AILS that was shown in the original (Wang et al., 2023) and Turkish (Çelebi et al., 2023) validation papers. However, three items (2, 5 and 12) were removed from the Arabic version because of low factor loading (less than 0.4) contributing less to the explanation of the construct variance, but the organizational level of the construct (the distribution of items in the factors) did not change. All remaining

items had good factor loading. Consequently, re-running the CFA on the remaining items showed excellent fit indices for that model. The removal of the three items 'I do not know how AI technology can help me', 'It is usually hard for me to learn to use a new AI application or product', and 'I am always alert to the abuse of AI technology' might be explained by the difference in terms of AI between Arab and Western countries in terms of economic, cultural, social, institutional, affordability, cost-effectiveness and satisfying public demands (Tachkov et al., 2022). Removing these items improved the model fit indices, as shown in Table 2, and made the model more robust. It also led to a good convergent validity of the overall scale, seen by the average variance extracted value of .63 (>.50). The Arabic-speaking population targeted in this study is different from the culture in China, which may account for the difference in results. China has better infrastructure that supports AI, as well as more advanced fields of education and work that use AI in their daily tasks; hence their higher exposure to AI as compared to most Middle Eastern and North African countries.

Internal consistency reliability coefficients were excellent, with McDonald $\omega = .92$ and Cronbach $\alpha = .92$. Those values were higher than the ones reported by the original (Wang et al., 2023) and Turkish (Çelebi et al., 2023) validation. Moreover,

Table 2. Fit indices of the different models tested deriving from the confirmatory factor analysis.

	RMSEA [90% CI]	SRMR	CFI	TLI
Four factors	.112 [.106; .118]	.078	.909	.875
Four factors model after removal of items 2, 5 and 12	.077 [.069; .086]	.023	.979	.965
Second order	.074 [.066; .082]	.023	.979	.967

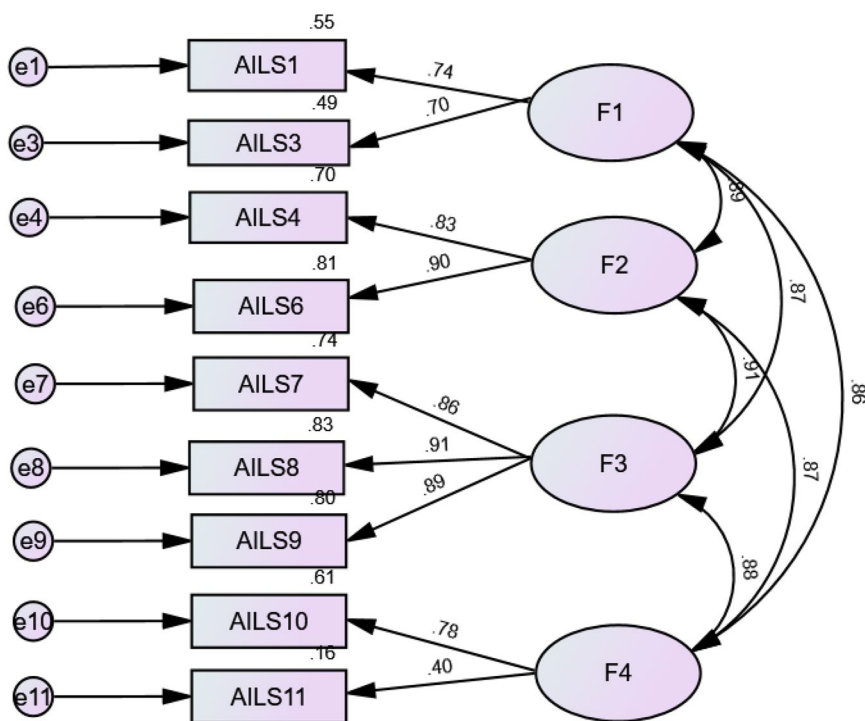


Figure 1. Standardised estimates of factor loadings from the confirmatory factor analysis in the total sample. This figure shows the loading of each item onto its corresponding factor and the correlation coefficients between factors.

Table 3. Measurement invariance across sex and country in the total sample.

Model	CFI	RMSEA	SRMR	Model comparison	Δ CFI	Δ RMSEA	Δ SRMR
Model 1: Sex							
Males	.961	.084	.052				
Females	.959	.075	.043				
Configural	.960	.055	.052				
Metric	.958	.053	.063	Configural versus metric	.002	.002	.011
Scalar	.956	.053	.064	Metric versus scalar	.002	<.001	.001
Model 2: Country							
Lebanon	.957	.094	.055				
Saudi Arabia	.948	.091	.055				
Morocco	.963	.066	.045				
Palestine	.959	.069	.046				
Configural	.957	.041	.055				
Metric	.955	.039	.065	Configural versus metric	.002	.002	.010
Scalar	.944	.042	.065	Metric versus scalar	.011	.003	<.001

Abbreviations: CFI=Comparative fit index; RMSEA=Steiger-Lind root mean square error of approximation; SRMR=Standardised root mean square residual.

scalar, metric and configural invariance was supported across sexes. Our study is the first to show an invariance across sexes, hence this study's contribution and uniqueness in bridging the gap of sexes invariance in the literature. Males showed higher AI literacy than females in our study, in agreement with the results of a meta-analysis that showed a better attitude towards AI in males (Cai et al., 2017). This might be because females may exhibit a higher threshold for competence before engaging with new technology, leading to a reluctance to embrace AI without a strong foundation in related areas (Blockchain Council, 2023). Females may express more caution regarding the regulation of AI and its impact on society, potentially influencing their decision to adopt AI technologies (Blockchain Council, 2023). Findings of higher AI literacy in males, as compared to females, implies the necessity to strengthen the foundations of AI technology and practices for Arab female university students. The AILS showed invariance across countries, which allows sound comparisons of AILS scores to be made across the different country groups. Significant differences were found in AILS levels between participants of different nationalities, with the highest scores being reported by Moroccans, followed by Palestinians, Saudi Arabians and Lebanese students. AI technology is not yet fully implemented in the Arab region, despite the fact that the United Arab Emirates and Saudi Arabia have shown strong commitments to implementing and enhancing AI literacy and skills (Al Muscati, 2023). Other countries may be less advanced in this area due to limited resources, lack of infrastructure, and insufficient access to trained personnel (PWC Middle East, 2023). It is of note that a systematic review of available literature on AI literacy measures found that none of the scales were tested for cross-cultural validity and

measurement error (Lintner, 2024). Thus, the practical implications offered by this study extend to being the first publication to report a cross-cultural validity, between different Arab-speaking countries ranging from the Middle East (Lebanon, Palestine and Saudi Arabia) to North Africa (Morocco). In the literature, the AI literacy scale has been revalidated in Turkish language as recently as 2023, being culturally and geographically the closest country to our target population. However, no direct cross-cultural validation was reported in either of their studies. Cross-cultural validity offers significant implications in AI literacy studies, whereby it gives insight into the performance of items on a culturally adapted (translated) scale. It is also an adequate reflection of the items' performance, belonging to the original version of the scale (Lintner, 2024). Hence, this study contributes by reporting to the literature from a cultural validity standpoint.

Furthermore, higher fear of AI correlated significantly with lower AILS score. A study by Schiavo et al. (2024) reported how acceptance of AI technology is influenced by reported literacy (hence AILS) and anxiety (fear of AI's society impact). Results of this survey highlight that literacy allows for a positive attitude to acceptance of AI, yet anxiety relates to a minimal but significant direct negative effect, along with a significant role for influence mediation of AI literacy.

4.1. Implications

The findings of this study shed the light on AI literacy, by using statistical measurements of CFA, measurement invariance and concurrent validity that clarify the implications of AI literacy in the Arab context. By making them more prepared to tackle AI interfaces, an increase in AI literacy across Arab

countries' demographics is bound to take place. Similarly, providing resources such as proper infrastructure and trained personnel can offer Arab countries the tools needed to enhance their AI literacy and counter any fear caused by lack of knowledge in the field of AI. At the level of education and pedagogy, making an Arabic version of the AILS available can guide course designs and development at the higher education system, to include AI in both curricula and assessment settings. In addition, assessing AI literacy through scale reliability could be used to characterize study populations in AI-related research. It is important that such assessment instruments meet psychometric quality criteria. Hence the importance of a valid AI literacy scale, adapted to the native language spoken by university students. Including the AILS at the freshman or sophomore level of university educational programs would allow scholars and instructors to design courses, customized to fit each generation's AI gaps. Hence allowing for a more effective syllabus design, adapted for a futuristic curriculum that includes AI into its educational programs. The design of scales such as the AILS is considered essential for evaluating teaching effectiveness of AI at the level of higher education like universities. Tools designed to assess AI literacy also offer the advantage of comparing the level of AI literacy of various subgroups (such as medical students), pinpoint their weaknesses and strengths, subsequently allowing the development of learning opportunities based on the findings (Laupichler et al., 2023). Researchers might benefit from psychometric properties of the Arabic AILS to assess and monitor the extent to which students learn central AI concepts for their careers in the future, while understanding ethical concerns that allow for a responsible AI use (Ng et al., 2021).

4.2. Study limitations

This study recruited university students through online convenience sampling; the latter tends to recruit participants who are interconnected, which can lead to a non-random sample. Certain groups of the population may be under- or overrepresented in snowball samples, which can skew the findings. Therefore, the results cannot be generalized to the wider Arab populations. To mitigate these biases, future studies should use a randomized sampling for better generalization of the results. The refusal rate is unknown, which adds to the selection bias. Moreover, females were more predominant than males in our

sample predisposing us to a selection bias. This demographic skew towards females impacts the social relevance of reported results. Proper randomization is not achieved in cases of selection bias, since the sample at hand is not representative of the population. Once again, randomization of sampling can bypass this bias by removing the demographic tilt towards women participants. We collected data using self-reported measures and may therefore be subject to social desirability effects. The self-reported nature of the data allows for social desirability bias, a type of response bias whereby participants tend to answer questions in a manner that seems favorable or acceptable by society. To overcome this bias, data from high-scoring participants can be rejected, or their high-score data corrected. Future studies should assess other psychometric qualities of the Arabic AILS, such as test-retest reliability or convergent validity.

5. Conclusion

The current study aims to validate the Arabic version of the AI literacy questionnaire, in a multinational context. The Arabic AILS was found to be valid, reliable and suitable for use among Arabic speaking university students. Input of university students from Morocco, Lebanon, Saudi Arabia and Palestine conclude with results of a higher AILS score in males and a higher mean AILS found in Morocco. Higher fear of AI scores were significantly but weakly associated with lower AI literacy scores. In the field of AI literacy, this study adds to existing literature by providing an Arabic measurement instrument for AI literacy that is based on the current literature on AI literacy. Its role includes important psychological constructs and reports a valid factorial structure. The uniqueness of this study lies in its contributions to the field of AI literacy, in the Middle East region and specifically to the Arabic-speaking population. The availability of AILS in Arabic may lead to a better understanding of the literacy properties correlated to AI, in both linguistic and regional contexts. This becomes relevant in terms of research on AI and its applications in the educational field, particularly among university students who are nowadays highly exposed to this technology.

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Ethics approval and consent to participate

The Ethics and Research Committee of the School of Pharmacy at the Lebanese International University approved this study protocol (2023RC-022-LIUSOP). Submitting the form online was considered equivalent to obtaining a written informed consent. All methods were performed in accordance with the relevant guidelines and regulations.

Author contributions

SH, FFR and SO involved in the study design. EH wrote the manuscript; DM, NM, TR, RA, KJ, BZ, FS, MD, AA, HAMS were responsible for the data collection. SH involved in data analysis and interpretation. RH revised the paper for intellectual content. All authors approved its final version.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Availability of data and materials

All data generated or analyzed during this study are not publicly available. The dataset supporting the conclusions is available upon request to the corresponding author (SH).

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Appendix 1. Artificial Intelligence Literacy Scale – English and Arabic items

يمكنني التمييز بين الأجهزة الذكية وغير الذكية.

I can distinguish between smart devices and non-smart devices

لا أعرف كيف يمكن أن تساعدني تقنية الذكاء الاصطناعي

I do not know how AI technology can help me

يمكنني تحديد تقنية الذكاء الاصطناعي المستخدمة في التطبيقات والمنتجات التي أستخدمها

I can identify the AI technology employed in the applications and products I use

يمكنني مهارة استخدام تطبيقات أو منتجات الذكاء الاصطناعي لمساعدتي في عملي اليومي

I can skillfully use AI applications or products to help me with my daily work.

عادة ما يكون من الصعب علي تعلم استخدام تطبيق أو منتج جديد للذكاء الاصطناعي

It is usually hard for me to learn to use a new AI application or product.

يمكنني استخدام تطبيقات أو منتجات الذكاء الاصطناعي لتحسين كفاءة عملي

I can use AI applications or products to improve my work efficiency.

يمكنني تقييم إمكانيات وقيود تطبيق أو منتج للذكاء الاصطناعي بعد استخدامه لفترة من الوقت

I can evaluate the capabilities and limitations of an AI application or product after using it for a while

يمكنني اختيار الحل المناسب من بين الحلول المختلفة التي يقدمها الوكيل الذكي

I can choose a proper solution from various solutions provided by a smart agent

يمكنني اختيار أنسب تطبيق أو منتج للذكاء الاصطناعي من مجموعة متنوعة مهمة معينة

I can choose the most appropriate AI application or product from a variety for a particular task

ألتزم دائماً بالمبادئ الأخلاقية عند استخدام تطبيقات أو منتجات الذكاء الاصطناعي

I always comply with ethical principles when using AI applications or products

لا أكون في حالة تأهب مطلقاً لقضايا الخصوصية وأمن المعلومات عند استخدام تطبيقات أو منتجات الذكاء الاصطناعي

I am never alert to privacy and information security issues when using AI applications or products

أنا دائماً في حالة تأهب لإساءة استخدام تقنية الذكاء الاصطناعي

I am always alert to the abuse of AI technology