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Nomophobia Questionnaire (NMP-Q) Across China, Bangladesh, Pakistan, and Iran: Confirmatory Factor Analysis, Measurement Invariance, and Network Analysis

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Abstract

The popularity and advancement of smartphones generate a new phenomenon of smartphone addiction. To promote early identification of individuals at risk of smartphone addiction, healthcare providers could assess if an individual has nomophobia (i.e., anxiety and worry of having no smartphone at hand). The present study aimed to evaluate the psychometric properties of the Nomophobia Questionnaire (NMP-Q) across four countries: China, Bangladesh, Pakistan, and Iran. Via cross-sectional design and convenience sampling, 7871 participants (5969 Chinese, 534 Bangladeshi, 666 Pakistani, and 702 Iranian) completed the NMP-Q. Confirmatory factor analysis (CFA) and network analysis were used to examine the psychometric properties of the NMP-Q across the four countries. CFA identified a four-factor structure (Tucker-Lewis index = 0.934, comparative fit index = 0.943, standardized root mean square residual = 0.037, and root mean square error of approximation = 0.079) for the NMP-Q, and the four-factor structure was measurement invariant across genders and countries. Network analysis results supported the CFA findings via visualized correlations among the NMP-Q items. The four-factor structure of the NMP-Q was consistently found in the four countries of China, Bangladesh, Pakistan, and Iran, indicating that the NMP-Q includes four specific domains. Measurement invariance suggests the NMP-Q may effectively assess nomophobia across genders and countries.

Keywords Internet addiction · Factor analysis · Measurement invariance · Network · Nomophobia · Cross-country

The benefits of the internet have increased with the development and utilization of smartphones. With Wi-Fi access, individuals on smartphones worldwide can engage in different types of virtual activities for a variety of purposes, including entertainment, work, or social

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interactions (Chang et al., 2023; Lin et al., 2023; Nurmala et al., 2022). Although smartphones have been designed and developed to help people live better lives, a minority of individuals exhibit problematic smartphone use (PSU) and associated problems such as problematic use of porn and problematic gaming (Ahorsu et al., 2023; Chang et al., 2022; Kakul et al., 2023; Pramukti et al., 2023; Saffari et al., 2022; Xu et al., 2022). PSU often involves strong desires or cravings focused on smartphone use (Chen, Pakpour, et al., 2020; Huang et al., 2022; Lin et al., 2019). Unlike gaming disorder as a form of specific internet addiction (Chen et al., 2023; Ghazi et al., 2023; Wu et al., 2023), PSU may constitute a behavioral addiction as a form of generalized internet addiction (Chen, Strong, et al., 2020; Leung et al., 2020).

Associations between PSU and health problems (e.g., psychological distress, sleep problems, and musculoskeletal discomfort) have been documented (Alimoradi et al., 2019; Wong et al., 2020; Yang et al., 2017). Apart from the hardware features of smartphones (e.g., blue light) that may contribute to health problems (Wong et al., 2020), a dependency on smartphone activities or apps may contribute to PSU. PSU may promote different health problems (e.g., sleep problems, musculoskeletal discomfort related to poor posture) (Alimoradi et al., 2019; Huang et al., 2023; Kamolthip et al., 2022; Lin et al., 2021; Kukreti et al., 2021; Yang et al., 2017).

Individuals with PSU may experience anxiety if their smartphone is not available (Lee et al., 2023; Liu et al., 2022). This anxiety has been termed nomophobia (derived from no-mobile phone phobia). Nomophobia may link to or promote PSU. Therefore, assessing nomophobia may be important for healthcare providers to evaluate if an individual is at elevated risk of having or developing PSU. Moreover, the relationship between nomophobia and PSU could be bidirectional. Specifically, when an individual develops the dependency of smartphone use, the individual is likely to be anxious of not having smartphone at hand and result in nomophobia (Liu et al., 2022). In addition, when an individual has nomophobia, the individual is likely to addict to smartphone use because of the individual would always have smartphone accessible (Karaoglan et al., 2023).

A commonly used instrument for assessing nomophobia is the Nomophobia Questionnaire (NMP-Q) (Yildirim & Correia, 2015). The NMP-Q was developed by King et al., (2010, 2013, 2014) who initially observed phobic phenomena among people using mobile phones or computers. Subsequently, King et al., (2014) redefined nomophobia with a focus on mobile phones: "Nomophobia is the modern fear of being unable to communicate through a mobile phone (MP) or the Internet…Nomophobia is a term that refers to a collection of behaviors or symptoms related to MP use. Nomophobia is a situational phobia related to agoraphobia and includes the fear of becoming ill and not receiving immediate assistance" (p.28). However, given that smartphones have supplanted earlier types of mobile phones worldwide, the present authors argue that nomophobia can be extended to or focused on smartphones.

The NMP-Q has been validated across different languages, including Spanish (González-Cabrera et al., 2017), Persian (Lin et al., 2018), Chinese (Gao et al., 2020), English (Tung et al., 2022), Greek (Gnardellis et al., 2023), Portuguese (Galhardo et al., 2020), and Indonesian (Rangka et al., 2018). Different methods of psychometric evaluation (e.g., confirmatory factor analysis and Rasch analysis) have been used to test the psychometric properties of the NMP-Q. However, to the best of the present authors' knowledge, the present literature lacks the following psychometric evidence for NMP-Q. First, the NMP-Q has never been translated properly into Bangla and Pakistani languages. Therefore, the Bangla and Pakistani versions of the NMP-Q have yet to be validated. Second, although measurement invariance of the NMP-Q has been examined across genders (e.g., Lin et al., 2018), such psychometric evidence is based on one language version. Therefore, it is unclear if such measurement invariance is consistent across different language versions. Additionally, it is unclear if the NMP-Q is measurement invariant across countries. Third, a

relatively new method in psychometric testing (i.e., network analysis) has never been used to examine the psychometric properties of the NMP-Q.

Although network analysis has been used for decades (Li et al., 2022), its use for testing psychometric properties is more recent. Network analysis has been described as using the "shape" of connections on graphs to visualize the properties of each node's (i.e., NMP-Q items in the present study) structure, positions, and dyadic properties (Borgatti et al., 2009). Via the visualized properties, social science researchers can clearly present how the nodes relate to each other, providing insight into psychometric networks (Borsboom et al., 2021). Therefore, network analysis uses nodes and edges (i.e., the correlation magnitudes between nodes) to explore potential model structure via a flexible and robust manner that does not have strong theoretical assumptions (Lecuona et al., 2022). In addition, network analysis illustrates and estimates the model structure for different subsamples (e.g., gender and country subgroups in the present study). Subsequently, the visualized patterns can be compared across the subsamples and help researchers to explore potential variations (or lack thereof) in measurement.

Given that the NMP-Q has not yet been translated and validated for use among Bangla and Pakistani populations, the first aim of the present study was to do so. The present study also aimed to examine if the NMP-Q was measurement invariant across genders and several Asian countries including China, Bangladesh, Pakistan, and Iran. The four countries were chosen for comparison because they are all Asian countries but located in different regions of Asia: China in East Asia, Bangladesh and Pakistan in South Asia, and Iran in West Asia. Therefore, using the four countries could provide a relatively full picture of NMP-Q in Asian populations. In addition, network analysis was used in to examine item features of the NMP-Q across genders and the aforementioned countries. With such psychometric information, healthcare providers in these countries may have a better understanding of how to validly assess nomophobia.

Methods

Participants and Data Collection

Participant recruitment and data collection procedures have been described elsewhere (Kukreti et al., 2021; Li et al., 2022; Liu et al., 2022), with the only inclusion criterion that aged 18 years or above. Several ethics committees approved study procedures (For Chinese participants: Guangzhou Sport University and Jianxi Psychological Consultant Association; for Bangladeshi participants: Institute of Allergy and Clinical Immunology of Bangladesh; for Pakistani participants: Department of Psychology, University of Sargodha, Sargodha, Pakistan; and for Iranian participants: Qazvin University of Medical Sciences). The study procedures adhered to the Declaration of Helsinki. Briefly, Chinese participants were recruited in two waves (October to November 2020 and November to December 2021); Bangladeshi participants were recruited between October and December 2020; Pakistani participants were recruited between March and July 2020; and Iranian participants were recruited between March and July 2020. Although Chinese participants were recruited in two waves, collecting data from different time points is not a serious bias to the present study's aim (i.e., validating the NMP-Q). Specifically, validation research needs to have participants with different levels of PSU and nomophobia and recruiting participants from different waves could increase the chance of having participants with different levels

of problematic smartphone use and nomophobia. All Chinese, Bangladeshi, and Pakistani participants were recruited using convenience sampling, and Iranian participants were recruited using random sampling from five universities in Qazvin. Regardless of country, all participants completed questionnaires via online surveys after they provided e-consent.

Nomophobia Questionnaire (NMP-Q)

The NMP-Q is a 20-item questionnaire assessing four domains of nomophobia: (i) not being able to communicate (six items), (ii) losing connectedness (five items), (iii) not being able to access information (four items), and (iv) giving up convenience (five items). All NMP-Q items are rated using a seven-point Likert scale from *strongly disagree* (scoring 1) to *strongly agree* (scoring 7). A summed score of the NMP-Q can be computed for the entire NMP-Q and each domain, with higher summed scores reflecting more severe nomophobia (Yildirim & Correia, 2015). Apart from the good psychometric properties shown in its original version, the NMP-Q has been translated into Chinese and Persian with good properties confirmed in Chinese and Iranian populations (Gao et al., 2020; Lin et al., 2018). However, given that the NMP-Q had never been translated into Bangla and Pakistani, the present authors translated the NMP-Q into Bangla and Pakistani according to rigorous international guideline proposed by Beaton, (2000). Specifically, two independent forward translations, two independent back translations, and expert panel discussion were adopted for Bangla and Pakistani NMP-Q translations to ensure their linguistic validity.

Data Analysis

Descriptive analysis was conducted using SPSS 20 and confirmatory factor analysis (CFA), and invariance testing was conducted using Mplus 7. Network analysis and the network comparison test (NCT) were performed utilizing JASP (Jeffrey's Amazing Statistics Program) and the R package, respectively.

The Tucker-Lewis Index (TLI, > 0.90), comparative fit index (CFI, > 0.90), root mean square error of approximation (RMSEA, < 0.08) (90% C.I.), and standardized root mean square residual (SRMR, < 0.08) were used to analyze CFA fit (McDonald & Ho, 2002; Byrne, 2013). A second-order model was also tested using Mplus 7. In addition, measurement invariance involving configural, metric, scalar, and error variance invariance, as well as structure invariance involving factor variance-covariance (i.e., factorial invariance), and latent mean invariance were assessed to examine further changes in the model fit across genders (Cheung & Rensvold, 2002; Little, 1997). Additionally, ΔCFI (≤ 0.01) was tested to verify measurement invariance and structural invariance (Wang, 2014).

The EBICglasso model was based on the Extended Bayesian Information Criterion (EBIC; Chen & Chen, 2008) and a graphical least absolute shrinkage and selection operator (LASSO; Friedman et al., 2008) regularization. The network system included nodes and edges. The centrality of nodes in the network was calculated including betweenness, closeness, strength, and expected influence (Epskamp et al., 2012). The network accuracy was examined through edge-weight accuracy, centrality stability, and testing for significant differences in nodes and edges (Epskamp et al., 2018). The nonparametric bootstrap (i.e., 1000 samples) was utilized to calculate edge-weight accuracy and test for significant differences in nodes and edges, while the case-dropping subset bootstrap (95% confidence intervals) was utilized to assess the stability of centrality indices (Epskamp et al., 2018). The correlation stability coefficient (CS-coefficient) (> 0.5) represents better node centrality

stability (Epskamp et al., 2018). The tuning parameter was set to 0.5 for a more parsimonious and easier explainable network (i.e., fewer edges, higher specificity, and sensitivity). Thicker edges and thinner edges represent stronger correlation and weaker correlation, respectively. Edge stability was estimated through 1000 times 95% (confidence interval) bootstrapping. The NCT was conducted to compare the structure network and the global network strength across gender.

Results

Descriptive Analysis of Variables

Among all participants ($N = 7871$), average total NMP-Q scores for males, females, and those who preferred not to say were 70.26, 78.32, and 78.06, respectively. For different countries, average total NMP-Q scores ranged from 72.61 to 93.16 (Table 1).

Confirmatory Factor Analysis (CFA)

The 20-item and four-factor model fit well ($\chi^2 = 8156.96$, df = 163, $p < 0.01$; TLI = 0.934; CFI = 0.943; SRMR = 0.037; RMSEA = 0.079) (Table 2). A second-order model was conducted and it verified the well-fitting structure of the NMP-Q ($\chi^2 = 5181.74$, df = 165, $p < 0.01$; TLI = 0.937; CFI = 0.945; SRMR = 0.040; RMSEA = 0.062) (Table 2).

Invariance Testing

As shown in Table 2, invariance testing was conducted including measurement invariance (i.e., configural, metric, scalar, and error variance invariance) and structural invariance (i.e., factor variance-covariance and latent mean invariance). The results of configural invariance showed that TLI and CFI were 0.938 and 0.946 ($\chi^2 = 5169.03$, df = 328, SRMR = 0.037, RMSEA = 0.061) for 7855 participants. The following TLI and CFI results for the different nested models testing measurement invariance in the sample ($N = 7855$) were metric (0.939 and 0.945), scalar (0.939 and 0.942), error variance (0.943 and 0.943), factor variance-covariance (0.940 and 0.942), and latent mean invariance (0.939 and 0.940) (Table 2). There was no statistically significant difference in gender (ΔCFI <

Table 1 Socio-demographic characteristics and NMP-Q scores ($N = 7871$)

Variables		N (%) mean $\pm$ SD	NMP-Q mean $\pm$ SD
Age, years		21.78 ± 6.00	
Gender	Male	2992 (38%)	70.26 ± 27.87
	Female	4863 (61.8%)	78.32 ± 27.27
	Preferred not to say	16 (0.2%)	78.06 ± 34.30
Country	China	5969 (75.8%)	74.07 ± 27.39
	Bangladesh	534 (6.8%)	93.16 ± 23.96
	Pakistan	666 (8.5%)	72.61 ± 29.39
	Iran	702 (8.9%)	74.27 ± 27.57

Table 2 Data-model fit of the NMP-Q in CFA and testing of gender invariance

Model	χ^2	df	TLI	CFI	SRMR	RMSEA (90% CI)	ΔCFI
20-item four-factor CFA (N = 7871)	8200.126	164	0.934	0.943	0.037	0.079 (0.077, 0.080)	
Second-order model 20-item four-factor CFA (N = 7871)	5224.70	166	0.937	0.945	0.040	0.062 (0.061, 0.064)	
Male (N = 2992)	3002.51	164	0.939	0.948	0.034	0.076 (0.074, 0.078)	
Female (N = 4863)	5456.31	164	0.928	0.938	0.039	0.081 (0.080, 0.083)	
China (N = 5969)	8088.34	164	0.921	0.932	0.043	0.090 (0.088, 0.092)	
Bangladesh (N = 534)	792.54	164	0.896	0.910	0.063	0.085 (0.079, 0.091)	
Pakistan (N = 666)	909.70	164	0.928	0.938	0.049	0.083 (0.077, 0.088)	
Iran (N = 702)	696.96	164	0.937	0.946	0.034	0.068 (0.063, 0.073)	
Measurement invariance of gender							
Configural invariance[a] (N = 7855)	5169.03	328	0.938	0.946	0.037	0.061 (0.060, 0.063)	
Metric invariance[b] (N = 7855)	5331.02	344	0.939	0.945	0.039	0.061 (0.059, 0.062)	0.001
Scalar invariance[c] (N = 7855)	5541.04	360	0.939	0.942	0.040	0.061 (0.059, 0.062)	0.003
Error variance invariance[d] (N = 7855)	5492.49	380	0.943	0.943	0.040	0.059 (0.057, 0.060)	0.001
Structural invariance of gender							
Factor variance-covariance invariance[e] (N = 7855)	5595.05	370	0.940	0.942	0.043	0.060 (0.059, 0.061)	
Latent mean invariance[f] (N = 7855)	5794.31	374	0.939	0.940	0.055	0.061 (0.059, 0.062)	0.002
Measurement invariance of country							
Configural invariance[a] (N = 7871)	8595.64	720	0.920	0.924	0.053	0.075 (0.073, 0.076)	
Metric invariance[b] (N = 7871)	8694.20	736	0.921	0.923	0.053	0.074 (0.073, 0.076)	0.001
Scalar invariance[c] (N = 7871)	9251.67	752	0.917	0.918	0.056	0.076 (0.074, 0.077)	0.005
Error variance invariance[d] (N = 7871)	11428.42	812	0.904	0.898	0.057	0.082 (0.080, 0.083)	0.020
Structural invariance of country							
Factor variance-covariance invariance[e] (N = 7871)	9555.49	782	0.918	0.915	0.074	0.076 (0.074, 0.077)	
Latent mean invariance[f] (N = 7871)	10504.28	794	0.910	0.906	0.092	0.079 (0.077, 0.080)	0.009

ΔCFI = [a] vs. [b]; [b] vs. [c]; [c] vs. [d]; [e] vs. [f]

0.01). These results indicate that the NMP-Q had good measurement and structural invariance across genders. For four countries, the result of configural invariance showed that TLI and CFI were 0.920 and 0.924 (χ^2 = 8595.64, df = 720, SRMR = 0.053, RMSEA = 0.075) for 7871 participants. The following TLI and CFI results for the different nested models testing measurement invariance in the sample (N = 7871) were metric (0.921 and 0.923), scalar (0.917 and 0.918), error variance (0.904 and 0.898), factor variance-covariance (0.918 and 0.915), and latent mean invariance (0.910 and 0.906) (Table 2). There was no statistically significant difference in countries (all ΔCFI < 0.01, except for a marginal ΔCFI in error variance invariance [0.020]). These results indicated that the NMP-Q had good measurement and structural invariance across different countries.

Network Analysis

EBICglasso Network Analysis The EBICglasso network of the 20-item NMP-Q is shown in Fig. 1. Node y10 ("If I did not have my smartphone with me, I would feel anxious because I could not instantly communicate with my family and/or friends") and node y11 ("If I did not have my smartphone with me, I would be worried because my family and/or friends could not reach me") had the strongest edge intensity (r = 0.499) among participants (Appendix S1). Node y11 had the highest strength centrality (strength = 1.812). Node y17 ("If I did not have my smartphone with me, I would be uncomfortable because I could not stay up-to-date with social media and online networks") also had higher strength centrality (strength = 1.628) (Appendices S2-S3). The stability of node strength (CS = 0.75) represented better centrality stability. The tests for significant differences indicated that the edges y10–y11 and y5 ("Running out of battery in my smartphone would scare me") to y6 ("If I were to run out of credits or hit my monthly data limit, I would panic") were significantly different from each other. All node strengths were also significantly different from each other (Appendix S4). The factor-level network including not being able to communicate, losing connectedness, not being able to access information, and giving up convenience are shown in Fig. 2. The edge f2 ("losing connectedness") had the equal strongest intensity with f1 ("not being able to communicate") and f3 ("not being able to access information") (both r-values = 0.423) (Appendix S6). Node f2 had the highest strength centrality (strength = 1.300) (Appendices S7-S8). The stability of factor-node strength (CS = 0.75) represented better centrality stability. The tests for significant
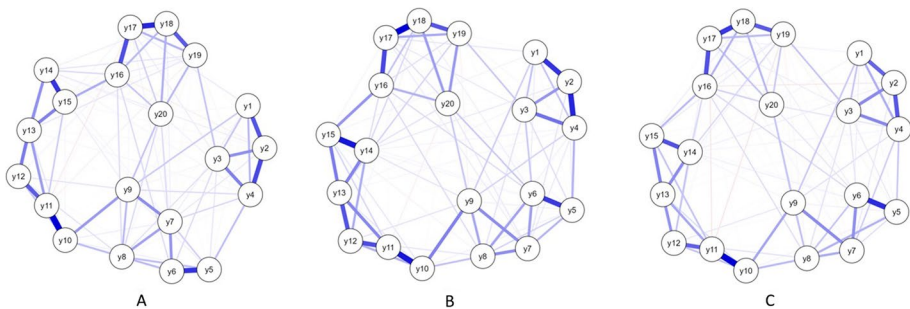

Fig. 1 EBICglasso model based on network analysis according to the NMP-Q among 7855 participants (**A**) and in males (**B**) and females (**C**). Note: y1–y20, NMP-Q; y1–y4, not being able to communicate; y5–y9, losing connectedness; y10–y15, not being able to access information; y16–y20, giving up convenience
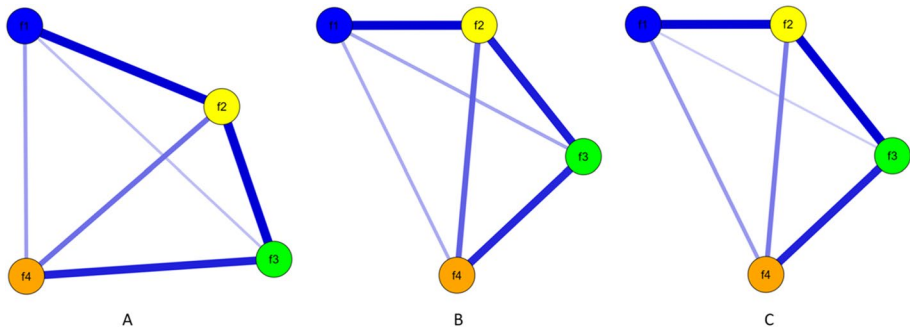
Fig. 2 EBICglasso model based on network analysis according to the NMP-Q among 7855 participants (**A**) and in males (**B**) and females (**C**). Note: f1, not being able to communicate; f2, losing connectedness; f3, not being able to access information; f4, giving up convenience

differences indicated that the edges f1 ("Not being able to communicate") to f4 ("Giving up convenience") were significantly different from each other. All node strengths were also significantly different from each other (Appendix S8).

EBICglasso Network Analysis Across Gender In the item-level network, nodes y17 and y18 ("If I did not have my smartphone with me, I would feel awkward because I could not check my notifications for updates from my connections and online networks") had the strongest edge intensity for males ($r = 0.444$), whereas nodes y10 and y11 had the strongest edge intensity for females ($r = 0.518$). Nodes y18 and y11 had the highest centrality (strength) among males (1.489) and females (2.037), respectively (Appendices S9-S12). In the factor-level network, nodes f1 and f2 had the strongest edge intensity among males ($r = 0.431$), while f2 and f3 had the strongest edge intensity among females ($r = 0.432$). Node f2 had the highest strength among males (1.328) and females (1.301) (Appendices S13-S15).

Comparison of Network Between Gender The network structure had no significant gender-related differences at either the item-level ($M = 0.086$, $p = 0.181$) or factor-level ($M = 0.063$, $p = 0.064$). The global strength had no significant gender-related differences at item-level (9.74 vs. 9.91, $p = 0.361$) but did have a significant difference at factor-level (1.74 vs. 1.72, $p = 0.038$) utilizing NCTs.

EBICglasso Network Analysis Across Countries The EBICglasso networks of the item-level and factor-level NMP-Q across countries are shown in Figs. 3 and 4, respectively. In the item-level network, nodes y10 and y11 had the strongest edge intensities between China ($r = 0.518$) and Iran ($r = 0.487$). Nodes y1 and y2 ($r = 0.517$) and y11 and y13 ($r = 0.438$) had the strongest edge intensities between Bangladesh and Pakistan. Nodes y11 and y10 had the highest centrality (strength) between China (2.139) and Bangladesh (1.520, Appendices S16-S21), whereas nodes y18 and y4 had the highest centralities (strengths) between Pakistan (1.989) and Iran (1.535). In the factor-level network, node f2 had the highest strengths, with values ranging from 1.223 to 1.391 (Appendices S22-S24).

Comparison of Networks Among Countries The network structure had significant differences between China and other countries at either the item-level or factor-level (all $p <$
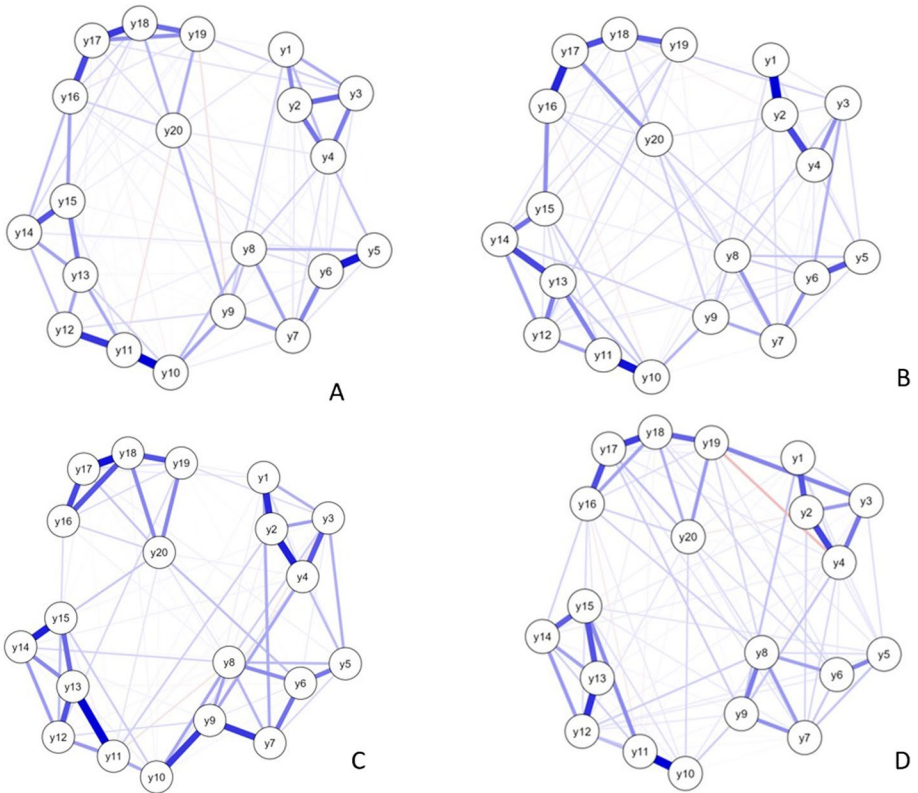
Fig. 3 EBICglasso model based on network analysis according to the NMP-Q among countries: **A** China, **B** Bangladesh, **C** Pakistan, and **D** Iran. Note: y1–y20, NMP-Q; y1–y4, not being able to communicate; y5–y9, losing connectedness; y10–y15, not being able to access information; y16–y20, giving up convenience
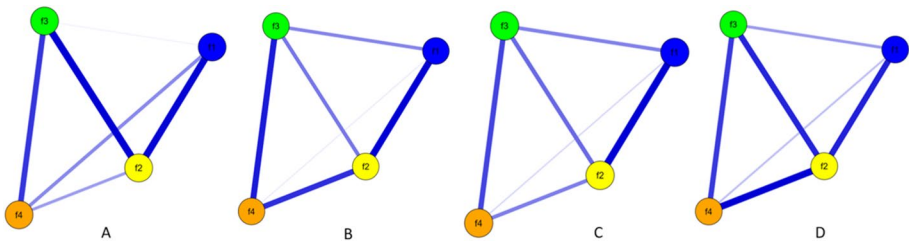

Fig. 4 EBICglasso model based on network analysis according to the NMP-Q among countries: **A** China, **B** Bangladesh, **C** Pakistan, and **D** Iran. Note: f1, not being able to communicate; f2, losing connectedness; f3, not being able to access information; f4, giving up convenience

0.001). The global strength had significant differences between China and the other countries at factor-level (all $p < 0.01$) but had no significant differences between China and Pakistan at item-level ($p = 0.262$) (Appendix 25).

Discussion

Although the Chinese and Persian language versions of the NMP-Q had been previously validated (Gao et al., 2020; Lin et al., 2018), the psychometric properties of Bangla and Pakistani versions had not been examined. The present study used rigorous translation method proposed by Beaton, (2000) to translate the NMP-Q into Bangla and Pakistani to ensure its linguistic validity and then tested the psychometric properties of the NMP-Q across four different language versions in four countries (i.e., China, Bangladesh, Pakistan, and Iran). Results of both CFA and network analysis demonstrated a four-factor structure of the NMP-Q with measurement invariance across genders and countries. Moreover, the validation findings are robust because the sample size for each country was sufficient ($N = 534$ to 5969) for the advanced statistical analyses used in the present study. Although the sample sizes were unbalanced between the countries (i.e., Chinese participants contributed to three fourths of the all participants), the validation results would not be severely biased due to the unbalanced sizes. In addition, the population sizes for the four countries show that Chinese population (~1.42 billion) is much larger than the Bangla (~0.17 billion), Pakistani (~0.23 billion), and Iranian (~0.09 million) populations. the present sample had comparable proportions to the populations' sizes of the four countries.

The identified four-factor structure is consistent with prior NMP-Q psychometric studies across Spanish (González-Cabrera et al., 2017), Persian (Lin et al., 2018), Chinese (Gao et al., 2020), English (Tung et al., 2022), Greek (Gnardellis et al., 2023), Portuguese (Galhardo et al., 2020), and Indonesian (Rangka et al., 2018) language versions. The present findings extended prior psychometric studies of the NMP-Q that employed CFA and Rasch analysis to using network analysis. Specifically, no prior studies have used network analysis to evaluate if the NMP-Q had a four-factor structure to the best of the present authors' knowledge. Although prior studies used Rasch analysis to verify the unidimensionality for each NMP-Q factor and CFA to confirm the four-factor structure of the NMP-Q, it is unclear how the NMP-Q items clustered together to form the factors. Via the network analysis results, items in each of the four NMP-Q factors were clearly illustrated to be associated. With different methodologies indicating the same factor structure of NMP-Q, multiple approaches support a four-factor structure. Specifically, nomophobia involves anxiety related to: (i) not being able to communicate, (ii) losing connectedness, (iii) not being able to access information, and (iv) giving up convenience (Yildirim & Correia, 2015).

Nomophobia reflects behaviors/symptoms related to mobile phone (including smartphone) use (King et al., 2010, 2013, 2014). How the 20 behaviors/symptoms assessed by the NMP-Q relate to each other is illustrated by the network analysis and CFA results. The four factors suggest important perceived functions of smartphones related to communication, connection, information accessibility, and convenience (Haug et al., 2015). Because of these functions, people may become anxious when they may not be able to use their smartphones and develop nomophobia (King et al., 2010, 2013, 2014).

Prior reports suggest that PSU and related constructs (e.g., internet addiction, social media addiction) may be relatively prevalent (Alimoradi et al., 2022; Kamolthip et al., 2022; Meng et al., 2022). Therefore, early identification of individuals at elevated risk of PSU appears important for healthcare providers. In this regard, individual and societal costs related to PSU could be minimized. Speculatively, the NMP-Q could be a useful instrument for healthcare providers to early detect at-risk individuals, and this possibility warrants direct examination.

The present CFA and network analysis results demonstrate that the NMP-Q has satisfactory psychometric properties to assess nomophobia among Chinese, Bangladeshi, Pakistani, and Iranian individuals. Accordingly, healthcare providers in the countries of China, Bangladesh, Pakistan, and Iran could use the NMP-Q to evaluate nomophobia and intervene as indicated.

Study limitations warrant mention. First, the present sample was collected via convenience sampling. Therefore, the generalizability of the present findings is limited because of possible sampling bias. Second, the present study did not examine test-retest reliability and longitudinal invariance of the NMP-Q; therefore, it is unclear if the four-factor structure of the NMP-Q is consistent across time. Third, there were no external measures to examine the concurrent or discriminant validity of the NMP-Q. Future studies are needed to explore how the NMP-Q relates to other instruments assessing similar and distinct concept (Csibi et al., 2018; Tung et al., 2022). Lastly, the samples analyzed in the present study were relatively young; therefore, the generalizability of the present findings cannot be applied to other age groups, especially older adults.

Conclusion

In conclusion, different statistical methods support the use of NMP-Q in China, Bangladesh, Pakistan, and Iran. The four-factor structure of the NMP-Q was consistently found in the four countries, supporting prior findings. Measurement invariance suggested that people of different genders (males and females) and from different countries (China, Bangladesh, Pakistan, and Iran) interpreted the 20 NMP-Q items similarly. The measurement invariance findings were further verified by network analysis, with results demonstrating similar edge intensities and centralities among the NMP-Q items across genders and countries. In this regard, the NMP-Q appears to be a sound instrument for assessing nomophobia.

Data Availability The data that support the findings of this study are available from the first author upon request.

Declarations

Ethical Approval Several ethics committees approved study procedures (For Chinese participants: Guangzhou Sport University and Jianxi Psychological Consultant Association; for Bangladeshi participants: Institute of Allergy and Clinical Immunology of Bangladesh; for Pakistani participants: Department of Psychology, University of Sargodha, Sargodha, Pakistan; and for Iranian participants: Qazvin University of Medical Sciences). The study procedures adhered to the Declaration of Helsinki.

Informed Consent All participants provided written informed consent or e-informed consent, and in the case of participants below 18 years old, one of their guardians also provided written informed consent. Subjects participated voluntarily and were free to withdraw at any time.

Competing Interests The authors declare that there is no conflict of interests. Dr. Potenza discloses the following: Dr. Potenza has consulted for Opiant Therapeutics, Game Day Data, the Addiction Policy Forum, AXA, Baria-Tek, and Idorsia Pharmaceuticals; has been involved in a patent application with Yale University and Novartis; has received research support from Mohegan Sun Casino and the Connecticut Council on Problem Gambling; has participated in surveys, mailings or telephone consultations related to drug addiction, impulse-control disorders or other health topics; has consulted for and/or advised gambling and legal entities

on issues related to impulse-control/addictive disorders; has provided clinical care in a problem gambling services program; has performed grant reviews for research-funding agencies; has edited journals and journal sections; has given academic lectures in grand rounds, CME events, and other clinical or scientific venues; and has generated books or book chapters for publishers of mental health texts. The other authors do not report disclosures.

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