



## Research article

# Internal consistency and structural validity of the nomophobia questionnaire (NMP-Q) and its translations: A systematic review with meta-analysis

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## ABSTRACT

**Background:** A psychological condition known as NOMOPHOBIA causes individuals to fear losing ability to use or reach their mobile phones. The NMP-Q (nomophobia questionnaire) is a commonly used survey for assessing symptoms related to nomophobia.

**Materials and methods:** We performed a meta-analysis using reliability generalization (RG) on the NMP-Q. Thirteen studies involving 15,929 participants have reported original reliability estimates of the NMP-Q determined through a comprehensive and methodical examination of the available literature.

**Results:** For the total scores, the pooled internal consistency reliability was 0.93 [0.91; 0.95] and for the subscales it ranged from 0.83 to 0.91. Specifically, 0.91 [0.88; 0.93], 0.84 [0.80; 0.88], 0.83 [0.78; 0.88, and 0.83 [0.80; 0.85] for the subscales. Subscale 1 = not being able to communicate; subscale 2 = losing connectedness; subscale 3 = not being able to access information; and subscale 4 = giving up convenience", respectively. All reported effect sizes are Cronbach's alphas. Structural validity supported a solution of four-factors.

**Conclusions:** NMP-Q has an excellent internal consistency. Structural validity of four factors appears to be vigorous in fitting NMP-Q items. Our recommendation is to require future studies using NMP-Q to provide a reliability estimate based on their own data.

## 1. Introduction

The fear of being without a mobile phone is referred to as nomophobia. The acronym was coined using parts of the letters from the terms NO MOBILE phone PHOBIA [1]. The disorder is relatively new and not officially recognized, so formal diagnostic criteria do not yet exist [2]. The nomophobia questionnaire (NMP-Q) was created by Yildirim and Correia, a self-reported tool commonly used for evaluating symptoms of nomophobia in both adolescents and adults [3]. The NMP-Q has been widely used for prevalence estimation

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and screening of nomophobia symptoms in both clinical and community settings [2,4,5]. The NMP-Q has recently been translated into Arabic [6,7], Greek [8], Persian [9,10], Chinese [11], Portuguese [12,13], Italian [14], and Spanish [15–17], and its psychometric qualities have remained consistently strong.

We examined the internal consistency of the NMP-Q across all validation studies, in all languages, with the aim of determining the most accurate estimates of reliability to inform future investigations using the NMP-Q. Psychometric theory holds that a test's dependability is a property of the scores received in each application of the test rather than an intrinsic quality of the test itself. Thus, depending on the make-up and variety of the study samples, the reliability of a specific test may vary from one investigation to another. This suggests that researchers should uniformly disclose the dependability they found in each report using their own data because reliability typically fluctuates with each test administration.

Researchers can statistically integrate several reliability coefficients obtained from using a particular test on various samples and settings by using meta-analysis. This specific approach to meta-analysis is called Reliability generalization (RG) [18]. RG typically assumes that some variations in the reliability coefficients are caused by unidentified or implicit mechanisms that limit and bias participant selection [18,19]. In RG meta-analysis the objective is to calculate the pooled reliability of test results, examine the reliability coefficients' variability, and, if needed, examine moderator variables that might explain variance [19]. It is a common practice in RG meta-analyses that structural validity is also systematically reviewed. There is no published RG meta-analysis for NMP-Q. The primary objective of this review is to present the first RG meta-analysis of the NMP-Q. It is crucial that test scores are reliable. A significant empirical inquiry is whether the reliability varies between different applications. The second goal is to offer a meticulous summary of the existing literature on the NMP-Q's structural validity.

## 2. Materials and methods

Reliability generalization meta-analyses (REGEMA) guidelines were followed during the conduct and reporting of this RG study [20,21]. Additionally, the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA 2020) was also used to improve transparency in our systematic review [22]. To avoid redundant meta-analysis, we documented the protocol on PROSPERO, which is a global database of systematically recorded reviews in social and health care (Registration reference: CRD42022355892).

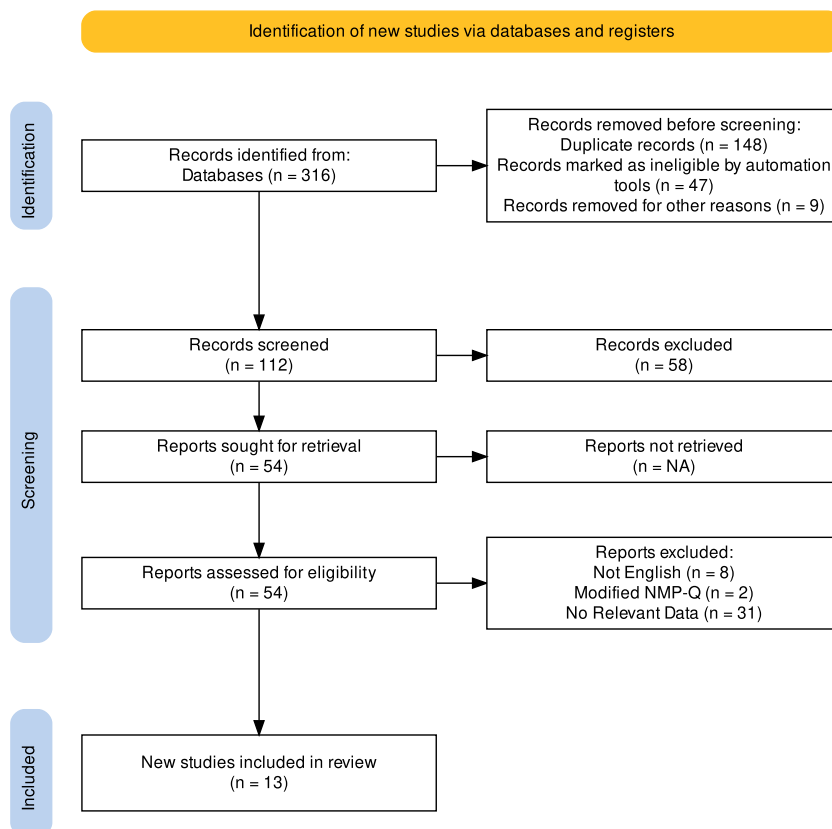


Fig. 1. Diagram of the PRISMA 2020 study selection flow.

### 2.1. Description of the NMP-Q and background information

The initial version of the NMP-Q comprises 20 items and was created through a comprehensive process that involved both qualitative and quantitative phases [3]. For each item on the NMP-Q, a score ranging from 1 (strongly disagree) to 7 (strongly agree) is assigned, and these scores are added up to obtain a total score. The NMP-Q has a maximum score of 140 and severity of nomophobia increases with a higher score. The total NMP-Q score is translated into the degree of nomophobia as follows: A score of 20 indicates a lack of the condition; a score of 21–59 indicates a mild condition; a score of 60–99 indicates a moderate condition; and a score of 100 (or more) indicates a severe condition [3].

Based on the results of semi-structured interviews conducted during the qualitative phase of scale development four subscales (or factors) were identified (subscale of factor 1: Being unable to communicate; subscale of factor 2: Losing connectedness; subscale of factor 3: Not being able to access information; and subscale of factor 4: Giving up convenience) [3]. The four factors were identified in an exploratory factor analysis using the 20-item instrument [3]. The results from quantitative analysis were highly consistent with the results of the qualitative derived factors [3].

The internal consistency measured using Cronbach's alpha was very good or excellent for each factor (0.81–0.94) and for the total NMP-Q (0.95) [3]. Its strong association ( $r = 0.71$ ,  $p < 0.01$ ) with the Mobile Phone Involvement Questionnaire allowed for concurrent validity [3].

### 2.2. Searching for the studies (database, manual, and grey literature)

Since the NMP-Q was released in 2015, the search for relevant studies included the period from 2015 to September 15, 2022. The following electronic databases were searched: EBSCO (including CINHAL), (PubMed/MEDLINE), ScienceDirect, Scopus, and Web of Science (ISI). In the electronic searches, Boolean algorithm was used to create search syntaxes. The keywords included “nomophobia questionnaire” OR “NMP-Q” OR “NMPQ” AND “valid\*” OR “reliab\*” OR “Cronbach” OR “factor analysis”. The (All Fields) option was used for all electronic searches. The \* account for all variations of the search team. For example, valid\* is representative for valid, validation, validity, etc.

The Google Scholar and the WorldCat (OCLC) content aggregators were also searched specifically for grey literature. The grey literature was examined and categorized utilizing ASReview, an open-source online tool that integrates digital technologies such as natural language processing with machine learning and artificial intelligence [23,24].

To find other research that potentially meet the selection criteria, the sources of the papers that were retrieved were also considered. Fig. 1 shows the flowchart for choosing the studies. We converted the final search results into a spreadsheet 365 file (Excel spreadsheet.xlsx) and removed duplicates. EndNote 20.4.1 (RIS) was used to manage citations.

### 2.3. Selection criteria of the studies

Each study had to meet the following requirements in order to be included in the meta-analysis: (a) to be a validation study where NMP-Q, or a translation maintaining the 20 items, was applied to a sample of participants, (b) report any internal consistency (reliability) estimates based on the sample used in the study; (c) published in English language; (d) samples of participants from any target population.

The following exclusion conditions were applied: (a) case-reports and case-series, (b) NMP-Q versions without the twenty items structure or those who introduced adaptations (cultural or linguistic) to the questionnaire, and (c) eliminated all studies that used the same dataset.

### 2.4. Data extraction

Two independent raters (HJ and ZS), both with PhDs or equivalent degrees, both experts in nomophobia research and specializing in meta-analyses, extracted all data for the RG meta-analysis. After consultation with a third review (KT) team member, discrepancies between raters were agreed upon.

Data extraction involved Cronbach alpha coefficients and sample sizes were obtained for the total scale NMP-Q scale. Moderators and descriptive data were coded as follows: (a) the arithmetic mean and the associated standard deviation of the age of participants (in years); (b) sex distribution of the sample (proportion of males); (c) language; (d) description of the target population; (e) test version; (f) the focus and rationale of the psychometric study; (g) sample size; (h) principal investigator; (i) year of study; (j) procedures used; (l) summary of validity findings; and (m) complete citation of the paper.

### 2.5. Quality evaluation of the studies that were analyzed

A modified form of the COSMIN (COnsensus-based Standards for the selection of health status Measurement INstruments) critical appraisal tool was used to assess the quality of included studies [25]. The COSMIN checklist can be used to assess the procedural quality of measurement property studies, such as systematic reviews of measurement properties. It is critical to consider the methodological quality of the selected studies in these systematic reviews. If the findings of good-quality studies diverge from those of poor-quality studies, this may indicate bias [25].

The COSMIN is brief form including four domains: (a) reliability; (b) validity; (c) responsive; and (d) interpretability for reported

**Table 1**  
Summary of the internal consistency and structural validity of the nomophobia questionnaire (NMP-Q).

SN	Ref	Study	Language	% Male	Mean Age	Population	Procedure	Sample	Reliability	Structural Validity	Quality
1	[14]	Adawi M, 2018	Italian	39.7	27.91 ± 8.63	Adults	PCA, Varimax	403	0.95	The eigenvalues and scree plot clearly demonstrated the three-factors structure of the translated questionnaire. The Cronbach's alpha coefficient for the NMP-Q was 0.95. (0.94, 0.89, and 0.88 for the three factors).	Acceptable
2	[6]	Al-Balhan EM, 2018	Arabic	18.8	21.62 ± 4.33	Adults	PCA, Varimax	512	0.88	Four factors were identified as the main contributors to 57.24% of the variance by the exploratory factor analysis. The average Cronbach's alpha was 0.88.	Acceptable
3	[9]	Elyasi F, 2018	Persian	44	25.00 ± 5.00	Adults	PCA, Varimax	425	0.93	The translated questionnaire's three-factorial structure was confirmed by the eigenvalues and scree-plot. For the NMP-Q as a whole, the Cronbach's alpha coefficient was 0.93. (For the three factors, the corresponding coefficients are 0.90, 0.77, and 0.71).	Acceptable
4	[7]	Farchakh Y, 2021	Arabic	41.2	27.98 ± 9.66	Adults	EFA, Promax	2260	0.95	The items on the nomophobia scale converged over a solution of three factors with Eigenvalues greater than one (Factor 1: Emotions related to losing connectedness, Factor 2: Being unable to communicate, and Factor 3: Being unable to access information; total variance explained: 66.65%, and Cronbach's alpha: 0.95).	Acceptable
5	[13]	Galhardo A, 2020	Portuguese	26.42	22.95 ± 5.36	Adults	EFA/CFA, Promax	500	0.96	Outstanding construct, discriminant, concurrent, and divergent validity, as well as outstanding consistency, were all demonstrated by the NMP-Q-PT. The NMP-Q-PT has proven to be a trustworthy and accurate tool for assessing nomophobia.	Acceptable
6	[12]	Galhardo A, 2022	Portuguese	53.9	13.61 ± 0.80	Adolescents	EFA/CFA, Promax	531	0.95	The concept, concurrent, and reliability validity of the NMP-Q-A were strong.	Acceptable
7	[11]	Gao Y, 2020	Chinese	51.95	18.00 ± 3.01	Adolescents and Adults	EFA/CFA, Varimax	2000	0.92	The 4-factor structure of the translated questionnaire is supported by the eigenvalues, the total variance explained, and the scree plot. The CFA met the adaptive requirement, and the scale had a high level of discriminant validity. The subscale values were 0.88, 0.84, 0.89, and 0.82, and the Cronbach alpha coefficient for this scale was 0.92.	Acceptable
8	[16]	González-Cabrera J, 2017	Spanish	46.1	15.41 ± 1.22	Adolescents	EFA, Varimax	306	0.95	Four dimensions were found by exploratory factor analysis to be responsible for 64.4% of the total variation. With an ordinal value of 0.95, the range from 0.75 to 0.92 depended on a number of variables.	Acceptable
9	[17]	Gutiérrez-Puertas L, 2016	Spanish	24.6	21.22 ± 3.58	Adults	EFA, Varimax	65	0.93	The findings supported the original questionnaire's four-dimensional structure, and the overall Cronbach's alpha score of 0.93 demonstrated the questionnaire's high level of internal consistency.	Unclear
10	[40]	Lee S, 2018	English	32.5	20.69 ± 4.33	Adults	EFA, Varimax	397	0.95	Four latent NMP-Q variables; alpha = 0.95.	Acceptable
11	[15]	León-Mejía A, 2021	Spanish	42.1	18.04 ± 3.3	Adults	CFA, NR	5012	0.85	Confirmatory factor analysis revealed four correlated factors that were explained by a general second-order factor. The NMP-Q dimensions' internal validity and reliability values, which range from 0.78 to 0.92, are satisfactory.	Acceptable
12	[10]	Lin CY, 2018	Persian	53.2	15.54 ± 1.20	Adults	CFA, NR	3216	0.95	According to Rach's findings, a four-factor structure was supported by the CFA.	Acceptable
13	[3]	Yildirim C, 2015	English	45	20.00 ± 2.00	Adults	EFA, Varimax	301	0.92	The NMP-Q has a four-factor structure that corresponds to the aspects of nomophobia, according to exploratory factor analysis. Since the NMP-Q has been demonstrated to yield precise and trustworthy results, it can be used to gauge the severity of nomophobia.	Acceptable

Notes: NMP-Q = nomophobia questionnaire, EFA = exploratory factor analysis procedure, CFA = confirmatory factor analysis procedure. Quality assessment performed using COSMIN (Consensus-based Standards for the selection of health status Measurement Instruments).

results [25]. To present the domain-level evaluations for each outcome in the quality assessment, a traffic light plot is employed, and to represent the distribution of bias verdicts within bias domains, weighted bar plots are used [26]. The combined result from all studies according to the modified COSMIN is presented in a summary plot format [26].

## 2.6. Statistical methods for data synthesis

The internal consistency of the NMP-Q across studies was evaluated using a combined alpha coefficient in this meta-analysis. Initially it was planned to extract the alpha coefficients for the NMP-Q total score and for each one of the four subscales. Alpha coefficients for the subscales were only computed for studies that reported four subscales.

The meta-analysis generated two forms of alpha coefficients, namely untransformed coefficients and transformed coefficients, the correlation coefficients were adjusted utilizing Fisher's Z equation. The formula is as follows:  $zr = \ln((1+r)/(1-r))/2$  [27]. The reason for performing the transformation was to standardize the distribution of the coefficients and establish steady variances [28].

The correlation coefficient was used as the outcome metric in the analysis. The construction of a forest plot and the computation of several statistics were used to examine the heterogeneity among reliability coefficients. The Paule-Mandel estimator was used to calculate the extent of heterogeneity (*i.e.*,  $\tau^2$ ) [29]. The results also included the Q-test for heterogeneity,  $I^2$  statistic, and H statistic. In case of detecting any level of heterogeneity, a 95% prediction interval (95%PI) for the actual results was also presented (*i.e.*,  $\tau^2 > 0$ , irrespective of the outcomes of the Q-test) [30].

Furthermore, the 95%PI compute the expected range of reliability coefficients in future primary studies [31]. Studentized residuals and Cook's distances are utilized to identify potential outliers and/or influential studies within the model [32,33]. When using Bonferroni correction with two-sided alpha = 0.05 for all k studies included in the meta-analysis, a study is deemed an outlier if its studentized residual exceeds the  $100 \times (1-0.05/(2 \times k))$ th percentile [32,33].

Studies were deemed influential if their Cook's distance was beyond the median and six times the Cook's distance interquartile range [32,33].

The pooled reliability coefficients and the associated confidence intervals, which were calculated using Fisher's Z transformations, were converted back into the original metrics to simplify the interpretation of the findings. For alpha coefficients of the total tool, we furthermore utilized Egger's test [34], Begg and Mazumdar Rank Correlation [34], and constructed a funnel plot (contoured for better visual assessment) with the trim-and-fill method to analyze the risk of publication bias [32,33].

Based on one or more explanatory variables, a meta-regression was used to forecast the relationship between the effect size as an outcome variable [35]. Age and sex were used in a univariate analysis with meta-regression.  $R^2$  was used to report effect sizes in meta-regression models that were statistically significant. Minor effect size was expressed as 1–2%, medium effect size as 3–13%, and large effect size as 14–26% [36].

Utilizing R software for statistical computing, all data were analyzed [37]. A significance level of  $<0.05$  was adopted to determine statistical significance. To execute the meta-analysis, the bundles "meta" [38], "metafor" [33], and "metacor" [39] were used. For quality judgement, risk-of-bias charts were generated using the package "robvis" [26]. The amount of information contained in each judgment is displayed in a summary plot (weighted). The overall risk of bias as well as the detailed risk of bias assessment for all studies are shown using a traffic light plot.

## 2.6. Funding

This study did not receive any dedicated funding from any public, commercial, or non-profit organizations.

## 2.7. Data availability

The corresponding author is willing to provide the data that underpins the results upon request, without any inquiry.

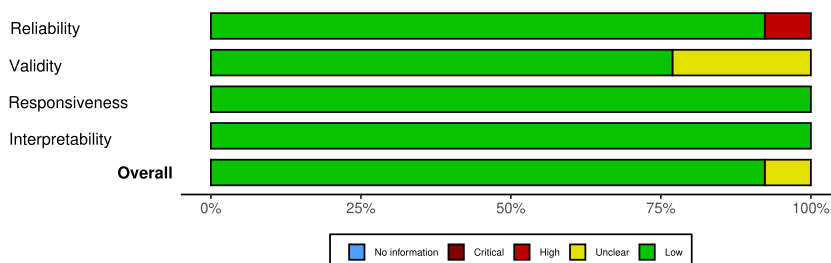


Fig. 2. An overview of the risk of bias analysis.

### 3. Results

#### 3.1. Descriptive results of the studies

Electronic database searches led to the discovery of 316 records from various sources. Following the elimination of duplicate records, 112 records remained. We then reviewed all potential articles' titles, abstracts, and full contents. The PRISMA 2020 flowchart details the search process in Fig. 1. A totality of 13 [3,6,7,9-17,40] studies with a total sample size of 15,929 participants were included in the final analyses. Table 1 presents summary of the internal consistency and structural validity of the NMP-Q.

The mean sample size of the studies was 1225 [95%CI 326; 2124] participants. The mean age was 20 [95%CI 18; 24] years and about 40% [95%CI 33; 46%] were males.

The studies included the following languages: Arabic N = 2 (15%), Chinese N = 1 (8%), English N = 2 (15%), Italian N = 1 (8%), Persian N = 2 (15%), Portuguese N = 2 (15%), and Spanish N = 3 (23%). The samples consisted of adults N = 10 (77%), followed by adolescents N = 2 (15%), and only one study used both adolescents and adults N = 1 (8%). Ten (77%) studies reported finding a four-factor model, and the remaining three (23%) reported finding a model of three-factors.

The studies included in this review were all high quality with low risk of bias, see Fig. 2. One study was of some concern due to small sample size. Detailed appraisal of the features of all the studies included is shown in Fig. 3.

#### 3.2. Pooled internal consistency and heterogeneity

The observed correlation coefficients were mostly positive (100%), with values ranging from 0.85 to 0.96. Based on the random-effects model, the projected average correlation coefficient for the total NMP-Q scores was 0.93 [95% CI 0.91; 0.95]. The average result was considerably different from zero ( $z = 103.01, p < 0.001$ ). The Q-test indicates that the true results were heterogeneous ( $Q(12) = 661.02, p < 0.001, \tau^2 = 0.001, I^2 = 98.54\%$ ). The range of 0.86–0.99 represents the 95% prediction interval for the actual results. The studies' actual results therefore tended to follow the estimated average result, even though there may be some heterogeneity.

Table 2 presents a meta-analysis of the nomophobia questionnaire's internal consistency and structural validity (NMP-Q). Fig. 4 displays the forest plot of the nomophobia questionnaire's overall score's internal consistency (NMP-Q).

Fisher r-to-z transformed correlation coefficient estimates showed an intercept of 1.69 [95% CI 1.58; 1.80], which is when transformed back to correlation coefficients are identical to results obtained using untransformed data (i.e., 0.93 [95% CI 0.91; 0.95]).

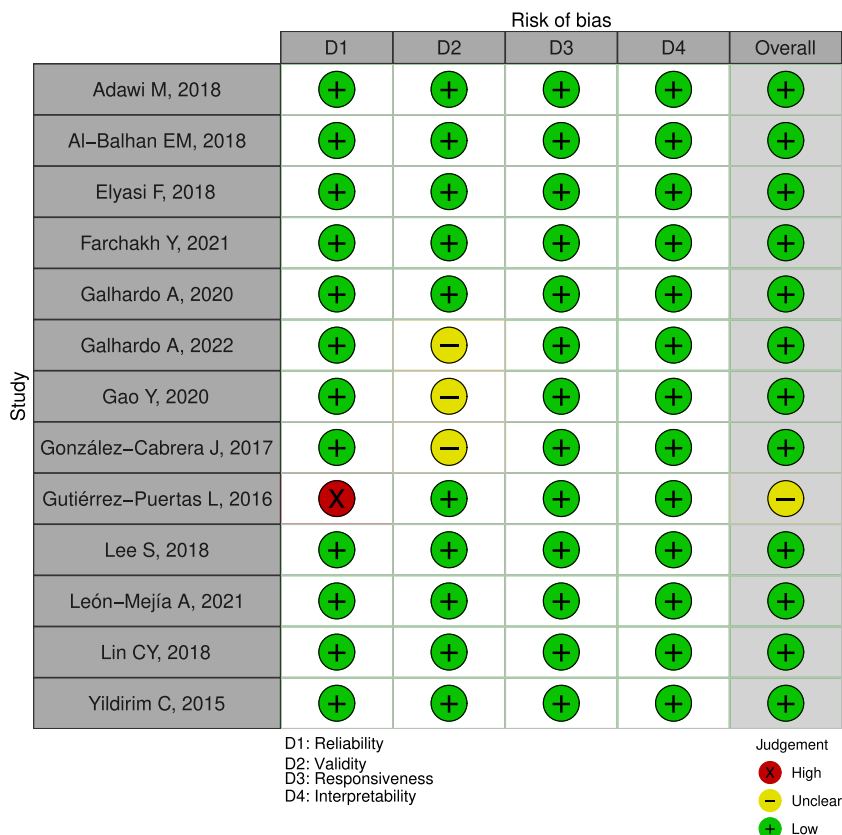


Fig. 3. Plot with traffic lights showing the risk of bias.

**Table 2**

Meta-analysis of the internal consistency and structural validity of the nomophobia questionnaire (NMP-Q) Estimates of internal consistency.

Parameter	Studies	Observations	Estimate	Z	$\tau$	$\tau^2$	I <sup>2</sup>	H <sup>2</sup>	R <sup>2</sup>	df	Q	p	Fail-Safe N	Begg and Mazumdar Rank Correlation	Egger's Regression
All NMP-Q	k = 13	n = 15,929	0.93 [0.91; 0.95]	103.01	0.03	0.001	98.54%	68.65	.	12	661.02	<0.001	0.001	<b>0.04</b>	<b>0.40</b>
Subscale 1	k = 10	n = 12,840	0.91 [0.88; 0.93]	64.67	0.04	<b>0.002</b>	98.73%	78.67	.	9	403.49	<0.001	0.001	<b>0.38</b>	<b>0.04</b>
Subscale 2	k = 10	n = 12,840	0.84 [0.80; 0.88]	42.16	0.06	<b>0.004</b>	97.99%	49.79	.	9	409.03	<0.001	0.001	<b>0.29</b>	<b>0.87</b>
Subscale 3	k = 10	n = 12,840	0.83 [0.78; 0.88]	33.47	0.08	<b>0.006</b>	99.19%	123.51	.	9	202.96	<0.001	0.001	<b>0.07</b>	<b>0.002</b>
Subscale 4	k = 10	n = 12,840	0.83 [0.80; 0.85]	64.49	0.04	<b>0.001</b>	94.69%	18.82	.	9	285.37	<0.001	0.001	<b>1.00</b>	<b>0.01</b>

Notes: NMP-Q = nomophobia questionnaire. Subscale 1 = Not being able to communicate; Subscale 2 = Losing connectedness; Subscale 3 = Not being able to access information; Subscale 4 = Giving up convenience. K: Indicates how many studies were included. N: Indicates how many samples from the included studies were included. The Duval and Tweedie trim and fill method was used to augment rank-based nonparametric data. Since the most extreme results were suppressed on one side of the funnel plot, the method was used to determine the number of studies that a meta-analysis was missing. The I<sup>2</sup> statistic measured the proportion of variation between samples that was caused by heterogeneity rather than randomness.  $\tau^2$  Describe in detail how widely the effects seen in s various samples vary (between-sample variance). Paule-Mandel estimator is used.  $\tau$  Under the presumption that these genuine effect sizes are normally distributed,  $\tau$  is an estimate of the standard deviation of the distribution of true effect sizes.

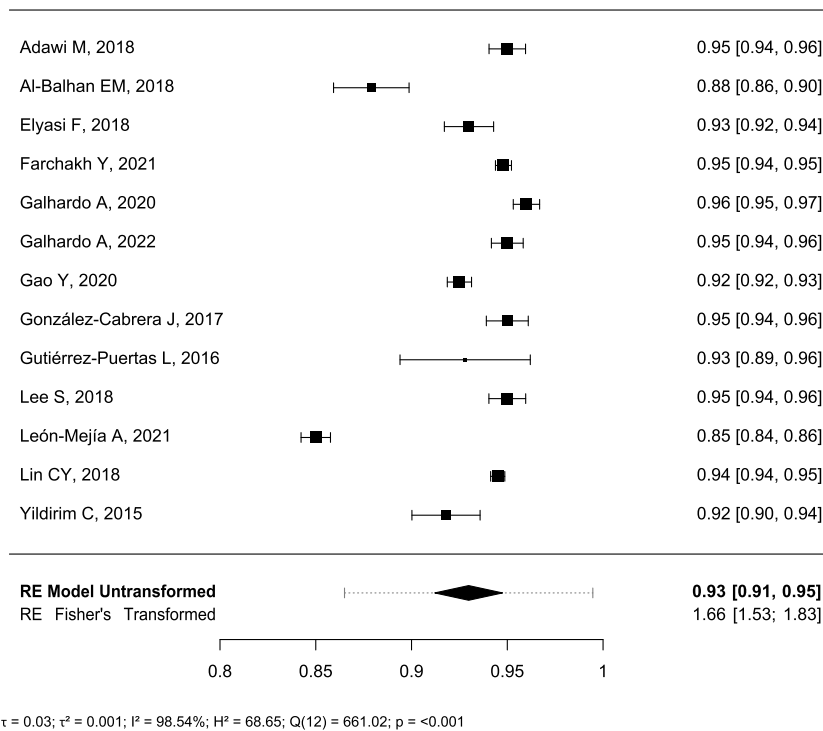


Fig. 4. Forest plot of the of the internal consistency of the total score of nomophobia questionnaire (NMP-Q).

Both untransformed alpha coefficients and Fisher r-to-z converted correlation coefficients were used for statistical analyses, but the results were identical. Consequently, raw untransformed alpha coefficients are presented.

One study [15] that had an importance greater than 2.89 and might be an outlier in the framework of this model when the studentized residuals were examined. Two studies [6,15] could be deemed to be excessively influential established by the Cook's distances. We made the assumption that there was no overall publication bias because the rank correlation test revealed funnel plot irregularity ( $p = 0.04$ ) but the regression exam did not ( $p = 0.40$ ). Fig. 5 shows funnel plot (contoured) of the of the internal consistency of the total score of nomophobia questionnaire (NMP-Q). Meta-regression models using the mean age of participants and proportion of males per study revealed that neither age  $p = 0.70$  nor sex  $p = 0.50$  are significant moderators for the effect size obtained.

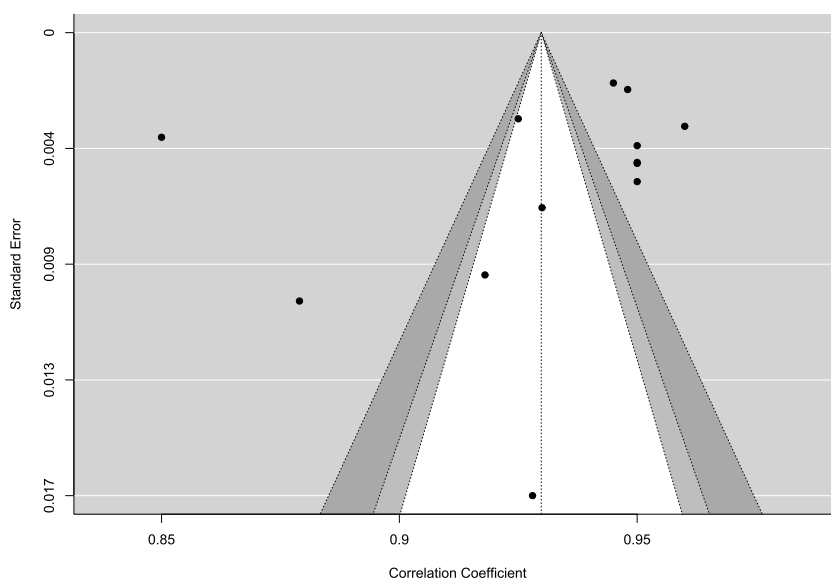


Fig. 5. Funnel plot (contoured) of the of the internal consistency of the total score of nomophobia questionnaire (NMP-Q).



### 3.3. Structural validity and detailed internal consistency of the four NMP-Q subscales

Structural validity was assessed using factor analysis techniques examining unidimensionality. Table 1 presents summary of the internal consistency and structural validity of the studies about the nomophobia questionnaire (NMP-Q). According to Table 1 a total of  $k = 10$  studies, involving  $n = 12,840$  participants were included in structural validation and in subscales analyses. Table 2 presents a meta-analysis of the nomophobia questionnaire's internal consistency and structural validity (NMP-Q). The observed correlation coefficients for subscale 1: "Not being able to communicate" ranged from 0.82 to 0.96, with the majority of estimations standing positive (100%). Based on the random-effects model, the projected average correlation coefficient was 0.91 (95% CI: 0.88 to 0.93). Consequently, the average result was considerably different from zero ( $z = 64.66$ ,  $p < 0.001$ ). The Q-test suggested that the real results are heterogeneous ( $Q(9) = 403.48$ ,  $p < 0.001$ ,  $\tau^2 = 0.001$ ,  $I^2 = 98.72\%$ ). The range of 0.82–0.99 represented the 95% prediction interval for the actual results. Thus, despite heterogeneity, the studies' actual findings typically followed the trajectory of the estimated average result. No studentized residuals value exceeded 2.80 in any of the studies, so there was no evidence of outliers in this model. Supplemental file 1 and Supplemental file 2.

All estimates of the observed correlation coefficients for subscale 2: "Losing connectedness" were positive (100%), ranging from 0.71 to 0.89. The estimated average correlation coefficient, calculated using the random-effects model, was 0.84 (95% CI: 0.81 to 0.88). As a result, the average result deviated from zero in a significant way ( $z = 42.16$ ,  $p < 0.001$ ). Inferred from the Q-test is that the actual results were heterogeneous ( $Q(9) = 409.02$ ,  $p < 0.001$ ,  $\tau^2 = 0.004$ ,  $I^2 = 97.99\%$ ). From 0.71 to 0.97, a 95% prediction interval for the actual results was provided. Therefore, despite the possibility of certain heterogeneity, the actual results of the reports tended to point in the similar general direction as the appraised average result. One study [10] had a value higher than 2.81 when the studentized residuals were examined, indicating that it might be an outlier in the framework of this model. One study [10] might be considered to have an excessive amount of influence, fitting to the Cook's distances. The rank correlation and regression tests did not reveal any funnel plot asymmetry ( $p = 0.29$  and  $p = 0.87$ , respectively). Supplemental file 3 and Supplemental file 4.

The observed correlation coefficients for subscale 3: "Not being able to access information" ranged from 0.64 to 0.91, with most estimations standing positive (100%). Based on the random-effects model, the estimated average correlation coefficient was 0.83 (95% CI: 0.78 to 0.88). The pooled outcome was then considerably different from zero ( $z = 33.47$ ,  $p < 0.001$ ). The Q-test indicated that the actual results were heterogeneous ( $Q(9) = 202.96$ ,  $p < 0.001$ ,  $\tau^2 = 0.005$ ,  $I^2 = 99.19\%$ ). From 0.67 to 0.98, a 95% prediction interval for the actual results was provided. Therefore, despite the possibility of some heterogeneity, the actual results of the studies tended to point in the same general direction as the estimated average result. The studentized residuals were examined, and one study [6] had a value greater than 2.81 and could possibly be an outlier for this model. Supplemental file 5 and Supplemental file 6.

The observed correlation coefficients for subscale 4: "Giving up convenience" ranged from 0.71 to 0.89, with all of estimates being positive (100%). Based on the random-effects model, an average correlation coefficient of 0.83 (95% confidence interval: 0.80 to 0.85), was estimated. As a result, the average outcome deviated significantly from zero ( $z = 64.49$ ,  $p < 0.001$ ). According to the Q-test, the actual results were heterogeneous ( $Q(9) = 285.37$ ,  $p < 0.001$ ,  $\tau^2 = 0.001$ ,  $I^2 = 94.68\%$ ). From 0.75 to 0.90, a 95% prediction interval for the actual results was provided. Therefore, despite the possibility of certain heterogeneity, the actual results of the studies tended to point in the same general direction as the estimated average result. No studentized residuals value exceeded 2.81 in any of the studies, so there was no evidence of outliers in this model. The Cook's distances showed that none of the studies possibly will be regarded as particularly important. However, the rank correlation analysis did not reveal funnel plot irregularity ( $p = 0.01$ ) as opposed to the regression test ( $p = 1.00$ ). Supplemental file 7 and Supplemental file 8.

## 4. Discussion

As a measure of reliability a test scores alpha coefficient must be over 0.70 to be considered good, over 0.80 to be considered very good, and over 0.90 to be considered excellent [41]. The Cronbach alpha coefficients in the available studies of NMP-Q ranged from approximately 0.80–0.94, representing very good to excellent psychometric properties. Traditionally meta-analysis is often used to address controversy; thus, one might inquire about the legitimacy of the importance of the pooled coefficient. As outlined in the Cochrane handbook for systematic reviews of interventions [42] there are four indications for meta-analysis. First, to amplify power. The probability of identifying a tangible effect as statistically significant if it occurs is defined as power [42]. Numerous individual studies may lack the statistical power to detect minor effects, but the likelihood of detecting an effect increases when multiple studies are merged [42]. Second, to improve precision. By using more information to estimate an effect size, the estimate can be improved [42]. Thirdly, to address inquiries that are not addressed by individual studies. Primary studies often focus on specific populations [42]. Choosing studies with differing characteristics can enable the assessment of consistency and, if applicable, the causes of variations in the effect estimates. Additionally, combining studies can help reconcile controversies that arise from seemingly contradictory findings [42]. In this reliability generalization we aimed to increase power, improve precision, and answer the question about the effect of language on NMP-Q psychometric properties.

The key results of this review indicated that the NMP-Q pooled results demonstrated an excellent internal consistency for the total NMP-Q score and for the first subscale "not being able to communicate." For the other three subscales *i.e.*, "losing connectedness," "not being able to access information," and "giving up convenience" internal consistency was very good.

Out of the four subscales of the NMP-Q, the first subscale or "not being able to communicate" showed the highest internal consistencies over 0.90, clearly excellent. This raises important point about the importance of this subscale in capturing the essence of nomophobia which is defined as the anxiety of being detached from mobile phone for connectivity purposes. It is the feeling of being unable to communicate with people instantly and not being able to use services that facilitate instant communication [1]. Additionally,

it encompasses feeling uncontactable and unreachable [1].

Ten out of the thirteen validation studies aligned and repeatedly showed a solid four-factors structure. Despite the fact that three investigations [7,9,14] did not perfectly suit the original structure discovered by Yildirim and Correia [3], the authors reported obtaining a factor structure that was comparable to the original one. Albeit there were specific differences, they reflected the socio-economic problems that underlie the nomophobia phenomena.

The fact that we were unable to identify any sex- or age-specific effects on the internal consistency of nomophobia is a significant finding regarding the psychometric features of the NMP-Q in relation to the literature. Nonetheless, it is important to be very cautious when interpreting the age-related findings as the age range was too narrow. A previous meta-analysis investigating the age- and sex-effects on the prevalence of nomophobia also showed no statistical difference between various ages and sex groups [2].

There is also evidence from another recent meta-analysis that shows that most people have mild or moderate symptoms, with mild, moderate, and severe symptoms being present in 25%, 50%, and 20%, respectively [43]. Severe symptoms are most common among university students from non-Western cultures and countries [43]. The year 2021 saw an increase in the prevalence of nomophobia, which could be linked to COVID-19 [43].

#### 4.1. Strengths and limitations

This review has one important strength. In terms of the NMP-Q, this is the first RG meta-analysis that describes (a) the normal reliability of scores across studies, (b) the degree of variability in NMP-Q reliability coefficients, and (c) the origins of this variability. The chief drawback of this review that we focused on validation studies only and did not include empirical studies that reported internal consistency for the total NMP-Q scores or its subscales. The focus to only include validation studies in our meta-analysis brought an important advantage to the analysis by focusing the scope of the research interest to studies using high standard approach of reporting reliability and validity metrics.

#### 4.2. Future scope

Our recommendation is to require future studies using NMP-Q to provide a reliability estimate based on their own data. This would allow researchers to better understand the reliability of the NMP-Q for their own study.

### 5. Conclusion

The NMP-Q has an excellent level of internal consistency. Four factors' structural validity appears to be strong in fitting NMP-Q items. Our recommendation is that future NMP-Q studies provide a reliability estimate based on their own data.

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#### Author contribution statement

Haitham Jahrami; Zahra Saif: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper. Khaled Trabelsi: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper. Nicola L. Bragazzi; Michael V. Vitiello: Conceived and designed the experiments; Wrote the paper.

#### Data availability statement

Data will be made available on request.

#### Declaration of interest's statement

Haitham Jahrami is a member of the advisory board for Heliyon (section: Heliyon Psychology).

The prediction interval is computed using  $\tau$ . NMP-Q Fit Statistics and Information Criteria for all NMP-Q.

Structural Model	log-likelihood	Deviance	AIC	BIC	AICc
Maximum-Likelihood	26.72	60.72	-49.45	-48.32	-48.25
Restricted Maximum-Likelihood	24.22	-48.44	-44.44	-43.47	-43.10

Notes: AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; AICc = small-sample equivalent AIC.

## Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.heliyon.2023.e15464>.

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