

Cognitive Change among Workers of Noisy Environments-Translation, Adaptation, and Validation of Cognitive Change Questionnaire 8-Tamil (CCQ8-T)

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ABSTRACT:

Background: Cognitive change has been one of the early sign for dementia. The Cognitive Change Questionnaire-8 (CCQ-8) is a brief, informant-based screening instrument for cognitive change, suitable for use in community surveys. The purpose of this study was to find out the level of cognitive change, however, there is no validated Tamil version of CCQ8 and we translated and validated the CCQ-8 in Tamil among workers exposed to noisy environments.

Methods: A sample of 102 workers of noisy environments with an age group of 25-46 yrs were randomly selected based on willingness to participate in the study. As per guidelines Content validity was assessed by five experts and psychometric properties of the CCQ-8-T were evaluated using internal consistency, test-retest reliability, construct validity (exploratory factor analysis), concurrent validity (correlation with MoCA) and Intraclass correlation coefficients (ICC) after two weeks for test-retest analysis.

Results: The level of cognitive change using CCQ-T, diagnosed 65% as having cognitive impairment, and 35% had no cognitive impairment. CCQ-8-T shows S-CVI/Ave=0.98, and exploratory factor analysis supported the unidimensional construct (0.779-0.889). CCQ-T had strong internal consistency (Cronbach's α = 0.93) and test-retest reliability (ICC = 0.76). There was a very strong negative correlation between CCQ-8 and MoCA scores (r = -0.705, p < .001).

Conclusion: The level of Cognitive change found to be 65%

diagnosed with the validated and culturally adapted CCQ-8-T and also strong correlation with MoCA. It was reliable tool in measuring of perceived cognitive difficulties at Tamil-speaking noisy environmental workers in community settings.

Keywords: Cognitive Change Questionnaire, Translation, Validation, Cognitive Impairment, Noise Exposure, Occupational Health.

Introduction

Cognition refers to "the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses."¹ It includes several domains of intellectual functioning, including attention, memory, reasoning, problem-solving, and language comprehension.² Cognitive impairment poses a major public health challenge due to its impact on quality of life, functional independence, and healthcare systems.³ Cognitive decline occurs as a continuum, starting as mild cognitive decline - slight but measurable cognitive decline without loss of functional ability,⁴ and progresses into a more comprehensive presentation. Among the several causes, the importance of noise exposure as a major environmental determinant of cognitive decline is being increasingly recognized.⁵ Environmental noise exposure is thought to affect the brain and cognition due to its detrimental effects on the learning process, sleep and stress.^{6,7}

Though there are several studies analyzing cognitive decline in older age group, there is a paucity of literature studying the same in younger adults. A systematic review which analyzed the effect of noise on cognitive abilities across lifespan measured in the general population rather than those diagnosed with medical diagnoses or symptoms, found that the literature on effect of noise on cognition of young-to-middle-aged adult populations was scarce. It suggested there is a need for more research on effect of noise on cognitive abilities of older teenagers and young-to-middle aged adults.⁸ The majority of the instruments used to screen for mild cognitive decline, such as the Mini-Mental State Examination (MMSE), the Montreal Cognitive Assessment (MoCA), the Clock Drawing Test (CDT), and the Six-item Cognitive Impairment Test, are validated in the older age group, which is

one of the reasons there are fewer studies in young and middle-aged adults.^{9,10} Despite the fact that MoCA and MMSE are the most widely used performance-based screening tools, and MOCA is advised as the best tool for identifying mild cognitive impairment in primary healthcare settings, their routine use in large, community-based populations may be constrained by their administration time, the requirement for trained personnel, and the impact of sociocultural background and educational level.^{11,12}

A recent review recommended that the Cognitive Change Questionnaire (CCQ), among other tools, can be suitable for assessment of mild cognitive decline in surveys.¹³ The eight-item Cognitive Change Questionnaire (CCQ-8), adapted from the original 22-item questionnaire, is an informant-administered brief screening tool for early-stage dementia and mild to moderate cognitive impairment.¹⁴ CCQ-8 correlates well with other validated cognitive measures, is unaffected by educational level, exhibits high accuracy, sensitivity, and specificity.¹⁵ Moreover, compared with physician-administered performance tests, informant-administered assessments may be more sensitive to early real-world functional changes that occur before clear deficits appear on performance-based tests.¹⁵⁻¹⁸ Even though, studies examining the impact of noise on cognition are scarce especially in Asia,⁸ the absence of validated tools which can be used in the community is a limiting factor. Owing to challenges, CCQ-8 offers an alternative and beneficial approach. However, the usefulness of the CCQ-8 was restricted by the absence of linguistically and culturally adapted and validated Tamil version of the questionnaire. This study aimed to check the level of cognitive change among middle-aged adult workers in noisy environments and to validate the Tamil-translated CCQ-8-T as per established international guidelines for translation and cultural adaptation.¹⁹

Materials and Methods

This was a community-based survey conducted among Tamil-speaking noisy environment workers (petrol Pump workers) with middle-aged adults 25-45 years validation from June 2023 to August 2023, approved by the Institutional Ethics Committee of Indira Gandhi Government General Hospital and Postgraduate Institute (Approval No. GHSAC/2020).

The individuals working in the noisy environment for a minimum period of 5 years and their working hours of ≥ 8 hours were included in the study. The workers with severe hearing loss, ear discharge, vertigo, smokers, chronic alcoholics, those taking hormonal/drug therapy, any neurological disorders, psychiatric medication, and sensitivity to noisy environments were excluded. The consent form was received from all the participants.

The validation study was carried at high noise hot spots that were identified in previous Puducherry noise studies and rechecked by noise meter. The primary source of noise was road side heavy vehicle and traffic. Statistical size was calculated as 97; the total of 102 noisy environment workers were selected for the study.

Translation and Adaptation:

After obtaining permission from the developer to use the original CCQ8 questionnaire for translation and validation, the English CCQ8 was culturally adapted with 5 experts and translated to Tamil by forward-backward translation.

- **Content validity for cultural adaptation**

Content validity of the English version with five psychologists was done initially for cultural adaptation relevance. An I-CVI value of 1, an S-CVI/Ave ≥ 0.90 , and an S-CVI/UA value of 1.0 are considered acceptable for five experts.²⁰

- **Forward and Back translation**

Two independent experts translated the English version of the CCQ-8 questionnaire in to Tamil. One translator was a psychologist proficient in English and Tamil, while the other was a linguistic specialist. Two translated versions were then reviewed and compared by a panel of experts,

consisting of another psychologist and the two translators. Any ambiguities in wording, their conceptual meaning, and cultural appropriateness were discussed and modifications were made to prepare a final Tamil version.

The questionnaire was translated back into English by two independent translators fluent in both English and Tamil. These translators were not exposed to the original English version of the questionnaire to prevent bias.

The back-translated versions were then compared with the original English version of the questionnaire. Any discrepancies in the original CCQ8 and the back-translated version were discussed between the forward and back translators. Keeping the meaning the same as that of the English version and ensuring that the questions were cross-culturally appropriate, necessary changes were made to the Tamil version²¹.

Content validity (Tamil version):

Five expert's, additional psychologists who were fluent in English and Tamil, familiar with the questionnaire reviewed the translated version for content validity. They independently rated each questionnaire item on a 7-point Likert scale based on its relevance, as was done for the English version. Ratings 5, 6, and 7 were considered "relevant," while 1, 2, 3, and 4 were considered "not relevant." I-CVI, S-CVI/Ave, and S-CVI/UA were calculated as mentioned for the English version.

Validation

The Tamil translated questionnaire was tested for its reliability and validity.

Internal consistency and Test-retest reliability

The final Tamil version of the questionnaire was tested for internal consistency as well as test-retest reliability. For internal consistency, the questionnaire was administered to the informants of 102 noisy environment workers between 25 and 45 years of age who consented to participate in the study and were not suffering from any psychiatric or neurological conditions. For test-retest reliability, the questionnaire was

administered again two weeks later to 50 of these participants' informants who had agreed to be retested.

Construct Validity: Exploratory Factor Analysis (EFA) was conducted to explore the factor structure.

Convergent Validity: The final version of the Tamil CCQ-8 and MoCA (as the gold-standard objective measure) were administered to 102 participants. Spearman's rank correlation coefficient was used to evaluate the correlation between CCQ-8 and MoCA total scores. Correlations between CCQ-8 scores and demographic variables (age, sex, height, weight) were investigated.

Statistical Analysis

The collected data were subjected to both descriptive and inferential statistics. Then psychometric properties of CCQ-T were tested, first internal consistency was assessed using Cronbach's alpha for reliability, for which a value of 0.6 or above was taken as acceptable.²² Secondly, intraclass correlation coefficients were assessed for Test-retest reliability. For that, a value above 0.8 is considered excellent reliability.²³ Correlation coefficients (Spearman's rho), a value above 0.7 is considered an excellent relationship,²⁴ and t-tests were calculated as described. A p-value < 0.05 was considered statistically significant.

The ROC (Receiver Operating Characteristics) and its coordinates were calculated for the diagnostic properties of the questionnaire. The statistical analysis of data was done using SPSS software.

Results

A total of 102 workers at noisy environmental were screened for CCQ8-T and MOCA. Males constitute 60.8% (n=62) of the study and 39.2% (n=40) were female, with the mean (SD) age of 35.62 (2.68) between the age group of 25 and 45 yrs, their mean (SD) value for height 156.41 (7.730), and weight is 70.09 (10.450). CCQ-T screening results revealed 57% with a score >2, were found to be Cognitive impairment, among workers 8 % workers showed mild cognitive impairment, score was 1 and 35% were no cognitive impairment. There was no statistically significant difference in age of males and females (t=0.884, p=0.744) was found.

Content validity

All experts rated each item as relevant for both the English and Tamil versions. Hence, the I-CVI for each item was 1.0. S-CVI/Ave and S-CVI/UA were also 1.0 for both versions.

Reliability

CCQ8-T Item characteristics

Corrected item-total correlations ranged from 0.61 to 0.86, all the items demonstrated strong corrected item -total correlations. Cronbach's alpha values of each item ranged from 0.91 to 0.93, among eight items. Removing any single item did not increase the alpha, so no item needed to be deleted. Finally the scale showed excellent internal consistency with a Cronbach's alpha of 0.93. CCQ8 Tamil item characteristics are listed

Table 1. Item-total statistics and Internal consistency of the CCQ8-T

Item	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Item 1	0.606	0.929
Item 2	0.729	0.92
Item 3	0.729	0.92
Item 4	0.745	0.919

Item 5	0.824	0.913
Item 6	0.857	0.91
Item 7	0.76	0.918
Item 8	0.776	0.917
Overall Cronbach's alpha-0.93		

Intraclass correlation coefficients for individual items ranged from 0.73 to 0.85. The total score correlation was 0.76, suggesting a good test-retest reliability.

Factor Analysis

Exploratory Factor Analysis (EFA) yielded a single-factor solution explaining 68.5% of the total variance. Analysis revealed that all eight items show loaded strongly on this single factor (loadings ranging from 0.779 to 0.889), confirming

the tool's unidimensionality and correlation between items were sufficient. Among eight items CCQ8, TQ6 (0.889) is highest and lowest on CCQ8TQ1(0.779).

It also revealed eigen values >1 and it justify its retention (Kaiser's criterion) and measure of Kaiser-Meyer-Olkin Sampling value was 0.903, it confirms sampling sufficiency. Bartlett's Test of sphericity as $X^2(28) 638.687$, $P < 0.001$, define appropriateness of EFA.

Table 2. Factor Loadings for the Tamil CCQ-8-T Items

Item Description	Factor Loading
Difficulty in learning how to use a tool, appliance, or gadget	0.779
Forgetting the correct month or year	0.845
Difficulty in using the phone to make calls	0.841
Difficulty in using a car, bus, taxi, or boat alone	0.793
Difficulty in taking medications without supervision	0.870
Trouble keeping updated with important information concerning the community or country	0.889
Difficulty in expressing their own opinions regarding family issues	0.813
Difficulty going out for a walk alone and returning home without getting lost	0.844

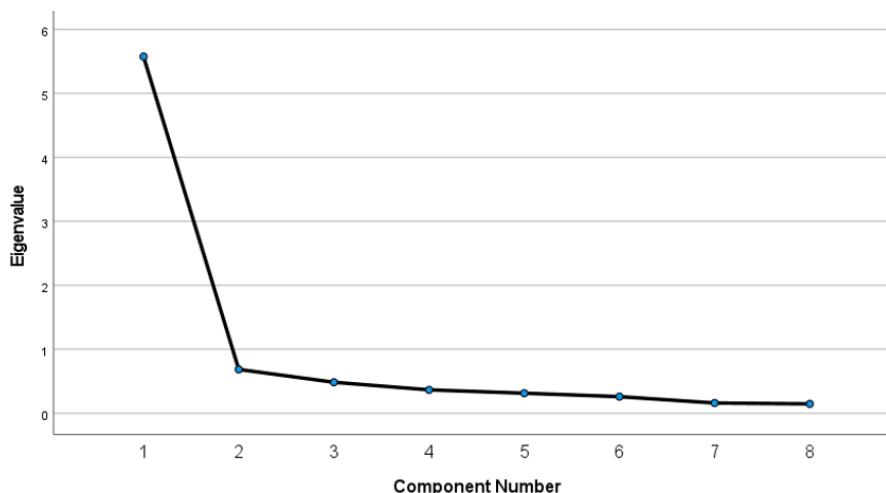


Figure 1: Screen plot indicating eigenvalues against component number for observing exploratory factor analysis (EFA) of CCQ-8 Tamil

Screen plot indicating eigenvalues against component number for observing exploratory factor analysis (EFA), Screen plot graph “elbow”

was seen after Component 1 and later component the curve levels off, it providing minimum meaningful variance in later components.

Convergent Validity

The mean (SD) of CCQ8-T total score and MOCA total score in noisy environmental workers is 3.921(3.352) and 21.2647(3.54). The original CCQ8 scores above two were considered mild cognitive impairments, while for MOCA, below 26 was mild cognitive impairment. CCQ8 score more than two was screened as mild cognitive impairments, and for MOCA cut-off score below

26 was screened as mild cognitive impairments, For the Convergent Validity, CCQ8-T and MOCA were compared. Spearman’s correlation analysis revealed a very strong, significant negative correlation between the CCQ-8-T and MoCA scores ($r = -0.705$, $p < .001$). CCQ-8 scores showed no significant correlation with age, sex, height, or weight. MoCA scores were also independent of these variables as shown in Table 3

Table 3. Spearman’s Correlations between Variables, CCQ-8-T, and MOCA (N=102)

Variable	CCQ-8 r (p-value)	MoCA r (p-value)
Age	.079 (.429)	.030 (.762)
Sex	.100 (.316)	-.131 (.188)
Height	-.060 (.551)	.149 (.135)
Weight	-.189 (.058)	.155 (.120)
CCQ8-T	1.000	-0.705 (.000)
MoCA	-0.705 (.000)	1.000

Noisy environment and cognition

Among noisy workers, the high-risk category constituted 57.8% ($n = 59$), whereas 42.2% ($n = 43$) belonged to the low-risk category according to central pollution control board, India.²⁵ However, no significant difference was found between the participant screened by CCQ8-T with age, height, and weight (all $p > .05$). The mean (SD) value of CCQ-8 scores was drastically higher in high-risk (HR) 6.54 (1.54) than low-risk (LR) 0.23(0.48), with $t=25.83$ and $p<.001$. Crucially, the mean (SD) value of total MoCA scores of high-risk groups 19.11(2.92) was lower than the low-risk group 24.21(1.75), its $t=10.15$ and $p=0.002$.

Diagnostic property of CCQ8 in noisy environment

ROC curve and its coordinates analyze the accuracy, performance and cut off score of the CCQ8 Tamil questionnaire in noisy environment as shown in Table 4. AUC of 0.980 indicate outstanding ability to discriminate between positive and negative classes, with a standard error of 0.0144 (Figure. 2). The Youden index (J) is 0.9661 at a criterion of 2, balancing sensitivity and specificity optimally.

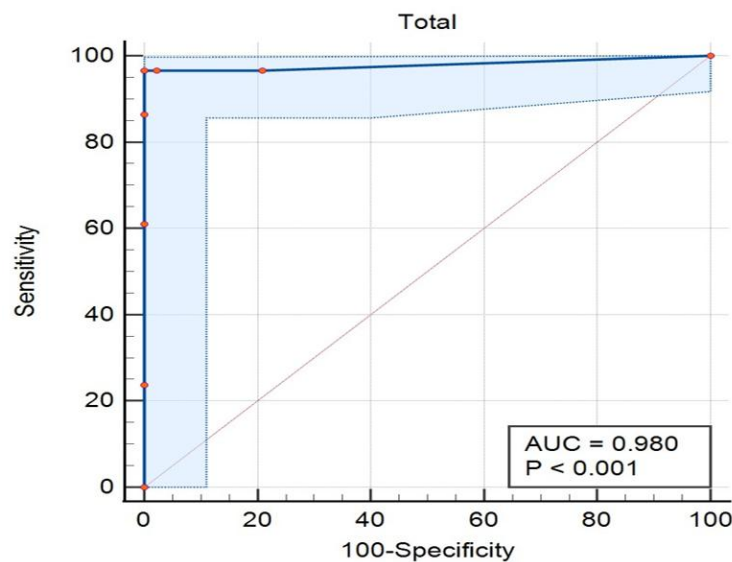


Figure 2: ROC curve and coordinate

Table 4: Criterion values and coordinates of the ROC curve

Tamil CCQ8 Noisy workers	Cutoff	Sensitivity (%)	Specificity (%)	PPV* (%)	NPV# (%)	Accuracy (%)
LR normal Vs HR (caught)	≥ 0	100.0	0.0	20	100	20
LR normal Vs HR likely	>1	96.6	97.7	90	99	97
Optimal: LR safe Vs HR confirm	>2	96.6	100.0	95	99	98

Tamil CCQ8 Noisy workers	Cutoff	Sensitivity (%)	Specificity (%)	PPV* (%)	NPV# (%)	Accuracy (%)
HR definite Vs LR rule out	>5	86.4	100.0	100	94	95
HR severe only	>6	61.0	100.0	100	82	90

*PPV: Positive predictive value. #NPV: Negative predictive value. LR: Low risk group. HR: High risk group

Discussion

The purpose of study was to translation, adaptation, and validation of CCQ8-T and to assess level of cognition among noisy environment workers. Burden of mild cognitive impairment and dementia is highest. The emerging evidence suggests that subtle cognitive deficits may begin much earlier, especially in individuals exposed to environmental and occupational stressors such as chronic noise.⁶ Sustained noise exposure may influence cognition through stress-mediated mechanisms involving cortisol dysregulation, sleep disturbance, and reduced attentional resources.²⁶ Since most cognitive screening instruments have been validated in older populations, data is sparse for young adults, particularly those exposed to chronic noise in community or occupational settings. This creates a methodological limitation in early identification of subtle cognitive decline in this demographic. In this context, the present study validated the CCQ-8-T in young adults aged 25–45 years to find out the level of cognition in the noise-exposed workers pollution, thereby addressing an important gap in community-based cognitive assessment.

The CCQ-8-T's cross-cultural adaptation and psychometric validation showed great reliability as measured by the intraclass correlation coefficient, adequate content validity, and good internal consistency with Cronbach's alpha of 0.93. The gold standard screening test for global cognition, the Montreal Cognitive Assessment scores, were used to demonstrate construct validity. The translated tool's diagnostic efficacy was further reinforced by ROC curve analysis. All of these

results point to the Tamil CCQ-8's linguistic adaptation and psychometric stability.

The relevance of validating such a tool in younger adults deserves emphasis. Most research on cognitive decline focuses on elderly populations, under the assumption that cognitive decline is age-related only. However, neurocognitive performance in early adulthood can be influenced by environmental exposures, occupational stress, sleep patterns, and lifestyle factors.²⁷ Noise exposure, in particular, has been shown to affect domains such as attention, processing speed, and working memory.⁸ This is also supported by our findings of cognitive decline in individuals exposed to environmental noise in high-risk areas. Therefore, a brief, culturally adapted screening instrument suitable for community deployment fills a significant public health need. It will help in early identification of cognitive changes in young noise-exposed adults allowing timely interventions, including noise mitigation strategies, occupational counselling, and lifestyle modification.

CCQ-8 were selected over among widely known performance-based tools like MoCA and MMSE because informant-based measures better detect mild cognitive decline,¹⁵⁻¹⁸ particularly where time, training, and educational differences can affect test performance.²⁸ Many commonly used cognitive tools are also not culturally adaptable without extensive modifications, which can limit their value in population-level screening.²⁹

The CCQ-8, on the other hand, is a brief informant-reported questionnaire that requires little training, has straightforward scoring, and works well for field surveys in environments with limited resources, such as occupational health

camps.¹⁴ CCQ-8 is a useful tool for early cognitive change detection in epidemiological surveys of community-dwelling groups and occupational health camps. Because of this, it is perfect for early cognitive change detection in community populations that are challenging to evaluate.

There are advantages to our study as well. First, we were able to get complete consensus from the experts on every item in the translated version. Additionally, psychologists participated in both forward and backward translation as part of the expert panel. A recent systematic review recommended involving qualified professionals in the translation process to avoid inaccurate translation or misinterpretation, leading to construct bias, and reported that only two of the six studies that included a backward translation process involved psychologists or psychiatrists as part of the panel.²⁹ Secondly, though cognitive function assessment targets a population aged more than 60 years, cognitive impairment may occur in a much younger population due to causes like noise pollution, vitamin B12 deficiency, etc.⁸ ³⁰It is known that cognitive assessment tools are influenced by multiple factors, including age, level of education, and culture.³¹

Therefore, in order to screen a large population for cognitive impairment, instruments that may be given to younger people and in community settings are required. Next, some contend that because the Western educational paradigm exposes students to test circumstances from a relatively young age, people from certain cultures—particularly those in the West—perform better on performance-based examinations than people from other cultures.^{32,33} Even after translation and validation, it is not surprising that people from underdeveloped nations do poorly on performance-based tests and may be mistakenly diagnosed with cognitive impairment.³⁴ Therefore, informant-based, simple-to-administer examinations are crucial choices for people from different cultures..

Nonetheless, despite these strengths, this study has its limitations. The validation was conducted in a specific age group and within a noise-exposed population, which may limit generalizability to

other age groups or clinical populations. Also, Tamil is spoken across several regions with dialectical differences, and it might be that the scale performs differently across different subgroups.

Future work should focus on longitudinal follow-up studies to determine whether CCQ-8 scores predict future cognitive decline or remain stable over time. In addition, since Tamil is spoken in many regions and dialects, studies in different communities and education levels will help determine its applicability in diverse communities.

Conclusion

The Tamil-translated CCQ-8 demonstrates acceptable reliability and validity for cognitive screening in young, noise-exposed adults. Given the scarcity of data in this age group and the increasing recognition of noise as a modifiable environmental risk factor for cognitive impairment, this tool may serve as a practical and culturally appropriate instrument for early community-based cognitive assessment.

Psychological problems and Cognitive change were the earliest sign of mild cognitive impairment for noise-exposed workers which we undetected leading to dementia.

Cognitive impairment in noisy environment workers were assessed by CCQ-8 questionnaires, which have been translated, adapted, and validated into Tamil using international protocols with adequate internal consistency and test-retest reliability.

The CCQ8-T translated version is suitable for the assessment of mild cognitive impairment in the community since it is easy to administer, score, and educationally non-dependent.

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