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Correcting for demographic variables on the modified Telephone Interview for Cognitive Status

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Abstract

Objective—Examine the effect of demographic variables on scores on the modified Telephone Interview for Cognitive Status (mTICS) in a healthy cohort and develop demographically-corrected normative data.

Design—Observational.

Setting—Primarily academic medical centers.

Participants—Five hundred seventy-six healthy older adults.

Measurements—mTICS.

Results—Age and education significantly correlated with mTICS score, and gender differences were also observed on this score. Ethnicity differences were not observed. Using regression equations, age, education, and gender significantly predicted mTICS total score.

Conclusions—By using these corrections, an individual's cognitive status may be more accurately predicted with this telephone screening instrument, although clinical validation is needed.

Introduction

The modified Telephone Interview for Cognitive Status (mTICS) (1) is a 14-item screening measure that can quickly evaluate an individual's global cognitive status. Its items tap attention, orientation, language, and learning and memory, yielding a total score ranging from 0 – 50, with higher scores indicating better cognition. The mTICS is similar to screening measures like the Mini Mental Status Examination, with the advantage that it can be administered by telephone. It was modified from the TICS by adding a delayed recall trial, which was dropped in the original version because it was too difficult for patients with Alzheimer's disease (2). Since the mTICS is more memory-laden (e.g., 20 of its possible 50

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points coming on learning and memory items), this measure may be a useful tool for identifying cases with a primary amnestic profile (e.g., amnestic Mild Cognitive Impairment and early Alzheimer's disease).

Studies of the mTICS and the TICS have led to mixed results regarding its diagnostic usefulness. For example, multiple studies have suggested that although these measures adequately identify cases of dementia, they struggle to identify milder phases of late life cognitive disorders (3-5). Conversely, other studies have found these measures to be useful in MCI (6-9), especially when they controlled for age and education in the analyses (10, 11). Since the mTICS tends to correlate with other screening measures (12, 13) and more comprehensive assessments of cognitive functioning (14-16), the mTICS might be useful as a screening measure for clinical trials on patients with cognitive impairments (7, 17). Its applicability in clinical settings, however, has not been widely studied.

Despite the potential benefits of the mTICS, a notable limitation is its lack of normative data with demographic corrections. Age and the mTICS total score tends to have an inverse association (11, 12, 14), whereas education has been positively associated with mTICS scores (11, 12, 18, 19). Interpretive errors can occur if demographic variables are not accounted for in cognitive measures (20-22).

Therefore, the purpose of the current study was to examine demographic influences on the mTICS and generate corrected normative data for this instrument. Based on existing research, it was expected that age and education would be related to mTICS scores. Although there is little mTICS-specific data to generate hypotheses on other demographic variables, it is also suspected that gender and ethnicity would also affect scores on this screening measure.

Methods

The institutional review board at each participating site approved all procedures prior to study commencement. As part of an epidemiological study of progressive supranuclear palsy (clinicaltrials.gov NCT00431301), two comparison groups were recruited. One comparison group consisted of non-genetically related family members (e.g., in-laws), friends, or neighbors of the patient, who were gender-matched and within 5 years of the patient's age. The second comparison group consisted of spouses or non-blood relatives of the patient, again within 5 years of the patient's age. To ensure that the comparison subjects were relatively healthy, they were administered the mTICS and a parkinsonism screening questionnaire. The first comparison group was administered these measures by telephone, whereas the second comparison group could have had them administered either in-person or by telephone. Comparisons from either group were excluded if: 1) they had an mTICS score <28, as this could indicate dementia (1) or 2) responses on the parkinsonism questionnaire suggested a diagnosis of, treatment for, or other characteristic symptoms of Parkinson's disease.

The two comparison groups did not significantly differ on mTICS scores, so they were combined for the following analyses. In the first set of analyses, the influence of demographic variables (age, education, gender, ethnicity) on mTICS scores was examined. Age and education influences on mTICS scores were examined with Pearson correlations. An independent t-test examined mTICS scores between males and females. A one-way ANOVA compared four ethnicity groups (Asian or Pacific Islander, Black or African American, Latina/Latino or Hispanic, White or European-American) on mTICS scores. Statistically significant influences from this first step were carried forward to the next step. In the second analysis, a stepwise linear regression was used to predict mTICS score from the statistically significant demographic variables in the first step. Stepwise regression was chosen over other models (e.g., hierarchical regression) as this type of regression has been widely used in neuropsychology to develop demographic corrections and to predict cognitive change across time (23, 24). Given the number of statistical comparisons, an alpha level of 0.01 was used.

Results

Five hundred seventy-six comparison subjects provided data for these analyses. As a group, they tended to be elderly (age: M = 68.1 years, SD = 7.7, range = 46 – 91), have some college (education: M = 15.5 years, SD = 3.3, range = 2 – 30), were primarily white/ European-American (95.8%), and were slightly more female (55%). Overall, their mean mTICS score was 37.8 (SD = 4.0, range = 28 – 50).

In the first step of the analyses, age negatively correlated with mTICS scores ($r = -0.32$, $n = 576$, $p<0.001$), and education positively correlated with this score ($r = 0.21$, $n = 576$, $p<0.001$). Females had significantly higher mTICS scores than males ($t[574] = -4.1$, $p<0.001$). No mTICS differences occurred among the ethnicity groups ($F[3,572] = 0.61$, $p = 0.61$). In examining statistical assumptions of the data, the linearity of associations appeared supported for age, education, and gender compared to the mTICS, whereas ethnicity deviated from linearity.

In the final model of the stepwise regression, age, education, and gender were all statistically significant predictors of the mTICS score ($F[3,572]=39.0$, $p<0.001$, $R^2 = 0.17$). Each step of the regression model is presented in Table 1. Visual inspection of the standardized predicted values of mTICS plotted against the standardized residual values from the final regression model seemed to suggest homoscedasticity. Additionally, no simple interactions between demographic variables (calculated as their products) significantly added to the final regression model when they were added as a second step.

Discussion

With applications in clinical and research settings, the mTICS has been growing in popularity as a cognitive screening instrument. However, normative data that corrects for demographic variables is lacking for this measure, which could lead to inaccurate interpretation of scores. Consistent with prior studies (11, 12, 17, 25), the current study found that mTICS scores were significantly affected by multiple demographic variables. For example, age was negatively associated with these scores, with younger adults performing better than older adults. Education showed the opposite pattern, where lower educational attainment was associated with lower scores on the mTICS. Females tended to score higher than males on this telephone screening instrument. The gender effect may be due to the fact that the mTICS is largely a verbal test that is heavily weighted towards memory items, and females tend to do better than males on both of these test characteristics (26). Ethnicity did not affect mTICS scores in this cohort. However, the lack of an effect of ethnicity may be due to our sample, which was poorly represented by non-whites. Greater representation of ethnic minorities (leading to more linear associations with mTICS scores) might have yielded different results, as racial/ethnic status typically does influence cognitive test performance (27). Overall, these results are consistent with the longstanding use of demographic corrections for many neuropsychological measures (20, 21). These correlations went in the expected directions, but the size of the findings was modest, accounting for 4 – 9% of the variance. Obviously, other factors must be influencing cognitive status, and future studies might examine other variables (e.g., occupational attainment, quality of education).

Given the potential influence of these variables on the mTICS, we next sought to develop normative data that corrected for these variables. Regression-based models are an established method for correcting for demographic variables on a variety of cognitive test scores (23). Using this method, we found that age, education, and gender significantly predicted the Total score on the mTICS. As expected based on the correlations, these regression model did not entirely capture the mTICS score (e.g., 17% of the variance accounted for), suggesting that other variables (e.g., hearing, fatigue, environmental distractions, anxiety) might contribute to this estimation. Nonetheless, these corrections may provide more accurate information about the cognitive status of individuals over the telephone by minimizing systematic error.

Although a clinical validation of these demographic corrections is beyond the scope of this study (e.g., the patients with progressive supranuclear palsy were not administered the mTICS) and external validation is clearly desirable, some internal examination of the utility of these corrections may be helpful. As noted in the first step of the analyses, age and education were significantly correlated with raw total score on the mTICS ($r = -0.32$ and $r = 0.21$, respectively), and males and females were statistically different on this total score. However, when demographically-corrected z-scores were generated for each participant using the information in Table 2, age and education were no longer related to this mTICS score ($r = 0.01$ [$p = 0.88$] and $r = 0.00$ [$p = 0.99$], respectively), and males and females showed comparable scores ($t[574] = 0.01$, $p = 0.97$). These post-hoc analyses show that the demographic corrections do remove the confounding variance in the current sample's mTICS scores. Again, external validation, especially in a clinical sample, is needed.

For those less familiar with these regression-based normative models, a couple examples might be beneficial. In the current sample, the mean age was 68 years, the mean education was 16 years, and most subjects were female. Based on these demographic variables and using the formula in Table 2, the total sample would predict an mTICS score of 38.4, which is very close to the observed mean mTICS score in this sample of 37.8. However, these corrections are more likely to be applied at the individual level. If an 80-year old male with only 8 years of education earned a score of 38 on the mTICS, then this would fall well above his predicted score of 32.97 (i..e., $41.36 - [80*0.15] + [8*0.29] + [1*1.29] = 32.97$). A 50-

year old female with a Master's degree would be predicted to have an mTICS score of 41.66 (i.e., 41.36 − [50*0.15] + [18*0.29] + [2*1.29] = 41.66). Not only can these models predict performance, but they can provide a frame of reference for how similar an observed performance is compared to a predicted performance. By dividing the difference of observed mTICS minus predicted mTICS by the standard error of the estimate of the regression model in Table 2, a z-score is calculated for each individual that shows how many standard deviation units he/she is away from his/her predicted score. For example, if the 80-year old male with 8 years of education actually gets a 38 on the mTICS, then this observed mTICS score is 1.39 standard deviation units above expectations based on his age and education (i.e., [38 − 32.97]/3.61 = +1.39). The 50-year old female with 18 years of education with an observed mTICS score of 36 would fall 1.57 standard deviation units below expectations (i.e., [36 − 41.66]/3.61 = −1.57). Importantly, the z-scores for the entire sample seem to be normally distributed (e.g., skewness = 0.05, kurtosis = 0.23), which makes their interpretation more straightforward. These case examples are presented in Table 3, and the interested reader can contact the first author to obtain an Excel spreadsheet that will perform these calculations.

Despite the appeal of these demographic corrections, there are some limitations that deserve mention. First, the current sample was relatively homogeneous, and the generalizability of these findings to those outside the demographic composition of this sample (e.g., 46 – 91 years old, nearly all Caucasian) is unknown. Future studies might examine the utility of these normative data in more diverse samples. Second, individuals scoring poorly on the mTICS (i.e., <28) were excluded from this study, which obviously limits the applicability of these findings to those with more severe levels of cognitive impairment. Therefore, until additional validation is completed, it would be most appropriate to only apply these normative corrections to individuals whose cognition generally falls in the "normal" range. Third, this sample was recruited from an epidemiological study of progressive supranuclear palsy, so it is not clear how valid these results would be in a purely clinical setting. For example, all comparison subjects had some relationship with a patient with progressive supranuclear palsy, although efforts were made to exclude those with similar symptoms/diagnoses/treatments. It should also be reiterated that clinical validation of these normative corrections are necessary before they be used in clinical decision-making. Fourth, there are a number of weaknesses inherent to telephone assessment, including that items are restricted to auditory domain, limited control over environmental factors, and the potential impact of a hearing deficit. For example, Beeri et al. (10) found that the mTICS was more sensitive if hearing loss was controlled for. In the current study, we did not screen for hearing loss in our participants. Similarly, we did not assess for environmental factors, such as a loud television in the background or a potential participant referring to a calendar when asked for the date. These factors could have affected the validity of the cognitive assessment and our overall findings. Even with these limitations, the current results would appear to further validate the mTICS as a valuable screening measure of cognitive status in adults.

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Appendix

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Table 1

Results of the stepwise regression.

Step	F; df; p	R^2	SEE	Δ F; df; p	Δ R^2	B, SE
1	63.1; 1,574; <0.001	0.10	3.75			
Age						−0.16, 0.02
Constant						48.84, 1.39
2	48.5; 2,573; <0.001	0.14	3.66	30.7; 1,573; <0.001	0.05	
Age						−0.16, 0.02
Education						0.26, 0.05
Constant						44.86, 1.54
3	39.0; 3,572; <0.001	0.17		17.1; 1,572; <0.001	0.02	
Age						−0.15, 0.02
Education						0.29, 0.05
Gender						1.29, 0.31
Constant						41.36,1.74

Note. SEE = standard error of the estimate of the regression model, B = unstandardized coefficients (i.e., beta weights), SE = standard error of coefficient.

Table 2

Prediction equation for demographically-corrected mTICS score

Prediction equation	SEE
mTICS Total predicted = 41.36 − (age*0.15) + (educ*0.29) + (gender*1.29)	3.61

Note. age = years old; educ = years of education; gender: 1 = male, 2 = female; mTICS = modified Telephone Interview of Cognitive Status; SEE = Standard Error of the Estimate of the regression model.

Table 3

Case examples

Example 1: 80 year old male with 8 years of education and an observed mTICS score of 38
mTICS Total predicted = 41.36 − (age*0.15) + (educ*0.29) + (gender*1.29)
mTICS Total predicted = 41.36 − (80*0.15) + (8*0.29) + (1*1.29) = 32.97
mTICS Total z-score = (observed − predicted) / SEE
mTICS Total z-score = (38 − 32.97) / 3.61 = +1.39
Example 2: 50 year old female with 18 years of education and an observed mTICS score of 36
mTICS Total predicted = 41.36 − (age*0.15) + (educ*0.29) + (gender*1.29)
mTICS Total predicted = 41.36 − (50*0.15) + (18*0.29) + (2*1.29) = 41.66
mTICS Total z-score = (observed − predicted) / SEE
mTICS Total z-score = (36 − 41.66) / 3.61 = −1.57

Note. age = years old; educ = years of education; gender: 1 = male, 2 = female; mTICS = modified Telephone Interview of Cognitive Status; SEE = Standard Error of the Estimate of the regression model.