

# Test of Memory Malingering (TOMM): Normative data for the Latin American Spanish speaking adult population

D. Rivera<sup>a</sup>, P.B. Perrin<sup>b</sup>, G. Weiler<sup>c</sup>, N. Ocampo-Barba<sup>d</sup>, A. Aliaga<sup>e</sup>, W. Rodríguez<sup>f</sup>, Y. Rodríguez-Agudelo<sup>g</sup>, A. Aguayo<sup>h</sup>, M. Longoni<sup>i</sup>, S. Trapp<sup>b</sup>, L. Esenarro<sup>j</sup> and J.C. Arango-Lasprilla<sup>k,a,\*</sup>

<sup>a</sup>*Faculty of Psychology and Education, University of Deusto, Bilbao, Spain*

<sup>b</sup>*Department of Psychology, Virginia Commonwealth University, Richmond, VA, USA*

<sup>c</sup>*Instituto de Prevención Social, Asuncion, Paraguay*

<sup>d</sup>*Fundación Horizontes, Santa Cruz de la Sierra, Bolivia*

<sup>e</sup>*Servicio Médico Legal, Ministerio de Justicia, Santiago, Chile*

<sup>f</sup>*Ponce Health Sciences University, Ponce, Puerto Rico*

<sup>g</sup>*Instituto Nacional de Neurología y Neurocirugía MVS, Mexico City, Mexico*

<sup>h</sup>*Instituto Vocacional Enrique Díaz de León, Guadalajara, Mexico*

<sup>i</sup>*Clínica de rehabilitación Las Araucarias, Buenos Aires, Argentina*

<sup>j</sup>*Instituto de Neuropsicología y Demencias, Lima, Peru*

<sup>k</sup>*IKERBASQUE, Basque Foundation for Science, Bilbao, Spain*

## Abstract.

**Background:** The Test of Memory Malingering (TOMM) is an instrument used to assess purposeful embellishment or fabrication of memory difficulties for personal gain. Although the TOMM can be used in non-English speaking cultures, it has not been validated in Spanish-speaking Central and South American contexts.

**Objective:** To generate normative data on TOMM across 7 countries in Latin America, with country-specific adjustments for gender, age, and education, where appropriate.

**Method:** The sample consisted of 2,266 healthy adults who were recruited from Argentina, Bolivia, Chile, Mexico, Paraguay, Peru, and Puerto Rico. Each subject was administered the TOMM as part of a larger neuropsychological battery. A standardized five-step statistical procedure was used to generate the norms.

**Results:** *t*-tests did not show significant differences in TOMM performance between men and women in any countries of the TOMM Trial 1 or 2. As a result, gender-adjusted norms were not generated.

**Conclusions:** The results from this study will have a large impact on the practice of neuropsychology in Latin America, as this is the first normative multicenter study to create norms for the TOMM in this global region.

Keywords: Normative data, Memory Malingering, Latin America, Memory

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\*Address for correspondence: Juan Carlos Arango-Lasprilla, Ph.D., IKERBASQUE Research Professor, Department of Psychology, University of Deusto, IKERBASQUE, Basque Foundation

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for Science, Bilbao, Spain. Tel.: +34 804 859 4329; E-mail: jcarango@deusto.es.

## 1. Introduction

Purposeful underperformance and exaggeration of symptoms are concerns when administering neuropsychological testing (Heilbrunner, Sweet, Morgan, Larrabee, Millis, & Conference Participants, 2009; Iverson, 2006). In order to identify patterns in performance that indicate malingering, a number of instruments and testing procedures have been constructed. The Test of Memory Malingering (TOMM; Tombaugh & Tombaugh, 1996) is a symptom validity instrument used to assess purposeful embellishment or fabrication of memory difficulties for personal gain (Tombaugh & Tombaugh, 1996). The TOMM uses a forced choice recognition method originally developed for sensory impairment (Brady & Lind, 1961; Grosz & Zimmerman, 1965), but later was adapted to assess for malingering (Pankratz, 1983). This test is considered the most widely used and researched test of malingering (Jelicic, Ceunen, Peters, & Merckelbach, 2011).

Tests of effort and malingering often use memory tasks and include a number of approaches to present the stimuli. Verbal tests can be administered, such as the Word Memory Test (Green, 2003), in which recall and recognition trials are administered based on oral stimuli. Numerical tests, such as the Victoria Revision (Slick, Hopp, Strauss, Hunter, & Pinch, 1994) of the Hiscock Digit-Memory Test (Hiscock & Hiscock, 1989), examine an individual's effort on recalling numbers. Visual tests, such as the TOMM (Tombaugh & Tombaugh, 1996), administer visual stimuli for later recognition. Other commonly used tests of malingering and effort include the Recognition Memory Test (Warrington, 1984), the 48-Picture Test (Chouinard & Rouleau, 1997), and the Rey (15-item) Memory Test (Rey, 1958). However, the TOMM is used widely for its efficient clinical utility and strong evidence base (Lezak, 2004; O'Bryant, Engel, Kleiner, Vasterling, & Black, 2007).

The TOMM requires the test taker to recognize visual stimuli, a testing modality that has been demonstrated to be efficacious with cognitively intact individuals, cognitively impaired individuals, and ages ranging from pediatric samples to older adults; however it is not appropriate for individuals with moderate to severe dementia (Donders, 2005; Koutstaal & Schacter, 1997; Light, 1991; Teichner & Wagner, 2004). The TOMM (Tombaugh & Tombaugh, 1996) is comprised of two learning and recognition trials and an optional retention trial that takes approximately 15 minutes to complete. Each of the learning and recognition trials includes the

same 50 visual items in variant orders. The visual stimuli are displayed to the test taker for three seconds in one-second intervals. After displaying the visual stimuli, the test taker is provided a forced choice recognition task in which the test taker must choose the correct visual stimuli from two options. Although the retention trial, a delayed, non-forced choice memory task, has been reported to be optional (Tombaugh & Tombaugh, 1996), research has indicated that, unless a comparable symptom validity test is also administered in the battery, the retention trial must be administered for greater accuracy (Greve & Bianchini, 2006). Examination of the instrument has demonstrated that a criterion cutoff score of 45 on Trial 2 provided 95% accuracy of identifying non-malingering patients without dementia, and specificity of 91% with all patients (Rees, Tombaugh, Gansler, & Moczynski, 1998; Tombaugh, 1997; Tombaugh & Tombaugh, 1996).

The TOMM is a symptom validity test used to assess for possible malingering in neuropsychological testing (Tombaugh & Tombaugh, 1996). This test is widely used in neuropsychological evaluations in which the veracity of the test taker's performance may be in question. The TOMM is also often administered in forensic testing (Gierok, Dickson, & Cole, 2005; Tombaugh, 2003; Weinborn, Orr, Woods, Conover, & Feix, 2003). The instrument is not only well regarded in clinical domains, but is also considered to have sufficient specificity and positive predictive value to be used as scientific evidence in United States court cases (Vallabhajosula & Van Gorp, 2001).

Although the TOMM has demonstrated notable utility in neuropsychological and forensic testing, the test also has a number of disadvantages. Literature indicates that test takers might malingering on tests they believe to be relevant to their perceived neurological condition, thus making the TOMM susceptible to test taker error (Arnold & Boone, 2007; Greiffenstein, 2007). In addition, the nature of the nonverbal administration of the TOMM reduces its utility with individuals that suffer from perceptual difficulties (Hegedish, & Hoofien, 2015). In this instance, a verbally administered test is of greater value.

A variety of symptom validity tests have been related to scores on the TOMM. For example, the Forced Choice trial in the California Verbal Learning Test – II (CVLT-II; Delis & Kramer, 2000) and the Rey-15 (Rey, 1964) have been found to have similar precision and strong agreement with the TOMM (McCaffrey, O'Bryant, Ashendorf, & Fisher, 2003; Moore & Donders, 2004). In a study examining the

relationships between malingering tests on the TOMM, the Rey-15, and the validity tests on the Minnesota Multiphasic Personality Inventory – Second Edition (MMPI-2; Hathaway & McKinley, 1989) it was found that the TOMM and the Rey-15 held a positive significant relationship, while the validity tests on the MMPI-2 did not positively correlate with the TOMM or Rey-15, indicating that the MMPI may be measuring a different construct (McCaffrey et al., 2003).

Research examining the psychometric properties of the TOMM in relation to cognitively intact and cognitively impaired individuals has demonstrated no differences, while both groups were differentiated from individuals with dementia (Teichner & Wagner, 2004). Further, group differences for FSIQ, PIQ, and mental status were demonstrated in which the cognitively intact individuals performed better than cognitively impaired individuals, and the cognitively impaired individuals performed better than individuals with dementia. Performance on the instrument is considered not to be impeded by age, gender, education level, depression, anxiety, and pain (Strauss, Sherman, & Spreen, 2006). However, clinicians are cautioned when administering the TOMM to individuals with premorbid psychiatric history, moderate to severe dementia, and financial incentives to malingering (Moore & Donders, 2004). In regard to elderly samples (e.g., cognitively intact, cognitive impairment without dementia, and with dementia), the TOMM has been found to be successful in identifying malingering when dementia has been ruled out (Teichner & Wagner, 2004). Further, performance in pediatric samples did not vary due to gender, ethnicity, parental occupation, and memory test scores (Donders, 2005).

The original standardization norms were conducted on three samples of individuals: 475 community participants, 70 community participants, and 135 inpatient and outpatients referred for neuropsychological evaluation (Tombaugh, 1997). The first two samples were drawn from Ottawa, and the third sample was comprised of individuals from Ottawa and Boston. No normative data examining race/ethnicity were reported in the standardization sample. Across the three samples, ages ranged from 16–90 years (Tombaugh, 1997) and in a separate standardization study ages ranging from 5–12 years were deemed appropriate for use of the TOMM (Constantinou & McCaffrey, 2003).

Evidence for the validity of the TOMM has been shown in a number of clinical samples featuring neurological conditions or psychiatric conditions. In general, the neurocognitive literature explains that the features

of the TOMM are insensitive to the effects of neurocognitive impairment (Tombaugh, 1997). There is also evidence for the specificity of the TOMM for individuals who have sustained traumatic brain injuries, in which the effects of the injury did not increase false positive results (Rees et al., 1998). Despite the TOMM's insensitivity to the effects of neurocognitive impairment, there is evidence to caution clinicians to rule out dementia diagnoses in order to prevent misclassification of malingering (Teichner & Wagner, 2004).

In addition to identifying malingering in cases examining neurocognitive changes, the TOMM has also been found to have utility when testing memory impairment in individuals with psychiatric conditions. There is evidence of the TOMM being insensitive to the effects of anxiety, depression, and active psychosis (Ashendorf, Constantinou, & McCaffrey, 2004; Duncan, 2005; Rees, Tombaugh, & Boulay, 2001; Weinborn et al., 2003). Together the literature indicates the appropriateness of the TOMM for testing malingering of memory impairment in a range of mental health conditions.

Although much of the evidence for validity is based on English-speaking samples, a limited base of literature on Spanish speakers has begun to develop. These studies primarily examine the TOMM with TBI samples from Spain and the United States (Ramírez, Chirivella-Garrido, Caballero, Ferri-Campos, & Noé-Sebastián, 2004; Strutt, Scott, Lozano, Tieu, & Peery, 2012; Vilar-Lopez, Gomez-Rio, Caracuel-Romero, Llamas-Elvira, & Perez-Garcia, 2008; Vilar-López et al., 2008). These studies provided preliminary evidence indicating the appropriateness for use of the TOMM with Spanish speakers, but each reported some level of caution. Specifically, each study was hampered by small samples and urged for larger studies with more advanced designs to be conducted. Further demographic characteristics, such as education level and location of the Spanish speakers were noted as contextual elements that may impact the results of the test. Due to its value of identifying malingering in neuropsychological testing, further work validating the TOMM in Spanish-speaking cultures was recommended.

The TOMM is the most widely used and researched tests of malingering (Jelicic, Ceunen, Peters, & Merckelbach, 2011). This instrument is considered a valuable tool in neuropsychological and forensic testing scenarios (Gierok, Dickson, & Cole, 2005; Tombaugh & Tombaugh, 1996; Tombaugh, 2003; Weinborn, Orr, Woods, Conover, & Feix, 2003). The TOMM has been reported to be a valuable test for individuals in English-speaking and many from non-English speaking

cultures (Strauss et al., 2006). However, it is to the authors' knowledge that it has only been validated for use with Spanish speakers in Spain (Ramírez et al., 2004; Vilar-López et al., 2008), and not validated in Spanish-speaking Central and South American contexts. Bush and colleagues (2005) have recommended greater examination of symptom validity tests, such as the TOMM, and suggest careful utilization of these instruments when applying them in diverse cultural contexts. The availability of the TOMM for testing in Central and South America will offer greater quality neuropsychological testing for underserved groups that will benefit from its use. Evidence for purposeful underperformance and exaggeration of symptoms is valuable for better patient care, such as generating accurate diagnoses and offering the most appropriate treatment. The aims of the present study are to adapt and validate the TOMM for use in a variety of Central and South American locations. It is to the authors' knowledge that this is the first effort of this magnitude to validate this measure within these cultures.

## 2. Method

### 2.1. Participants

The sample consisted of 2,266 healthy individuals who were recruited from Argentina, Bolivia, Chile, Mexico, Paraguay, Peru, and Puerto Rico. The participants were selected according to the following criteria: a) were between 18 to 95 years of age, b) were born and currently lived in the country where the protocol was conducted, c) spoke Spanish as their native language, d) had completed at least one year of formal education, e) were able to read and write at the time of evaluation, f) scored  $\geq 23$  on the Mini-Mental State Examination (MMSE, Folstein, Folstein, & McHugh, 1975; Ostrosky-Solís, López-Arango, & Ardila, 2000; Villaseñor-Cabrera,

Guàrdia-Olmos, Jiménez-Maldonado, Rizo-Curiel, & Perú-Cebollero, 2010), g) scored  $\leq 4$  on the Patient Health Questionnaire-9 (PHQ-9, Kroenke, Spitzer, & Williams, 2001), and h) scored  $\geq 90$  on the Barthel Index (Mahoney & Barthel, 1965).

Participants with self-reported neurologic or psychiatric disorders were excluded due to a potential effect on cognitive performance. Participants were volunteers from the community and signed an informed consent. Table 1 presents socio-demographic and participant characteristics for each country. The multi-center study was approved by the Ethics Committee of the coordinating site, the University of Deusto, Spain.

### 2.2. Instrument administration

The TOMM begins with the presentation of stimuli notebook 1 (learning test), which contains 50 drawings. Following presentation of the stimuli, the participant is shown 50 pairs of pictures where one of the drawings appears for each panel previously presented and a new drawing. The task is to indicate what the picture was presented in the learning phase. Then, the participant is presented with notebook stimulus 2 (learning test 2), which also contains 50 drawings. The task and the process for learning in this second test is the same as in the previous (Tombaugh, Vilar-López, García, & Puente, 2011).

### 2.3. Statistical analyses

The detailed statistical analyses used to generate the normative data for this test are described in Guàrdia-Olmos, et al., (2015). In summary, the data manipulation process for each country-specific dataset involved five steps: a) *t* – tests for independent samples and effect sizes (*r*) were conducted to determine gender effects. If the effect size was larger than 0.3, gender was included in the model with gender dummy coded and

Table 1  
Sample distribution by age, education and gender

	<i>n</i> Total	Age Mean (SD)	Education		Gender	
			1 to 12	>12	Male	Female
			<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Argentina	320	45.7 (19.5)	148 (46.3%)	172 (53.8%)	96 (30.0%)	224 (70.0%)
Bolivia	274	55.8 (22.0)	226 (82.5%)	48 (17.5%)	99 (36.1%)	175 (63.9%)
Chile	320	55.1 (19.6)	241 (75.3%)	79 (24.7%)	134 (41.9%)	186 (58.1%)
Mexico	555	56.3 (19.2)	456 (82.2%)	99 (17.8%)	173 (31.2%)	382 (68.8%)
Paraguay	263	53.0 (14.8)	216 (82.1%)	47 (17.9%)	101 (38.4%)	162 (61.6%)
Peru	244	43.5 (20.6)	87 (35.7%)	157 (64.3%)	87 (35.7%)	157 (64.3%)
Puerto Rico	290	50.8 (18.5)	158 (54.5%)	132 (45.5%)	123 (42.4%)	167 (57.6%)

female as the reference group (male = 1 and female = 0). b) A multivariate regression model was used to specify the predictive model including gender (if effect size was larger than 0.3), age as a continuous variable, and education as a dummy coded variable with 1 if the participant had >12 years of education and 0 if the participant had 1–12 years of education. If gender, age and/or education was not statistically significant in this multivariate model with an alpha of 0.05, the non-significant variables were removed, and the model was re-run. Then a final regression model was conducted that included age (if statistically significant in the multivariate model), dichotomized education (if statistically significant in the multivariate model), and/or gender (if effect size was greater than 0.3) [ $\hat{y}_i = \beta_0 + (\beta_{Age} \cdot Age_i) + (\beta_{Educ} \cdot Educ_i) + (\beta_{Gender} \cdot Gender_i)$ ]; c) residual scores were calculated based on this final model ( $e_i = y_i - \hat{y}_i$ ); d) using the *SD* (residual) value provided by the regression model, residuals were standardized:  $z = e_i/SD_e$ , with *SD<sub>e</sub>* (residual)=the standard deviation of the residuals in the normative sample; and e) standardized residuals were converted to percentile values (Strauss et al., 2006). Using each country's dataset, these steps were applied to TOMM Trial 1 scores and TOMM Trial 2 scores. In certain countries, there was no effect of gender, nor age, nor education on the scores. In these cases, the normative data were generated directly using the raw scores.

### 3. Results

#### 3.1. TOMM Trial 1

Regarding the effect of gender on TOMM Trial 1 scores, the *t*-tests did not show significant differences between men and women in all countries. Table 2 shows

the results of the gender analyses by country on TOMM Trial 1 scores. As shown in Table 2, the effect sizes for all countries were less than 0.3, and therefore gender was not taken into account to generate TOMM Trial normative data for any of the countries in the study.

The final seven TOMM Trial 1 multivariate linear regression models for each country are shown in Table 3. In all countries except Bolivia and Chile, the TOMM Trial 1 score increased for those with more than 12 years of education (see Table 3) and, in all countries except Puerto Rico, TOMM Trial 1 scores decreased in a linear fashion as a function of age. The amount of variance explained in TOMM Trial 1 scores ranged from 4% (in Argentina) to 29% (in Paraguay).

#### 3.2. TOMM Trial 2

Regarding the effect of gender on TOMM Trial 2 scores, the *t*-tests did not show significant differences between men and women in all countries. Table 4 shows the results of the gender analyses by country on TOMM Trial 2 scores. As shown in Table 4, the effect sizes for all countries were less than 0.3, and therefore gender was not taken into account to generate TOMM Trial normative data for any of the countries in the study.

The final seven TOMM Trial 2 multivariate linear regression models for each country are shown in Table 5. In all countries except Bolivia, Chile, and Mexico the TOMM Trial 2 score increased for those with more than 12 years of education (see Table 5) and, in all countries except Puerto Rico, TOMM Trial 2 scores decreased in a linear fashion as a function of age. The amount of variance explained in TOMM Trial 2 scores ranged from 2% (in Mexico) to 33% (in Paraguay).

Table 2  
Effect of gender in the TOMM learning trial 1

Country	Gender	Mean (SD)	<i>t</i>	df	Sig. (2-tailed)	<i>r</i>
Argentina	Male	47.9 (2.4)	0.48	318	0.632	0.027
	Female	47.8 (2.6)				
Bolivia <sup>a</sup>	Male	45.2 (5.9)	-0.73	162.6	0.468	0.057
	Female	45.7 (4.5)				
Chile	Male	46.7 (3.6)	0.45	318	0.651	0.025
	Female	46.5 (3.7)				
Mexico <sup>a</sup>	Male	47.1 (3.3)	0.87	465.9	0.385	0.040
	Female	46.8 (4.8)				
Paraguay	Male	45.3 (3.6)	0.86	261	0.391	0.053
	Female	44.9 (2.9)				
Peru <sup>a</sup>	Male	47.6 (2.4)	1.00	223.29	0.321	0.066
	Female	47.2 (3.3)				
Puerto Rico	Male	47.0 (3.9)	-1.57	288	0.118	0.092
	Female	47.6 (3.1)				

<sup>a</sup>Value of the *t*-test for independent groups from the different variances with the corresponding correction of Yuen-Welch of degrees of freedom.

Table 3  
Final multiple linear regression models for TOMM learning trial 1

Country		B	Std. Error	<i>t</i>	Sig.	R <sup>2</sup>	SD <sub>e</sub> (residual)
Argentina	(Constant)	48.164	0.401	120.009	<0.001	0.044	2.461
	Age	-0.016	0.007	-2.269	0.024		
	Education	0.763	0.279	2.733	0.007		
Bolivia	(Constant)	48.947	0.808	60.584	<0.001	0.071	4.890
	Age	-0.061	0.013	-4.556	<0.001		
Chile	(Constant)	50.350	0.572	88.086	<0.001	0.136	3.418
	Age	-0.069	0.010	-7.061	<0.001		
Paraguay	(Constant)	48.214	0.703	68.551	<0.001	0.293	2.665
	Age	-0.069	0.012	-5.624	<0.001		
	Education	2.694	0.470	5.729	<0.001		
Peru	(Constant)	48.099	0.524	91.864	<0.001	0.164	2.778
	Age	-0.041	0.009	-4.617	<0.001		
	Education	1.574	0.379	4.148	<0.001		
Puerto Rico	(Constant)	46.620	0.268	173.858	<0.001	0.055	3.364
	Education	1.630	0.397	4.100	<0.001		

Table 4  
Effect of gender in the TOMM learning trial 2

Country	Gender	Mean (SD)	<i>t</i>	df	Sig. (2-tailed)	<i>r</i>
Argentina	Male	49.8 (0.8)	-0.24	318	0.808	0.014
	Female	49.8 (0.6)				
Bolivia <sup>a</sup>	Male	47.6 (4.7)	-1.82	136.1	0.071	0.154
	Female	48.5 (2.7)				
Chile	Male	48.9 (2.1)	0.89	318	0.374	0.050
	Female	48.7 (2.1)				
Mexico	Male	48.9 (2.8)	-0.24	553	0.809	0.010
	Female	49.0 (3.2)				
Paraguay	Male	46.5 (3.3)	1.55	261	0.121	0.096
	Female	45.9 (3.1)				
Peru <sup>a</sup>	Male	49.4 (1.4)	1.33	222.4	0.184	0.089
	Female	49.1 (1.9)				
Puerto Rico	Male	49.5 (1.6)	-0.39	288	0.693	0.023
	Female	49.5 (1.3)				

<sup>a</sup>Value of the *t*-test for independent groups from the different variances with the corresponding correction of Yuen-Welch of degrees of freedom.

Table 5  
Final multiple linear regression models for TOMM learning trial 2

Country		B	Std. Error	<i>t</i>	Sig.	R <sup>2</sup>	SD <sub>e</sub> (residual)
Argentina	(Constant)	50.088	0.111	452.119	<0.001	0.066	0.679
	Age	-0.008	0.002	-3.815	<0.001		
	Education	0.174	0.077	2.251	0.025		
Bolivia	(Constant)	51.003	0.558	91.477	<0.001	0.100	3.374
	Age	-0.051	0.009	-5.500	<0.001		
Chile	(Constant)	51.293	0.321	159.649	<0.001	0.176	1.921
	Age	-0.045	0.005	-8.254	<0.001		
Mexico	(Constant)	50.275	0.403	124.811	<0.001	0.022	3.052
	Age	-0.024	0.007	-3.523	<0.001		
Paraguay	(Constant)	49.737	0.682	72.936	<0.001	0.331	2.584
	Age	-0.078	0.012	-6.567	<0.001		
	Education	2.663	0.456	5.841	<0.001		
Peru	(Constant)	49.483	0.285	173.807	<0.001	0.216	1.510
	Age	-0.023	0.005	-4.724	<0.001		
	Education	1.166	0.206	5.655	<0.001		
Puerto Rico	(Constant)	49.304	0.113	436.836	<0.001	0.025	1.416
	Education	0.454	0.167	2.712	0.007		

### 3.3. Normative procedure

Norms (e.g., a percentile score) for the TOMM Trial 1 and Trial 2 scores were established using the five-step procedure described above. To facilitate the understanding of the procedure to obtain the percentile associated with a score on this test, an example will be given. Suppose you need to find the percentile score for an Argentine man, who is 50 years old and has 13 years of education. He has a score of 47 on the TOMM Trial 1. The steps to obtain the percentile for this score are: a) Check Table 2 to determine if the effect size of gender in the country of interest (Argentina) on this test and task (TOMM Trial 1) is greater than 0.3 by country. The column labelled  $r$  in Table 2 indicates the effect size. In this example, the effect size is 0.027, which is not greater than 0.3. For Argentines on this test, gender does not influence scores to a sufficient degree to take it into account gender when determining the percentile. b) Find Argentina in Table 3, which provides the final regression models by country for TOMM Trial 1. Use the B weights to create an equation that will allow you to obtain the predicted TOMM Trial 1 score. The corresponding B weights are multiplied by the actual age and dichotomized education scores and added to a constant in order to calculate the predicted value. In this case, the predicted TOMM Trial 1 score would be calculated using the equation [ $\hat{y}_i = 48.164 + (-0.016 \cdot Age_i) + (0.763 \cdot Dichotomized\ Educational\ Level_i)$ ] (the values have been rounded for presentation in the formula). The subscript notation  $i$  indicates the person of interest. The person's age is 50, but the education variable is not continuous in the model. Years of education is split into either 1 to 12 years (and assigned a 0) or more than 12 years (and assigned a 1) in the model. Since our hypothetical person in the example has 13 years of education, his educational level value is 1. Thus the predicted value is  $\hat{y}_i = 48.164 + (-0.016 \cdot 50) + (0.763 \cdot 1) = 48.164 - 0.810 + 0.763 = 48.117$ . c) In order to calculate the residual value (indicated with an  $e$  in the equation), we subtract the actual value from the predicted value we just calculated ( $e_i = y_i - \hat{y}$ ). In this case, it would be  $e_i = 47 - 48.117 = -1.117$ . d) Next, consult the  $SD_e$  column in Table 3 to obtain the country-specific  $SD_e$  (residual) value. For Argentina, it is 2.461. Using this value, we can transform the residual value to a standardized  $z$  score using the equation ( $e_i/SD_e$ ). In this case, we have  $(-1.117)/2.461 = -0.454$ . This is the standardized  $z$  score for an Argentine man aged 50 with 13 years

of education and a score of 47 on the TOMM Trial 1. e) The last step is to look up the tables in the statistical reference books (e.g. Strauss et al., 2006) or use a trusted online calculator like the one available at <http://www.measuringu.com/pcalcz.php>. In the online calculator, you would enter the  $z$  score and choose a one-sided test and note the percent of area after hitting the submit button. In this case, the probability of 0.454 corresponds to the 32th percentile. Please remember to use the appropriate tables that correspond to each test (Trial 1 vs. Trial 2) when performing these calculations. If the percentile for the TOMM Trial 2 score is desired, Tables 4 and 5 must be used.

### 3.4. User-friendly normative data tables

The five-step normative procedures explained above can provide more individualized norms. However, this method can be prone to human error due to the number of required computations. To enhance user-friendliness, the authors have completed these steps for a range of raw scores based on small age range groupings (see Guàrdia-Olmos, et al., 2015) and created tables that clinicians can more easily use to obtain a percentile range associated with a given raw score on this test. These tables are available by country and type of test (TOMM Trial 1 vs. TOMM Trial 2) in the Appendix. In order to obtain an approximate percentile for the above example (converting a raw score of 47 for an Argentine man who is 50 years old and has 13 years of education) using the simplified normative tables provided, the following steps are recommended. (1) First, identify the appropriate table ensuring the specific country and test. In this case, the table for TOMM Trial 1 scores for Argentina can be found in Table A1. (2) Note if the title of the table indicates that it is only to be used for one specific gender. In this case, gender is not specified. Thus Table A1 is used for both males and females. (3) Next, the table is divided based on educational level (1 to 12 vs. more than 12 years of education). Since this man has 13 years of education, he falls into the ">12 years of education" category. These data can be found in the top section of the table. (4) Determine the age range most appropriate for the individual. In this case, 50 falls into the column 48–52 years of age. (5) Read down the age range column to find the approximate location of the raw score the person obtained on the test. Reading down the 48–52 column, the score of 47 obtained by this Argentine man corresponds to an approximate percentile of 30.

The percentile obtained via this user-friendly table method (30th) is slightly different than the more exact one (32th) obtained following the individual conversion steps above because the table method is based on an age range (e.g., individuals aged 48–52) instead of the exact age (individuals aged 50). If the exact score is not listed in the column, you must estimate the percentile value from the listed raw scores.

#### 4. Discussion

The purpose of the current study was to generate normative data on the TOMM across seven countries in Latin America, with country-specific adjustments for gender, age, and education, where appropriate. The final multiple linear regression models explained between 4–29% of the variance in TOMM Trial 1 scores and 2–33% of the variance in TOMM Trial 2 scores. On both TOMM trials, no gender differences emerged in any country. This finding supports previous work suggesting that TOMM performance is not affected by gender (Strauss, Sherman, & Spreen, 2006). As a result, gender-adjusted norms were not generated for the TOMM, and neuropsychologists administering the TOMM in Latin America should not make gender-adjustments in calculating percentiles.

TOMM Trial 1 and 2 scores decreased linearly as a function of education in almost all countries, except neither score set was associated with education in Chile, Bolivia, or Mexico. To the authors' knowledge, these general effects of education have not previously emerged in the literature, and as a result, this may be a unique contribution of the current study. Therefore, neuropsychologists in Latin America should use the education-adjusted norms generated in this study for each country on the TOMM, except in Chile, Bolivia, and Mexico. This differential pattern of effects across various countries in Latin America may have to do with the likely substantial differences in the quality of education across different countries in the region.

TOMM scores increased with advancing age in most countries in this study, except Puerto Rico and Mexico on Trial 1 and Puerto Rico on Trial 2. Again, to the authors' knowledge, these effects of age have not previously been reported and may be unique to this study. As a result, the current findings suggest that TOMM corrections for age should be made in most countries tested in this study, but not Puerto Rico and Mexico for Trial 1 or Puerto Rico for Trial 2.

#### 4.1. Limitations and future directions

The current study has several limitations and directions for future research. First, the TOMM is a fairly common measure of memory malingering in Latin America, but several other common measures should be normed using the same procedures to improve their accuracy in Latin America. Also, future studies should examine the ecological validity and psychometric properties of the TOMM and other malingering instruments in Latin America. Researchers need to create malingering instruments within Latin American cultures with high ecological validity, as the TOMM was developed and validated initially in a Western culture which may differ in important ways from those cultures in Latin America. Developing malingering assessments in the context of local cultures, instead of simply translating and norming them from other cultures and global regions, would be an important advance in the assessment of malingering throughout the region.

Second, neuropsychologists need to exercise caution when using the TOMM norms from the current study in assessing malingering with the TOMM in countries other than those in this study. Future studies should develop TOMM norms in Latin American countries not included in this study, such as Ecuador, Uruguay, Venezuela, and Panama. Despite this, the TOMM norms from the current study may represent a more accurate assessment of malingering in other Latin American countries than some of the norms currently in use, but this generalizability is a key area for future research.

Third, participants in this study spoke Spanish as their primary language, but they may have spoken secondary languages also. TOMM scores may differ according to bilingualism, which was not assessed in the current study. Future research in Latin America should include this as a potential research question. Participants were recruited from specific regions and cities in each country, not nationally within the countries. Although the current study was the largest TOMM normative project yet conducted in Latin America, or in any global region, it should be seen as a first step toward larger, nationally representative studies. The current sample was also limited in that although many participants had fewer than 12 years of education, participants who were illiterate were excluded. Therefore, the current TOMM norms may not apply well to adults unable to read, so future studies should collect data on illiterate individuals, as well as those with neurological conditions and among children.

Despite these limitations, only small-scale and limited studies have produced TOMM norms in Spanish-speaking populations such as Spanish-speakers from Spain or the U.S. (Ramírez et al., 2004; Strutt et al., 2012; Vilar-Lopez et al., 2008). Therefore, the current study was the first systematic and large-scale study to create TOMM norms across seven countries in Latin America, with over 2,000 participants. It was one of the most comprehensive TOMM normative studies to date in any global region, and its norms have the potential to improve the assessment of malingering with the TOMM in Latin America unlike any study before it.

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Appendix

Table A1  
Normative data for the TOMM trial 1 stratified by age and education levels for ARGENTINA

		Age (Years)												
Percentile		18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77
>12 years education	95	–	–	–	–	–	–	–	–	–	–	–	–	–
	90	–	–	–	–	–	–	–	–	–	–	–	–	–
	85	–	–	–	–	–	–	–	–	–	50.0	50.0	50.0	50.0
	80	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	49.9	49.9	49.8	49.7
	70	49.9	49.8	49.7	49.6	49.6	49.5	49.4	49.3	49.2	49.2	49.1	49.0	48.9
	60	49.2	49.1	49.1	49.0	48.9	48.8	48.7	48.7	48.6	48.5	48.4	48.3	48.2
	50	48.6	48.5	48.4	48.4	48.3	48.2	48.1	48.0	48.0	47.9	47.8	47.7	47.6
	40	48.0	47.9	47.8	47.7	47.7	47.6	47.5	47.4	47.3	47.3	47.2	47.1	47.0
	30	47.3	47.2	47.2	47.1	47.0	46.9	46.8	46.8	46.7	46.6	46.5	46.4	46.4
	20	46.5	46.5	46.4	46.3	46.2	46.1	46.0	46.0	45.9	45.8	45.7	45.6	45.6
	15	46.0	46.0	45.9	45.8	45.7	45.6	45.6	45.5	45.4	45.3	45.2	45.2	45.1
	10	45.5	45.4	45.3	45.2	45.1	45.0	45.0	44.9	44.8	44.7	44.6	44.6	44.5
	5	44.6	44.5	44.4	44.3	44.2	44.2	44.1	44.0	43.9	43.8	43.8	43.7	43.6
	1 to 12 years of education	95	–	–	–	–	–	–	–	–	–	–	–	–
		90	–	–	–	–	–	–	50.0	50.0	50.0	50.0	50.0	50.0
85		50.0	50.0	50.0	50.0	50.0	50.0	49.9	49.8	49.8	49.7	49.6	49.5	49.4
80		49.9	49.8	49.7	49.7	49.6	49.5	49.4	49.3	49.3	49.2	49.1	49.0	48.9
70		49.1	49.0	49.0	48.9	48.8	48.7	48.6	48.6	48.5	48.4	48.3	48.2	48.1
60		48.5	48.4	48.3	48.2	48.1	48.0	48.0	47.9	47.8	47.7	47.6	47.6	47.5
50		47.8	47.8	47.7	47.6	47.5	47.4	47.4	47.3	47.2	47.1	47.0	46.9	46.9
40		47.2	47.1	47.1	47.0	46.9	46.8	46.7	46.7	46.6	46.5	46.4	46.3	46.3
30		46.6	46.5	46.4	46.3	46.2	46.2	46.1	46.0	45.9	45.8	45.7	45.7	45.6
20		45.8	45.7	45.6	45.5	45.4	45.4	45.3	45.2	45.1	45.0	44.9	44.9	44.8
15		45.3	45.2	45.1	45.0	45.0	44.9	44.8	44.7	44.6	44.6	44.5	44.4	44.3
10		44.7	44.6	44.5	44.4	44.4	44.3	44.2	44.1	44.0	44.0	43.9	43.8	43.7
5		43.8	43.7	43.6	43.6	43.5	43.4	43.3	43.2	43.2	43.1	43.0	42.9	42.8

Table A2  
Normative data for the TOMM trial 1 stratified by age for BOLIVIA

		Age (Years)												
Percentile		18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77
95	–	–	–	–	–	–	–	–	–	–	–	–	–	
90	–	–	–	–	–	–	–	–	–	–	–	50.0	50.0	50.0
85	–	–	–	–	–	–	–	50.0	50.0	50.0	49.7	49.4	49.1	
80	–	–	50.0	50.0	50.0	50.0	50.0	49.7	49.4	49.1	48.8	48.5	48.1	
70	50.0	50.0	49.6	49.3	49.0	48.7	48.4	48.1	47.8	47.5	47.2	46.9	46.6	
60	48.9	48.6	48.3	48.0	47.7	47.4	47.1	46.8	46.5	46.2	45.9	45.6	45.3	
50	47.7	47.4	47.1	46.8	46.5	46.2	45.9	45.6	45.3	45.0	44.6	44.3	44.0	
40	46.5	46.2	45.9	45.6	45.3	45.0	44.7	44.3	44.0	43.7	43.4	43.1	42.8	
30	45.2	44.9	44.6	44.3	43.9	43.6	43.3	43.0	42.7	42.4	42.1	41.8	41.5	
20	43.6	43.3	43.0	42.7	42.4	42.1	41.8	41.5	41.2	40.8	40.5	40.2	39.9	
15	42.6	42.3	42.0	41.7	41.4	41.1	40.8	40.5	40.2	39.9	39.6	39.3	39.0	
10	41.5	41.2	40.8	40.5	40.2	39.9	39.6	39.3	39.0	38.7	38.4	38.1	37.8	
5	39.7	39.4	39.1	38.8	38.5	38.2	37.9	37.6	37.2	36.9	36.6	36.3	36.0	

Table A3  
Normative data for the TOMM trial 1 stratified by age for CHILE

Percentile	Age (Years)												
	18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77
95	–	–	–	–	–	–	–	–	–	–	50.0	50.0	50.0
90	–	–	–	–	–	–	–	–	–	50.0	50.0	49.9	49.2
85	–	–	–	–	–	–	50.0	50.0	49.8	49.4	49.1	48.7	48.4
80	–	–	–	50.0	50.0	50.0	49.8	49.4	49.1	48.7	48.4	48.0	47.7
70	50.0	50.0	50.0	49.7	49.4	49.0	48.7	48.3	48.0	47.6	47.3	47.0	46.6
60	49.8	49.5	49.1	48.8	48.4	48.1	47.8	47.4	47.1	46.7	46.4	46.0	45.7
50	49.0	48.6	48.3	47.9	47.6	47.2	46.9	46.6	46.2	45.9	45.5	45.2	44.8
40	48.1	47.8	47.4	47.1	46.7	46.4	46.0	45.7	45.4	45.0	44.7	44.3	44.0
30	47.2	46.8	46.5	46.2	45.8	45.5	45.1	44.8	44.4	44.1	43.7	43.4	43.1
20	46.1	45.8	45.4	45.1	44.7	44.4	44.0	43.7	43.3	43.0	42.6	42.3	42.0
15	45.4	45.1	44.7	44.4	44.0	43.7	43.3	43.0	42.7	42.3	42.0	41.6	41.3
10	44.6	44.2	43.9	43.6	43.2	42.9	42.5	42.2	41.8	41.5	41.1	40.8	40.5
5	43.4	43.0	42.7	42.3	42.0	41.6	41.3	40.9	40.6	40.3	39.9	39.6	39.2

Table A4  
Normative data for the TOMM trial 1 for MEXICO

Percentile	Raw Score
95	–
90	–
85	–
80	50.0
70	–
60	49.0
50	48.0
40	–
30	47.0
20	46.0
15	44.4
10	43.0
5	40.0

Table A5  
Normative data for the TOMM trial 1 stratified by age and education levels for PARAGUAY

		Age (Years)													
Percentile		18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77	
> 12 years of education	95	–	–	–	–	–	–	–	–	50.0	50.0	50.0	50.0	49.8	
	90	–	–	–	–	–	–	–	50.0	50.0	49.9	49.5	49.2	48.8	
	85	–	–	–	–	–	–	50.0	49.9	49.6	49.2	48.9	48.5	48.2	
	80	–	–	–	50.0	50.0	50.0	49.7	49.4	49.0	48.7	48.3	48.0	47.7	
	70	–	50.0	50.0	49.9	49.6	49.2	48.9	48.5	48.2	47.8	47.5	47.2	46.8	
	60	50.0	49.9	49.5	49.2	48.8	48.5	48.1	47.8	47.5	47.1	46.8	46.4	46.1	
	50	49.5	49.2	48.9	48.5	48.2	47.8	47.5	47.1	46.8	46.5	46.1	45.8	45.4	
	40	48.9	48.5	48.2	47.8	47.5	47.2	46.8	46.5	46.1	45.8	45.4	45.1	44.8	
	30	48.2	47.8	47.5	47.1	46.8	46.4	46.1	45.8	45.4	45.1	44.7	44.4	44.0	
	20	47.3	47.0	46.6	46.3	45.9	45.6	45.2	44.9	44.6	44.2	43.9	43.5	43.2	
	15	46.8	46.4	46.1	45.7	45.4	45.1	44.7	44.4	44.0	43.7	43.3	43.0	42.7	
	10	46.1	45.8	45.4	45.1	44.8	44.4	44.1	43.7	43.4	43.0	42.7	42.4	42.0	
	5	45.2	44.8	44.5	44.1	43.8	43.5	43.1	42.8	42.4	42.1	41.7	41.4	41.1	
	1 to 12 years of education	95	–	50.0	50.0	50.0	49.8	49.5	49.2	48.8	48.5	48.1	47.8	47.4	47.1
		90	50.0	49.9	49.6	49.2	48.9	48.5	48.2	47.9	47.5	47.2	46.8	46.5	46.1
85		49.6	49.3	48.9	48.6	48.2	47.9	47.6	47.2	46.9	46.5	46.2	45.8	45.5	
80		49.1	48.7	48.4	48.1	47.7	47.4	47.0	46.7	46.3	46.0	45.7	45.3	45.0	
70		48.2	47.9	47.5	47.2	46.9	46.5	46.2	45.8	45.5	45.1	44.8	44.5	44.1	
60		47.5	47.2	46.8	46.5	46.1	45.8	45.5	45.1	44.8	44.4	44.1	43.7	43.4	
50		46.8	46.5	46.2	45.8	45.5	45.1	44.8	44.4	44.1	43.8	43.4	43.1	42.7	
40		46.2	45.8	45.5	45.1	44.8	44.5	44.1	43.8	43.4	43.1	42.8	42.4	42.1	
30		45.5	45.1	44.8	44.4	44.1	43.7	43.4	43.1	42.7	42.4	42.0	41.7	41.3	
20		44.6	44.3	43.9	43.6	43.2	42.9	42.5	42.2	41.9	41.5	41.2	40.8	40.5	
15		44.1	43.7	43.4	43.0	42.7	42.4	42.0	41.7	41.3	41.0	40.6	40.3	40.0	
10		43.4	43.1	42.7	42.4	42.1	41.7	41.4	41.0	40.7	40.3	40.0	39.7	39.3	
5		42.5	42.1	41.8	41.4	41.1	40.8	40.4	40.1	39.7	39.4	39.0	38.7	38.4	

Table A6  
Normative data for the TOMM trial 1 stratified by age and education levels for PERU

		Age (Years)													
Percentile		18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77	
> 12 years education	95	–	–	–	–	–	–	–	–	–	–	–	–	–	
	90	–	–	–	–	–	–	–	–	–	50.0	50.0	50.0	50.0	
	85	–	–	–	–	–	–	–	50.0	50.0	49.9	49.7	49.5	49.3	
	80	50.0	50.0	50.0	50.0	50.0	50.0	50.0	49.8	49.6	49.4	49.1	48.9	48.7	
	70	50.0	50.0	49.9	49.7	49.5	49.3	49.1	48.9	48.7	48.5	48.3	48.1	47.9	
	60	49.6	49.3	49.1	48.9	48.7	48.5	48.3	48.1	47.9	47.7	47.5	47.3	47.1	
	50	48.9	48.7	48.4	48.2	48.0	47.8	47.6	47.4	47.2	47.0	46.8	46.6	46.4	
	40	48.2	48.0	47.8	47.5	47.3	47.1	46.9	46.7	46.5	46.3	46.1	45.9	45.7	
	30	47.4	47.2	47.0	46.8	46.6	46.4	46.2	46.0	45.8	45.6	45.4	45.2	45.0	
	20	46.5	46.3	46.1	45.9	45.7	45.5	45.3	45.1	44.9	44.7	44.5	44.3	44.1	
	15	46.0	45.8	45.6	45.4	45.2	44.9	44.7	44.5	44.3	44.1	43.9	43.7	43.5	
	10	45.3	45.1	44.9	44.7	44.5	44.3	44.1	43.9	43.7	43.5	43.3	43.1	42.9	
	5	44.3	44.1	43.9	43.7	43.5	43.3	43.1	42.9	42.7	42.5	42.3	42.1	41.9	
	1 to 12 years of education	95	–	–	–	–	–	50.0	50.0	50.0	50.0	50.0	49.8	49.6	49.4
		90	–	–	50.0	50.0	50.0	49.8	49.6	49.4	49.2	49.0	48.8	48.6	48.4
85		50.0	50.0	49.8	49.6	49.4	49.2	48.9	48.7	48.5	48.3	48.1	47.9	47.7	
80		49.6	49.4	49.2	49.0	48.8	48.6	48.4	48.2	48.0	47.8	47.6	47.4	47.2	
70		48.7	48.5	48.3	48.1	47.9	47.7	47.5	47.3	47.1	46.9	46.7	46.5	46.3	
60		48.0	47.8	47.6	47.4	47.2	47.0	46.8	46.5	46.3	46.1	45.9	45.7	45.5	
50		47.3	47.1	46.9	46.7	46.5	46.3	46.1	45.9	45.6	45.4	45.2	45.0	44.8	
40		46.6	46.4	46.2	46.0	45.8	45.6	45.4	45.2	45.0	44.8	44.5	44.3	44.1	
30		45.8	45.6	45.4	45.2	45.0	44.8	44.6	44.4	44.2	44.0	43.8	43.6	43.4	
20		44.9	44.7	44.5	44.3	44.1	43.9	43.7	43.5	43.3	43.1	42.9	42.7	42.5	
15		44.4	44.2	44.0	43.8	43.6	43.4	43.2	43.0	42.8	42.6	42.4	42.2	41.9	
10		43.7	43.5	43.3	43.1	42.9	42.7	42.5	42.3	42.1	41.9	41.7	41.5	41.3	
5		42.7	42.5	42.3	42.1	41.9	41.7	41.5	41.3	41.1	40.9	40.7	40.5	40.3	

Table A7  
Normative data for the TOMM trial 1 stratified by education levels for PUERTO RICO

Percentile	1 to 12 years of education	>12 years of education
95	–	–
90	–	–
85	50.0	–
80	49.4	–
70	48.4	50.0
60	47.5	49.1
50	46.6	48.3
40	45.8	47.4
30	44.9	46.5
20	43.8	45.4
15	43.1	44.8
10	42.3	43.9
5	41.1	42.7

Table A8  
Normative data for the TOMM trial 2 stratified by age and education levels for ARGENTINA

Percentile	Age (Years)												
	18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77
<i>&gt;12 years of education</i>													
95	–	–	–	–	–	–	–	–	–	–	–	–	–
90	–	–	–	–	–	–	–	–	–	–	–	–	–
85	–	–	–	–	–	–	–	–	–	–	–	–	–
80	–	–	–	–	–	–	–	–	–	–	–	–	–
70	–	–	–	–	–	–	–	–	–	50.0	50.0	50.0	50.0
60	–	–	–	–	–	50.0	50.0	50.0	50.0	49.9	49.9	49.9	49.8
50	50.0	50.0	50.0	50.0	50.0	49.9	49.9	49.8	49.8	49.8	49.7	49.7	49.7
40	49.9	49.9	49.9	49.8	49.8	49.8	49.7	49.7	49.6	49.6	49.6	49.5	49.5
30	49.8	49.7	49.7	49.6	49.6	49.6	49.5	49.5	49.5	49.4	49.4	49.3	49.3
20	49.5	49.5	49.5	49.4	49.4	49.4	49.3	49.3	49.2	49.2	49.2	49.1	49.1
15	49.4	49.4	49.3	49.3	49.3	49.2	49.2	49.1	49.1	49.1	49.0	49.0	49.0
10	49.2	49.2	49.2	49.1	49.1	49.1	49.0	49.0	48.9	48.9	48.9	48.8	48.8
5	49.0	49.0	48.9	48.9	48.8	48.8	48.8	48.7	48.7	48.7	48.6	48.6	48.5
<i>1 to 12 years of education</i>													
95	–	–	–	–	–	–	–	–	–	–	–	–	–
90	–	–	–	–	–	–	–	–	–	–	–	–	–
85	–	–	–	–	–	–	–	–	–	–	–	–	–
80	–	–	–	–	–	–	–	–	–	–	50.0	50.0	50.0
70	–	–	–	–	–	50.0	50.0	50.0	50.0	50.0	49.9	49.9	49.8
60	50.0	50.0	50.0	50.0	50.0	49.9	49.9	49.8	49.8	49.8	49.7	49.7	49.7
50	49.9	49.9	49.9	49.8	49.8	49.7	49.7	49.7	49.6	49.6	49.6	49.5	49.5
40	49.8	49.7	49.7	49.7	49.6	49.6	49.5	49.5	49.5	49.4	49.4	49.4	49.3
30	49.6	49.5	49.5	49.5	49.4	49.4	49.4	49.3	49.3	49.2	49.2	49.2	49.1
20	49.4	49.3	49.3	49.3	49.2	49.2	49.1	49.1	49.1	49.0	49.0	49.0	48.9
15	49.2	49.2	49.2	49.1	49.1	49.0	49.0	49.0	48.9	48.9	48.9	48.8	48.8
10	49.1	49.0	49.0	49.0	48.9	48.9	48.8	48.8	48.8	48.7	48.7	48.7	48.6
5	48.8	48.8	48.7	48.7	48.7	48.6	48.6	48.6	48.5	48.5	48.4	48.4	48.4

Table A9  
Normative data for the TOMM trial 2 stratified by age for BOLIVIA

Percentile	Age (Years)												
	18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77
95	–	–	–	–	–	–	–	–	–	–	–	–	–
90	–	–	–	–	–	–	–	–	–	–	–	–	–
85	–	–	–	–	–	–	–	–	–	–	–	–	50.0
80	–	–	–	–	–	–	–	50.0	50.0	50.0	50.0	50.0	49.7
70	–	–	–	–	50.0	50.0	50.0	49.9	49.7	49.4	49.2	48.9	48.7
60	–	50.0	50.0	50.0	49.8	49.5	49.3	49.0	48.8	48.5	48.3	48.0	47.8
50	50.0	49.7	49.5	49.2	49.0	48.7	48.4	48.2	47.9	47.7	47.4	47.2	46.9
40	49.1	48.9	48.6	48.4	48.1	47.9	47.6	47.3	47.1	46.8	46.6	46.3	46.1
30	48.2	48.0	47.7	47.5	47.2	46.9	46.7	46.4	46.2	45.9	45.7	45.4	45.2
20	47.1	46.9	46.6	46.4	46.1	45.9	45.6	45.4	45.1	44.8	44.6	44.3	44.1
15	46.5	46.2	46.0	45.7	45.4	45.2	44.9	44.7	44.4	44.2	43.9	43.7	43.4
10	45.7	45.4	45.1	44.9	44.6	44.4	44.1	43.9	43.6	43.4	43.1	42.8	42.6
5	44.4	44.2	43.9	43.7	43.4	43.2	42.9	42.7	42.4	42.1	41.9	41.6	41.4

Table A10  
Normative data for the TOMM trial 2 stratified by age for CHILE

Percentile	Age (Years)												
	18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77
95	–	–	–	–	–	–	–	–	–	–	–	–	–
90	–	–	–	–	–	–	–	–	–	–	–	50.0	50.0
85	–	–	–	–	–	–	–	–	–	–	50.0	49.9	49.7
80	–	–	–	–	–	–	–	50.0	50.0	50.0	49.7	49.5	49.3
70	–	–	–	–	–	50.0	50.0	49.8	49.6	49.3	49.1	48.9	48.7
60	–	–	50.0	50.0	50.0	49.7	49.5	49.3	49.1	48.8	48.6	48.4	48.1
50	50.0	50.0	49.9	49.7	49.5	49.3	49.0	48.8	48.6	48.3	48.1	47.9	47.7
40	49.9	49.7	49.5	49.2	49.0	48.8	48.5	48.3	48.1	47.9	47.6	47.4	47.2
30	49.4	49.2	48.9	48.7	48.5	48.3	48.0	47.8	47.6	47.3	47.1	46.9	46.7
20	48.8	48.5	48.3	48.1	47.9	47.6	47.4	47.2	47.0	46.7	46.5	46.3	46.1
15	48.4	48.2	47.9	47.7	47.5	47.3	47.0	46.8	46.6	46.3	46.1	45.9	45.7
10	47.9	47.7	47.5	47.2	47.0	46.8	46.6	46.3	46.1	45.9	45.7	45.4	45.2
5	47.2	47.0	46.8	46.6	46.3	46.1	45.9	45.6	45.4	45.2	45.0	44.7	44.5

Table A11  
Normative data for the TOMM trial 2 stratified by age for MEXICO

Percentile	Age (Years)												
	18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77
95	–	–	–	–	–	–	–	–	–	–	–	–	–
90	–	–	–	–	–	–	–	–	–	–	–	–	–
85	–	–	–	–	–	–	–	–	–	–	–	–	–
80	–	–	–	–	–	–	–	–	–	–	–	–	–
70	–	–	–	–	–	–	50.0	50.0	50.0	50.0	50.0	50.0	50.0
60	50.0	50.0	50.0	50.0	50.0	50.0	49.8	49.7	49.6	49.5	49.4	49.2	49.1
50	49.8	49.7	49.6	49.4	49.3	49.2	49.1	49.0	48.8	48.7	48.6	48.5	48.4
40	49.0	48.9	48.8	48.7	48.6	48.4	48.3	48.2	48.1	48.0	47.8	47.7	47.6
30	48.2	48.1	48.0	47.9	47.7	47.6	47.5	47.4	47.3	47.1	47.0	46.9	46.8
20	47.2	47.1	47.0	46.9	46.8	46.6	46.5	46.4	46.3	46.2	46.0	45.9	45.8
15	46.6	46.5	46.4	46.3	46.1	46.0	45.9	45.8	45.7	45.5	45.4	45.3	45.2
10	45.9	45.8	45.7	45.5	45.4	45.3	45.2	45.1	44.9	44.8	44.7	44.6	44.5
5	44.8	44.7	44.6	44.4	44.3	44.2	44.1	44.0	43.8	43.7	43.6	43.5	43.4

Table A12  
Normative data for the TOMM trial 2 stratified by age and education levels for PARAGUAY

	Percentile	Age (Years)												
		18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77
>12 years of education	95	–	–	–	–	–	–	–	–	–	–	–	50.0	50.0
	90	–	–	–	–	–	–	–	–	–	–	–	50.0	49.9
	85	–	–	–	–	–	–	–	–	50.0	50.0	49.7	49.3	48.9
	80	–	–	–	–	–	–	50.0	50.0	49.9	49.5	49.1	48.8	48.4
	70	–	–	–	–	50.0	50.0	49.9	49.5	49.1	48.7	48.3	47.9	47.5
	60	–	–	–	50.0	49.9	49.6	49.2	48.8	48.4	48.0	47.6	47.2	46.8
	50	–	50.0	50.0	49.7	49.3	48.9	48.5	48.1	47.7	47.4	47.0	46.6	46.2
	40	50.0	49.8	49.4	49.0	48.7	48.3	47.9	47.5	47.1	46.7	46.3	45.9	45.5
	30	49.5	49.1	48.7	48.3	48.0	47.6	47.2	46.8	46.4	46.0	45.6	45.2	44.8
	20	48.7	48.3	47.9	47.5	47.1	46.7	46.3	46.0	45.6	45.2	44.8	44.4	44.0
	15	48.2	47.8	47.4	47.0	46.6	46.2	45.8	45.4	45.1	44.7	44.3	43.9	43.5
10	47.5	47.2	46.8	46.4	46.0	45.6	45.2	44.8	44.4	44.0	43.7	43.3	42.9	
5	46.6	46.2	45.8	45.4	45.1	44.7	44.3	43.9	43.5	43.1	42.7	42.3	42.0	
1 to 12 years of education	95	–	–	–	–	50.0	50.0	50.0	49.7	49.3	48.9	48.5	48.2	47.8
	90	–	–	–	50.0	49.9	49.6	49.2	48.8	48.4	48.0	47.6	47.2	46.8
	85	–	–	50.0	49.7	49.3	48.9	48.5	48.2	47.8	47.4	47.0	46.6	46.2
	80	50.0	50.0	49.6	49.2	48.8	48.4	48.0	47.6	47.3	46.9	46.5	46.1	45.7
	70	49.5	49.1	48.8	48.4	48.0	47.6	47.2	46.8	46.4	46.0	45.6	45.3	44.9
	60	48.8	48.4	48.1	47.7	47.3	46.9	46.5	46.1	45.7	45.3	45.0	44.6	44.2
	50	48.2	47.8	47.4	47.0	46.6	46.2	45.9	45.5	45.1	44.7	44.3	43.9	43.5
	40	47.5	47.2	46.8	46.4	46.0	45.6	45.2	44.8	44.4	44.0	43.7	43.3	42.9
	30	46.8	46.5	46.1	45.7	45.3	44.9	44.5	44.1	43.7	43.4	43.0	42.6	42.2
	20	46.0	45.6	45.2	44.9	44.5	44.1	43.7	43.3	42.9	42.5	42.1	41.7	41.4
	15	45.5	45.1	44.7	44.3	43.9	43.6	43.2	42.8	42.4	42.0	41.6	41.2	40.8
10	44.9	44.5	44.1	43.7	43.3	42.9	42.6	42.2	41.8	41.4	41.0	40.6	40.2	
5	43.9	43.6	43.2	42.8	42.4	42.0	41.6	41.2	40.8	40.5	40.1	39.7	39.3	

Table A13  
Normative data for the TOMM trial 2 stratified by age and education levels for PERU

	Percentile	Age (Years)												
		18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77
>12 years of education	95	–	–	–	–	–	–	–	–	–	–	–	–	–
	90	–	–	–	–	–	–	–	–	–	–	–	–	–
	85	–	–	–	–	–	–	–	–	–	–	–	–	–
	80	–	–	–	–	–	–	–	–	–	–	50.0	50.0	50.0
	70	–	–	–	–	–	–	50.0	50.0	50.0	50.0	49.8	49.7	49.6
	60	–	–	–	50.0	50.0	50.0	49.9	49.8	49.7	49.6	49.4	49.3	49.2
	50	50.0	50.0	50.0	49.9	49.7	49.6	49.5	49.4	49.3	49.2	49.1	48.9	48.8
	40	49.8	49.7	49.6	49.5	49.4	49.3	49.1	49.0	48.9	48.8	48.7	48.6	48.5
	30	49.4	49.3	49.2	49.1	49.0	48.8	48.7	48.6	48.5	48.4	48.3	48.2	48.0
	20	48.9	48.8	48.7	48.6	48.5	48.4	48.2	48.1	48.0	47.9	47.8	47.7	47.6
	15	48.6	48.5	48.4	48.3	48.2	48.1	47.9	47.8	47.7	47.6	47.5	47.4	47.3
10	48.3	48.1	48.0	47.9	47.8	47.7	47.6	47.5	47.4	47.2	47.1	47.0	46.9	
5	47.7	47.6	47.5	47.4	47.3	47.2	47.0	46.9	46.8	46.7	46.6	46.5	46.4	
1 to 12 years of education	95	–	–	–	–	–	–	–	–	–	50.0	50.0	50.0	50.0
	90	–	–	–	–	–	–	50.0	50.0	50.0	49.9	49.8	49.7	49.6
	85	–	–	–	–	50.0	50.0	49.9	49.8	49.7	49.6	49.5	49.4	49.2
	80	50.0	50.0	50.0	50.0	49.8	49.7	49.6	49.5	49.4	49.3	49.2	49.0	48.9
	70	49.8	49.7	49.6	49.5	49.4	49.2	49.1	49.0	48.9	48.8	48.7	48.6	48.5
	60	49.4	49.3	49.2	49.1	49.0	48.8	48.7	48.6	48.5	48.4	48.3	48.2	48.0
	50	49.0	48.9	48.8	48.7	48.6	48.5	48.3	48.2	48.1	48.0	47.9	47.8	47.7
	40	48.7	48.5	48.4	48.3	48.2	48.1	48.0	47.9	47.7	47.6	47.5	47.4	47.3
	30	48.2	48.1	48.0	47.9	47.8	47.7	47.6	47.4	47.3	47.2	47.1	47.0	46.9
	20	47.8	47.6	47.5	47.4	47.3	47.2	47.1	47.0	46.9	46.7	46.6	46.5	46.4
	15	47.5	47.3	47.2	47.1	47.0	46.9	46.8	46.7	46.5	46.4	46.3	46.2	46.1
10	47.1	47.0	46.9	46.8	46.6	46.5	46.4	46.3	46.2	46.1	46.0	45.8	45.7	
5	46.6	46.4	46.3	46.2	46.1	46.0	45.9	45.8	45.6	45.5	45.4	45.3	45.2	

Table A14  
Normative data for the TOMM trial 2 stratified by education levels for PUERTO RICO

Percentile	1 to 12 years of education	>12 years of education
95	–	–
90	–	–
85	–	–
80	–	–
70	50.0	–
60	49.7	50.0
50	49.3	49.8
40	48.9	49.4
30	48.6	49.0
20	48.1	48.6
15	47.8	48.3
10	47.5	47.9
5	47.0	47.4