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Research Article

Beck Anxiety Inventory: Measurement Invariance, Latent Mean Comparison, and Reliability in Adults from Buenos Aires

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Abstract

This research aimed to provide new psychometric evidence of the Argentine Beck Anxiety Inventory (BAI) version in a sample of adults from Argentina. More specifically, the objectives were: 1) test the factor structure of the BAI; 2) assess gender, education, age, and region invariance; 3) test the latent factor mean difference across gender, education, age, and region; 4) analyze the reliability of the BAI; 5) provide population-based norms. The sample was composed of 1,410 adults ranging between 18 and 65 years (*M* = 32.41; *SD* = 10.45). Results showed that the BAI should be interpreted as unidimensional. Full configural, metric, and scalar invariance across gender, education, age, and region were obtained for the unidimensional model. The BAI presented adequate reliability values. Latent mean comparisons showed that men experienced more anxiety than women, that college-educated experienced more anxiety than non-college, that older people experienced more anxiety than younger people, and that people living in Greater Buenos Aires experienced more anxiety than those from Buenos Aires City. The BAI is an invariant measure of anxiety symptoms with good psychometric properties.

Keywords: BAI; anxiety; invariance; latent mean comparison; reliability.

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Anxiety is a future-oriented state of mind associated with preparing for possible upcoming negative events (Barlow, 2004). While anxiety responses are often adaptive, maladaptive responses could be problematic and trigger anxiety disorders. In this sense, adaptive and maladaptive anxiety can be distinguished according to five criteria: dysfunctional cognition, impaired functioning, persistence, false alarms, and stimulus hypersensitivity (Clark & Beck, 2011). Anxiety disorders are characterized by elevated sensitivity to threat; a preconscious attentional bias toward personally relevant threat stimuli and a bias to interpret ambiguous information in a threat-relevant way; and elevated amygdala responses to the specific threat of the disorder (Craske et al., 2011). Regarding symptom self-report, anxiety disorders are related to prototypical fear, physiological arousal, thoughts of imminent threat, prototypical anxiety, avoidance behaviors, tension, and thoughts of future threat (Barlow, 2004; Clark & Beck, 2011; Craske et al., 2011).

Anxiety disorders have been positioned as the most prevalent worldwide (Datani et al., 2021) and in Argentina (Cía et al., 2018). Epidemiologic investigation suggests that anxiety disorders very often precede the onset of other psychiatric disorders, that anxiety symptoms may predict worse outcomes like suicidality, and that anxiety disorders are associated with reduced educational attainment or lower occupational status, and economic costs (Chisholm et al., 2016; Kessler et al., 2009; Stein et al., 2017). Regarding comorbidity, anxiety disorders are associated with depression, other anxiety disorders, personality disorders, substance abuse disorders, chronic physical disorders, coronary heart diseases, stroke, and diabetes (Bandelow et al., 2017; Stein et al., 2017). In addition, several studies have reported an increase in anxious symptomatology during the COVID-19 pandemic (da Silva et al., 2021; Etchevers et al., 2021; Rajkumar, 2020; Vindegaard & Benros, 2020). Despite this situation, it is estimated that only a quarter of the people who meet the criteria for the diagnosis of anxiety have received

psychological treatment (Alonso et al., 2018). In this context, it is essential to have valid and reliable instruments to assess anxiety accurately and to be able to plan interventions.

The Beck Anxiety Inventory (BAI; Beck et al., 1988) is one of the most popular instruments for measuring the construct of anxiety (Bardhoshi et al., 2016) and is the most cited in scientific databases (Piotrowski, 2018). Due to its popularity, several investigations have been oriented toward studying its psychometric properties.

The original BAI (Beck et al., 1988) consists of 21 items developed from a pool of 86 items that represented a tow factor structure, with one factor referencing somatic symptoms and another measuring subjective symptoms of anxiety and panic. The final validation was carried out with 160 psychiatric outpatients. Regarding its internal consistency, an alpha of .92 was reported. In 1993, the BAI was reissued, with the authors reporting the use of clinical (n=393) and non-clinical (n=65) standardization samples (Beck & Steer, 1993). The authors reported that the BAI exhibited adequate discriminant validity between participants with and without anxiety and correlated moderately with depression measures. Since its original publication, the BAI has been studied through numerous investigations through different regions and samples (e.g., Creamer et al., 1995; de Lima Osório et al., 2011; Fydrich et al., 1992; Hewitt & Norton, 1993; Leyfer et al., 2006; Magán et al., 2008; Manne et al., 2001; Morin et al., 1999; Osman et al., 1993; Osman et al., 1997; Quintão et al., 2013; Sanz, 2014; Sica & Ghisi, 2007; Vázquez Morejón et al., 2014; Wetherell & Gatz, 2005).

Regarding the BAI's psychometric properties, a meta-analysis performed by Bardhoshi et al. (2016) reviewed 192 articles reviewed between 1993 and 2013 using the English version of the BAI, an aggregated internal consistency of alpha = .91 and test-retest reliability =.65 were reported. Most reviewed papers primarily supported the original 2-factor solution as evidence of structural validity. Diagnostic accuracy varied according to sample size and cutoff score (Bardhoshi et al., 2016).

In the last years, different investigations examined BAI's psychometric properties. Geissner & Huetteroth (2018) validated the German version of the BAI in three samples with n=145, n=90, and n=174 inpatients diagnosed with anxiety disorders. It was informed that BAI was unidimensional, and alpha coefficients from .91 to .94, that groups of patients with different diagnoses could be differentiated, and midrange correlations between anxiety and depression

measures. Accordingly, previous research reported a one-factor structure of the BAI (Magán et al., 2008).

Blázquez et al. (2020) analyzed the internal structure of the BAI in 1245 Mexican adults. A high internal consistency of the total scale, alpha = .911 was found. However, the investigation failed to find a satisfactory model regarding factor structure. Toledano-Toledano et al. (2020) examined the psychometric properties of the BAI in 445 Mexican family caregivers of children with cancer. Confirmatory factor analysis supported a single-factor model. The reduction to 11 items led to good reliability (alpha = .89).

In Argentina, Vizioli & Pagano (2020) adapted and validated the BAI in a sample of 269 participants from Buenos Aires. A comparison of the original 2-factor model (Beck et al., 1988), the unidimensional model (Geissner & Huetteroth, 2018; Magán et al., 2008), and a 4-factor model (Osman et al., 1993) indicated that the unidimensional model showed the best fit. Reliability was obtained with an ordinal alpha of .93 and an ordinal omega of .95. Pagano & Vizioli (2021) examined discriminant validity and test-retest reliability of this version of the BAI. As evidence of test-retest reliability, an interclass correlation coefficient of .82 (*95% CI* = .69 - .90) was obtained, with 52 participants from Buenos Aires completing two administrations separated by three months. Pagano & Vizioli (2021) assessed discriminant validity with depression through three methods, finding moderate correlations between the BAI and the BDI scores, two separated constructs of anxiety and depression through exploratory factor analysis, and evidence of discrimination indicated by the heterotrait-monotrait (HTMT) proportion. Also, Vizioli & Pagano (2022) examined the reliability and validity of the BAI in a sample of 746 participants across different estimation methods. Confirmatory factor analyses were performed to test the one-, two- and four-factor models to obtain evidence of structural validity. It was reported that the unidimensional model showed a better fit regardless of the estimation method. As evidence of reliability, results showed alpha = .94 (.93 - .95); omega = .95; algebraic greatest lower bound = .97; factorial greatest lower bound = .96; beta = .86; H = .91; theta = .88.

While there are several studies of the BAI, only a few assessed measurement invariance. Bagheri et al. (2021) found that the Persian BAI was invariant through 150 people living with HIV/AIDS and a general population sample consisting of 500 participants, while Clark et al. (2016) found that the BAI was invariant across time in a sample of 151 individuals with cardiovascular disease. Assessing measurement invariance across groups can be used to detect a series of potential biases (Chen, 2007) and enable latent mean comparisons (Milfont &

Fischer, 2010). Thus, the general objective of this investigation is to provide new psychometric evidence of the Argentine version of the BAI in a sample of adults from Buenos Aires. Specifically, this study aims to 1) test the factor structure of the BAI 2) assess gender, education, age, and region invariance; 3) test the latent factor mean difference across gender, education, age, and region; 4) analyze the reliability of the BAI; 5) provide population-based norms. This research is expected to provide more information about the functioning of the BAI to clinicians, researchers, and educators interested in the measurement and treatment of anxiety.

Method

Participants

A convenience community sample of 1,410 adults ranging between 18 and 65 years (M = 32.41; SD = 10.45) was collected. All participants were residents of Buenos Aires City (43.4%; n = 612) and Greater Buenos Aires (56.6%; n = 798). Regarding genre, 72% (n = 1015) reported women and 28% (n = 395) informed men. Education level ranged from incomplete primary school (0.2%; n = 3), complete primary school (0.4%; n = 6), incomplete high school (4.5%; n = 63), complete high school (13.5%; n = 190), incomplete college or university studies (42.2%, n = 595), complete college or university studies (31.8%; n = 449) and postgraduate (7.4%; n = 104). Regarding marital status, 50.1% (n = 706) were single, 38.2% married or living together (n = 539), 11.2% (n = 157) were divorced or separated, and 0.6% (n = 8) were widowed.

Measures

Sociodemographic questionnaire: To collect sociodemographic data, a questionnaire that investigated gender, age, education, marital status, and region of residence (Buenos Aires City or Greater Buenos Aires) was used.

Beck Anxiety Inventory (BAI; Beck et al., 1988): The BAI measures anxiety and consists of 21 items. Each of the items refers to a characteristic symptom of anxiety. A Likert scale with four options was used to reflect the severity of anxiety symptoms. The BAI total raw score is obtained by a sum of the 21 item scores, with respondents reporting the degree to which the symptoms bothered them during the past week on a 4-point Likert-type scale ranging from 0 (not at all) to 3 (severely). This inventory was locally adapted with adequate psychometric properties (Pagano & Vizioli, 2021; Vizioli & Pagano, 2020, 2022).

Procedure

Data was collected using virtual platforms. Participants completed the informed consent and then the BAI as a part of an online survey. Informed consent explained the aims of the investigation, confidentiality and anonymity guarantees, participation was voluntary and without compensation, and participants could withdraw at any time. This investigation and its procedures followed the ethical principles of the Declaration of Helsinki (World Medical Association, 2013), which establishes the principles and fundamental ethics for research involving human beings and recommendations from the American Psychological Association (2010).

Data analysis

The factor structure of the Argentine version of the BAI was evaluated. Confirmatory factor analysis was performed to assess the goodness of fit of the unidimensional model, according to previous research (Vizioli & Pagano, 2020, 2022). A large enough sample was collected to obtain consistent estimates (Kyriazos, 2018). With the items having four response options, data were treated as ordinal (Rhemtulla et al., 2012). The robust unweighted least squares (RULS) estimation method was used (Holgado-Tello et al., 2018), and Satorra-Bentler scaled $\chi 2$ statistic and robust standard errors were computed. The fit was assessed using several indices: Satorra-Bentler scaled $\chi 2$; Comparative Fit Index (CFI), Tucker Lewis fit Index (TLI), Root Mean Square of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). CFI and TLI values of ≥ .90 and ≥.95 were judged adequate or excellent, respectively, and RMSEA values of ≤.08 and ≤.06 indicated an acceptable or excellent fit. SRMR values of ≤.08 indicated a good fit (Byrne, 2016; Hu & Bentler, 1999). Standardized factor loadings of ≥.50 were acceptable (Johnson & Stevens, 2001).

Measurement invariance was tested across gender (woman [*n* = 1015] vs men [*n* = 395]), education (no college degree [*n* = 857] vs college degree [*n* = 553]), age (≤29 years [*n* = 709] vs >30 years [*n* = 701]) and region (Buenos Aires City [*n* = 612] vs. Greater Buenos Aires [*n* = 798]). The sample was divided into two groups by median split (median = 29) to test age invariance. According to Byrne (2016), configural, metric and scalar invariance were assessed. To assess configural invariance, an unrestricted model which serves as a baseline was tested (Wang et al., 2018). Metric invariance was assessed by testing a model with constrained factor loadings across groups (Van de Schoot et al., 2012). Scalar invariance was assessed by testing

a model with factor loadings and intercepts constrained to be equal across groups. Changes of ≤.01 in CFI, paired with changes in RMSEA of ≤.015 and SRMR of ≤.030 (for metric invariance) or ≤.015 (for scalar invariance), were considered acceptable (Chen, 2007).

Third, latent means differences were evaluated using the scalar invariance model as a baseline (Byrne, 2006). To test gender differences, the women's group latent mean was set to 0, allowing the men's group to estimate freely. To test education differences, the non-college group's latent mean was set to 0, allowing the college group to vary. To assess differences across age, the younger group's latent mean was set to 0, and the older group was allowed to vary. To estimate latent mean differences across the region, the Buenos Aires City group's latent mean was set to 0, and Greater Buenos Aires Group was allowed to estimate freely. The critical ratio (CR) value was calculated as a measure of latent mean differences. CR is calculated by parameter estimate divided by its standard error. A CR value above 1.96 indicates statistically significant differences (Byrne, 2006). Hedges' g was calculated as a measure of effect size.

Fourth, coefficients alpha, omega, lambda-2, lambda-6, and greatest lower bound (GLB) with their 95% confidence intervals were computed to test reliability. Values ≥ .70 were judged as acceptable (Groth-Marnat, 2009).

Fifth, according to previous research, population-based norms were calculated using percentile scores (Sanz, 2014; Vizioli & Pagano, 2020).

Results

Factor Structure

Unidimensional model showed good fit: Satorra-Bentler scaled $\chi 2(189) = 1348.059$; CFI= .983; TLI= .981; SRMR= .064; RMSEA= .066 (90% Confidence Interval = .063 – .069). As seen in Table 1, all standardized factor loadings showed acceptable values.

Table 1.

Confirmatory factor analysis standardized factor loadings and parameter estimates

Item	Standardized factor loadings	95% Confidence Interval		Standard Error	*p*
		Lower	Upper		
Item 1	.53	.48	.58	.03	< .001
Item 2	.56	.51	.61	.02	< .001
Item 3	.62	.57	.66	.02	< .001
Item 4	.71	.68	.74	.02	< .001
Item 5	.76	.73	.79	.01	< .001
Item 6	.71	.69	.75	.02	< .001
Item 7	.76	.73	.79	.02	< .001
Item 8	.75	.72	.78	.01	< .001
Item 9	.79	.76	.82	.01	< .001
Item 10	.76	.74	.79	.01	< .001
Item 11	.76	.73	.80	.02	< .001
Item 12	.68	.64	.73	.02	< .001
Item 13	.74	.71	.78	.02	< .001
Item 14	.76	.73	.79	.02	< .001
Item 15	.74	.70	.78	.02	< .001
Item 16	.63	.59	.68	.02	< .001
Item 17	.76	.73	.80	.02	< .001
Item 18	.54	.45	.58	.02	< .001
Item 19	.63	.55	.71	.04	< .001
Item 20	.51	.45	.56	.03	< .001
Item 21	.59	.54	.64	.03	< .001

Invariance across gender, education, age, and region

Invariance was tested considering the unidimensional model. Full configural, metric and scalar invariance was supported for gender, education, age, and region. (Table 2)

Table 2

Multiple group confirmatory factor analysis invariance test across gender, education, age and region

	S-Bχ2 (DF)	CFI	TLI	SRMR	RMSEA (CI 90%)	ΔCFI	ΔSRMR	ΔRMSEA
1. Gender								
Configural invariance	1808.809(398)	.979	.978	.074	.071 (.068 - .074)			
Metric invariance	1609.420(397)	.982	.981	.070	.066 (.063 - .069)	.003	.004	.005
Scalar invariance	1727.350(439)	.981	.981	.070	.065 (.061 - .068)	.002	.004	.006
2. Education								
Configural invariance	2013.258(399)	.975	.974	.075	.076(.073 - .079)			
Metric invariance	1746.874(398)	.979	.978	.073	.069(.063 - .073)			
Scalar invariance	1896.196(439)	.978	.979	.072	.069(.066 - .072)			
3. Age								
Configural invariance	1742.554(399)	.980	.979	.073	.069(.063 - .073)			
Metric invariance	1735.934(398)	.980	.979	.073	.069(.063 - .073)	.000	.000	.000
Scalar invariance	1847.253(439)	.979	.980	.071	.068(.064 - .071)	.001	.002	.001
4. Region								
Configural invariance	1628.270(398)	.982	.981	.071	.066 (.063 - .070)			
Metric invariance	1594.346(397)	.982	.981	.070	.065 (.062 - .069)	.000	.001	.001
Scalar invariance	1619.054(439)	.982	.983	.069	.062 (.069 - .065)	.000	.002	.004

Note: S-Bχ2= Satorra-Bentler scaled χ2; df = degrees of freedom; CFI= Comparative fit index; TLI= Tucker–Lewis Index; SRMR= standardized root-mean-square residual; RMSEA root-mean-square error of approximation; 90% CI= lower and upper boundary of 90% confidence interval for RMSEA.

Latent mean differences across gender, education, age, and region

Regarding gender, latent mean comparisons showed that men experienced more anxiety than women (CR = 11.38; $p < .001$; *Hedges' g* = .26). Education differences yielded significant results, with college-educated experiencing more anxiety than non-college (CR = 9.19; $p < .001$;

Hedges' g = .21). Age comparison, showed that older people experienced more anxiety than younger (CR = 8.99; *p* > .001; *Hedges' g* = .12). Finally, differences across the region showed that people living in Greater Buenos Aires experienced more anxiety than people from Buenos Aires City (CR = 8.96; *p* > .001; *Hedges' g* = .09).

Table 3.
Mean (M), standard deviation (SD), the value of the critical ratio (CR) and Hedges' g of latent mean comparisons across gender, education, age and region

	M	*SD*	CR	*Hedges' g*
1. Gender				
Male	11.85	10.82	7.67	.25
Female	14.69	11.22		
2.Education				
Non-college	15.79	11.80	9.18	.20
College	12.50	10.06		
3. Age				
Younger	14.55	11.60	9.01	.12
Older	13.23	10.76		
4. Region				
Buenos Aires City	13.52	11.56	8.93	.09
Greater Buenos Aires	14.18	11.00		

Reliability

Coefficients alpha, omega, lambda-2, lambda-6, and greatest lower bound (GLB) with their 95% confidence intervals were computed to estimate reliability. As seen in Table 4, all values were considered acceptable (≥.70).

Table 4.
Omega (ω), alpha (α), lambda 2 (λ2), lambda 6 (λ6) and greatest lower bound (GLB) reliability estimates with 95% confidence intervals.

Estimate	Ω	α	λ2	λ6	GLB
Point estimate	.926	.922	.926	.930	.955
95% CI lower bound	.919	.916	.919	.924	.953
95% CI upper bound	.932	.927	.933	.937	.962

Population-based norms

Population-based norms for the BAI are provided in Table 5. Norms were calculated using percentile scores.

Table 5.
Population-based norms (percentiles)

Raw score	Percentile
1	5
2	10
6	25
11	50
20	75
30	90
37	95
Mean	13,89
Standard deviation	11,20

Discussion

The present research aimed to provide new psychometric evidence of the Argentine version of the BAI in a sample of adults from Buenos Aires. Regarding factor structure, results showed that the unidimensional model showed a good fit, with excellent values for both CFI and TLI (≥.95). While the factor structure of the BAI varies across different samples or regions, other validation studies have found similar results (Geissner & Huetteroth, 2018; Magán et al., 2008; Vizioli & Pagano, 2020; 2022). It is worth noting that standardized factor loadings showed acceptable values, even considering a relatively restrictive criterion (≥.50).

Applying a rarely used approach of the BAI, the present investigation obtained evidence of full configural, metric and scalar invariance across gender, education, age, and region for the unidimensional model measured by 21 items. This means the unidimensional model holds regarding gender, education, age, or region. These findings are essential since the measurement invariance since invariance has been very little studied in the case of the BAI. Previous research works have focused on the study of invariance across time (Clark et al., 2016) or considering samples of people living with HIV/AIDS (Bagheri et al., 2021). In this sense, this research provides a basis for future replications.

After full invariance was established, latent mean differences across groups were tested using multigroup confirmatory factor analysis. This approach is also relatively new when it comes to BAI analysis. Latent mean comparison requires invariance across groups and is a more accurate way of making comparisons of means across groups than the traditional ways of evaluating differences according to observed means (Bai et al., 2011; Milfont & Fischer, 2010; Raju et al., 2002). Latent mean comparisons showed that men experienced more anxiety than women, that college-educated experienced more anxiety than non-college, that older people experienced more anxiety than younger, and that people living in Greater Buenos Aires experienced more anxiety than people from Buenos Aires City. These results coincide with previous investigations that made comparisons of observed means. Accordingly, research literature shows that women experience higher overall psychological symptoms (Etchevers et al., 2021; Mazza et al., 2020), specifically more anxiety than men (Gao et al., 2020; Grenier et al., 2019; Khesht-Masjedi et al., 2019). One explanation for this outcome could be that women in Latin America tend to exhibit greater stress due to the high number of tasks, gender discrimination, and violence (Etchevers et al., 2021).

Also, the results are consistent with previous investigations that reported that more educated people showed greater levels of anxiety than less educated (Le et al., 2020). This result could be explained by considering the expectations set by the people who invested more in their training and their financial stress (Le et al., 2020; McCloud & Bann, 2019; Solomou & Constantinidou, 2020; Somers et al., 2006). However, literature research shows mixed findings regarding anxiety and education level. For example, Zhang et al. (2018) found that women with lower education level experimented more anxiety than those with higher education, while Tsaras et al. (2018) informed that differences were not significant, and Lijster et al. (2017) reported no differences in anxiety disorder subtypes. This difference in the research literature may be due to cultural and socioeconomic factors. In particular, the results of this research can be explained by the recession and economic instability, as well as by the high poverty rates (Etchevers et al., 2021).

Regarding age differences, the present investigation found that older people experienced more anxiety than younger, as found in previous research (Grenier et al., 2019). Nevertheless, some investigations suggest that younger people may experience more anxiety than older (Etchevers et al., 2021; Nwachukwu et al., 2020; Solomou & Constantinidou, 2020). However, it should be considered that anxiety exhibits qualitative changes with age, with younger people more

concerned about their finances and older people about their health (Balsamo et al., 2018; Carlucci et al., 2018).

This research yielded differences in anxiety levels across the region, with people from Greater Buenos Aires experiencing greater levels of anxiety than people from Buenos Aires City. These results are consistent with previous research (Vizioli & Crespi, 2020) and can be explained considering that, in previous research, people who live in regions of Greater Buenos Aires reported less perceived health status, greater anxious and depressive symptoms, and fewer health coverage alternatives than those who live in the City of Buenos Aires (Rodríguez Espínola et al., 2019).

This research also shielded adequate reliability indices for the Argentine version of the BAI, consistence with previous research (Pagano & Vizioli, 2021; Vizioli & Pagano, 2020; 2022). These results provide evidence that this version of the BAI is an adequate instrument for use in research and in the clinical or educational field.

Limitations and Future Research Suggestions

This research has some limitations. First, although the sample is relatively large, convenience sampling depends on the participants' availability, impacting the findings' generalizability (Lemos & Richaud, 2021; Otzen & Manterola, 2017). Second, data were collected only in Buenos Aires City and Greater Buenos Aires. Although the selected region concentrates much of the Argentine population, it does not represent other regions.

Future research could include random samples of different regions of the country to represent different regions and sociodemographic characteristics. Also, considering qualitative changes in the development of anxiety (Balsamo et al., 2018; Carlucci et al., 2018), the development of a longitudinal study could help to understand the phenomenon taking into account the passage of time and the characteristics of different life stages. Finally, including clinical samples to learn more about the functioning of the BAI is of interest.

Conclusion

In summary, the psychometric analyses allow us to conclude that the Argentine version of the BAI is a valid and reliable instrument. As a novelty of this research, obtaining full configural, metric and scalar invariance across gender, education, age, and region for the unidimensional model measured by 21 items can be mentioned as evidence of construct validity, which means

that the construct remains stable regardless of gender, place of residence, age, or education level. Since it is an instrument characterized by its simple and brief administration, these results are helpful for the different fields of application of psychology. This research also provides percentile scores, which stand out for their ease of interpretation, facilitating use in practice, especifically in the clinical field (Sanz, 2014).

Establishing invariance made it possible to analyze latent means comparisons, which showed that men experienced more anxiety than women, that college-educated experienced more anxiety than non-college, that older people experienced more anxiety than younger and that people living in Greater Buenos Aires experienced more anxiety than people from Buenos Aires City. These findings make it possible to know how these sociodemographic variables can affect the variation of anxiety between individuals and are presented as factors to consider when designing public policies on mental health.

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