



Assessing autism knowledge in Portugal: validation of the autism spectrum knowledge scale (ASKS-PT)

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Abstract

Public understanding of autism spectrum disorder (ASD) influences societal attitudes, healthcare policies, and support systems. However, no validated instrument exists to assess autism knowledge in the Portuguese population. This study aimed to adapt and validate the Autism Spectrum Knowledge Scale – General Population version (ASKSG) for Portugal, ensuring its linguistic, cultural, and psychometric robustness. A sample of 353 Portuguese adults, aged between 18 and 76 years ($M=34.24$, $SD=13.49$), completed the scales' Portuguese adaptation (ASKS-PT) via an online survey. The scale's psychometric properties were examined using Item Response Theory (2PL model), internal consistency (Cronbach's α), and test-retest reliability. The ASKS-PT demonstrated strong internal consistency and good test-retest reliability. The 2PL model outperformed the Rasch model, confirming that item difficulty and discrimination effectively differentiated knowledge levels. While participants displayed high accuracy on common misconceptions, gaps persisted in areas such as autism prevalence, genetic risk factors, and diagnostic methods. Participants with prior autism contact scored significantly higher, and women outperformed men, while a family history of mental illness did not predict higher knowledge. The ASKS-PT is a valid and reliable instrument for assessing autism knowledge in Portugal. It offers a valuable tool for researchers, educators, and policymakers to evaluate autism awareness, identify misinformation, and inform public health initiatives.

Keywords Autism knowledge assessment · Psychometric validation · Item response theory (IRT) · Public awareness of autism · Cross-cultural adaptation

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Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by distinct patterns of communication and social interaction, as well as repetitive behaviours

and restricted interests in specific topics or objects (American Psychiatric Association [APA], 2022). Autistic individuals¹ experience distinct cognitive and sensory processing profiles that influence how they perceive and interact with their environment (Brosnan & Mills, 2016). ASD can be reliably diagnosed as early as 18 to 24 months of age, when characteristic features become distinguishable from typical development and other neurodevelopmental conditions (Zeidan et al., 2022).

This condition is described as a spectrum due to the substantial variability in how its characteristics manifest, ranging from mild to more complex presentations. Consequently,

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¹ In this article, we adopt identity-first language (e.g., “autistic individuals”) in line with evidence that many autistic adults prefer this terminology over person-first alternatives, which have historically been more common in healthcare and educational contexts (Taboas et al., 2023). We acknowledge that language preferences vary across individuals, and this usage is not intended to negate personal modes of self-identification. Overall, the use of identity-first language reflects an effort to adopt inclusive terminology while respecting diverse perspectives within autistic communities.

support needs vary widely: some autistic individuals require minimal support, whereas others present significant needs that call for tailored interventions. Each autistic person is therefore unique and benefits from individualized support approaches. Although the aetiology of autism is not yet fully understood, there is robust evidence for a strong genetic contribution to its development (APA, 2022).

Over the past decades, autism prevalence has increased globally, driven by expanded diagnostic criteria, improved assessment tools, and greater public awareness (Zeidan et al., 2022). Reported estimates vary widely across general-population studies from multiple countries, partly due to methodological differences and variability in the age groups assessed. In the United States, approximately 1 in 36 children aged 8 years is diagnosed with autism (Maenner et al., 2023), whereas in England 0.82% of the population identifies as autistic (O’Nions et al., 2023). In Portugal, prevalence estimates have shifted from 0.025% in earlier general-population research (Oliveira et al., 2007) to between 0.09% and 0.7% in recent childhood studies, reflecting improved diagnostic awareness rather than an actual incidence change (Rasga et al., 2023). Overall, these figures are likely underestimated due to underdiagnosis and unequal access to services, especially in low-resource settings (O’Nions et al., 2023).

Evidence from the autism spectrum disorders in the European Union (ASDEU) project, a large-scale European study, demonstrates significant regional variability in diagnostic pathways, availability of specialized professionals, and service resources in the Centro region of Portugal. This variability reflects cultural and systemic factors within the Portuguese context, which can influence prevalence estimates, the planning of support services, and public understanding of autism (Rasga et al., 2023).

Beyond documenting regional variability, these findings highlight ongoing challenges related to diagnostic accessibility and the availability of specialized support services. Despite the growing number of diagnoses, there remains a critical gap in research regarding public awareness of autism in Portugal. Public knowledge of autism plays a fundamental role in shaping societal attitudes, healthcare policies, and educational frameworks (Zeidan et al., 2022). A well-informed public contributes to early identification and intervention, which are associated with improved developmental and educational outcomes (Salari et al., 2022). Additionally, public awareness influences stigma reduction, employment opportunities, and community inclusion. Identifying gaps in autism knowledge is therefore an essential step in developing effective awareness campaigns and ensuring equitable access to resources.

To identify and address gaps in public autism knowledge, researchers have developed several psychometric

instruments. Early tools, such as the *Beliefs About Autism* questionnaire (Furnham & Buck, 2003), examined perceptions of etiology and treatment. However, this instrument does not align with the current DSM-5 framework (Su et al., 2023).

Later, the *Autism Stigma & Knowledge Questionnaire* (ASK-Q) (Harrison et al., 2017) evaluated multiple domains including diagnosis and stigma. However, the ASK-Q relies on outdated epidemiological data and provides a relatively superficial assessment of intervention-related factors.

More recently, the *Autism Spectrum Knowledge Scale - General Population* version (ASKSG) (McClain et al. 2019a) has emerged as a comprehensive tool aligned with DSM-5 criteria. The ASKSG evaluates knowledge across key domains such as etiology, symptoms, diagnosis, treatment, and prognosis. It comprises 31 descriptive items (e.g., “Vaccines can cause autism spectrum disorder”), with higher scores indicating greater knowledge.

The scale has demonstrated strong psychometric properties, including reliability and validity, and has been successfully validated across multiple cultural contexts (Harrison et al., 2017; McClain et al. 2019b). In the United States, it has been used to evaluate autism knowledge among both the general public and parents of autistic children (Benallie et al. 2020; Golson et al., 2022). In China, it has been applied to measure public autism knowledge and parental understanding of autism in children aged 0 to 14 (Su et al., 2023; Zhong et al., 2024). Additionally, the ASKSG has proven effective in evaluating the impact of educational interventions, such as video-based awareness campaigns aimed at improving public understanding of autism (Ha et al., 2022). These studies underscore the instrument’s versatility, reliability, and adaptability to different sociocultural contexts.

Despite the growing body of research utilising the ASKSG, no validated instruments currently exist for assessing autism knowledge within the Portuguese population. Portugal presents distinct cultural and systemic conditions that may shape autism knowledge, including differences in educational curricula and teacher training on neurodevelopment, regional variability in access to specialised healthcare professionals, and historically lower public recognition of autism outside clinical and urban centres (Rasga et al., 2023). These factors (spanning educational system structures, unequal healthcare pathways, and sociocultural attitudes toward autism) underscore the need for a version of the ASKSG that is not only translated, but also culturally and systemically adapted. Addressing this gap is essential for developing a comprehensive understanding of public autism knowledge and for informing efforts to reduce diagnostic inequities, combat stigma, and foster inclusive educational and healthcare practices.

In this context, this study aims to adapt and validate a Portuguese version of the ASKSG, a well-established instrument for measuring autism knowledge. Establishing its psychometric robustness in the Portuguese context will provide a reliable tool for assessing public autism knowledge, identifying gaps in understanding, and informing the development of targeted educational initiatives and awareness campaigns. Ultimately, a validated Portuguese version of the ASKSG will constitute a valuable resource for future research and policy development, supporting efforts to enhance societal inclusion and improve outcomes for autistic individuals and their families in Portugal.

Method

Participants

The study sample comprised 353 adults from the Portuguese population. Participants ranged in age from 18 to 76 years

Table 1 Sociodemographic characteristics of the sample

| Age | M (SD) | n (%) |
|---|----------------|-------------|
| | 34.24 (13.489) | |
| Gender | | |
| Male | | 91 (25.8%) |
| Female | | 258 (73.1%) |
| Non-binary | | 4 (1.1%) |
| Education | | |
| Primary education | | 3 (0.9%) |
| Secondary education | | 109 (30.8%) |
| Higher education | | 235 (66.6%) |
| Doctoral Level | | 6 (1.7%) |
| Marital status | | |
| Prefer not to answer | | 3 (0.9%) |
| Single | | 214 (60.6%) |
| Married or Common law marriage | | 119 (33.7%) |
| Divorced | | 13 (3.7%) |
| Widowed | | 4 (1.1%) |
| Children | | |
| Yes | | 127 (36%) |
| No | | 226 (64%) |
| Socio-economic status | | |
| Prefer not to answer | | 66 (18.7%) |
| Less than 20,000€ | | 161 (45.6%) |
| Between 20,000€ and 34,999€ | | 82 (23.2%) |
| Between 35,000€ and 49,999€ | | 27 (7.7%) |
| Between 50,000€ and 74,999€ | | 10 (2.8%) |
| Between 75,000€ and 99,000€ | | 3 (0.8%) |
| More than 100,000€ | | 4 (1.2%) |
| Family history of mental illnesses | | |
| Yes | | 133 (37.7%) |
| No | | 220 (62.3%) |

Note. Socio-economic status was assessed based on participant's self-reported annual income

($M=34.24$, $SD=13.49$). The sample was predominantly female (73.1%), with 25.8% identifying as male and 1.1% as non-binary.

In terms of educational attainment, the majority of participants (66.6%) had completed higher education (bachelor's degree or equivalent), while 28.3% had completed secondary education (high school diploma). A smaller proportion (2.5%) reported lower educational qualifications, including completion of primary or lower secondary education (e.g., up to 4th, 6th, or 9th grade), and 1.7% held doctoral degrees. However, the sample was skewed towards women and highly educated respondents, which may limit generalisability to the broader Portuguese population.

Socioeconomic status was assessed based on annual income. Nearly half of participants (45.6%) reported earning less than €20,000 per year, while 23.2% reported incomes between €20,000 and €34,999; 18.7% preferred not to disclose this information. Although income was collected as part of the demographic profile, it was not required for the IRT analyses; therefore, all participants were retained in the analytic sample regardless of income non-disclosure.

Marital status varied across participants: 60.6% were single, 33.7% were married or in a common-law partnership, and 5.7% were divorced, widowed, or opted not to disclose their status.

Additionally, 36.0% of participants reported having children. Regarding family history, 37.7% disclosed a family history of mental health conditions, whereas 62.3% reported no such history. For a complete demographic breakdown, see Table 1.

Revision of the ASKSG

To accurately assess autism knowledge in Portugal, several items on the Autism Spectrum Knowledge Scale – General Population version (ASKSG) underwent revision. These modifications ensured cultural relevance, alignment with regional knowledge gaps, and scientific accuracy within the Portuguese context. The adaptation process was guided by best practices in scale validation (Beaton et al., 2000; Hambleton et al., 2012) and cross-cultural adaptation methodologies (Van de Vijver & Hambleton, 1996).

Revision of item 1: autism prevalence

The original item states, “Less than 2% of people in the US have autism spectrum disorder.” To avoid geographic bias, we modified this to: “Less than 2% of people have autism spectrum disorder”. This revision aligns with global estimates suggesting approximately 1% of the worldwide population is autistic (Su et al., 2023; Zeidan et al., 2022). By removing the specific reference to the United States,

the item remains scientifically accurate without assuming respondents possess knowledge of foreign epidemiological data.

Revision of item 12: physical coordination

The original item stated, “Some individuals with autism spectrum disorder may be uncoordinated or clumsy”, with “False” designated as the correct response. However, converging evidence from clinical and neurodevelopmental research indicates that motor coordination difficulties are relatively common among autistic individuals (Mosconi & Sweeney, 2015; Miller et al., 2024). In line with this evidence, McClain et al. (2021) updated the item keying to reflect current scientific understanding.

Accordingly, the correct response to this item was revised to “True”, ensuring that the content of the scale is consistent with contemporary evidence regarding motor coordination in autism. This modification improves the construct validity of the instrument by aligning item content with internationally accepted clinical knowledge.

Translation procedure

To ensure the ASKSG was culturally and linguistically appropriate for the Portuguese population, this study employed the TRAPD method: Translation, Review, Adjudication, Pretesting, and Documentation (Vujcich et al., 2021). Recognized as a gold standard for cross-cultural research (Behr & Shishido, 2016), the TRAPD framework ensures linguistic accuracy, cultural relevance, and psychometric consistency while preserving the integrity of the original instrument. This structured process has been shown to identify semantic ambiguities, culturally embedded assumptions, and comprehension difficulties that might otherwise remain undetected, thereby reducing measurement bias and supporting the validity of adapted instruments in cross-cultural research (Walde & Völlm, 2023).

Translation phase

Two professional translators fluent in Portuguese and English independently translated the ASKS-G. They received a detailed briefing on the instrument’s theoretical foundations, study objectives, and best practices for autism-related terminology, ensuring consistency with language preferred by autistic communities. Annotated references guided the translation to maintain semantic equivalence and align with Portuguese cultural and linguistic norms (Vujcich et al., 2021).

Review and adjudication

An expert panel of two bilingual professionals in autism research, survey design, and psychometrics reviewed both translations item by item. They resolved discrepancies and ambiguities, ensuring that each item accurately reflected the original scale’s intent. When neither translation fully conveyed the meaning, the panel developed alternatives prioritizing technical accuracy, cultural appropriateness, and accessibility for individuals with diverse educational backgrounds.

During the adjudication process, special attention was given to cultural nuances, particularly in areas related to commonly used terminology for autism-related characteristics, potential stigma in autism-related discourse, and expressions that might unintentionally reinforce ableist perspectives. To enhance acceptability and engagement among Portuguese respondents, inclusive and non-stigmatizing language was prioritized. This approach aligns with contemporary discourse on autism advocacy, ensuring that the adapted scale respects neurodiversity while maintaining linguistic and scientific precision (Bottema-Beutel et al., 2021).

Pretesting

Following adjudication, the final Portuguese version of the ASKSG underwent pretesting with a sample of 12 Portuguese-speaking adults. Participants ranged in age from 18 to 56 years ($M=28.7$, $SD=12.68$) and were predominantly female (66.7%). All participants had completed higher education. Most were single (83.4%), two reported having children, and socioeconomic status varied, with approximately half reporting an annual income below €20,000. In addition, half of the pretest participants reported a family history of mental illness.

The pretest sample was used to evaluate item clarity, comprehension, and readability across varying levels of familiarity with autism. Participants provided qualitative feedback on wording, interpretability, and perceived ambiguity, which informed minor refinements to sentence structure and terminology. The sociodemographic characteristics of the pretest sample are summarised in Table 2.

Documentation

Each stage of the translation process was meticulously documented, including identified discrepancies, justifications for adjudication decisions, and modifications made following pretesting. This detailed documentation enhances transparency and provides a comprehensive record of translation

Table 2 Sociodemographic characteristics of the pretest sample ($n=12$)

| Age | M (SD) | <i>n</i> (%) |
|------------------------------------|---------------|--------------|
| | 28.67 (12.68) | |
| Gender | | |
| Male | | 3 (25.0%) |
| Female | | 8 (66.7%) |
| Non-binary | | 1 (8.3%) |
| Education | | |
| Higher education | | 12 (100%) |
| Marital status | | |
| Single | | 10 (83.4%) |
| Married or Common law marriage | | 1 (8.3%) |
| Divorced | | 1 (8.3%) |
| Children | | |
| Yes | | 2 (16.7%) |
| No | | 10 (83.3%) |
| Socio-economic status | | |
| Prefer not to answer | | 3 (25%) |
| Less than 20,000€ | | 6 (50%) |
| Between 20,000€ and 34,999€ | | 1 (8.3%) |
| Between 35,000€ and 49,999€ | | 2 (16.7%) |
| Family history of mental illnesses | | |
| Yes | | 6 (50%) |
| No | | 6 (50%) |

Note. Socio-economic status was assessed based on participant's self-reported annual income

quality, ensuring that the adaptation process can be systematically evaluated and replicated in future research (Vujcich et al., 2021).

By adhering to the TRAPD methodology, this study ensured that the Portuguese adaptation of the ASKSG is linguistically accurate, culturally attuned, scientifically valid, and accessible across diverse respondent groups. The layered approach of TRAPD mitigates risks of misinterpretation or cultural misalignment, strengthening the reliability and validity of the ASKSG as an assessment instrument for autism knowledge in Portugal.

Data collection and procedures

This study employed a non-random convenience sampling method to efficiently collect data from a diverse audience within Portugal. The survey was disseminated via social media platforms, maximizing accessibility and reaching individuals across various geographic regions. Data collection was conducted electronically using Qualtrics, a secure and user-friendly platform that facilitated seamless participation while ensuring efficient data management.

Prior to participation, all individuals received detailed information about the study's objectives, including its purpose, confidentiality measures, and their right to withdraw at any time without penalty. Informed consent was obtained

electronically, ensuring that participants fully understood their rights and the voluntary nature of their involvement. To maintain participant autonomy and comfort, respondents were allowed to complete the survey independently at their convenience, reducing potential response biases associated with time constraints or external pressures.

The survey comprised two sections. The first section collected sociodemographic information, including age, gender, educational attainment, and income. The second section consisted of the Autism Spectrum Knowledge Scale – Portuguese version (ASKS-PT), which assessed participants' knowledge of autism.

To enhance data quality and minimise inattentive responding, two attention-check items were embedded within the survey. For example, one item instructed participants to “Select the second response option”, followed by the options “car”, “motorbike”, and “boat”, with “motorbike” as the correct response. Responses from participants who failed to answer both attention-check items correctly were automatically excluded prior to the creation of the final dataset. As a result, the exact number of excluded cases is not available. Only responses meeting the predefined attention criteria were retained for analysis, ensuring the integrity and reliability of the data used in the study.

Results

Data analysis

IRT framework and model selection

We assessed the structural validity of the Autism Spectrum Knowledge Scale – Portuguese Population version (ASKS-PT) using Item Response Theory (IRT), specifically the two-parameter logistic (2PL) model (Zhu et al., 2019). Prior studies using the ASKSG primarily relied on the Rasch model (Rasch, 1980), which assumes equal discrimination across items and uniform contribution to the latent construct. However, this assumption may not adequately reflect real-world data, as item discrimination often varies across knowledge items.

The 2PL model was therefore selected because it estimates both item difficulty and discrimination parameters, allowing for a more refined evaluation of how effectively individual items differentiate respondents across levels of autism knowledge. This flexibility is particularly relevant for assessing knowledge constructs, where items may vary in their capacity to distinguish between lower and higher levels of understanding (Kadhem and Nikoloulopoulos 2023a, b).

All analyses were conducted using R version 4.4.1. Initial IRT analyses were performed with the “ltm” package, and item-level 2PL models were estimated using the “mirt” package.

Model comparison results

Model comparisons were conducted using likelihood-ratio tests (LRT) and Akaike Information Criterion (AIC) to determine the best-fitting model. The LRT indicated that the 2PL model provided a significantly better fit than the Rasch model, $\chi^2(30)=75.255; p<0.001$. Consistent with this result, the 2PL model yielded a lower AIC value (AIC=10,714.59) compared to the Rasch model (AIC=10,729.85), reflecting a better balance between model fit and parsimony ($\Delta\text{AIC}=15.26$).

The 2PL model also accounted for approximately 1% more explained variance than the Rasch model. Although this increase is modest in absolute terms, in the context of psychological measurement it reflects enhanced sensitivity to subtle differences in autism knowledge across

participants, particularly at intermediate levels of ability, where the Rasch model may be less discriminative (Stemler & Naples, 2021). Allowing item discrimination to vary therefore enables more precise estimation of individual knowledge levels and gaps, supporting more nuanced interpretation and application of ASKS-PT data in both research and applied contexts.

Assumptions and diagnostic checks

Item fit was evaluated using infit and outfit mean square (MSQ) statistics. All items demonstrated acceptable fit, with MSQ values approximating 1.00, indicating that item responses conformed adequately to model expectations (Bond and Fox 2015; Linacre 2002a, b; Wright and Linacre 1994). Unidimensionality was supported on theoretical grounds, as the ASKS-PT is designed to assess a single latent construct (i.e., general knowledge about autism) encompassing prevalence, aetiology, symptoms, diagnosis, and intervention. This conceptualisation is consistent with prior empirical work on the original ASKSG, which treated autism knowledge as a unidimensional trait (McClain et al. 2019a; Harrison et al., 2017).

Local independence was assumed based on the unidimensional specification of the model and the absence of overlapping or sequentially dependent item content. This assumption should be further examined in future studies using residual-based diagnostics.

We also computed descriptive statistics to summarise response distributions. The normality of item-level responses was assessed using absolute skewness and kurtosis. Across items, absolute skewness values ranged from 0.006 to 2.364, and kurtosis values ranged from -2.011 to 3.608. All values fell within commonly accepted thresholds for approximate normality (skewness <3 ; kurtosis <7 ; Kline, 2023), supporting the appropriateness of the applied analyses. Item-level skewness and kurtosis values are reported in Table 3.

Group comparisons

We explored group differences in autism knowledge using independent samples *t*-tests, with sex, family history of mental illness, and prior familiarity with autism as grouping variables. As Levene’s tests indicated violations of homogeneity of variance ($p < 0.05$), we applied Welch’s *t*-tests to ensure robust statistical inference. Effect sizes were quantified using Cohen’s *d* to facilitate interpretation of the magnitude of observed differences.

By integrating IRT modelling, reliability assessment, diagnostic checks, and group comparisons, this analytical approach provides a comprehensive psychometric evaluation of the ASKS-PT.

Table 3 Item-level skewness and kurtosis values for the ASKS-PT

| Item | Skewness (Sk) | Kurtosis (Ku) |
|------|---------------|---------------|
| 1 | 2.243 | 3.051 |
| 2 | -0.706 | -1.511 |
| 3 | 0.561 | -1.675 |
| 4 | 1.637 | 0.683 |
| 5 | -2.064 | 2.274 |
| 6 | 1.848 | 1.423 |
| 7 | 1.273 | -0.381 |
| 8 | -2.364 | 3.608 |
| 9 | -1.079 | -0.842 |
| 10 | -1.613 | 0.604 |
| 11 | -2.282 | 3.228 |
| 12 | -0.831 | -1.316 |
| 13 | -2.206 | 2.881 |
| 14 | 0.461 | -1.798 |
| 15 | 0.282 | -1.932 |
| 16 | 0.761 | -1.430 |
| 17 | -2.206 | 2.881 |
| 19 | 0.587 | -1.665 |
| 20 | 2.206 | 2.881 |
| 21 | 1.802 | 1.318 |
| 22 | -0.549 | -1.709 |
| 23 | -0.006 | -2.011 |
| 24 | -1.095 | -0.805 |
| 25 | 0.789 | -1.386 |
| 26 | -2.282 | 3.228 |
| 27 | -0.803 | -1.363 |
| 28 | -1.848 | 1.423 |
| 29 | 0.258 | -1.944 |
| 30 | 0.706 | -1.511 |
| 31 | -0.051 | -2.009 |

Reliability and validity

Participants’ responses were coded in a binary format, with correct answers assigned a value of 1 and incorrect or “don’t know” responses coded as 0. This coding approach ensured consistency across all analyses and aligned with standard psychometric evaluation methods in Item Response Theory (IRT).

We applied the two-parameter logistic (2PL) model, to assess the psychometric properties of the ASKS-PT. This model accounts for both item difficulty and discrimination, providing a more refined analysis of how well individual items differentiate between participants with varying levels of autism knowledge. Fit indices, including mean square error (MSQ) values for infit and outfit statistics, indicated that all items conformed to acceptable fit thresholds (Bond & Fox, 2015; Wright & Linacre, 1994). No items exceeded the recommended MSQ boundaries, with all values approximating 1.00, suggesting that item responses closely aligned with model expectations.

These findings indicate that the ASKS-PT functions coherently as a measure of a single underlying construct (Stolt et al., 2022), consistent with the unidimensional specification adopted and with prior validation studies of the ASKSG (McClain et al. 2019a; Harrison et al., 2017). A summary of the MSQ fit indices is visually presented in

Fig. 1, which illustrates the strong alignment between individual items and model parameters.

The internal consistency of the 31-item ASKS-PT was assessed using Cronbach’s alpha (α) coefficient, a widely used measure of reliability. The scale demonstrated good internal consistency, with $\alpha=0.85$. Within the IRT framework, measurement precision was primarily evaluated through item and test information functions, which provide conditional estimates of reliability across different levels of the latent trait rather than a single global coefficient (Embretson & Reise, 2000).

Item difficulty and discrimination

The two-parameter logistic (2PL) Item Response Theory (IRT) model was employed to estimate item difficulty (b) and discrimination (a) parameters, as well as participants’ latent autism knowledge levels (θ), using maximum likelihood estimation. This approach enables a detailed examination of how individual items function across different levels of autism knowledge. Item difficulty represents the level of the latent trait at which a participant has a 50% probability of answering an item correctly, such that higher b -values indicate more difficult items. Item discrimination reflects the extent to which an item differentiates between individuals with higher versus lower levels of autism knowledge,

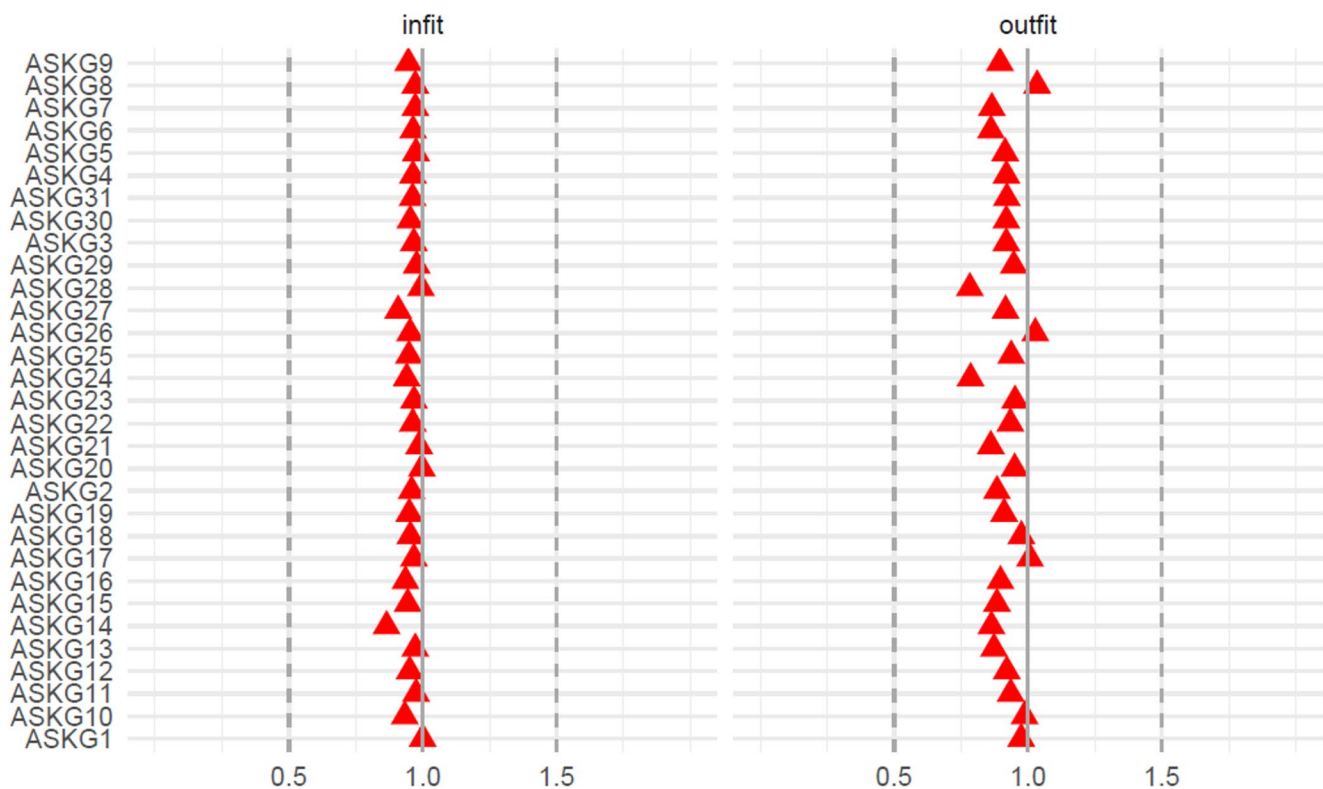


Fig. 1 Infit and outfit values for each item on the scale

with higher a -values indicating greater discriminatory power (Lee & Bolt, 2018).

Table 4 presents the number and percentage of correct responses for each ASKS-PT item, together with the corresponding item difficulty (b) and discrimination (a) parameters estimated under the 2PL model. Items are ordered according to increasing difficulty, illustrating the scale's capacity to capture a wide range of autism knowledge levels across participants.

Consistent with this ordering, the easiest items were those with the lowest difficulty parameters. Item 8 ("All individuals with autism spectrum disorder have low intelligence quotients (IQs)") was among the easiest items on the scale ($b=-1.55$), with 88.1% of participants answering correctly, indicating that misconceptions regarding intellectual functioning in autism were relatively uncommon in this sample. In contrast, Item 23 ("It is possible for autism spectrum disorder to develop in adulthood") showed

intermediate difficulty ($b=-0.07$), with 50.1% correct responses, suggesting greater variability in public understanding of autism's developmental course.

The most difficult item was Item 1 ("Less than 2% of people have autism spectrum disorder"), which exhibited the highest difficulty parameter ($b=4.29$) and was answered correctly by only 12.7% of participants. This finding indicates substantial misconceptions regarding autism prevalence within the Portuguese population and aligns with broader evidence of public uncertainty surrounding epidemiological estimates.

The distribution of item difficulty parameters is illustrated in Fig. 2, which shows that the ASKS-PT includes items spanning a broad range of difficulty levels. This spread indicates that the scale is well suited to discriminating between individuals with low, average, and high levels of autism knowledge.

Item discrimination (a) parameters were also examined to assess how effectively individual items distinguished between participants with different knowledge levels. Higher discrimination values indicate steeper item characteristic curves and greater sensitivity to differences in the latent trait. As shown in Fig. 3, items varied in their discrimination capacity, with several items demonstrating strong ability to differentiate between lower and higher levels of autism knowledge.

Participants' latent knowledge scores (θ) were further examined to characterise the overall distribution of autism knowledge within the sample. As depicted in Fig. 4, most participants clustered around $\theta=0$, corresponding to average knowledge levels, with fewer individuals at the lower and higher extremes. This approximately normal distribution of the latent trait is consistent with patterns commonly observed in IRT-based assessments (Carter et al., 2022) and suggests that the ASKS-PT effectively captures meaningful variability in autism knowledge across the population.

Taken together, the item-level analyses and graphical representations confirm that the ASKS-PT demonstrates appropriate item difficulty and discrimination characteristics. The scale captures a wide spectrum of autism knowledge and provides robust measurement across varying levels of the latent trait, supporting its validity as a psychometrically sound instrument.

Status quo of autism knowledge in Portugal

The findings revealed that participants exhibited a high level of accuracy on several items of the ASKS-PT, with eight items having a correct response rate above 80%. The item with the highest correct response rate was Item 8, "All individuals with autism spectrum disorder have low intelligence quotients (IQs)," which 88.1% of participants answered

Table 4 Item accuracy and item response theory parameters for the ASKS-PT (2PL Model)

| Nº | Accuracy (%) | Accuracy (n) | Discrimination parameter (a) | Estimated difficulty parameter (b) |
|----|--------------|--------------|------------------------------|------------------------------------|
| 8 | 88.1% | 311 | 1.969 | -1.547 |
| 11 | 87.5% | 309 | 1.514 | -1.735 |
| 26 | 87.5% | 309 | 1.578 | -1.694 |
| 13 | 87% | 307 | 1.514 | -1.690 |
| 17 | 87% | 307 | 1.348 | -1.815 |
| 5 | 85.8% | 303 | 1.671 | -1.516 |
| 28 | 83.9% | 296 | 1.474 | -1.490 |
| 10 | 81.3% | 287 | 1.610 | -1.261 |
| 24 | 73.9% | 261 | 1.701 | -0.863 |
| 9 | 73.7% | 260 | 1.453 | -0.935 |
| 12 | 69.1% | 244 | 1.205 | -0.826 |
| 27 | 68.6% | 242 | 1.660 | -0.649 |
| 2 | 66.6% | 235 | 1.220 | -0.698 |
| 22 | 63.2% | 223 | 0.949 | -0.656 |
| 31 | 51.3% | 181 | 0.929 | -0.051 |
| 23 | 50.1% | 177 | 0.788 | 0.003 |
| 29 | 43.6% | 154 | 0.709 | 0.410 |
| 15 | 43.1% | 152 | 1.126 | 0.322 |
| 14 | 38.8% | 137 | 1.720 | 0.405 |
| 3 | 36.5% | 129 | 0.877 | 0.737 |
| 19 | 36% | 127 | 1.025 | 0.687 |
| 30 | 33.4% | 118 | 0.985 | 0.841 |
| 16 | 32.3% | 114 | 1.160 | 0.806 |
| 25 | 31.7% | 112 | 1.007 | 0.918 |
| 18 | 31.4% | 111 | 0.935 | 0.985 |
| 7 | 23.2% | 82 | 1.037 | 1.385 |
| 4 | 18.4% | 65 | 1.006 | 1.749 |
| 21 | 16.4% | 58 | 1.050 | 1.846 |
| 6 | 16.1% | 57 | 1.184 | 1.718 |
| 20 | 13% | 46 | 0.660 | 3.099 |
| 1 | 12.7% | 45 | 0.466 | 4.293 |

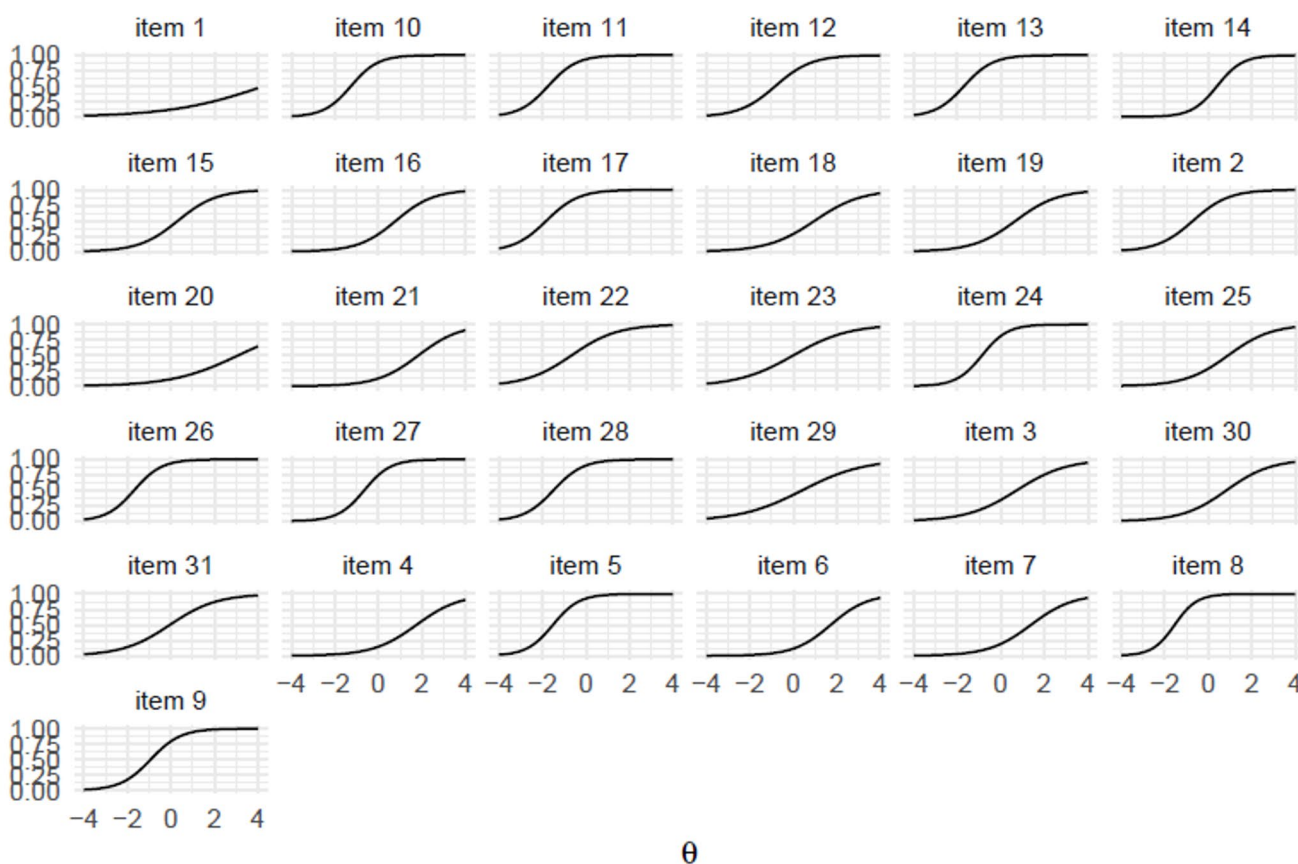


Fig. 2 Item characteristic curves (ICCs) for the 2PL model

correctly. This was followed by Item 11, “Individuals with autism spectrum disorder may have rigid routines or rituals,” and Item 26, “Restricting certain foods (e.g., gluten) is an effective treatment for autism spectrum disorder,” both of which had a correct response rate of 87.5%.

Other items with high accuracy rates included Item 13, “Some individuals with autism spectrum disorder may be uncoordinated or clumsy,” and Item 17, “autism spectrum disorder can only be diagnosed after 4 years of age,” both correctly answered by 87.0% of participants. Similarly, Item 5, “autism spectrum disorder is caused by a lack of maternal affection,” had a correct response rate of 85.8%, indicating that the majority of respondents were aware of the outdated and disproven “refrigerator mother” hypothesis. Additionally, item 28, “The child’s intelligence quotient (IQ) and age influence the success of autism spectrum disorder treatment,” was correctly answered by 83.9% of participants. Finally, Item 10, which functioned as an attention-check question, was answered correctly by 81.3% of participants, further validating the attentiveness of respondents.

Conversely, the items with the lowest correct response rates identified key areas where autism knowledge remains limited among the Portuguese population. Item 6,

“Advanced paternal age is a risk factor for autism spectrum disorder,” was answered correctly by only 16.1% of participants, suggesting a lack of awareness regarding genetic and environmental risk factors. Similarly, Item 20, “autism spectrum disorder can be diagnosed with brain imaging,” had a correct response rate of 13.0%, reflecting common misconceptions regarding diagnostic tools for autism.

The most challenging item, Item 1, “Less than 2% of people have autism spectrum disorder,” was answered correctly by just 12.7% of participants. While this low correct response rate suggests limited public knowledge of autism prevalence, the item’s wording may also introduce ambiguity, as prevalence estimates have evolved over time and vary across countries and age groups (Fombonne, 2020; Su et al., 2023; Zeidan et al., 2022). This potential interpretative ambiguity should be considered when interpreting responses to this item.

These results suggest that while basic knowledge about autism characteristics and outdated myths appears relatively strong, more nuanced scientific knowledge particularly regarding risk factors, diagnostic processes, and prevalence estimates remains underdeveloped. Participants who correctly answered the more complex items likely possessed

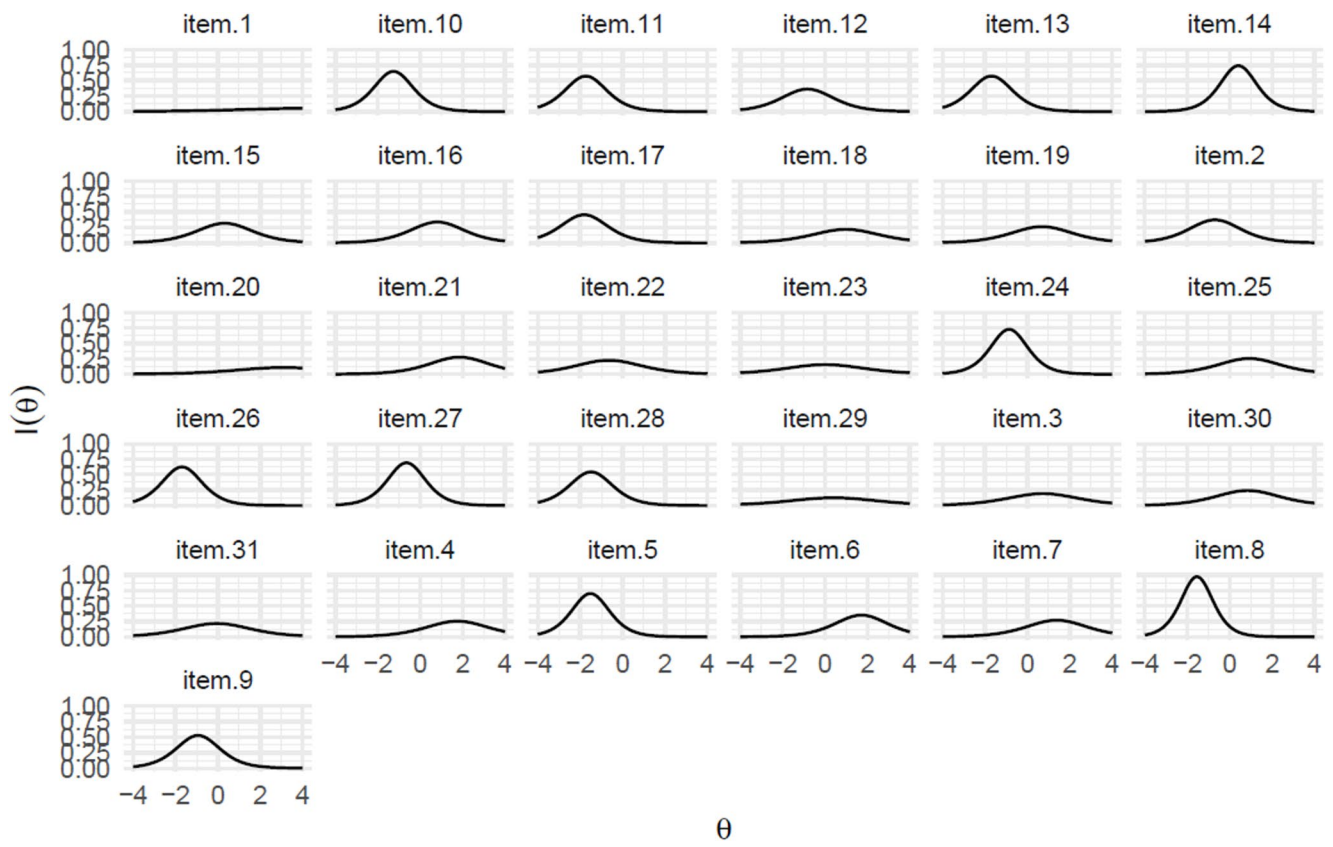


Fig. 3 Item information curves (IICs) for the 2PL model

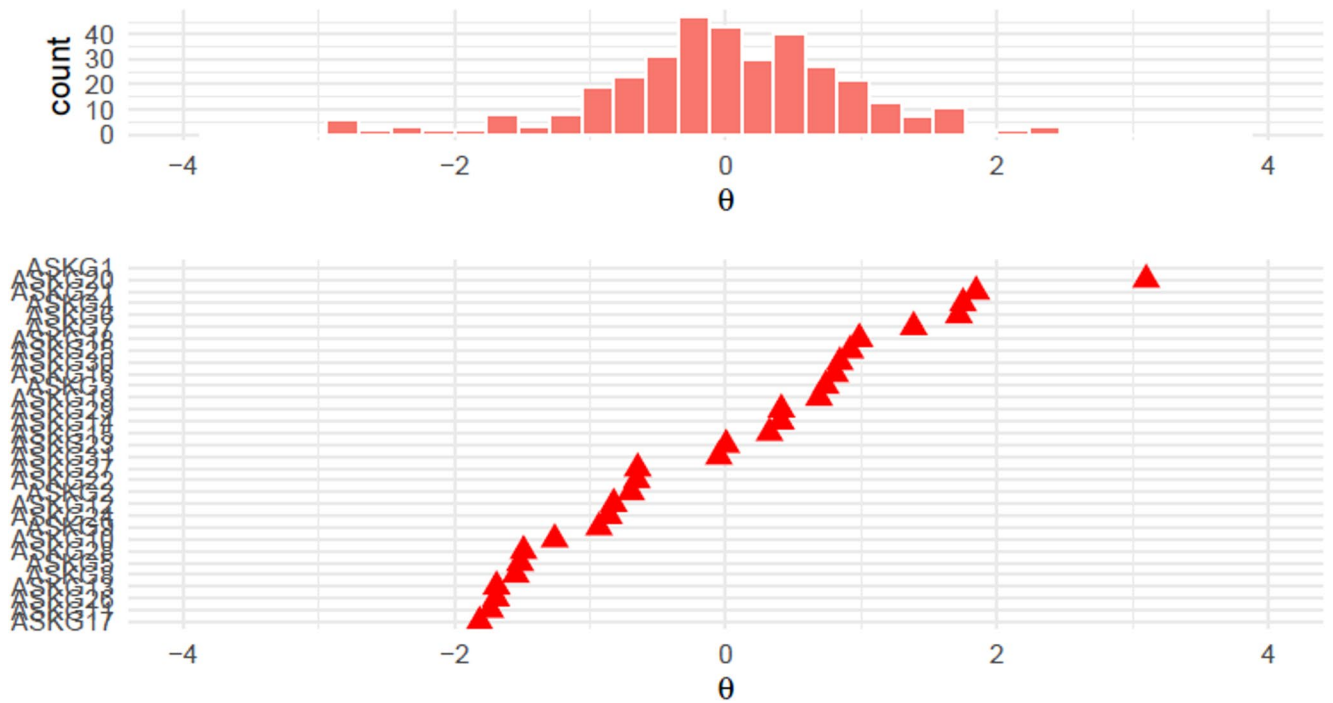


Fig. 4 Score interval for ASD knowledge (θ): Transformation from raw correct counts across 31 items to logit scale

a more advanced understanding of autism, underscoring the need for targeted educational initiatives to address specific knowledge gaps within the Portuguese population.

Group differences in autism knowledge

We conducted an independent samples *t*-test to examine differences in knowledge between individuals with and without a family history of mental illness. Participants with a family history of mental illness ($M=15.84$, $SD=5.71$) did not score significantly differently from those without ($M=15.07$, $SD=4.77$), $t(297.057)=1.350$, $p=0.168$, $d=0.146$, 95% CI: $[-0.33, 1.87]$. These results suggest that familial exposure to mental health conditions did not have a significant impact on autism knowledge levels within the sample.

A separate independent samples *t*-test was performed to assess whether prior contact with autism influenced participants' knowledge scores. Participants with prior contact with autism ($M=17.72$, $SD=4.04$) scored significantly higher than those without prior contact ($M=14.34$, $SD=5.30$), $t(261.013)=6.548$, $p < 0.001$, $d=0.783$, 95% CI $[2.37, 4.40]$. The moderate-to-large effect size (Cohen's $d=0.783$) suggests that direct exposure to autism—whether through personal, professional, or social interactions—substantially enhances autism-related knowledge.

Gender differences in autism knowledge were also examined. Women ($M=16.15$, $SD=2.21$) scored significantly higher than men ($M=13.20$, $SD=5.16$), $t(124.715)=-4.138$, $p < 0.001$, $d=0.589$, 95% CI $[-4.37, -1.54]$. This moderate effect size may reflect differences in exposure to or engagement with autism-related information, although further research is needed to clarify underlying mechanisms.

These group comparisons were exploratory in nature and were not adjusted for multiple testing or for potential covariates such as age and education; therefore, the results should be interpreted with appropriate caution.

Test-retest reliability

To assess the stability and reliability of the ASKS-PT over time, 40 participants from the original sample completed the questionnaire a second time, approximately one month after the initial administration. A Pearson correlation coefficient was used to measure the consistency between the two assessments. The results indicated a strong, positive correlation between the first and second administrations [$r=0.645$, $p < 0.001$], demonstrating that participants' autism knowledge scores remained highly stable over time.

Discussion

The present study aimed to adapt and validate the ASKSG for use in the Portuguese population, examining its reliability, validity, and psychometric properties. Overall, the findings provide strong evidence that the ASKS-PT is a reliable, valid, and robust instrument for assessing autism knowledge within the Portuguese cultural and linguistic context, consistent with the psychometric performance of the original ASKSG. The successful adaptation of the ASKS-PT represents a significant contribution to autism research in Portugal, where validated tools for assessing public autism knowledge have been lacking.

Importantly, this study addresses a critical national gap by providing a culturally adapted and psychometrically sound measure of autism knowledge for the Portuguese population. Beyond enabling accurate assessment at the national level, the ASKS-PT also facilitates meaningful comparisons with international research, supporting cross-cultural investigations and the development of targeted educational initiatives and public awareness strategies.

Item performance and implications for autism knowledge in Portugal

Item Response Theory analyses indicated that item difficulty was well distributed across low, moderate, and high levels of autism knowledge, allowing the scale to effectively differentiate between participants with varying levels of understanding. The most challenging item, which assessed knowledge of autism prevalence (“Less than 2% of people have autism spectrum disorder”), showed the lowest correct response rate (12.7%), suggesting that many participants may lack accurate epidemiological knowledge.

This finding should be interpreted with caution, as prevalence estimates for autism vary substantially across countries, age groups, and methodological approaches (Fombonne, 2020; Zeidan et al., 2022). Although recent global estimates converge around a prevalence of approximately 1% (Su et al., 2023), Portugal-specific estimates remain heterogeneous, ranging from early general-population figures (0.025%) to more recent childhood estimates of up to 0.7% (Oliveira et al., 2007; Rasga et al., 2023). The observed difficulty associated with this item therefore suggests that some respondents may not possess accurate or up-to-date epidemiological knowledge, highlighting the relevance of public education initiatives aimed at improving understanding of autism prevalence and diagnostic access in Portugal.

In contrast, items addressing widely disseminated misconceptions about autism showed high correct response rates. For example, the item stating that all autistic individuals have low intelligence quotients was correctly answered by 88.1% of participants, indicating substantial public awareness that intellectual disability is not a defining feature of autism (Happé & Frith, 2020). Similarly, high accuracy was observed for items related to rigid routines and the outdated “refrigerator mother” hypothesis, suggesting that some historical misconceptions have largely diminished.

However, items tapping into more complex scientific knowledge (particularly those related to risk factors and diagnostic procedures) were associated with lower accuracy. Poor performance on items concerning advanced paternal age and the use of brain imaging for diagnosis underscores persistent gaps in understanding of autism aetiology and evidence-based diagnostic practices. Together, these findings indicate that while general awareness of autism characteristics appears relatively strong, more nuanced scientific knowledge remains underdeveloped, reinforcing the need for targeted educational interventions.

Group differences in autism knowledge

Group comparisons revealed meaningful differences in autism knowledge associated with prior contact with autism. Participants reporting previous exposure to autistic individuals demonstrated significantly higher knowledge scores than those without such contact, a pattern consistent with prior international research (Golson et al., 2022; Zhong et al., 2024). This finding suggests that direct or indirect interaction with autism may enhance knowledge acquisition, underscoring the importance of inclusive social environments, professional training, and experiential learning opportunities in improving public understanding.

Gender differences were also observed, with women scoring higher than men on autism knowledge. This finding aligns with previous studies (Herrero et al., 2024; Khougar et al., 2024) and may reflect gendered differences in exposure to or engagement with autism-related information. However, the underlying mechanisms remain unclear, and further research is needed to clarify whether these differences reflect social, educational, or occupational factors.

Notably, having a family history of mental illness was not associated with higher autism knowledge, suggesting that general mental health awareness does not necessarily translate into autism-specific knowledge and highlighting the importance of targeted autism education.

Methodological considerations and limitations

Despite the strong psychometric performance of the ASKS-PT, several limitations should be acknowledged.

First, the sample composition limits generalisability. The sample was predominantly female and highly educated, which may have inflated knowledge estimates given the association between educational attainment and scientific literacy (Kline, 2023). Future studies should prioritise more demographically balanced samples, particularly with respect to gender, educational background, and geographic distribution.

Second, the use of convenience sampling via social media likely introduced selection bias, as individuals with a pre-existing interest in autism-related topics may have been more inclined to participate. This recruitment strategy may therefore overestimate population-level autism knowledge. Employing probability-based or nationally representative sampling methods would strengthen external validity in future research.

Third, the relatively small test–retest subsample ($n=40$) may limit the precision of stability estimates. Although test–retest reliability was satisfactory, future longitudinal validation studies should aim to include larger subsamples to provide more robust estimates of temporal stability.

Fourth, group comparisons were conducted using multiple independent *t*-tests without adjustment for multiple testing and without controlling for potential covariates such as age or educational attainment. These analyses were exploratory and should therefore be interpreted with caution, as the absence of correction increases the risk of Type I error and limits the precision of inferences regarding group differences (Tabachnick & Fidell, 2019). Future research should incorporate multivariate approaches and appropriate correction procedures.

Finally, the present study did not examine convergent or discriminant validity. Although the ASKS-PT is designed to assess autism-specific knowledge, it remains important to empirically distinguish this construct from related domains such as general mental health literacy, scientific knowledge, or intelligence (Urbina, 2014). Future validation efforts should include additional measures to further substantiate the construct validity of the scale.

Implications and future directions

The validated Portuguese adaptation of the ASKSG represents an important step toward improving the assessment of autism knowledge and informing public education efforts in

Portugal. The findings highlight specific areas (particularly prevalence, risk factors, and diagnostic processes) where knowledge gaps persist and where educational interventions may be most impactful.

Autism awareness strategies in Portugal could benefit from a multifaceted approach combining school-based education, community and media campaigns, and targeted training for healthcare and education professionals. Such initiatives have the potential to improve public understanding, reduce stigma, and support more informed engagement with autism-related issues (Fombonne, 2020; Zeidan et al., 2022).

Future research should explore how autism knowledge relates to attitudes and behaviours, including stigma reduction, acceptance, and inclusion. Additionally, evaluating the effectiveness of awareness interventions using experimental or pre–post designs would further establish the practical utility of the ASKS-PT in policy and educational contexts.

Conclusion

In conclusion, this study provides strong evidence for the reliability, validity, and psychometric robustness of the Portuguese adaptation of the Autism Spectrum Knowledge Scale. The ASKS-PT effectively captures meaningful variability in autism knowledge within the Portuguese population, while also identifying persistent gaps in scientific understanding. Although limitations related to sampling and validity assessment warrant further investigation, the ASKS-PT constitutes a valuable tool for advancing autism research, informing public policy, and guiding evidence-based initiatives aimed at promoting inclusion and improving outcomes for autistic individuals and their families in Portugal.

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Author Contributions Telma Sousa Almeida was responsible for the conceptualization of the study. The methodology was planned and designed by Telma Sousa Almeida and Beatriz Dias Almeida. The formal analysis was carried out by João Marôco, Patrícia de Oliveira Gonçalves, Beatriz Dias Almeida. The data collection was conducted by Beatriz Dias Almeida, Patrícia de Oliveira Gonçalves, and Telma Sousa Almeida. The original draft of the manuscript was written by Beatriz Dias Almeida and Patrícia de Oliveira Gonçalves. The review and editing of the manuscript were carried out by Telma Sousa Almeida.

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Data availability The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethical Considerations Ethical approval was not required for this study.

Consent for participation All participants received a comprehensive description of the study prior to participation, as presented on the online survey platform. Informed consent was obtained from each participant before they could proceed with the study. Individuals who did not provide consent were not permitted to continue.

Consent for publication Not applicable.

Conflicts of Interest The authors declare that they have no conflicts of interest relevant to the content of this article.

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