**Psychometric properties and the factor structure of the Russian
version of the RAADS-14: a self-report questionnaire for autism
screening**

**Translation of RAADS-14 into Russian and preliminary validation
of RAADS-14 Rus**

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Abstract

The general aim of our research was to construct and validate a Russian version of the RAADS-14 (the RAADS-14 Rus), a short self-report questionnaire designed for ASD screening, to provide the initial reference point in developing the body of instruments for assessing autistic traits in Russian-speaking adult population. This measure was chosen due to its good psychometric characteristics, reported ability to provide initial assessment for differential diagnosis, and simplicity of use.

The data were collected for the total of 1569 adults, including groups of non-psychiatric controls ($n=849$), adults with self-diagnosed ASD ($n=91$), and adults with clinically established ASD ($n=25$). The RAADS-14 Rus is characterized by good reliability and satisfactory construct and discriminative validity. The factor structure of the RAADS-14 Rus is similar to the factor structure of the original version and includes three domains: Social mentalizing, Social anxiety, and Sensory and cognitive perception, the between-factor correlations varying from .25 to .51. According to the initial assessment, the discriminative properties are also good ($AUC = .88$). The mean values of the RAADS-14 total scores for the non-psychiatric population were notably higher than the original RAADS-14 total scores (median = 13 compared to 3) confirming prior anecdotal evidences of greater mean scores yielded by international ASD assessment tools on Russian-speaking populations. The correlations of the RAADS-14 Rus total score with the Big Five personality trait scores were similar to the data previously obtained for other national samples.

The results of the study indicate that RAADS-14 Rus is a promising tool for ASD screening and can become one of the first stepping-stones in establishing a comprehensive system of ASD assessment and diagnostics for adult Russian-speaking population.

Introduction

RAADS-14 as a screening tool for autism spectrum disorders in adult population

Autism spectrum disorder (ASD) is a range of neurodevelopmental conditions characterized by persisting deficits in social communication and interaction, repetitive and stereotyped behavior, and restricted interests [1]. The prevalence of ASD in adult population is steadily increasing, it greatly affects the quality of life of adults with ASD and impairs a significant burden on health and social care [2]. Autism in adults with no intellectual impairments is also quite frequent [3], and often underdiagnosed [4], particularly in women [5]. Late identification and general underdiagnostics and misdiagnostics of ASD leads to a problem of ‘a lost generation’ of autistic adults with no intellectual impairments [6]. The comorbidity of ASD and other neuropsychiatric conditions is quite high [7], differential diagnostics can also pose a problem, therefore proper assessment of autistic traits and related problems can be crucial for increasing the quality of life of people with ASD [8]. There is a range of self-report questionnaires available for screening of ASD in adults with no intellectual impairments, the most widely used being: the Autism-Spectrum Quotient (AQ, 50 items) [9] and its shorter versions, AQ-10, AQ-20, and AQ-J-21[10]; the Ritvo Asperger and Autism Diagnostic Scale - Revised (RAADS-R, 80 items) [11] and its short version RAADS-14 [8]; the Social Responsiveness Scale, 2nd edition –Adult form (SRS-A or SRS2-A, 65 items) [12]; and the Adult Social Behavior Questionnaire (ASBQ, 44 items) [13]. A systematic review found that stronger evidences of good or satisfactory measurement and diagnostic properties exist for AQ-50, AQ-S, and RAADS-R and RAADS-14 [10].

The RAADS-14 is a 14-item self-report questionnaire specifically designed to be used as a screening tool for ASD and distributed under CC BY 2.0 Creative Commons License [8]. It was developed on the basis of the longer and more comprehensive RAADS-R, which has demonstrated good overall psychometric properties, test-retest reliability, discriminant and convergent validity, sensitivity and specificity [11,14,15]. The RAADS-14 was developed using the Swedish version of the RAADS-R [11] and validated on Swedish clinical and non-clinical samples. According to the reported factor structure, the RAADS-14 consists of three factors corresponding to domains of Mentalizing deficits, Social anxiety and Sensory reactivity. All the items are scored on a four-point Likert scale (ranging from 0 to 3) indicating duration of each symptom (3 = ‘true now and when I was young’, 2= ‘true only now’, 1= ‘true only when I

was younger than 16' and 0 = 'never true'). Item scores are summed to produce the total score and the subscale scores. The recommended cutoff of 14 for the original English version yielded excellent sensitivity of 0.97 and specificity of 0.95 over non-psychiatric population. The gender differences were moderate: neurotypical males scoring somewhat higher than females in the mentalizing deficits and social anxiety domains, while females scored higher than males in the sensory reactivity domain. The RAADS-14 is very short and easy to administer and has already demonstrated the potential to distinguish efficiently between ASD and other neuropsychiatric conditions in adult population.

Assessing autistic traits in adult population in Russia: Current problems and possible directions

The situation with clinical diagnostics of ASD in adult population in Russia is changing to the better but remains very problematic, underdiagnosis being the major issue. According to the official statistical data by Rosstat (Russian statistical agency), in 2016 there were only 96 adults officially diagnosed as having ASD (less than 0.001% of adult population) [16], which is at least 1000 times less than the estimates based on European cohort statistics. This huge disagreement reveals the fact that it was virtually impossible to get an official diagnosis of ASD for high functioning adolescents and adults for two major reasons. The first reason is related to underdiagnosis of ASD in childhood during 1970-2010s which was less pronounced than for adults but still quite prominent: as of 1999, the officially recognized ratio was 1 in 385 [17]. For children without intellectual impairments the diagnosis was almost never officially established, often in order to help the parents to avoid the stigma [18]. The second reason is an almost routine obligatory change of the official clinical diagnosis from ASD to some other neuropsychiatry condition performed when a person reaches adolescence or adulthood, most commonly, to schizoaffective disorder and/or mental retardation, this nosological practice was officially reproved only on the June 30th, 2014 [19]. On the October 4th, 2017, Russian Ministry of Health issued a letter of instructions (№ 17-1/10/1-6371) explicitly prohibiting an unfounded change of diagnosis from ASD to another mental condition for individuals reaching adulthood, as some psychiatrists tended to adhere to the old diagnosis-switching practice [20]. Due to the efforts of governmental and non-governmental institutions, autism professionals, parental community, and autism community it is now widely recognized that ASD in adults

is currently underdiagnosed in Russia but implementing the diagnostic routines will have to take some time, and is hindered by the lack of diagnostic tools and trained professionals. The Russian version of ADOS-2 was published only in 2016 [21,22], and the adult module still remains under validation.

In this situation, the need for self-assessment tools in the autistic community has long been perceived as high. Despite that, to our best knowledge, no self-assessment tools for evaluating autistic traits and for screening of ASD in adult population or adolescents has been officially developed, adapted, and validated on Russian-speaking samples. Several attempts were made by members of autistic community to provide Russian versions of internationally recognized questionnaires, even if just for a rough reference; the largest collection of unofficial translations (including AQ, RAADS-R, Aspie Quiz, and The Broad Autism Phenotype Test) is presented at a web-site related to autism and to the problems of people with ASD [23] developed and maintained by members of Russian autism community. There are multiple anecdotal evidences that most of these questionnaires used with cut-offs established for European samples tend to overestimate the prominence of autistic traits but no data on this issue have been officially reported.

The lack of ASD diagnostic tools and inventories assessing autistic traits validated on Russian-speaking samples significantly limits the options to assess criterion validity of any emerging ASD screening questionnaire. In order to get additional circumstantial evidences, special efforts could be made to evaluate the questionnaire's discriminant validity comparing it to other personality trait inventories. There are numerous studies exploring the links between the autism traits and other personality factors and constructs. The Big Five personality model is probably the most well-established general personality construct [24] which was found to strongly relate to the autism traits in a large number of studies, consistently revealing moderate positive correlations of ASD scores to neuroticism, and weak to moderate negative correlations to all the other Big Five factors [25]. A study utilizing multivariate approaches to explore the relations between IPIP-NEO-120 and RAADS-R scores found that Big Five personality factors accounted for 70 % of variance in autism trait scores [26]. These findings suggest that a Big Five personality questionnaire would be a good tool to assist in affirming the validity of an ASD assessment tool.

Aim and general design of the study

The general aim of our research was to construct and validate a Russian version of the RAADS-14 (the RAADS-14 Rus) to provide the initial reference point in developing the body of instruments for assessing autistic traits in Russian-speaking adult population. This measure was chosen due to its good psychometric characteristics, reported ability to provide initial assessment for differential diagnosis, and simplicity of use. The study aims to assess the reliability of the RAADS-14 Rus, its factor structure, and to provide the initial estimates of the questionnaire's validity, diagnostic properties, and potential for use as a screening tool for ASD in adults with no intellectual impairments. We have also formulated two specific research hypotheses:

- 1) The RAADS-14 Rus total scores and subscale scores will have weak to moderate correlations to the scores of the Big Five personality factors, consistent to the previous studies.
- 2) The distribution of the RAADS-14 scores could be different for general Russian-speaking population, producing greater mean total score values and yielding potentially higher cutoff scores to provide reasonable sensitivity of the questionnaire.

Methods

Participants and Procedure

A total of 1569 adults have agreed to voluntarily participate in the study. The data were collected for three different samples:

Sample 1: Non-psychiatric control sample of young adults (college and vocational school students, n=849) who volunteered to participate for research credits. The recruitment was performed in 4 educational institutions in Moscow (n=522) and in 5 educational institutions in other Russian regions (n=327), the consent rate was above 0.7. A part of the participants (n= 652) used paper and pen version, other participants used web-based survey forms and completed them in class settings.

Sample 2: A sample with a higher than normal ratio of adults with ASD (total n=356) was recruited using snowball sampling by targeting autism-related communities to ensure a higher than normal ratio of participants with ASD. The sample included 25 participants with official or unofficial diagnosis established in clinical settings and 91 participants reporting self-diagnosed ASD. All the participants in this sample used web-based survey forms and completed them at their convenience.

Sample 3: An additional web-based sample was recruited using snowball sampling (total n=364) to provide the data for evaluating possible relations between the autism traits measured by the RAADS-14 Rus and the Big Five personality traits. All the participants in this sample used web-based survey forms and completed them at their convenience.

The data collection was anonymous for all the participants but the participants from samples 2 and 3 were suggested to provide their emails (this was optional and the emails were used for the sole purpose of providing the feedback with participant's personal RAADS-14 Rus scores and general follow-up for the study). All the participants provided their informed consent before completing the questionnaire. All the aspects of the data collection and treatment reported in the present article were approved by the Pushkin Institute research ethics committee. 55 participants from Sample 1 failed to provide the answers to all the questions and were excluded from further analyses, reducing the number of the accepted participants for Sample to 796. No participants were excluded from other samples, yielding a total of 1514 participants. For detailed age and gender statistics for all the samples see Table 1.

Sample		Age Mean	Age, SD	Mean RAADS- 14 Score	RAADS- 14 Score SD
Sample I					
	Women (n=535)	20.3	5.4	14.3	7.4
	Men (n=285)	19.9	3.8	13.1	7.7
	Total (n=849)	20.1	4.9	13.9	7.5
Sample II					
	Women (n=229)	37.1	9.2	18.1	11.5
	Men (n=107)	38.0	11.3	19.6	10.0
	Other (n=20)	31.1	10.1	29.3	7.4
	Total (n=356)	37.0	10.0	19.2	11.1
Sample III					
	Women (n=263)	31.7	10.1	18.5	9.2
	Men (n=85)	32.4	9.5	16.1	8.2
	Other (n=16)	33.0	9.0	24.3	9.0
	Total (n=364)	31.9	9.9	18.2	9.1

Table 1. General characteristics of the study samples.

Materials

RAADS-14 Rus. The original 14 items of the RAADS-14, as published in [8], were translated from English into Russian independently by a team of three certified translators, all of them had a prior experience with ASD-related problems of at least 2 years. A consensus version was composed collegially by the three translators, an impartial editor, and a member of ASD community having more than 5 years of consulting experience with ASD-related problems. Back-translation performed independently by two English native speakers unfamiliar to the original revealed no meaningful disagreement with the original version. As in the original RAADS-14, all the items were scored on a four-point Likert scale (ranging from 0 to 3) indicating duration of each symptom (3 = ‘true now and when I was young’, 2= ‘true only now’, 1= ‘true only when I was younger than 16’ and 0 = ‘never true’). The item scores were summed to produce the total score (for general total score statistics by samples see Table 1). The Russian version of the form is provided in Supporting information (S1 Table).

The Big Five personality model. To assess the Big Five personality factors we used a Russian version of the NEO-FFI [27]. This questionnaire is reasonably brief (50 items) and its factor structure has been consistently replicated for different Russian-speaking samples [28,29].

Data analysis

General psychometric properties and the factor structure. To evaluate the reliability and the factor structure of the RAADS-14 Rus we pooled the participants from all the samples resulting in a total of 1514 participants. Cronbach's α was used to assess the reliability of the scale. Previous national adaptations of ASD-related tools revealed that the factor structures of the adapted versions often differ from the factor structures of the original versions [30,31] therefore we used exploratory analysis rather than confirmatory factor analysis to assess the factor structure of the RAADS-14 Rus and to compare it to the factor structure of the original RAADS-14. Principal component analysis (PCA) with varimax rotation was used as a factor extraction technique [32].

Screening properties. The discriminatory power was assessed using a receiver operating characteristic (ROC) curve, estimating sensitivity (the rate of true positives for the ASD sample), specificity (1 minus the rate of false positives for the non-psychiatric control sample), and the area under the curve (AUC) as a measure of the discriminatory power (an AUC greater than 0.7 is generally considered satisfactory)[33]. As we have argued before, the current state of official diagnostics of ASD in Russia makes it impossible or very difficult to ensure a thorough official assessment of ASD traits in ASD sample to verify the clinical diagnosis. In this study we used only the participants with official or unofficial diagnosis established in clinical settings (n=25) to provide the initial estimates of the sensitivity of the RAADS-14 Rus.

Demographics and correlation analyses. Age and gender effects were assessed separately for all the samples due to prominent differences in the demographics and clinical characteristics of the samples. The first sample can be considered a satisfactory approximation of Russian general young adult population [34]; the other samples were biased to include more individuals with ASD and other people somehow related to autism communities. Due to the non-normal nature of the data, all the group-related differences were assessed with the Mann–Whitney *U*-tests and Kruskal-Wallis ANOVAs. Spearman's rank-order correlations were used for subscale cross-correlations and for correlations with the Big Five factor scores.

Statistical analysis. All the statistical analyses were performed using Statistica 10.0 and IBM SPSS Statistics 23 software. Bonferroni corrections for multiple comparisons were used where appropriate.

Results

Reliability and the factor structure

Cronbach's α for the 14 items of the RAADS-14 Rus was 0.81 demonstrating good reliability of the questionnaire with an average inter-item correlation of 0.24.

According to Cattell's scree test [35], a three-component decision was selected for detailed analysis.

The three principal components respectively explained 30.4%, 9.4%, and 7.9% of the total variance, up to a cumulative value of 47.7%.

The component loads for the respective components were moderate to high, varying from .46 to .74 (Table 2). The analysis of the items of the components of the RAADS-14 Rus revealed that the factor structure of the Russian version corresponded well to the original factor structure. The composition of the Social anxiety (SA) domain of the RAADS-14 Rus (Items 3, 5, 6, 8) was identical to the original Social anxiety domain. Five of the seven items from the original RAADS-14 Mentalizing deficits domain, related to understanding others (Items 1, 4, 9, 11, 13), constituted the Social mentalizing domain of the RAADS-14 Rus. All the three items from the original RAADS-14 Sensory reactivity domain (Items 2, 7, 10) and two items from the original Mentalizing deficits domain, initially belonging to the Circumscribed interests domain of RAADS-R [8] and related to cognitive rigidity and generalizing deficit (Items 12 and 14) constituted a new five-item factor that can be best described as the Sensory and cognitive perception (SCP) domain. The domain scores are calculated as sums of the item scores for each domain. All the correlations between the domain scores were positive and significant, of low to moderate strength (ToM vs SA = .51, ToM vs SCP = .28, SA vs SCP = .25) evidencing relative independence of the screen domains. The comparison of the domain scores between the non-psychiatric participants and the participants with clinically established ASD diagnosis revealed very robust effects (all $ps < .0001$) indicating that the ASD participants scored higher on each domain compared to the non-psychiatric participants.

№	Item	Social Mentalizing	Sensory and cognitive perception	Social anxiety	RAADS-14 / RAADS-R screen domain
1	It is difficult for me to understand how other people are feeling when we are talking	<u>.741</u>	-.026	.142	Mentalizing deficits
2	Some ordinary textures that do not bother others feel very offensive when they touch my skin	.082	<u>.585</u>	.119	Sensory reactivity
3	It is very difficult for me to work and function in groups	.250	.371	<u>.580</u>	Social anxiety
4	It is difficult to figure out what other people expect of me	<u>.628</u>	.161	.321	Mentalizing deficits
5	I often don't know how to act in social situations	.493	.200	<u>.536</u>	Social anxiety
6	I can chat and make small talk with people*	.015	-.034	<u>.654</u>	Social anxiety
7	When I feel overwhelmed by my senses, I have to isolate myself to shut them down	.013	<u>.587</u>	.104	Sensory reactivity
8	How to make friends and socialize is a mystery to me	.311	.194	<u>.668</u>	Social anxiety
9	When talking to someone, I have a hard time telling when it is my turn to talk or to listen	<u>.511</u>	.196	.371	Mentalizing deficits
10	Sometimes I have to cover my ears to block out painful noises (like vacuum cleaners or people talking too much or too loudly)	.051	<u>.591</u>	.179	Sensory reactivity
11	It can be very hard to read someone's face, hand, and body movements when we are talking	<u>.753</u>	.075	.168	Mentalizing deficits
12	I focus on details rather than the overall idea	.346	<u>.464</u>	-.282	Mentalizing deficits/ Circumscribed interests
13	I take things too literally, so I often miss what people are trying to say	<u>.636</u>	.327	-.064	Mentalizing deficits
14	I get extremely upset when the way I like to do things is suddenly changed	.223	<u>.591</u>	.037	Mentalizing deficits/ Circumscribed interests

* - reversed item

Table 2. The factor loads of the items and the factor structure the RAADS-14 Rus compared to the RAADS-14 and the RAADS-R.

Distribution of scores and discriminative properties

The distributions of total RAADS-14 Rus scores in non-psychiatric young adults (Sample 1, all the participants, $n = 794$, mean = 13.9, SD = 7.5, median = 13), adults with clinically established ASD diagnosis (Sample 2 subsample, $n=25$, mean = 28.3, SD = 9.0, median = 29), and self-diagnosed adults with ASD (Sample 2 subsample, $n=91$, mean = 27.9, SD = 8.8, median = 29) are shown at Figure 1. The score distribution in non-psychiatric young adults was skewed to the left, while the score distributions for self-diagnosed and clinically diagnosed adults with ASD were very similar and were skewed to the right, with no prominent ceiling effects observed for any of the samples. The distribution of scores for the ASD participants was very similar to the data obtained with the RAADS-14 for Swedish ASD population [8]. The distribution of the RAADS-14 Rus scores for the non-psychiatric adults was less extremely skewed to the left compared to the Swedish data, producing much greater mean and median (13.9 and 13 vs. 3.9 and 3), confirming our prediction that mean RAADS-14 Rus scores are expected to be higher than the original scores.

Fig. 1. The distribution of scores for non-psychiatric young adults, participants with clinically established ASD diagnosis, and self-diagnosed ASD participants.

A ROC curve comparing the results of non-psychiatric young adults ($n = 794$) and participants with ASD diagnosis established in clinical settings ($n = 25$) yielded an AUC of 0.88, evidencing good discriminative properties of the RAADS-14 Rus (Figure 2). A cutoff of 18 points and above would yield a sensitivity of

274 88.0% and a specificity of 64.7%; a cutoff of 22 points and above would yield a sensitivity of 84.0% and
 275 a specificity of 85.4%.

276
 277 **Fig. 2. The receiver operating characteristics of RAADS-14 Rus.**
 278 Diagonal segments are produced by ties

279
 280 **Fig. 3. Operating characteristics of the RAADS-14 Screen.**
 281 Sensitivity and specificity for various threshold scores for individuals with autism spectrum disorder
 282 (ASD) (dotted line) compared with non-psychiatric individuals (bold line)

Age and Gender differences

Considering large difference in mean age and in the RAADS-14 Rus scores between the samples, the assessment of possible relations between age and the RAADS-14 Rus total scores was performed separately for all the samples and, additionally, for the self-diagnosed and officially diagnosed adults with ASD. There was a weak but significant negative correlation of -.22 for the Sample 1, and no significant correlations were observed for Samples 2 and 3 or for the ASD subgroups.

The gender differences were also assessed separately for all the samples and, additionally, for the self-diagnosed and officially diagnosed adults with ASD. The participants who reported their gender as 'other' (Sample 2 $n=20$; Sample 3 $n=16$) were characterized by significantly higher RAADS-14 Rus total scores than the participants stating their gender as both male or female for Sample 2 ($H(2, N=356) = 19.05$, $p_{corr} < .001$) and for Sample 3 ($H(2, N=364) = 10.40$, $p_{corr} < .05$) (see Table 1). There were no significant differences between the males and the females in the RAADS-14 Rus total scores for any of the samples, nor for the ASD subgroups. The RAADS-14 Rus domain score comparison for males and females in the non-psychiatric population revealed that, similarly to the RAADS-14 validation study, females scored higher than males for Sensory and cognitive perception domain ($p < .01$, females: Mean = 7.11, SD = 3.77; males: Mean = 5.91, SD = 3.70). No significant differences were found between males and females for Social anxiety and Social mentalizing domains of the RAADS-14 Rus.

Correlations with Big Five personality traits

The correlations of the RAADS-14 Rus total scores and domain scores with the Big Five personality factors are given in Table 3. The total score yielded moderate positive correlations with Neuroticism (.45), moderate negative correlation with Extraversion (-.49), and weak but significant negative correlations with the other Big Five factors. Social mentalizing and Social anxiety domains each yielded similar correlation patterns, while Sensory and cognitive perception domain had weaker correlations with the Big Five facets reaching significance only for Neuroticism and Extraversion.

Big Five traits	RAADS-14 Rus Total	Social mentalizing	Sensory cognitive perception and Social anxiety
Neuroticism	.45**	.33**	.27**
Extraversion	-.46**	-.30**	-.23**
Openness to	-.13**	-.10	-.11*

experience				
Agreeableness	-.17**	-.17**	-.06	-.18**
Conscientiousness	-.23**	-.17**	-.08	-.25**

* - p-value<0.05, ** - p-value<0.01

Table 3. The correlations between the RAADS-14 Rus total scores and subscores, and the Big Five personality factors.

Discussion

Reliability, validity, and discriminative properties of the RAADS-14 Rus

The aim of this study was to develop a Russian version of the RAADS-14 (the RAADS-14 Rus) and to assess its reliability, factor structure, validity and discriminative properties. The RAADS-14 Rus has exactly the same item composition as the original version; it has good reliability and factor structure similar to the original version [8]. The three resulting domains are named as Social mentalizing, Sensory and cognitive perception, and Social anxiety. The items 12 and 14, describing non-social cognitive perception, were found to be more closely associated with the items related to sensory perception and reactions, rather than with the items related to social mentalizing deficit. This, however, corresponds well to the initial domain structure of the RAADS-R (see Table 2): the resulting Sensory and cognitive perception domain of the RAADS-14 Rus is comprised of the items from Circumscribed interests and Sensory reactivity domains of the RAADS-R, and the resulting Social mentalizing domain of the RAADS-14 Rus includes only those items from Mentalizing domain of the RAADS-R that are related to understanding others. The item composition of the resulting factors corresponds well to standard clinical and developmental interpretation of the autistic traits evidencing good face validity of the questionnaire. There was a very robust difference in the scores of all the RAADS-14 Rus screening domains between the non-psychiatric population and the ASD sample, further confirming construct validity of the RAADS-14 Rus.

The original RAADS-14 was composed of the items yielding the highest discriminative properties for ASD diagnosis; owing to this approach, the questionnaire was characterized by excellent discriminative properties at distinguishing between ASD participants and non-psychiatric controls and by good discrimination between ASD and other neuropsychiatric conditions. The total RAADS-14 Rus scores also has good discriminative properties for distinguishing between ASD participants and non-psychiatric controls with AUC of .88. At the moment we would recommend using a provisional cutoff of 22 points and above. This cutoff yield a good sensitivity of 84.0% and a specificity of 85.4%. Lowering the cutoff to 17 points marginally increases sensitivity but results in a big drop of specificity. Further studies on larger samples and better validation of clinically established ASD diagnosis using tools like ADOS-2 and ADI-R are required to establish more reliable cutoffs.

The mean RAADS-14 scores were much higher for the Russian sample than for the original Swedish sample, particularly for non-psychiatric controls (13.9 vs 3.9); it confirms prior anecdotal evidences that pilot non-validated versions of autism assessment self-report questionnaires produce higher scores for Russian samples than for Western European and American samples. This results in much higher cutoffs and lower screening specificity. The underlying reasons for this effect are yet unclear; at this moment we would suggest that that they are related to culture-specific biases in self-reporting and speaking about one's problems and social competences rather than to elevated autistic traits in Russian neurotypical population. Further research is sought to understand the nature of this effect and to develop more sensitive autism screening tools specifically for Russian-speaking samples.

Age and Gender differences

The RAADS-14 Rus total score revealed weak but significant negative correlation with age for the non-psychiatric young adult sample, consistent with the previous data indicating that different facets of autistic traits in adults tend to somewhat decrease with age [36] [37]. The female to male differences in the RAADS-14 Rus scores were quite minor and generally similar to data from the original RAADS-14 validation study collected for Swedish samples [8]. In our study a significant part of subjects in Samples 2 and 3 indicated their gender as 'other' or non-binary (total n =36). The non-binary participants scored significantly higher than the males and females; this also corresponds to the prior findings in other national samples [38–40]

The RAADS-14 Rus and the Big Five personality model

The correlations of the Big Five personality traits with the total RAADS-14 Rus score, taken as a general measure of autistic traits, were highly consistent with the earlier findings [41], revealing moderate positive correlations with Neuroticism, moderate negative correlation with Extraversion, and weaker negative correlations with Agreeableness, Openness to experience, and Conscientiousness, similarly to a study using RAADS-R and IPIP-NEO-120 [42]. These results support good discriminative validity of the RAADS-14 Rus and confirm our prediction that the character of the relation between autistic traits, as measured by the RAADS-14 Rus, and the Big Five personality traits for the Russian sample is similar to such relation for other national populations. It can serve as a circumstantial evidence that the RAADS-14 Rus may be used as a tool providing an estimate of the degree of autism traits.

Limitations and future directions

The main limitations of the study stem from the lack of validated ASD assessment tools currently available in Russian and from very high estimates of underdiagnosis of ASD in Russian adults with no intellectual impairments. Due to our limited options to assess concurrent validity of the RAADS-14 Rus, to the lack of reliable confirmation of clinical status of ASD participants, and to the limited size of the ASD sample in this study all the estimates of the discriminative properties of the RAADS-14 Rus should be interpreted strictly as preliminary. These findings require further validation on larger clinical and non-clinical samples. However, considering that

a) to our best knowledge, the RAADS-14 Rus is the first self-assessment inventory addressing autistic traits in adults with no intellectual impairments, and

b) the non-psychiatric sample of young adults is relatively large and represents several Russian regions, the data were collected with high consent rate and can be considered a satisfactory approximation of the age cohort, at least for larger cities,

the RAADS-14 Rus can become one of the first stepping-stones in establishing a comprehensive system of ASD assessment and diagnostics for adult Russian-speaking population.

Further efforts should be made to ensure better screening sensitivity and may lead to development of new screening instruments based on larger initial pools of ASD-related items and using item selection centered around single-item discriminatory power similarly to the process used for developing the original RAADS-14.

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519 **Supporting information**

520 S1 Appendix. The forms of the RAADS-14 Rus in Russian and the original RAADS-14 with scoring
521 instructions.

522 S2 Appendix. The complete anonymized dataset for all the study samples.