Investigating Measure Bias in Autism Spectrum Disorder Between Sexes

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Background

•Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that impairs an individual's social, communication, and behavioral skills.

•Males are 4.5 times more likely to be diagnosed with ASD compared to females (Christensen et al., 2016).

•One possible reason for the difference in diagnostic rates is that females may be better able to mask their symptoms and therefore go undiagnosed more often than males (Mandy et al., 2012).

•The goal of this study is to understand the potential gender bias in two types of measures of ASD severity (ADOS-2 and SRS-2) by examining consistency between parent (SRS-2) and clinician (ADOS-2) reports of ASD symptoms.

•If there is evidence of gender bias, this study will also explore if these findings are the same in a group of children who did not reach research criteria for a diagnosis of autism.

•Based on the hypothesis that females are better at masking their autistic traits, we expect less agreement between clinician and parent ratings of autism symptoms in females compared to males.

Methods

Participants:

Primary analysis: 164 children (91 males, 73 females) aged 8-17 years with a confirmed diagnosis of autism participated in the study.
All participants have an IQ over 70 and have a diagnosis of ASD confirmed via the ADOS-2 and ADI-R.

Exploratory analysis: 14 children (8 males, 6 females) aged 8-17 years who have a community diagnosis of autism but did not meet research criteria on ADOS-2 for ASD.

Groups	Age	Verbal IQ	Non-Verbal IQ	Spatial IQ	Full Scale IQ
ASD Males (N = 91)	M = 148.00 SD = 35.61	M = 99.66 SD = 21.31	M = 100.74 SD = 18.00	M = 99.52 SD = 16.14	M = 100.20 SD = 19.37
ASD Females (N = 73)	M = 149.60 SD = 33.48	M = 101.93 SD = 20.25	M = 99.93 SD = 18.03	M = 97.87 SD = 18.29	M = 100.23 SD = 20.24
No Dx Males (N = 8)	M = 169.88 SD = 33.45	M = 103.25 SD = 15.19	M = 104.38 SD = 15.36	M = 96.63 SD = 18.78	M = 102.00 SD = 14.58
No Dx Females (N = 6)	M = 149.50 SD = 42.83	M = 105.00 SD = 9.12	M = 101.50 SD = 15.24	M = 101.67 SD = 9.63	M = 102.83 SD = 9.85

ASD males and females did not significantly differ on age or IQ.

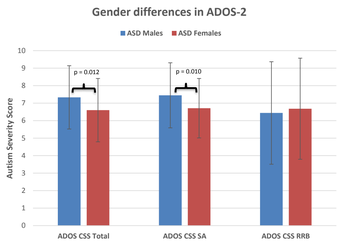
Measures

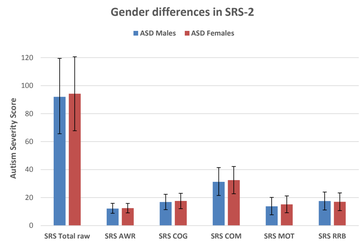
Autism Diagnostic Observation Schedule, Second Edition (ADOS-2) (Lord et al. 1989)	A clinician-child interaction measure that scores the child's communication, social skills, and restricted or repetitive behavior (RRB). Calibrated severity scores (CSS) were calculated and used in these analyses.
Social Responsiveness Scale, Second Edition (SRS-2) (Constantino et al. 2012)	A survey completed by the parent about their child's social and autism-related impairments provides a total score as well as subscale scores for social awareness, social cognition, social communication, social motivation, and restricted interests and repetitive behavior.
Autism Diagnostic Interview, Reviewed (ADI-R) (Le Couteur et al. 2003)	An interview conducted by a clinician that is administered to the parent of a child with symptoms of ASD.

Results

Question 1: Do the ADOS-2 and SRS-2 share similar patterns in autism severity scores in males and females?

A series of Independent-samples t-tests were run comparing genders (M, F) on ADOS-2 Calculated Severity Score (Total Severity, Social Affect (SA) and Restricted and Repetitive Behaviors (RRB)) and SRS-2 subscale and total raw scores.





Females scored significantly lower than males on ADOS-2 CSS Total (t(162)=2.55, p = 0.012) and ADOS-2 CSS Social Affect (SA) (t(162)=2.62, p = 0.010), indicating less autism severity in females compared to males as rated by clinicians. There were no significant differences between genders on the SRS-2 total score or any of its subscales

Question 2: Do the correlations between ADOS-2 and SRS-2 differ between genders?

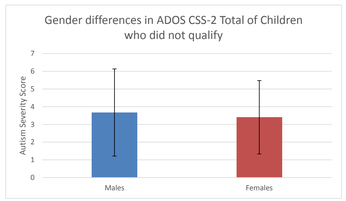
Correlations were run between ADOS-2 CSS (Social Affect and Total) and SRS-2 (all subscales) separately for males and females.

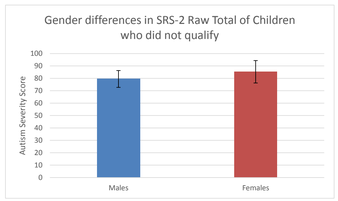
	ADOS-2 CSS Social Affect		ADOS-2 CSS Total	
	Males	Females	Males	Females
SRS Total	p =0.409	p = 0.289	p = 0.150	p = 0.593
SRS Awareness	p = 0.488	p = 0.117	p = 0.292	p = 0.677
SRS Cognition	p = 0.558	p = 0.927	p = 0.611	p = 0.405
SRS Communication	p =0.340	p = 0.181	p = 0.247	p = 0.712
SRS Motivation	p = 0.002	p = 0.405	p = 0.002	p = 0.364
SRS Restricted Interests and Repetitive behavior	p = 0.551	p = 0.945	p = 0.782	p = 0.349

Higher SRS motivation scores were associated with higher ADOS-2 CSS SA (R = 0.316) and CSS Total (R = 0.324) scores for males but not females. No other correlations were significant.

Question 3: Do the patterns of gender differences seen in children with autism differ in participants who had a clinical diagnosis but did not meet research criteria for ASD?

A series of Independent-samples t-tests were run comparing genders for kids who did not qualify for the study on ADOS-2 Calculated Severity Score Total and SRS-2 Total raw.





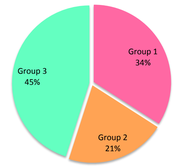
Of the males and females who did not qualify for the study, there are no significant differences between genders on either the ADOS-2 or the SRS-2.

Question 4: Are there gender differences in Clinician and Parent ratings of autism severity?

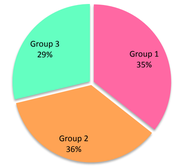
To further understand the pattern of gender differences seen in Question 1, we looked at each participant's ADOS-2 CSS total score and their SRS-2 raw total score and categorized their autism severity scores as being rated as MILD, MODERATE, or SEVERE based on the cutoffs provided by each measure.

		SRS-2 Severity Groups					
		1 Mild range (58-72 raw)		2 Moderate range (73-97 raw)		3 Severe range (98+ raw)	
		Males	Females	Males	Females	Males	Females
ADOS-2 Severity Groups	1 Mild range (3-4)	0	2	2	2	5	5
	2 Moderate range (5-7)	4	5	18	12	12	19
	3 Severe range (8-10)	5	4	12	12	23	7

Males



Females



We then separated the participants into three more groups based on their categories:
Group 1: Clinician report puts child in higher autism severity bracket than parent report.
Group 2: Parent report puts child in higher autism severity bracket than clinician report.
Group 3: Parent and clinician reports put child in the same autism severity bracket.
A chi squared test was calculated to look for any gender differences in the distribution between groups.

The chi squared test was significant (X^2 (2, N = 164) = 6.08, p = 0.048).
-Follow up chi squares indicate that there is a significant difference between genders in the distribution between groups 2 and 3 (X^2 (1, N = 107) = 5.20, p = 0.024).
-Females are more likely to be rated as having higher autism severity when scored by parents compared to clinicians (36%) compared to males (21%).
-Males are more likely to be scored the same for autism severity by parents and clinicians (45%) compared to females (29%).
-Males (34%) and females (35%) are equally likely to be rated as having higher autism severity by clinicians than parents.

Discussion

-Based on parent and clinician reports, there is inconsistency in the patterns of gender differences, with females preforming better than males on the ADOS-2, but the SRS-2 showing no difference in autism severity. One explanation for these findings could be, like predicted, females are better at masking their autism symptoms when outside of home. This would mean clinicians may not see the full extent of female's symptoms, resulting in lower ratings of autism severity compared to males.

-SRS Motivation was significantly correlated with CSS SA and CSS Total for males but not for females. Not all subscales follow the same pattern of higher correlation of measures for males than females, but this finding follows the hypothesis that there is more agreement in parent and clinician report for males than females.

-The chi squared tests show that clinician and parent reports of autism severity are more consistent in males than in females, and females are more likely than males to be reported as having higher autism severity by parents than clinicians. This supports the hypothesis that females might be masking their symptoms and therefore going underdiagnosed.

-Taken together, these findings suggest that clinician and parent report is more consistent for males than females, which supports our hypothesis that females may be masking their symptoms. It is also possible that it's the measures themselves that are not equally sensitive to the gender differences in the way that males and females show autism symptoms. There is no baseline to compare results to, therefore we cannot conclude which measure is more accurate in diagnosing autism severity.

-There are no significant difference between clinician and parent reports for children who did not qualify for this study. This is not consistent with our findings in children with a confirmed diagnosis of autism, but with such a small sample size (N = 14), these results might change with a larger number of participants.

-Overall the findings for this study could aid in understanding the relationship between gender and measurement tools and help inform whether traditional diagnostic measures are equally effective in diagnosing both males and females.