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Yazan Bader April 12, 2022

Examining the Association Between Symptom Severity and Adaptive Functioning in Autism Spectrum Disorder

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An abstract of

a thesis submitted to the Faculty of Emory College of Arts and Sciences

of Emory University in partial fulfillment

of the requirements of the degree of

Bachelor of Arts with Honors

Psychology

2022

Abstract

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By Yazan Bader

The purpose of this study is to expand upon our understanding of ASD and its heterogeneity. To accomplish this, the study aimed to examine the relationship between diagnostic metrics often used in the assessment of children with ASD. Namely, the association between symptom severity and adaptive functioning was analyzed. Furthermore, this study aimed to explore the interaction between demographic variables such as race, and socioeconomic background and the aforementioned diagnostic variables. To accomplish this, data collected by licensed clinicians at the Marcus Autism Center for the Autism Diagnostic Observation Schedule and the Vineland Adaptive Behavior Scales was analyzed. The participants in this study were 105 children aged between 21 to 127 months. Our findings suggested that on average, children of non-white racial identity exhibited greater symptom severity despite not differing significantly across all measures of adaptive functioning. Additionally, symptom severity was significantly predictive of adaptive functioning; this association was not moderated by race, or socioeconomic status. The study was limited by its small sample size and reliance on parent testimony for assessing adaptive functioning. For future studies, adaptation from a cross-sectional to a longitudinal study design, as well as increasing sample size is recommended.

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INTRODUCTION

Background:

Our understanding of Autism Spectrum Disorder (ASD) has evolved tremendously since its first documentation by Leo Kanner in his 1943 publication *Autistic Disturbances of Affective Contact*. Through thorough examination of 11 case studies of children exhibiting "peculiarities" in their behavior, Kanner made a number of observations including but not limited to obsessiveness, stereotypy, and echolalia. Kanner summarized his observations by describing the individuals as unable to "relate themselves in the ordinary way to people and situations from the beginning of life." (Kanner, 1943). Despite significant differences in their symptomatology, these behavioral deficits were falsely classified as instances of *childhood schizophrenia* until the official inclusion of autism in the third edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III) in 1980 (Harris, 2016).

Nevertheless, the array of behaviors that constitute ASD is ever broadening and increasing in nuance. In the present day, the DSM-V defines ASD by the following criteria: "persistent deficits in social communication and interaction across multiple contexts" as well as "at least two instances of restricted or repetitive behaviors, interests, or activities." Deficits in social communication are often expressed as inattention to external social cues such as emotion, and nonverbal communication. Restricted and repetitive behaviors can refer to stereotyped speech or echolalia, excessive desire for structure or routines, circumscribed interests, or increased/decreased sensitivity to sensory stimulation (American Psychiatric Association, 2013). Historically, ASD, formerly known as Autistic Disorder, was part of an assortment of developmental disorders collectively referred to as 'Pervasive Developmental Disorders' (PDD). Such disorders, including Autistic Disorder, Rett's Disorder, Asperger's Disorder, and

Childhood Disintegrative Disorder, all shared characteristic deficits in social development but differed markedly in the timing of symptom onset and the degree of language competency (American Psychiatric Association, 2000). As a result of criticism of distinct diagnoses for disorders of such similar pathology, the DSM-V replaced PDDs with a more encompassing title of 'Autism Spectrum Disorder'. Therefore, the phenotypic profile of autism is continuing to broaden, evidenced by the steady increase in national prevalence year after year; the prevalence rate is 1 in 54 as of 2020. (Centers for Disease Control and Prevention, 2020).

In the present day, the metrics used to assess and diagnose ASD are reflective of its heterogeneity. In this case, heterogeneity refers to the high degree of phenotypic variation observed in those on the autism spectrum (Georgiades, 2013). As such, assessment of those diagnosed with ASD or at risk of an ASD diagnosis often demands a multifaceted approach. Examples of the components of assessment include symptom severity, and adaptive functioning. Independently, the individual variables of ASD assessment are well understood (Oosterling, 2010); nevertheless, their interaction remains largely understudied. Therefore, an objective of this study is to bridge this gap, and further our understanding of the interactions that take place between the developmental modalities often used to assess and diagnose ASD.

Autism Symptom Severity:

It is common for children on, or suspected of being on the autism spectrum to be evaluated with a *symptom severity score* (Wiggins, 2019). This score is a calibrated metric typically derived through completion of the Autism Diagnostic Observation Schedule (ADOS) (see **Methods**). The severity score was conceptualized to be a quantifiable measure of the symptomatic behavior present across multiple domains of development (Gotham, 2009). The

calibrated severity score is derived from measures of social affect and restricted and repetitive behaviors and interests (RRB) (Hus, 2014). Existing literature on these domains suggests distinct developmental trajectories and that these domains may be differentially predicted by demographic variables (Hus et al., 2014). Furthermore, empirical evidence suggests that the ADOS severity score is generally stable over a 1–2-year period in children on the autism spectrum (Shumway, 2012). Additionally, cognitive measures such as verbal IQ are less predictive of the calibrated score when compared to raw totals (Gotham, 2012). These findings imply success in the ADOS' goal of evaluating developmental delay irrespective of possible linguistic limitations.

Adaptive Functioning:

Adaptive functioning refers to the level of competency with which one is able to modify their behavior across contexts and environments. This is typically assessed using the Vineland Adaptive Behavior Scales (VABS) (Farmer, 2019). Currently, substantially less is known about the factors predictive of, or impacting adaptive functioning when compared to symptom severity. Nevertheless, recent findings suggest that despite a positive association between adaptive functioning and Full-Scale IQ, sensory behavior and RRB frequency is *not* predictive of adaptive functioning (Tillmann, 2019). Furthermore, there remains a gap in the literature as to how factors such as race and socioeconomic background may interact with the above relationships.

Disparities:

Racial disparities in American healthcare are an established phenomenon that emphasize the sizable gaps in accessibility that must be bridged before true equity is achieved (Ayanian, 2015). In the case of ASD, delays in the provision of intervention and accurate diagnosis are

critical, as they can greatly impede a child's ability to overcome deficits in socialization and communication; additionally those diagnosed later in life are at a greater risk for exhibiting maladaptive behavior (Hall, 2012). As it stands, there are noticeable racial disparities in the provision of ASD specific resources. It is documented that among children of intellectual disability, non-white children were significantly less likely to receive an ASD diagnosis when compared to their white counterparts (Mandell, 2009). Furthermore, black children with ASD are diagnosed, on average, nearly six months later than white children, and are twice as likely to have a comorbid intellectual disability (Knopf, 2020). To date there is no observed association between IQ and family income, maternal education, and gestational age at birth among black children with ASD. As such, it is likely that this observed disparity in intellectual disability prevalence can be attributed to an interaction between delays in diagnosis and inadequate access to effective intervention (Constantino, 2020). Nevertheless, existing literature suggests that symptom severity may not be truly predictive of adaptive functioning or cognitive ability. In fact, a study published in 2015 suggests that the developmental trajectories of symptom severity and adaptive functioning may be entirely independent (Szatmari, 2015). Despite this, the relationship between these variables has yet to be examined over large and diverse data sets. Furthermore, little research has been done to examine how this association is moderated by demographic and socioeconomic factors. Examining racial and socioeconomic background as potential moderating variables opens the door for meaningful conclusions on the state of affairs regarding equity in healthcare, as well as possible next steps to increase accessibility to ASD resources.

ASD intervention can take on a variety of forms, however the majority of methods operate under the common goal of increasing targeted behaviors, reducing maladaptive behaviors. The nuances of what constitutes targeted and undesired behaviors has been a point of

controversy in the scientific and ASD advocacy communities. Nevertheless, empirical evidence suggests that early intervention was predictive of reductions in symptom severity that were stable through at least 1 year; importantly, the child's age at start of intervention was negatively associated with benefits derived (Itzchak, 2011). Unfortunately, there remains disparities in use of ASD support systems, as non-white children from low-income backgrounds are less likely to access specialized, or educational services (Smith, 2020). However, there remains a gap in the literature regarding disparities in outcomes derived from intervention (Steinbrenner, 2022). Additionally, much of the deficits in our current understanding of the impact of race on ASD outcomes are attributable to underreporting. In a 2014 review by Pierce et al. that had examined publications from three major autism-journals over a 6-year span, it was found that over 70% of articles failed to adequately report racial/ethnic participant information (Pierce, 2014).

Objective:

The primary purpose of this study is to expand upon our understanding of ASD and its heterogeneity. To accomplish this, the study aims to examine the relationship between diagnostic metrics often used in assessment of children with ASD. Namely, the association between symptom severity and adaptive functioning are to be analyzed.

Furthermore, this study aims to explore the interaction between demographic variables such as race, and socioeconomic background and the aforementioned diagnostic variables. The underlying purpose is to provide context to the existing literature evidencing racial disparities in diagnosis and intervention access by assessing ASD phenotypic differences between groups. Additionally, this study hopes to examine a participant pool with an unprecedented

degree of sample diversity, making way for greater real-world validity, and allowing for relevant implications.

On account of documented disparities in access to, and use of early intervention resources, we hypothesize that children of non-white or low socioeconomic background will, on average, score higher on symptom severity, and lower on measures of adaptive functioning than those of white or higher socioeconomic background. Across all participants, we predict that symptom severity will be negatively associated with measures of adaptive functioning. However, we expect that the association will be stronger in children of nonwhite or less affluent background; this prediction is based on the belief that increased access to intervention in children of white or affluent background may allow for the overcoming of deficits in adaptive functioning ordinarily predicted by symptom severity.

METHODS

Setting:

Data was collected at the Marcus Autism Center (MAC) located in Atlanta, Georgia. As one of only five National Institutes of Health recognized Autism Centers of Excellence, MAC remains highly regarded as a hub for ASD research, and treatment (Marcus Autism Center, 2022). As an affiliate of the Children's Healthcare of Atlanta (CHOA), the center houses a number of clinics for administration of diagnostic measures, as well as applied behavior analysis (ABA) treatments for those younger than 21 years of age. Appointments at MAC are available to those possessing a referral from a licensed medical professional. Those approved for an intake

diagnostic evaluation typically undergo a parent-clinician interview, and assessments of adaptive, cognitive, and developmental competency.

Participants:

The data used in this study was collected from records of those admitted for diagnostic evaluation at the MAC clinic. The age of participants ranged from 21 to 127 months; use of data for research was approved by the Institutional Review Board of Children's Healthcare of Atlanta (CHOA). Clinical data was collected by licensed clinicians. Enrollment was completely voluntary and consent for involvement in research was given by all parents/guardians. The participants in this study were admitted into MAC between the dates of August 22, 2016 and August 24, 2020 (n=1523). However, the sample size was reduced to those who had completed both the Vineland Adaptive Behavior Scales (VABS) and one of the four Autism Diagnostic Observation Schedule (ADOS) modules (n=105). Participants were all originating from the state of Georgia, and varied in racial identity; for the purposes of this study, racial identification was dichotomized into white-identifying (n = 50), and non-white-identifying (n=55). Individuals were not omitted on the basis of comorbidity with other intellectual or developmental disorders.

Procedure:

Data collection took place at MAC in Atlanta, GA, and was facilitated by one of several licensed clinicians employed by CHOA. Participants were children processed through the MAC clinic, and as part of standard intake, were administered several behavioral measures and questionnaires. Additionally, each parent/guardian underwent an interview to provide demographic information, or family history that may lend context to the nature of their child's diagnostic results.

Following data collection, item-level information from diagnostic measures was inputted into the Marcus Data Exchange (DEX). DEX is a database unique to MAC that houses all item-level and summary information recorded in clinical visits. Once diagnostic measures were entered, participants' medical records were extracted from CHOA's EPIC server. This allowed for the retrieval of demographic information including age, race/ethnicity, and socioeconomic status (SES). This resulted in a large quantity (n=1523) of clinical data available for analysis. This larger participant pool was later reduced (n=105); participant data was omitted in the absence of either a completed ADOS or VABS assessment.

Measures:

The relevant measures were the Autism Diagnostic Observation Schedule (ADOS), the Vineland Adaptive Behavior Scales (VABS), and the MAC Clinical Intake Questionnaire. The following sections detail the measures used in data collection, as well as the relevant variables derived from each.

ADOS (all modules)

The ADOS is a measure of ASD symptom severity wherein an examiner instructs the examinee to conduct a series of semi-structured tasks aimed to assess their communicative, social, motor, and cognitive competency. Each task is scored independently according to the presence of abnormalities or absence of typically developed behavior. Although some tasks require formal set-up and instruction, the majority are observational in nature so as not to impose a feeling of evaluation upon the examinee.

Authored by Dr. Catherine Lord in 1989, the ADOS was designed to be semi-structured, referring to the mix of active task instruction, and naturalistic observation. A common criticism

of the ADOS is its high generalizability to other developmental disorders; this results in a greater risk of false positive diagnosis (Maddox et. al, 2017). Despite possessing a high degree of result sensitivity, the ADOS has also scored highly on bias risk according to QUADAS-2 (Randall et. al, 2018).

The ADOS comes in one of five possible modules depending on the examinee's stage in development; the toddler module is targeted at children under 30 months of age, module one is targeted towards nonverbal children, module two towards children possessing minimal verbal skills, module three towards verbally fluent children who are comfortable playing with toys, and module four is designed for verbally fluent adolescents or adults, and incorporates questions about daily living tasks. At this time, there is no published module for non-verbal adults. Across all modules, children are scored based on the occurrence of behaviors typically indicative of ASD including but not limited to echolalia, unusual finger movements near the face, and heightened sensory sensitivity. For each task, the examinee was scored on a Likert scale of 0 – 3, with greater scores corresponding to increased abnormalities in behavior. Through DEX we were able to use the ADOS item-level scores to calculate a calibrated severity score spanning a ten-point scale of concern with 0 being little to no concern and 10 being extreme concern.

VABS

The VABS is a measure of adaptive functioning, which refers to one's ability to carry out daily tasks at a level that is developmentally appropriate. For this measure, the parent/guardian is interviewed on a 297-item questionnaire and asked to assess their child on levels of communication, daily living skills, socialization, motor skills, and maladaptive behavior. The VABS aims to measure behavior across contexts that extend beyond the lab. Co-authored by Dr. Celine Saulnier, Dr. Sara Sparrow, and Dr. Domenic Cicchetti in 2016, the VABS Third Edition

has been widely considered to be a reliable and valid means of assessing adaptive functioning (Pepperdine, 2018). The VABS is not intended exclusively for ASD diagnosis, but is made generalizable to a variety of developmental disorders (Saleem, 2019). That said, this generalizability may limit its ability to diagnose specifically ASD in isolation from other measures.

The VABS was administered in an interview-style format. The parent/guardian of the examinee was brought into the center to answer a series of questions pertaining to the child's development. In a similar fashion to the ADOS, frequency of behavior was rated on a Likert scale of 0 – 2 with 0 representing an absence of behavior, 1 representing an occasionally occurring behavior, and 2 representing a frequently occurring behavior. The questionnaire contained 297 unique questions ordered in ascending levels of developmental demand, however the technician was trained to enact the ceiling/floor rule for efficiency purposes. According to this rule, if a child was able to answer 2 on a question that would imply the same score on less demanding questions, those questions were to be assigned a score of 2, as well. Similarly, if a child scored four 0s in a row, it can be assumed that the rest of the questions in that section were scored with 0, as well. This is to reduce the strain on parents and ensure that question accuracy was not influenced by interview fatigue.

The individual item scores in the VABS were aggregated to form an Adaptive Behavior Composite (ABC). This composite is an amalgamation of the child's performance across three domains: communication, daily living skills, and socialization. The communication domain is a measure of the child's receptiveness to commands, ability to respond appropriately according to context, and make requests. The daily living skills domain measures the ability to carry out everyday tasks with a proficiency typical of the child's age. Finally, the socialization domain

assesses the child's ability to behave appropriately in social situations, and form interpersonal relationships. The ABC is a widely accepted indicator of a child's level of adaptive function; in this measure, an ABC score of 100 is considered statistically average.

MAC Clinical Intake Questionnaire

Administered upon intake into the clinic, this parent-clinician interview is intended to provide context on the child's demographic information such as race and parental education.

Variables

- Diagnostic Variables
    - ADOS symptom severity score
    - Adaptive Behavior Composite (ABC):
        - Socialization Standard Score
        - Daily Living Skills Standard Score
        - Communication Standard Score
- Demographic Variables
    - Socioeconomic status: operationalized as parental education
    - Age at Evaluation
    - Racial Identity

Data Analysis:

This study aimed to examine the association between autism severity according to the ADOS calibrated severity score, and adaptive functioning according to the ABC. Thus, a linear regression was performed to assess the strength of the association across all study participants.

Following this, the regression was repeated with the inclusion of demographic interaction variables such as race, and parental education as potential moderators. Furthermore, the above analyses were repeated to examine the association between symptom severity and the individual components of the ABC (i.e. socialization, daily living skills, and communication). Additionally, Welch two sample t-tests were conducted to compare the mean scores on measures of symptom severity and adaptive functioning across the demographic groups.

RESULTS:

Sample:

Prior to the start of data analysis the total pool of participant data collected (n=1523) was reduced (n=105) on the basis of pre-established exclusion criteria. Participants' data were omitted entirely from analysis if they did not possess both a completed VABS and ADOS, as this made it impossible to perform meaningful tests regarding the relationship between adaptive functioning and symptom severity. The descriptive data is shown in **Table 1.**

Contrary to national demographic composition, the majority of participants within the study identified as something other than white (~52.4%). For feasibility of mean comparison, participant data according to racial identity was dichotomized into white-identifying and non-white-identifying. Additionally, the ratio of male (n=79) to female (n=26) participants was (~3:1). Sample demographic proportions are outlined in **Table 2.**

DATA ANALYSIS

Mean Comparisons

The first round of data analysis was an investigation into mean differences that may exist between demographic groups across diagnostic measures of ASD. This was done to establish baseline expectations for a potential race effect that may impact the association between measures of symptom severity and adaptive functioning. The demographic variable of interest was racial identity, this variable was dichotomized and groups were compared via t-test on measures of ADOS calibrated symptom severity score, VABS adaptive behavior composite, socialization standard score, daily living skills standard score, communication standard score, age at evaluation and estimated socioeconomic status operationalized as average years parents had spent in education.

Among all variables, mean values of participants did not differ significantly on the basis of race, with the exception of the ADOS calibrated severity score ($p = 0.021$; $t = -2.318$; 95% significance). On average, participants identifying as white ($m = 6.00$; $SD = 2.84$) exhibited significantly reduced symptomatic severity scores when compared to non-white counterparts ($m = 7.15$; $SD = 2.2$). Full t-test results are outlined in **Table 3.**

Bivariate Correlation Analysis & Moderation Analysis

Following this, we conducted a Pearson bivariate correlation analysis for each combination of our diagnostic variables as well as average parental years spent in education. Symptom severity score was significantly correlated with the adaptive behavior composite ($p = 0.003$; $r = -0.284$) , as well as the socialization ($p < 0.001$; $r = -0.328$), daily living skills ($p = 0.039$; $r = -0.202$), and communication standard scores ($p = 0.010$; $r = -0.251$). As expected, the VABS composite score, as well as the subscales were all significantly associated with each other.

Furthermore, socialization standard score, in particular, was significantly associated with age at evaluation (p = 0.046; r = -0.195). Full correlation analysis is presented in **Table 4.**

Following bivariate correlation analysis, we sought to investigate possible interaction effects produced by the demographic variables that may impact the observed associations. To accomplish this, we carried out linear regression analyses between symptom severity, as the predictor variable, and measures of adaptive functioning, as the dependent variable, with interaction terms included. In the case of the racial-identity variable, symptom severity and race were centered at 0 to allow for clear interpretation of coefficients. Following this step, an interaction term was created which multiplied these two variables. Finally, symptom severity, racial identity, and the interaction term were run against each of the measures of adaptive functioning (**Table 5**). Across all dependent variables, (ABC (p=0.507), socialization standard score, daily living skills standard score, and communication standard score) race was *not* found to be a significant moderator of the association with symptom severity (**Figure 1**). The same procedure was repeated for the parental education variable, and, similarly, moderation effects were deemed *not* significant.

DISCUSSION:

Despite the immense shifts in our understanding of ASD that have transpired over the past several decades, its heterogeneity remains a well-documented characteristic that has been apparent since the disorder's earliest accounts. Nevertheless, there exists gaps in our knowledge regarding the ways the many domains of behavior influence, or associate with one another. Recent studies have yielded mixed findings, with some suggesting distinct and independent developmental trajectories, and others proposing strong associations. This study sought to bridge

this gap in understanding, and investigate the nature of association between ASD symptom severity and adaptive functioning. Furthermore, this study aimed to examine observed associations for potential moderation by demographic variables such as racial identity, parental education, and age at time of evaluation.

We hypothesized that symptom severity and adaptive functioning would be negatively associated. However, we anticipated that any found association would be weaker in children of white identity, or children of greater parental years spent in education. This prediction was made on the assumption that such demographic characteristics would be indicative of increased affluence, and consequently improved access to intervention resources. Therefore, we anticipated that greater access to resources would offset potential deficits in adaptive functioning predicted by symptom severity. Evidence supporting racial differences in symptom severity has been inconsistent. Nevertheless, the findings of the mean comparisons for ADOS calibrated severity score point to a significant increase in symptomatology for children who identify as races other than white. Interestingly, such difference was not found in measures of adaptive functioning, nor parental education.

There are a number of possible interpretations for these findings. When speculating on underlying causes for such results it is important to bear in mind the structure and limitations of the measures used in evaluation. The ADOS, the measure of symptom severity utilized in this study, is conducted in a single session, in-clinic, and is reliant on the clinician's observation of semi-structured tasks. This renders evaluation via the ADOS prone to the biases of the clinician; this is especially relevant in the case of ASD assessment wherein there is a high potential for ambiguity associated with coding behavior (Herbrecht, 2019). Therefore, it is possible that the discrepancy observed in symptomatology is representative of racial bias in evaluation.

Alternatively, the VABS, the primary measure of adaptive functioning, is reliant on parent/guardian testimony of a child's behavior across contexts. Therefore, a clinician's assessment of a child's level of adaptive functioning is almost entirely tethered to the accuracy of the parent's account. This renders the results of the VABS susceptible to cultural differences in display rules; therefore, it is possible that deviance from accuracy in adaptive functioning may be impacted by cultural differences (Donohue, 2019).

The relationship between age at evaluation and behavioral outcomes is well-documented in the existing literature. Typically, earlier evaluation is predictive of reduced symptomatology and improved adaptive functioning (Corsello, 2005). In our study, age at time of evaluation was only significantly associated with the socialization subscale of the VABS. However, it is important to note that while the age variable is representative of the first lifetime ASD assessment for many children in the study, such is not the case across all participants. Interestingly, age at evaluation was *not* significantly associated with the remaining measures of adaptive functioning, nor was it significantly associated with symptom severity. These unexpected findings lend to a variety of interpretations. It is possible that socialization, i.e. interpersonal relationships with other children, play, and social engagement, is the behavioral domain with the greatest room for acquisition and learning. This interpretation would suggest that symptomatology is more stable in comparison, irrespective of date of intervention.

In line with our hypothesis, the ADOS symptom severity score was a significant predictor of the ABC score. Although similarly significantly associated with all behavioral subscales, symptom severity was an especially strong correlate of socialization standard score when compared to daily living skills and communication. Furthermore, the results of multiple regression analyses of these variables against potential moderators suggest that the observed

associations are *not* moderated by race, or parental education. These findings contrast with recent findings which yielded negligible associations between ADOS symptom severity and adaptive functioning, as assessed via the VABS (Kanne et al., 2011). However, data collection from the Kanne study sampled participant data from a far broader age range (4-17 years) whereas this study observed an age range of 21 to 127 months; it is possible that earlier in life, the association between symptom severity and adaptive functioning may be stronger (Saulnier & Klin, 2008). Given the non-linear rate of social development observed in typically developing children, it's possible that these two variables stabilize independently over time (Grimm, 2011). Additionally, it is worth noting that the bulk of research on the association between these two variables was conducted prior or shortly following the diagnostic grouping of Asperger's Disorder and Autistic Disorder into Autism Spectrum Disorder in 2013. As a result, it is possible, particularly in older youths, that differential treatment/intervention plans in childhood may contribute to lack of significant association between symptomatology and adaptive functioning (Ohan, 2015).

Limitations/Future Directions

Despite the fact that data from ~1523 participants was amassed in the collection phase of this study, the absence of diagnostic measures necessary for analysis resulted in a substantial reduction of sample size to 105. Consequently, any conclusions or implications derived from analysis are limited by the small sample. In a follow-up study, it would prove beneficial to sample a larger pool of participants, such that a greater volume of participant data is available following exclusion criteria.

Although intuitive, the use of parental years spent in education as an operational variable for socioeconomic status lacks empirical evidence suggesting its validity as a representative of financial wealth. It may prove more comprehensive to derive an aggregate estimate of socioeconomic status that incorporates parental education, estimated income according to zip code, and insurance type. Such changes may result in findings with stronger implications into the nature of socioeconomic background's impact on ASD phenotype.

The choice of diagnostic measures, namely the ADOS and VABS, are incongruent in that the former is assessed via clinical observation, and the latter is reliant on parent testimony. This mismatch in the evaluative procedure may represent differential bias vulnerability. This may explain the lack of moderation via race that is typically found in similar study designs.

Furthermore, the lack of cognitive measures included in analysis limits the ability to fully enrich our understanding of how domains of behavior interact and associate with one another. In a future study, it would prove valuable to include measures of nonverbal, and verbal IQ from the Mullen Scales of Early Learning to incorporate analysis of cognitive variables.

Additionally, adapting this study design to a longitudinal model wherein a cohort is followed over some years and re-evaluated periodically would allow for meaningful conclusions regarding how our variables of interest develop over time, and if development trajectories differ significantly according to demographic variables.

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Tables/Figures:

Table 1

Descriptive Statistics for Numerical Variables

	N	Minimum	Maximum	Mean	Std. Deviation
Symptom Severity	105	1.00	10.00	6.600	2.58174
Adaptive Behavior Composite	105	50	93	71.02	9.618
Communication Standard Score	105	42	102	72.52	13.369
Daily Living Skills Standard Score	105	46	105	74.25	11.702
Socialization Standard Score	105	49	95	71.92	10.310
Parental Education Years	81	8.00	18.00	13.33	2.10331
Age at Evaluation	105	21	127	56.55	25.257

Note: This table represents the descriptive statistics for diagnostic variables, and numerical demographic variables (parental education and age at evaluation).

Table 2

Frequency Statistics for Categorical Variables

Race		
	Frequency	Percent
Non-White	55	52.4
White	50	47.6
Total	105	100.0
Sex		
Female	26	24.8
Male	79	75.2
Total	105	100.0

Note: This table represents the frequency and group composition of demographic variables for race and sex.

Table 3

Mean Differences for Demographic Categorical Variables

Variable	Non-White		White			
	Mean	SD	Mean	SD	F	Sig.
Symptom Severity	7.15	2.21	6.00	2.84	5.465	0.021*
Adaptive Behavior Composite	70.31	9.57	71.80	9.71	0.091	0.764
Communication Standard Score	70.76	12.53	74.46	14.11	0.004	0.952
Daily Living Skills Standard Score	73.95	12.33	74.58	11.09	0.325	0.570
Socialization Standard Score	71.76	10.03	72.10	10.71	0.006	0.936
Parental Education Years	13.05	2.06	13.64	2.13	0.431	0.513
Age at Evaluation	53.75	22.28	59.64	28.08	3.436	0.067

*p<0.05

Note: This table represents the mean differences between non-white and white participants across all numerical variables.

Table 4

Results of Bivariate Correlation Analysis

Variable	Symptom Severity		Adaptive Behavior Composite	
	Pearson Correlation	Sig.	Pearson Correlation	Sig
Symptom Severity	1.00	-	-0.284**	0.003
Adaptive Behavior Composite	-0.284**	0.003	1.00	-
Communication Standard Score	-0.251**	0.010	0.872**	<0.001
Daily Living Skills Standard Score	-0.202*	0.039	0.900**	<0.001
Socialization Standard Score	-0.328**	<0.001	0.832**	<0.001
Parental Education Years	-0.146	0.193	0.005	0.964
Age at Evaluation	-0.140	0.153	-0.027	0.788

*p<0.05

**p<0.01

Note: This table represents the results of bivariate analyses across all numerical variables.

Table 4 (cont.)

Results of Bivariate Correlation Analysis

Variable	Parental Education		Age at Evaluation	
	Pearson Correlation	Sig.	Pearson Correlation	Sig
Symptom Severity	-0.146	0.193	-0.140	0.153
Adaptive Behavior Composite	0.005	0.964	-0.027	0.788
Communication Standard Score	0.011	0.923	0.081	0.409
Daily Living Skills Standard Score	-0.038	0.733	-0.007	0.943
Socialization Standard Score	-0.034	0.761	-0.195*	0.046

*p<0.05

**p<0.01

Table 5

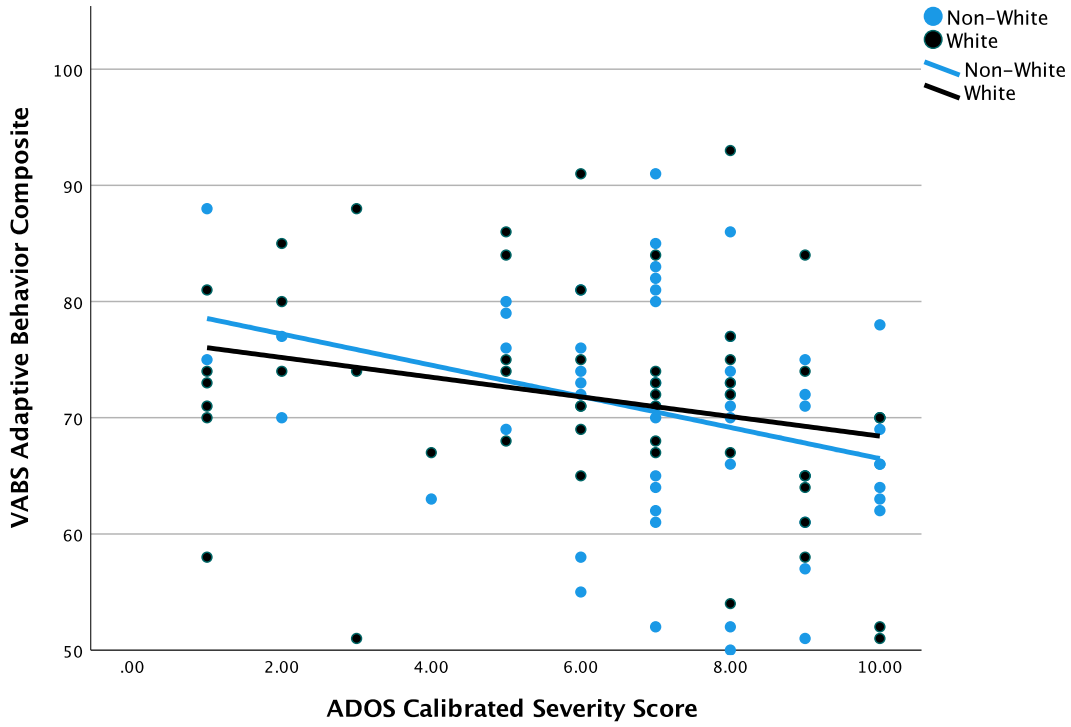
Moderation Analysis for Race

Variable	B (coefficient)	Std Error	t-value	Sig
Symptom Severity	-1.093	0.371	-2.944	0.004
Race/Ethnicity	-0.126	0.936	-0.134	0.893
Severity x Race	-0.248	0.371	-0.666	0.507
*p<0.05				

Note: This table represents the results of moderation analysis when race is introduced as an interaction variable in the association between symptom severity and adaptive functioning.

Figure 1

Linear Regression: Symptom Severity against Adaptive Functioning



Note: This figure depicts the association between symptom severity and adaptive functioning as quantified by the ADOS calibrated severity score and the VABS ABC, respectively. Additionally, separate trendlines are included to visualize the impact of race as a potential moderator of this association.