

**Exploring the Relationships Between Socioeconomic Status, Expressive Language
and Self-Injurious Behaviors in Children with Autism Spectrum Disorders**

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Abstract

A class of behaviors with particular concern in children with autism spectrum disorders (ASD) are self-injurious behaviors (SIBs) due to their potential to cause physical harm. Roughly half of children with ASD engage in SIBs, making the identification of risk factors important in protecting the health and safety of these children. This study analyzed data from 66 children with the purpose of identifying potential risk factors for both the presence and severity of 8 specific types of SIBs. The following risk factors were examined: expressive language ability, annual household income, maternal education level, paternal education level, and combined parent education level. Prevalence rates were calculated for each risk factor, showing differing SIB prevalence across risk factors. Correlations were also calculated between each potential risk factor and each type of SIB's presence and severity ratings. All risk factors tested were not independently significantly associated with specific types of SIBs. This study presents a new finding that the interaction between household income and combined parent education level are significantly associated with total SIB severity. This supports the theory that socioeconomic status may impact children with ASD and their families.

Keywords: Autism; Self-injurious behaviors; Restricted and repetitive behaviors; Socioeconomic Status; Expressive Language

1. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition that affects approximately 1 in 54 children in the U.S. (Maenner et al., 2020) and is characterized by persistent social communication and interaction deficits and the presence of restricted and repetitive behaviors, interests, or activities (RRBs) (American Psychiatric Association, 2013). The exact cause of ASD has not yet been identified but current research suggests that the development of ASD is the result of gene-environment interactions (Chaste & Leboyer, 2012).

RRBs are a core feature of ASD and their presence is required for diagnosis. RRBs include repetitive motor movements, insistence on sameness, fixated interests, abnormal sensory reactions, compulsions, and self-injurious behaviors. These behaviors may cause interference and disruption in social communication that can negatively impact aspects of an individual's functioning (Richler, Heurta, Bishop, & Lord, 2010). RRBs are often evident in very early childhood (Short & Schopler, 1988; Stone et al., 1999; Cox et al., 1999) and can persist throughout an individual's lifespan (Fecteau et al., 2003).

A class of RRBs with particular importance is self-injurious behaviors (SIBs). SIBs are a class of behaviors that cause physical harm or injury to self, with the potential to cause irreversible injury, hospitalization, or death (Minshaw et al., 2014). Types of SIBs include hitting self, biting self, pulling hair, and picking skin. The estimated prevalence of SIBs in children with ASD is between 27-50% (Soke et al., 2016; Summers et al., 2017). The behavioral model suggests that children with ASD engage in SIBs due to the

social motivation to communicate with others (Summers et al., 2017). Children may use SIBs as a form of communication, either for the purposes of getting their caregiver's attention or even to draw attention to a certain body part. It further suggests that SIBs are learned behaviors with a desirable outcome, such as receiving attention from caregivers. Previous research has found that the presence of SIBs in children with ASD is negatively correlated with quality of life and positively correlated with health risks (Minshawi et al., 2014). Engaging in SIBs also doubles their odds of psychiatric hospitalization (Mandell, 2007). This combination of high prevalence rate, increased need for medical care, and reduced quality of life makes researching SIBs important for the health and safety of children with ASD.

Identifying and understanding predictors of SIBs serves as a potential method for better understanding these behaviors and increasing the long-term health and safety of children with ASD. Previous exploration of this topic has identified several potential predictors of engaging in SIBs including: ASD severity, lower cognitive ability, impulsivity, overactivity, lower adaptive functioning (e.g., lower communication skills), regression, psychiatric conditions, sensory issues, and lower socioeconomic status (SES) (Minshawi et al., 2014; Duerden et al., 2012; Lavery et al., 2020; Soke et al., 2016; Williams et al., 2018; Neuhaus et al., 2018; Soke et al., 2017). Different forms of SES including maternal education level, health insurance type, and income have been examined. Unfortunately, results across these studies are inconsistent. A number of factors have been mentioned as potentially affecting replication of results, including the use of different types of datasets, multiple definitions of SES, varied inclusion criteria, and lack of standardized measures

of SIBs. In addition, SIBs are often grouped into general categories instead of listing individual types of behaviors. Such groupings can limit researchers' interpretations of their data, such as causing specific types of behaviors to go unreported and grouping together children, despite them engaging in different types of behaviors. Intensity of behavior is also commonly excluded as a measure of risk, further limiting our understanding of further health and safety risks.

To address these issues, we used standardized types of SES including household income, maternal education, and paternal education, standardized ASD diagnosis criteria (Autism Diagnostic Schedule Observation-2nd Edition; ADOS-2; Lord et al., 2012), expressive language level based on ADOS-2 module and a newer measure designed specifically to capture a wide range of different RRBs, including SIBs. We also used the Behavior and Sensory Interest Questionnaire (BSIQ; Hanson et al, 2016), an investigator administered questionnaire used to assess the type, frequency, and intensity of specific RRBs, including 8 specific types of SIBs. This questionnaire is a newer measure than the ones used in previous SIB risk factor research and includes more specific types of SIBs, in addition to assessing the intensity of individual SIB types (Duerden et al., 2012; Laverty et al., 2020; Williams et al., 2018).

Existing research has yet to examine if relationships exist between specific types of SIBs, SES, and expressive language levels. Exploring the relationships between SES, expressive language, and specific types of SIBs may add to our understanding of who is

most at risk for these behaviors and potentially increase our ability to provide earlier and more appropriate intervention services to children and their families.

The current study will test the following hypotheses regarding SIBs, SES, and expressive language ability:

1. Individual SIB's presence and severity ratings will have differing correlations with levels of SES.
2. Individual SIB's presence and severity ratings will have differing correlations with levels of expressive language abilities.
3. There will be a difference in total number of SIBs based on SES and language.
4. There will be a difference in total severity of SIB based on SES and language.
5. There will be a difference in the prevalence of individual SIB's based on SES and language.

2. Methods

Data collected previously at Boston Children's Hospital for The Phenotypic and Genetic Factors in ASD study, the Boston Autism Consortium and The Simons Variation in Individuals Project were analyzed in the present study. A total of 66 children ages 2 to 18 years old (mean age = 6.28 years old, 60.6% male) met the inclusion criteria of an ASD diagnosis, completed ADOS-2 Module 1 or 2 administration, caregiver completed BSIQ, and caregiver completed medical history questionnaire with demographic information.

2.1 Autism Diagnosis: ASD diagnosis was confirmed meeting the cutoff score using the Autism Diagnostic Observation Schedule-2 (ADOS-2; Lord et al., 2012). The ADOS-2 is

a play-based clinician administered assessment of ASD symptoms that evaluates communication, reciprocal social interactions, and RRBs. It also uses a 4-module system designed for different levels of language ability (Lord et al., 2012), ranging from pre-verbal abilities to fluency.

2.2 Expressive Language Ability: For the present study, only individuals who were administered ADOS-2 modules (1 and 2) were analyzed. These two groups were: Module 1 for preverbal/single words or Module 2 for phrase speech. Based on module type, children were separated into 2 expressive language level groups.

2.3 Socioeconomic Status: Participants also were required to have the “demographic information” section completed on the medical history questionnaire. This information included demographic information on participants including gender, total annual household income, maternal education level, and paternal education level. All children in this study had two parents, a mother and father. *Household income* was divided into 3 SES groups: 1) Low = < \$20,000 - 50,999; 2) Medium = \$51,000 - 100,999; 3) High = \$101,000 - > 160,000. *Maternal and parental education levels* were coded using a numeric system: 1 = Less than 8th grade, 2 = Some high school, 3 = Finished high school or equivalent, 4 = Some college or AA degree, 5 = Bachelor’s degree, 6 = Post graduate degree. Parents total education level was also calculated to make a combined education variable, *combined parent education level*.

2.4 Self-Injurious Behavior: Participants were also required to have a completed Behavior and Sensory Interests Questionnaire (BSIQ). The BSIQ is an investigator administered interview that asks caregivers questions about 74 different RRBs and sensory interests, common in individuals with neurodevelopmental disability such as ASD (Hanson et al., 2016). The BSIQ contains six categories: Stereotyped Behavior, Compulsive and Ritualistic Behaviors, Rigidity, Aggression and Self Injurious Behavior, Language Perseveration, and Perseverative Interests.

Presence of Behavior: Caregivers are asked whether each behavior is “current” or if it has “ever” occurred and the age at which the behavior began and ended. For this study, the information was translated into the absence/presence of behaviors and coded as 0 or 1 (0 = not occurred, 1 = occurred). Total SIB scores for presence (Total Number) were calculated for each participant by adding the 8 behavior specific scores together.

Severity of Behavior: Caregivers are also asked to rate the severity of each behavior which is coded on a scale from 0 to 3 (0 = behavior not present, 1 = behavior occasionally present, 2 = behavior is present and frequently occurs but the is able to stop when asked and it does not interfere with their daily activities, 3 = the behavior is present and is associated with disruptions in daily activities and causes distress when interrupted). Behaviors coded as a 3 are collapsed down to a 2 in the scoring process. For this study, severity scores were coded as 0, 1, or 2. Total SIB scores for severity (Total Severity) were also calculated for each participant by adding the 8 behavior specific scores together.

The following 8 behaviors from the Aggression and Self Injurious Behavior section of the BSIQ are examined in the present study:

Table 1. Description of each SIB type and corresponding number.

SIB Number	SIB Type
SIB 1	Hitting: Slaps Self
SIB 2	Hitting: Bangs Head or Other Body Part Repetitively
SIB 3	Biting Self
SIB 4	Pulling Hair (Trichotillomania)
SIB 5	Scratching Self
SIB 6	Inserting Finger(s) Into Object(s)
SIB 7	Picking Skin
SIB 8	Other

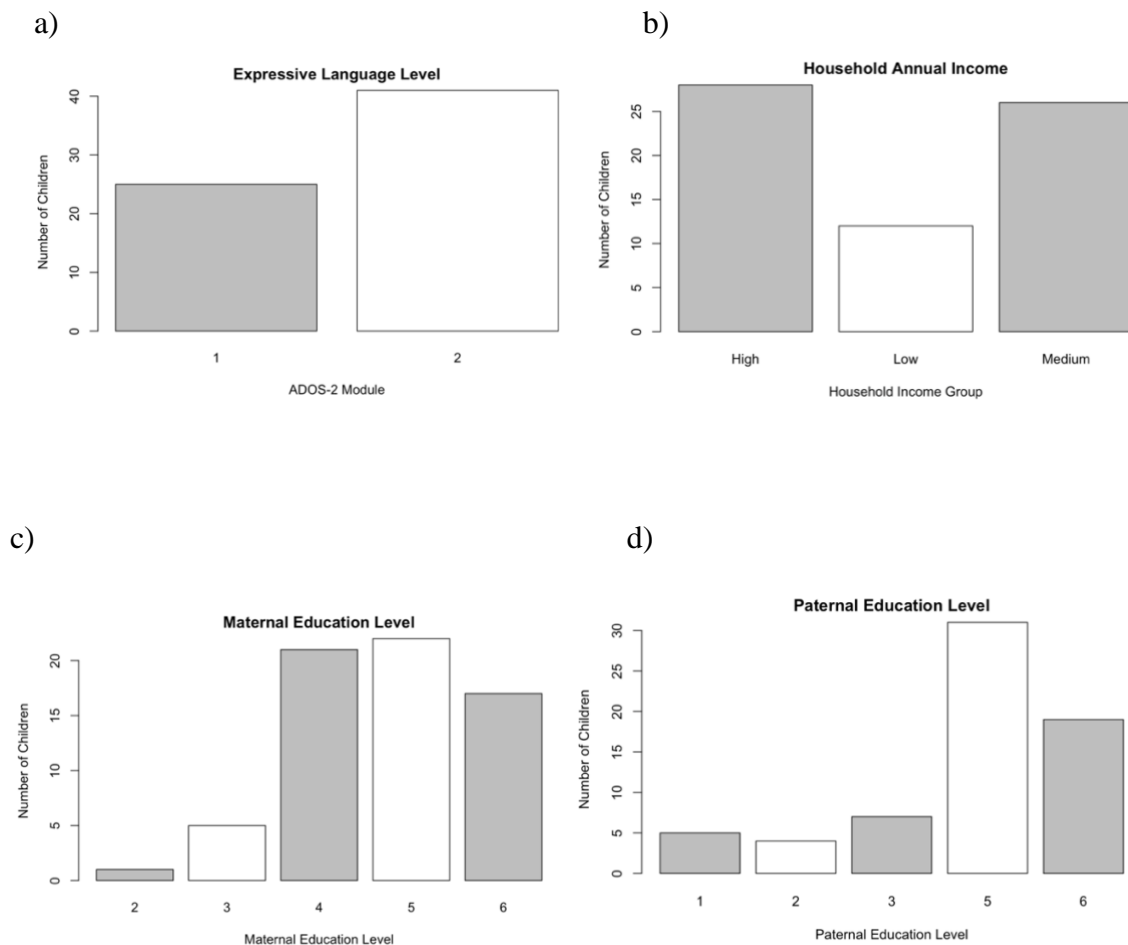
2.5 Statistical Analysis: The dataset was imported into RStudio for analysis using the readr, dplyr, ggplot2, tidyverse, broom, car, FSA, tinytex, psych, corrplot, and corrgram packages. First, the data were cleaned, removing all individuals that did not meet the study's inclusion criteria. Chi-Squared tests were used to determine correlations between the presence of SIB 1 through SIB 8 SIBs and ADOS-2 Module (Mod 1, Mod 2), as well as the correlations between the severity rating of each of the SIB 1 through SIB 8 and ADOS-2 Module (Mod 1, Mod 2). Chi-Squared tests were also used to determine correlations between the presence of each of the 8 SIBs and each of the 3 types of SES measures (household income groups, maternal education levels, paternal education levels, and combined parent education levels), as well as the correlations between the severity of each of the 8 SIBs and the 3 types of SES measures. Multiple factor ANOVAs were used to determine if expressive language (ADOS-2 Module 1 or 2) and each of the 3 SES measures are significant predictors of SIB Total Number and SIB Total Severity. Prevalence rates were also calculated for each SIB type across the groups.

3. Results

3.1 Descriptive Statistics: Of the 66 children, 25 children were administered the ADOS-2 Module 1 (Figure 1a). Families reported household incomes across all three groups with

12 in the low household income group, 26 in the medium household income group, and 28 in the high household income group (Figure 1b.). 59.09% of children had mothers with a bachelor's degree or postgraduate degree (Figure 1c.). 75% of children had fathers with a bachelor's degree or postgraduate degree (Figure 1d.). Almost half of participants engaged in at least one type of SIB (46.96%, $n = 31$).

Figure 1. Descriptive Statistics. Number of children in each grouping: a) Expressive Language Level, b) Household Income Group, c) Maternal Education Level, d) Paternal Education Level

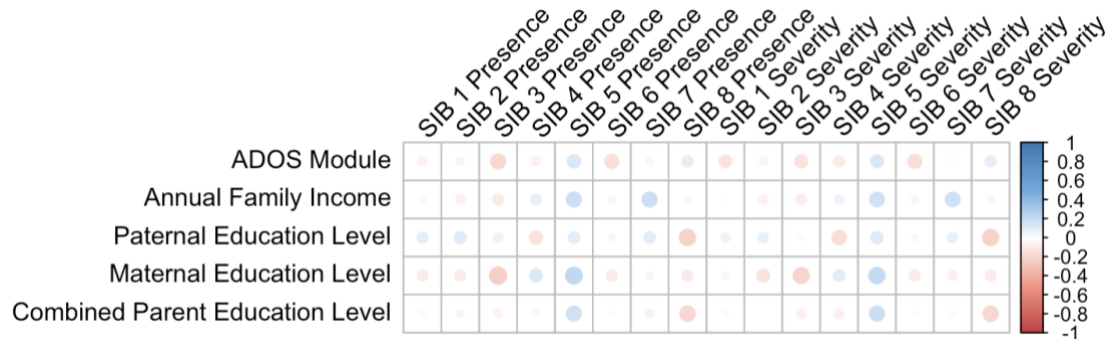


3.2 Correlations between potential risk factors and SIBs: Correlations were calculated between presence of each SIB type (SIB 1-SIB 8) and ADOS-2 Module (Mod 1 and Mod 2) as well as each SIB type's severity scores (0-2) and ADOS-2 Module (Figure 1). The presence and severity of SIB types did not significantly differ by ADOS-2 Module group ($p > 0.05$). However, some SIBs and their severity scores were trending positively with ADOS-2 Module, while others were trending negatively with ADOS-2 module. ADOS-2 Module and SIB 3 may have a negative relationship, $X^2 (1, N = 66) = 1.4297, p = 0.213$. Regarding SIB severity, ADOS-2 Module and SIB 1 severity may have a negative relationship, $X^2 (2, N = 66) = 2.846, p = 0.241$.

Correlations were calculated between presence of each SIB type (SIB 1 – SIB 8) and household income as well as parent education levels: maternal education level, paternal education level, and combined parent education level (Figure 2.). Additionally, the correlations between SIB 1 through SIB 8's severity scores and household income as well as parent education levels: maternal education level, paternal education level, and combined parent education level (Figure 2.). The presence and severity of each SIB type did not significantly differ by each measure of SES ($p > 0.05$; Figure 2). However, some SIBs were trending positively with different SES measures, while others were trending negatively. Household income and SIB 5 may have a positive relationship, $X^2 (4, N = 66) = 2.79, p = 0.246$ (Figure 2), maternal education level and SIB 3 may have a negative relationship, $X^2 (4, N = 66) = 6.09, p = 0.192$ (Figure 2). Paternal education level may also have a negative relationship with SIB 4, $X^2 (4, N = 66) =$

4.91, $p = 0.296$ (Figure 2). The severity of SIB 8 may have a negative relationship with combined parent education level, $X^2(8, N = 66) = 12.38, p = 0.134$ (Figure 2).

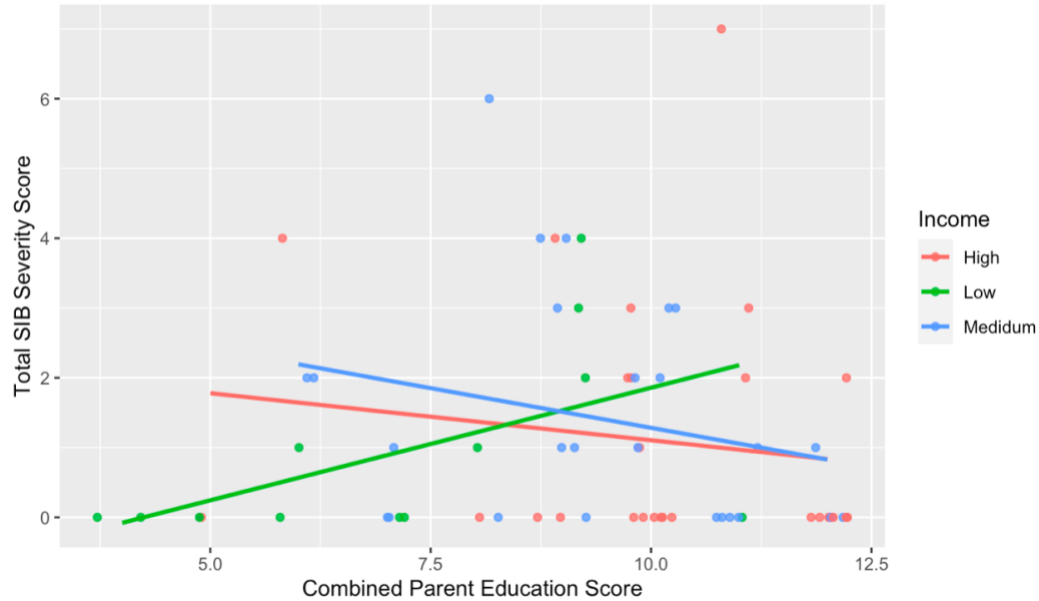
Figure 2. Correlations between ADOS-2 module, household income, paternal education level, maternal, and the 8 SIB severity and presence scores. Blue indicates positive correlations, while red indicates negative correlations. The intensity of the color represents how negative or positive the correlation is. The size of the circle indicates the level of significance with larger sizes closer towards significance. * would indicate a significant correlation.



3.3 Interaction between Household Income and Parent Education: A three-way ANOVA

did not yield any main effects of household income, combined parent education level, or ADOS-2 Module on total SIB severity. $F(1,58) = 0.73, p = 0.396$. However, the interaction effect between household income and combined education was significant, $F(1,58) = 4.09, p = 0.0477$. Children in the low income group showed a positive slope in total SIB severity based on combined parent education, while children in the medium and high income groups showed a negative slope in total SIB severity based on combined parent education. The total SIB severity for the low income group differed significantly from the medium income group, $p = 0.0435$. Household income, combined parent education level, or ADOS-2 Module did not yield any significant main or interaction effects on the total number of SIBs.

Figure 3. Total SIB severity scores grouped by household income and combined parent education level scores with a significant interaction effect between the two variables, $F(1,58) = 4.09, p = 0.0477$. The low income and medium income groups differed significantly, $p = 0.0435$.



3.4 Prevalence rates: Prevalence rates for each type of SIB (SIB 1 – SIB 8) were calculated for ADOS-2 module, household income, maternal education, and paternal education groups (Table 2.). In the lower expressive language level group (ADOS-2 Module 1), SIB 2 and SIB 3 had the highest prevalence rates. In the higher expressive language level group (ADOS-2 Module 2), a wider array of SIBs was observed with SIB 1, SIB 2, and SIB 3 having the highest prevalence rates. In the lowest household income group, SIB 2 had the highest prevalence rate and only 3 SIBs were observed. Comparatively, the medium and high household income groups both recorded six different SIBs. Maternal education level groups 4 and 5 had a wide range of SIBs and SIB 3 had the highest prevalence rate in both groups. Paternal education group 5 had the widest array of SIBs with SIB 2 and SIB 3 having highest prevalence rates.

Table 2. Prevalence rates of each type of SIB, grouped by ADOS-2 Module and SES measures.

	SIB 1	SIB 2	SIB 3	SIB 4	SIB 5	SIB 6	SIB 7	SIB 8
ADOS-2 Mod 1	5%	24%	36%	8%	0	4%	4%	0
ADOS-2 Mod 2	14.63%	19.51%	19.51%	4.88%	4.88%	0	2.44%	2.44%
Low Income	8.33%	33.33%	25%	0	0	0	0	0
Medium Income	26.92%	15.38%	34.61%	7.69%	0	3.84%	0	3.84%
High Income	10.71%	21.42%	17.86%	7.14%	7.14%	0	7.14%	0
Maternal Edu 2	0	0	0	0	0	0	0	0
Maternal Edu 3	0	40%	40%	0	0	0	0	0
Maternal Edu 4	28.57%	23.8%	38.09%	4.76%	0	4.76%	4.76%	4.76%
Maternal Edu 5	18.18%	18.18%	33.33%	4.54%	0	0	4.54%	0
Maternal Edu 6	5.88%	17.64%	5.88%	11.76%	11.76%	0	0	0
Paternal Edu 1	0	0	0	0	0	0	0	0
Paternal Edu 2	0	0	0	25%	0	0	0	25%
Paternal Edu 3	14.29%	28.57%	42.89%	14.29%	0	0	0	0
Paternal Edu 5	29.03%	29.03%	38.71%	6.45%	3.23%	3.23%	3.23%	0
Paternal Edu 6	5.26%	15.78%	10.52%	0	5.26%	0	5.26%	0

4. Discussion

The present study explored 8 individual types of SIBs in children with ASD and their correlation with potential risk factors, including expressive language and three measures of SES (household income, paternal education and maternal education). Both presence and severity of SIBs were examined. Additionally, prevalence rates were calculated for each of the 8 SIBs for all language and SES groups.

Results showed that in our cohort expressive language level was not independently significantly associated with specific types of SIBs in children with ASD. This result is supported by a previous study that found verbal ability to not be significantly associated with SIBs in children with ASD (Williams et al., 2018). However, as mentioned previously, there are conflicting studies in this area and there have been previous findings that language is associated with SIBs. In a sample of adolescents with ASD, for example, fewer individuals with higher numbers of SIBs had low expressive language skills (Rattaz et al., 2015).

All three measures of SES that were tested in the present study and were not independently significantly associated with specific types of SIBs in children with ASD. This is in contrast with what previous research that has shown SES, such as lower levels of maternal education (Soke et al., 2017) and lower household income (Neuhaus et al., 2018; Soke et al., 2016) being associated with increased SIBs in children with ASD.

An interaction between expressive language level and SES on total severity and number of SIBs was not found. This relationship has not been previously examined. This lack of significant interaction may be explained by recent research. Maternal education level has recently been shown to account for variability in expressive language in toddlers and preschoolers with ASD, indicating children with ASD who have mothers with lower education levels have less expressive language skills and those with mothers with higher education levels have better expressive language skills (Olson et al., 2021). While SIBs

were not explored in Olson et al. (2021), this relationship between expressive language skills and maternal education level may also apply to children in the present study's cohort.

The interaction between household income and combined parent education level was significantly associated with total SIB severity, which has not been previously reported. Children from both medium- and high-income families showed reduced total severity of SIBs as parental education scores increased. However, children from low-income families show increased total severity of SIBs as their parent's combined education levels increased. The income groups interaction may be attributed to differences in the financial resources of families, access to services via referrals from healthcare professionals, or their ability to afford these services. Participants from the medium- and high-income groups may have more ability to pay for services out-of-pocket, increasing the number of services for their child had access to and reducing SIB severity with more intervention programs. For the children in the lower income group, SIB total severity may increase as parent education increases due to the high cost of secondary education. While parents may have a higher degree, they may have loans or still be in the process of obtaining higher degrees, which reduce the amount of disposable income that parents have if they have outstanding loans or need to continue paying educational fees. Reduced parental disposable income limits access to intervention services which could impact the severity of their child's SIBs.

This interaction is different than some previous research that had shown different measures of SES as risk factors of SIBs. Our study found that parental education levels may not be an accurate predictor of SES for the purposes of SIB risk factor research. Previous research has both supported and refuted this finding. For example, Soke et al. (2017) found that maternal education level is significantly associated with SIBs in children with ASD while Rattaz et al. (2015) showed no significant differences in SIBs based on parent's SES.

The prevalence rate of each type of SIB (SIB 1 – SIB 8) were calculated for each language and SES group. This measure provides insight on which specific SIBs may be most common, based on potential language and SES risk factors. Prevalence rate is not frequently included in SIB research as many studies just look at the general presence/absence of SIBs and not individual behaviors (Rattaz et al., 2015; Soke et al., 2017; Neuhaus et al., 2018; Williams et al., 2018). Previous research has examined prevalence rates of specific types of SIBs, however rates are not often calculated based on potential risk factor group (Handen et al., 2018).

4.1 Limitations and Future Directions: Multiple limitations have been identified for the present study. First, the SIB and SES data was collected via parent report which may not be completely accurate. Parents are not trained professionals and may miss or misinterpret certain behaviors. The reporting of SIBs for older children may also be less accurate as time between behavior and reporting increases.

Small sample size reduced our statistical power to find significant relationships between variables. Our sample size of 66 was relatively small compared to other published literature on predictors of SIBs, some with over 1,000 participants (Soke et al., 2017; Neuhaus et al., 2018). Studying a larger sample size would allow for better detection of associations between the specific types of SIBs and potential predictors.

Third, due to sample size limitations, this study only included children with ASD who were administered Module 1 preverbal/single words or Module 2 for phrase speech. There are three ADOS-2 Modules used for children: 1) preverbal/single words, 2) phrase speech, 3) verbally fluent. Future studies will ideally include these children who are verbally fluent. Including an additional expressive language group of children administered the verbally fluent ADOS-2 module (Module 3) would add information for analysis. Additional participants would also be desirable for household income analysis. The low household income (< \$20,000 – 50,999) group had only 12 participants, while both the medium- and high- household income groups had over 20 participants. Exact values of household income would also be ideal in future data collection to allow for the creation of regression models with income as a continuous variable.

There are still many gaps in current research on risk factors for SIBs in children with ASD, making the continuation of this research important for the health and safety of children with ASD and their families. Due to contradicting results from research studies, additional research needs to focus on examining these discrepancies. Future directions for researching the relationships between SES, expressive language, and SIBs in children

with ASD should examine specific types of SIBs as well as include samples with diverse SES backgrounds.

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