Original Research Article

Geographic Variation in Autism Spectrum Disorder Prevalence Across CDC ADDM Surveillance Sites with Socioeconomic Indicators in the United States

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ABSTRACT

This study examined national and regional trends in autism spectrum disorder (ASD) prevalence in the United States. Publicly available data from the Centers for Disease Control and Prevention (CDC) Autism and Developmental Disabilities Monitoring (ADDM) Network were used for the data analysis. A population-level descriptive surveillance analysis was conducted using site-year observations of reported ASD prevalence per 1,000 8-year-old children from the early 2000s through the early 2020s. To summarize overall prevalence patterns, descriptive statistics were used. In addition, a linear time-trend model was generated and applied to quantify temporal change across reporting cycles. The analysis demonstrated a clear and sustained increase in reported ASD prevalence over time, with significant geographic variation across surveillance areas. There was a right-skewed distribution of prevalence estimates, indicating that a smaller number of regions showed significantly higher reported rates, while many regions reported moderate prevalence levels. In the time-trend model, ASD prevalence rose substantially across reporting years, supporting the interpretation that the increase in reported diagnoses reflects a long-term structural trend rather than isolated fluctuations. Geographic differences were interpreted with reference to prior studies suggesting that socioeconomic conditions, healthcare access, diagnostic capacity, and public awareness may contribute to variation in identification patterns across regions. Since the reproducible quantitative analysis was based on ADDM prevalence observations rather than a fully merged socioeconomic dataset, the findings in this study and their interpretations should be understood as ecological and descriptive rather than causal. Overall, the results emphasize the importance of considering structural influences when interpreting ASD prevalence trends and geographic disparities.

Keywords: Autism spectrum disorder (ASD); prevalence trends; descriptive surveillance analysis; ecological analysis; socioeconomic disparities; diagnostic access; public health surveillance

INTRODUCTION

Autism spectrum disorder (ASD) is a neurodevelopmental condition shaped by persistent challenges in social communication and interaction, along with repetitive or restricted patterns of behavior and interests (1). Over the past two decades, the United States has witnessed rapidly increasing diagnosis rates and growing demands for diagnostic and support services

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Accepted March 31, 2026
https://doi.org/10.70251/HYJR2348.42307312

for ASD as it has emerged as a major concern in the area of public health. According to the surveillance conducted by the Centers for Disease Control and Prevention (CDC) Autism and Developmental Disabilities Monitoring (ADDM) Network, ASD prevalence among children has significantly increased across multiple reporting cycles (1). Due to an increase of ASD prevalence rate, it has been debated about whether rising ASD prevalence demonstrated real changes in incidence or improved identification and access to diagnostic services.

Although ASD is usually diagnosed in early childhood, it is currently recognized as a lifelong condition with a potential to affect individuals across the lifespan. Historically, school-aged children, particularly those in the age from 4 to 8, were of the focus from most surveillance efforts because of the reliability of clinical data sources (1). However, it has been highlighted by recent research that examining ASD prevalence across broader age groups, including adolescents and adults, was important because individuals with ASD tended to have delayed recognitions or limited access to healthcare services from diagnosis occurring in later periods (2). With this expanded scope of research, the need for population-level studies has been emphasized to examine ASD prevalence trends across time and geographic regions.

According to recent national estimates, the importance of understanding ASD trends has been further emphasized. Studies examining ASD prevalence and treatment patterns in the United States from 2016-2022 reported an increasing ASD prevalence with declining treatment service. This suggested growing disparities between identification and service availability for ASD (3). With these findings, the rise in ASD diagnosis has been reported to not solely reflect biological factors but be influenced by healthcare accessibility, awareness, and policy changes. According to long-term epidemiological studies, a sustained increase in recorded ASD diagnoses has been reported over time, supporting the need to understand structural drivers of these trends (4, 5).

Investigating rising ASD prevalence is one approach to examine demographic and geographic disparities. According to prior studies, a significant variation in diagnosis rates has been documented across race, ethnicity, and geographic location (6-8). For example, differences in access to specialized healthcare providers, parental awareness, and educational resources have been linked to disparities in early identification (6). This has been further suggested by geographic variation in access to autism-related healthcare services that structural and systematic factors may strongly influence observed patterns in ASD (7). These disparities emphasize the importance of examining ASD diagnosis in the socioeconomic perspective.

Socioeconomic factors, including income, education level, poverty rates, and healthcare insurance coverage, play an essential role in determining early intervention and access to diagnostic services (9-11). According to prior research, children from higher socioeconomic backgrounds were more likely to receive earlier and more frequent diagnostic evaluations, and this was associated with higher reported prevalence in wealthier regions (9). However, poor communities with limited healthcare infrastructure often struggled with delayed diagnosis and lack of access to services (10). These findings suggest that observed prevalence of ASD may indicate differences in diagnostic access instead of emphasizing biological variation alone.

Several studies have examined disparities in ASD diagnosis through either descriptive or qualitative approaches (6). Other research has examined demographic predictors of ASD prevalence by using statistical and epidemiological modeling (12). However, most of the prior studies have focused on demographic characteristics without specifically employing a quantitative framework for modeling ASD diagnosis rate as a function of socioeconomic predictors at the population level (13). Furthermore, only a few studies have applied CDC surveillance data with socioeconomic predictors to generate a descriptive quantitative model in ASD diagnosis rates (14, 15).

Since understanding how socioeconomic conditions influence ASD diagnosis may inform public health policy, resource allocation, and equitable access to diagnostic services, this literature gap is important. To be more specific, a quantitative framework may contribute to distinguish between biological and structural explanations for rising ASD prevalence, while providing a foundation for corresponding with diagnostic trends in the future. To achieve this goal, this study aims to answer the research question about how socioeconomic variables correspond with diagnosis rates of site-level autism disorder in the United States. This study hypothesized that surveillance sites with higher average income and educational attainment will show higher diagnosis rate of ASD, while surveillance sites with higher poverty rates will indicate lower reported diagnosis rates of ASD because of limited access to diagnostic resources.

METHODS AND MATERIALS

Study Design

A quantitative, population-level observational design was employed in this study to examine trends in autism spectrum disorder (ASD) diagnosis rates, while establishing a simple quantitative framework that linked ASD prevalence to socioeconomic conditions across ADDM surveillance sites in the United States. The main focus of the analysis was on publicly available secondary data. The methodological goal consisted of describing temporal and geographic variation in ASD prevalence, while developing an exploratory ecological framework to interpret how diagnosis patterns may be associated with structural and socioeconomic conditions.

Data Source

ASD Prevalence Data

Estimates of autism prevalence were obtained from the Centers for Disease Control and Prevention (CDC) Autism and Developmental Disabilities Monitoring (ADDM) Network. The ADDM Network provides surveillance-based estimates of ASD prevalence per 1,000 8-year-old children only for selected site-defined geographic areas in the United States instead of all U.S. states. In this study, reported ASD prevalence per 1,000 8-year-old children was used as the dependent variable. In addition, ADDM reporting years from the early 2000s through the early 2020s were included in the analysis. Since ADDM data are reported by surveillance site and year, each observation in the dataset showed one surveillance site-year observation. Only if the identical surveillance site appeared in multiple reporting cycles, they were pooled across years and interpreted as repeated site-year observations in the descriptive and explanatory analyses.

Socioeconomic Contextual Indicators

Socioeconomic conditions were considered in this study as contextual ecological factors that were relevant to geographic differences in ASD identification and diagnostic access. To guide interpretation of four commonly discussed indicators: median household income, poverty rate, educational attainment, and health insurance coverage of children, prior literature was used. These variables were discussed as structural contextual factors rather than as a fully reproduced multivariable merged dataset since the main reproducible quantitative analysis was based on publicly available ADDM prevalence site-year observations.

Data Preparation

Data preprocessing was performed in Python. The CDC ADDM prevalence dataset was organized by surveillance site and reporting year, while calculating descriptive statistics across site-year observations. Since the prevalence dataset used in this study did not contain the socioeconomic variables in analyzable merged form, the main reproducible quantitative analysis focused on descriptive statistics and time-trend modeling of ADDM site-year prevalence observations. Records with missing or incomplete information were excluded from comparative analysis if necessary.

Descriptive statistics, such as mean, median, standard deviation, and range were calculated to summarize ASD prevalence across sites. Line graphs were used to visualize the temporal trends, while evaluating geographic variation through distribution analysis. Since ASD prevalence increased across reporting cycles, this study cautiously interpreted the socioeconomic comparisons as broad ecological patterns that may partially reflect temporal trends. Accordingly, the analytic unit throughout the study was the surveillance site-year observation rather than the state as a whole.

Mathematical Model

A simple linear time-trend model was used as a quantitative framework to estimate the increase in reported ASD prevalence across ADDM surveillance site-year observations. ASD prevalence per 1,000 8-year-old children was the dependent variable, and calendar year was used as the predictor. This model was used to quantify the overall temporal increase in ASD prevalence within the ADDM surveillance dataset, while supporting the descriptive trend analysis. The model used in this study was as follows:

$$ASD_t = \beta_0 + \beta_0 \, Year_t + \varepsilon_t$$

Where ASD_t shows the reported ASD prevalence per 1,000 children for each ADDM site-year observation, $Year_t$ represents the reporting year, β_1 is the yearly change in prevalence, and ε_t is the error term.

RESULTS

Descriptive Statistics of ASD Prevalence

Significant temporal and geographic variation in autism spectrum disorder (ASD) prevalence was revealed across the United States from the early 2000s through the early 2020s by descriptive statistical

analysis of CDC Autism and Developmental Disabilities Monitoring (ADDM) data. Across all observed years and geographic regions, the mean value of ASD prevalence was calculated to be around 16.72 per 1,000 children. Median was calculated to be 14.70 per 1,000 children, and a standard deviation was calculated to be 9.78. Considerable dispersion was shown by the relatively large standard deviation compared to the mean in prevalence estimates across locations and reporting periods.

The observed range of prevalence values turned out to be wide, extending from nearly 0 per 1,000 children in several early reporting regions to above 50 per 1,000 children in some recent reporting areas. According to the difference between the mean and median, along with the wide range and high variability, it was indicated that the distribution of ASD prevalence was right-skewed (Figure 2). The right-skewed distribution suggests that a small number of regions reported greatly higher diagnosis rates, while many regions remained at moderate prevalence levels. From this geographic dispersion, there was initial evidence that ASD diagnosis rates were not evenly distributed across the United States and may have been influenced by region-specific factors, including healthcare access, screening practices, or broader socioeconomic conditions.

Temporal Trends in ASD Diagnosis Rates

According to the trend analysis, there was a strong and consistent upward trajectory in ASD diagnosis rates over the period of the study (Figure 1). In the early 2000s, ASD prevalence estimates were reported to be at around 2-3 per 1,000 children. By the early 2010s, ASD prevalence turned out to increase to around 8-12 per 1,000 children. This showed a steady growth phase in reported diagnoses. It was during the early 2010s through the early 2020s when the most rapid increase was shown in ASD prevalence. During this period, multiple reporting regions had prevalence levels recorded above 20 per 1,000 children. This represented a significant increase compared to earlier decades. This pattern showed that ASD prevalence shifted from relatively rare detection in earlier reporting cycles to substantially more common identification in recent years.

Across nearly all reporting periods, the upward trajectory was consistent, demonstrating that the increase was unlikely to be the result of isolated anomalies or short-term fluctuations. However, the findings demonstrated how a long-term structural trend was reflected in ASD diagnosis rates.

Geographic Variation Across Regions

Along with temporal growth, the analysis indicated a significant geographic variability. Higher ASD prevalence was consistently reported in certain regions compared with others throughout the study period. According to this persistent variation, it has been suggested how regional characteristics may have influenced diagnostic outcomes.

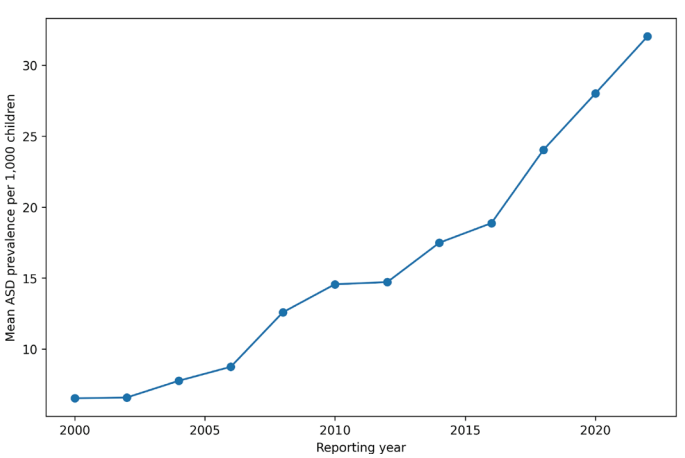

Figure 1. *Temporal trend in reported ASD prevalence across CDC ADDM surveillance site-year observations from the early 2000s through the early 2020s. In the figure, the overall increase in reported prevalence across surveillance periods is summarized and presented descriptively.*

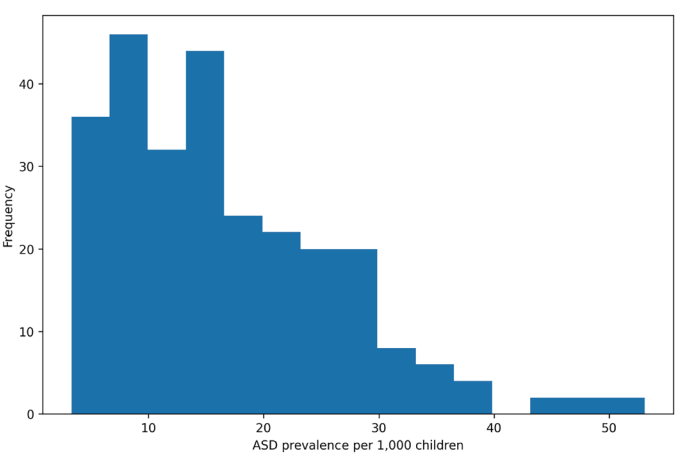

Figure 2. *Distribution of reported ASD prevalence across CDC ADDM surveillance site-year observations included in the descriptive analysis. In this figure, variability in reported prevalence across observations is illustrated rather than individual-level differences.*

Further evidence of geographic disparities was provided by the right-skewed distribution observed in the descriptive statistics. Although many regions were shown to be around moderate prevalence levels, there was a subset of regions consistently indicating higher rates as shown in the skewed distribution. This pattern is consistent with the hypothesis that differences in healthcare infrastructure, diagnostic capacity, awareness, and broader socioeconomic conditions may contribute to variation in reported ASD prevalence. According to the presence of both high- and low-ASD prevalence regions across multiple reporting cycles, geographic disparities were suggested to be systematic rather than random.

Quantitative Time-Trend Analysis

To quantify the strong secular increase in ASD prevalence across reporting cycles, a linear time-trend model was generated by using ADDM site-year observations, along with ASD prevalence per 1,000 children as the dependent variable and calendar year as the predictor.

Using ADDM Network observations only and excluding the aggregate "total" row, the analytic sample comprised 268 site-year observations from 21 surveillance areas across 12 reporting cycles from 2000 to 2022. A significant increase in ASD prevalence was shown by the linear time-trend model over time (β=1.19 per 1,000 children per calendar year, SE = 0.11, 95% CI: 0.98 to 1.40, $p < 0.001$, $R^2 = 0.691$, adjusted $R^2 = 0.690$). Per two-year reporting cycle, ASD prevalence increased by around 2.38 per 1,000 children. These findings support the descriptive observation that reported ASD prevalence increased greatly across the study period. Since the attached prevalence dataset did not contain site-level socioeconomic covariates in analyzable form, fully estimated multivariable regression results were not generated, while interpreting socioeconomic comparisons as descriptive ecological patterns.

DISCUSSION

The findings in this study indicated a clear and sustained increase in autism spectrum disorder (ASD) diagnosis rates across the United States over the past two decades in combination with significant geographic variation. These findings were shown to be consistent with national surveillance reports, reinforcing the interpretation that the rise in ASD prevalence was not solely related to biological factors. Instead, structural and socioeconomic influences may have played an important role in shaping diagnostic outcomes as shown from the observed patterns.

This interpretation was supported primarily by the descriptive geographic patterns and the quantified temporal increase in prevalence, considered alongside prior literature on disparities in diagnostic access and socioeconomic context. Prior literature suggests that areas with higher income and educational attainment may have higher access to developmental screening, specialty evaluation, and diagnostic services, while areas with higher poverty rates may face more barriers to identification. This pattern is consistent with the idea that ASD identification is influenced by access to healthcare, awareness of developmental screening, and specialized diagnostic services. From this perspective, the results in this study suggested how observed ASD prevalence may reflect diagnostic opportunity rather than actual underlying incidence.

The geographic variability reported in this study has important policy implications. Specifically, regions with lower ASD diagnosis rates may not have fewer children with ASD. Instead, they may struggle with barriers to early screening and diagnostic evaluation. Reducing disparities and promoting more equitable identification across regions may be supported by improving access to healthcare infrastructure, increasing public awareness, and expanding insurance coverage.

However, there are several limitations that should be considered when interpreting the findings in this study. First, aggregated site-level data were used in the analysis that may introduce the possibility of ecological bias. Therefore, associations reported at the population level cannot be interpreted as individual-level relationships. Second, surveillance-based prevalence estimates were used in this study that may be influenced by differences in diagnostic practices, reporting procedures, and regional awareness. Third, this study generated an intentionally simple linear time-trend model without including all potential determinants of ASD diagnosis, such as healthcare workforce availability or policy differences between surveillance sites. Despite these aforementioned limitations, this study provided an important population-level perspective about how ASD diagnosis patterns may be shaped by socioeconomic conditions, highlighting the need for further research through more detailed datasets.

CONCLUSION

This study examined national and regional trends of diagnosis rates of autism spectrum disorder (ASD) in

the United States, while exploring how socioeconomic factors may influence observed ASD prevalence patterns. There was a substantial increase in ASD diagnosis rates over the past two decades based on the results in this study, showing significant geographic variability across ADDM surveillance sites. The findings in this study suggest that socioeconomic conditions, including income, education, poverty, and health insurance coverage may explain differences in reported ASD diagnosis rates. This suggests that access to diagnostic resources may contribute to shaping ASD prevalence patterns.

These results highlight the importance of considering structural and socioeconomic influences when interpreting the trends of ASD. Ensuring more equitable identification of ASD across regions may be supported by improving access to healthcare services, expanding screening programs, and addressing disparities in diagnostic resources. Future studies should apply more detailed datasets and more fully specified statistical models to better understand the factors driving disparities in reported ASD prevalence and to support data-informed public health decisions.

CONFLICT OF INTEREST

The author declares no conflicts of interest related to this work.

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