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EXAMINING THE DIFFERENCES IN AUTISM QUOTIENT SCORES BASED ON ETHNICITY

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ABSTRACT

Definitive explanations on the associations between demographics and cause as well as the cure of Autism Spectrum Disorder (ASD) are yet to be known due to the unavailability of universal datasets and cost-effective diagnostic measures. This study analyzed large ASD screening data to examine whether symptoms of ASD differ based on ethnicity. The result showed a significant difference in the Autism Quotient (AQ) scores based on ethnicity among children, adolescents, and adults. Higher internal consistency was recorded on self-reported cases. This study will advance understanding of the influence of demographics on ASD symptoms. It is suggested that future studies should improve the reliability of AQ as screening tool.

Keywords: Autism, Ethnicity, Demographics, Autism Quotient

INTRODUCTION

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that was initially misconceived to be prevalent only in western countries. The influence of demographics on prevalence is among the early misconceptions about autism. Due to the inaccessibility of screening instruments, a significant number of studies focused on regional data to describe the influence of demographic differences on the symptoms of autism spectrum disorder (ASD). However, researchers and practitioners proposed numerous screening instruments and practices to mitigate the drawbacks of current ASD diagnostic procedures. ASD screening is a quick and preliminary practice of determining people "at-risk" of ASD for a referral to the rigorous diagnostic procedures. Among the popular screening instruments, studies have employed versions of Autism Quotient (AQ) to numerically score the symptoms of ASD in children (Auyeung *et al.*, 2008), adolescents (Baron-cohen et al., 2006) and adults (Woodbury-Smith *et al.*, 2005). In this study, we analyzed three large datasets in drawing vital conclusions on the effects of the demographic factor of ethnicity on the symptoms of ASD based on AQ scores.

LITERATURE REVIEW

Currently, little is known about the effect of demographics on the symptoms of ASD and this impedes vital generalizable assertions on symptomatology and epidemiology of autism spectrum disorder. Significant research has been conducted on the influence of assorted demographic factors on ASD (Baron-cohen *et al.*, 2006; Frazier *et al.*, 2014; Rosenberg *et al.*, 2018; Sedgewick, Leppanen, & Tchanturia, 2019; Tillmann *et al.*, 2018; Woodbury-Smith *et al.*, 2005). Although previous studies investigated the influence of ethnicity on ASD (Keen, Reid and Arnone, 2010; Dealberto, 2011; Zaroff and Uhm, 2012; Becerra *et al.*, 2014; Pierce *et al.*, 2014; Harrison *et al.*, 2017; Yingling, Hock and Bell, 2018; Abdullahi *et al.*, 2019; Nevison and Zahorodny, 2019; Yingling, Bell and Hock, 2019); there is less evidence on the differences in the symptoms of ASD between ethnicities from a large dataset of children, adolescents and adults. For instance, Dealberto (2011) reviewed of related studies

and laments the complexity in the relationship between ethnicity and ASD. Similarly, Zaroff and Uhm (2012) conducted a comprehensive literature review by comparing data across the assorted studies with particular focus on ethnicity and suggested that methodological factors are largely responsible for the differences in ASD prevalence across studies. Pierce *et al.*, (2014) highlighted that ethnicity has not been adequately reported based on the review of three autism-related journals over a 6-year period.

Keen, Reid, and Arnone (2010) conducted a retrospective case-note analysis on 428 children diagnosed with ASD over a period of 6-years to examine the link between maternal ethnicity and the rate of childhood ASD. The result showed higher risk of ASD among children of mothers born outside Europe and mothers of Black ethnicity had a significantly higher risk compared with White mothers. Becerra *et al.*, (2014) investigated the presence of significant difference in ASD phenotypes based on maternal ethnicity from a large sample of children diagnosed with ASD. The result indicated a significant association of maternal ethnicity with child's and its severity. Harrison *et al.*, (2017) employed measurement noninvariance in examining the diagnostic accuracy of Autism Diagnostic Observation Schedule (ADOS) among 2458 culturally-diverse participants and found significant item-level bias based on ethnicity.

Recently, Nevison and Zahorodny (2019) analysed a decade of U.S birth cohorts of children with ASD in tracking time trends in the prevalence of ASD based on ethnicity and found various fluctuations between the racial groups. Similarly, Abdullahi *et al*., (2019) analysed the Western Australian Register of 4776 children diagnosed with ASD from 1999 to 2017 and found that children born to immigrant mothers had an increased risk of ASD symptoms.

However, further investigation on how ASD symptoms vary across ethnicities could help in understanding the possible need to redesign how ASD should be defined and diagnosed based on demographic variations (Abdullahi *et al.*, 2019; Evans *et al.*, 2018; Nevison & Zahorodny, 2019).

The research question

A definitive explanation of the associations between ethnicity and prevalence of ASD remains unknown. While some studies relatively maintained the aging assumptions of its higher prevalence in western countries (Becerra *et al.*, 2014; Kogan *et al.*, 2008; Palmer *et al.*, 2010; Rosenberg *et al.*, 2009), others aligned the increase to accessibility of effective diagnostic tools and practices (Begeer *et al.*, 2009; Canino *et al.*, 2010; Honda *et al.* 2005). Although studies identified the significance of ethnicity as a risk factor for ASD (Keen, Reid and Arnone, 2010; Dealberto, 2011; Becerra *et al.*, 2014), the omission of a balanced ethnicity data in previous ASD studies impedes comparative analyses on its prevalence rates across ethnic groups (Zaroff and Uhm, 2012). The main research question of the study will examine whether there is a significant difference in ASD scores based on ethnicity in the different datasets (children, adolescents, adults and combined datasets).

METHODOLOGY

Participants

The voluntary 1875 participants were drawn from various ethnicities, and countries. Cross tabulations shown in Tables 1 and 2 described the demographic splits of the participants in children, adolescents, and adults screening categories (datasets).

Data Collection Tool

Three distinct open-source datasets for children, adolescents, and adults screened for "at-risk" of ASD were obtained from a mobile-based ASD screening study conducted by Thabtah (2019). In addition to demographic data, each of the datasets captured ten responses based on AQ-children, AQ-adolescents, and AQ-adults for screening children, adolescents, and adults respectively. Thabtah (2019) discussed the development, scoring, and validity of the questions contained in AQ-children, AQ-adolescents, and AQ-adults. The responses were rated on a 2-point scale with "Strongly Agree" and "Agree" assigned value 1 while others assigned value 0. The reliability scale of the items' response yielded a Cronbach's Alpha values of .639, .677, and .712, for children, adolescents, and

adults respectively while .692 was recorded as the overall Cronbach's Alpha as shown in Table 3.

It worth noting that, the research viability of autism quotient is limited by its lack of subscales; yielding only one reliability score. Thus, in the present study reliability scores for the screening categories were calculated as well as the overall. Higher internal consistency (α=.712, Table 3), higher "self-reported cases" (n=920, Table 4), and higher incidence rate of "at-risk" cases (n= 358, Table 5) were recorded on adults' screening category. These findings provide significant indicators of how less reliable third-party responses (by parents, carers, or clinicians) might be on the true symptoms of ASD. In other words, self-reported cases have higher consistency than third-party responses.

Data Analysis

The datasets were organized and analyzed using SPSS 22. After a thorough check on data quality, and the reliability of the items, statistical techniques were employed in examining the research question. In the analysis on the ethnicity as categorical a data and ASD score provides continuous data, after conducting normality tests on the categories, it was found that basic conditions for applying parametric tests were not satisfied by the data (Harwell, 1988; McKight and Najab, 2010; Siegel, 2012). Thus, the effect of ethnicity on ASD scores in each dataset and the combined datasets was estimated by employing the k-independent samples test of Kruskal Wallis.

RESULTS AND DISCUSSION

We employed descriptive statistics to determine whether there is enough statistical evidence in favor of differences in ASD scores across the participants based on ethnicity. The combined dataset indicated the wide range between the numbers of observations in each screening category (Table 1-5); not normally distributed and not fit for parametric techniques (Harwell, 1988; McKight and Najab, 2010; Siegel, 2012). Thus, as stated earlier Kruskal Wallis is the most appropriate statistical technique to used. Based on the results found as shown in Tables 7-10 and summarized in Table 6, "there is a significant difference in ASD scores based on ethnicity in every the dataset (children, adolescents and adults datasets) as well as the combined dataset.

Table 1: Gender disparity

		Screening Category			Total
		Children	Adolescence	Adult	
Gender	Male	363	117	596	1076
	Female	146	131	522	799
Total		509	248	1118	1875

Table 2 : Ethnicity

		Screening Category			Total
		Children	Adolescence	Adult	
Ethnicity	Aboriginal	6	3	21	30
	Asian	99	24	162	285
	Black	25	20	58	103
	Hispanic	17	10	23	50
	Latino	16	8	36	60
	Middle eastern	107	46	210	363
	South Asians	23	3	39	65
	White	198	118	524	840
	Others	18	16	44	78
Total		509	248	1117	1874

Table 3: Cronbach's Alpha

Category	Number of cases	Number of items	Cronbach's Alpha
Children	509	10 items	0.639
Adolescences	248	10 items	0.677
Adults	1118	10 items	0.712
Overall	1875	10 items	0.692

Table 4: User

		Screening Category			Total
		Children	Adolescence	Adult	
User	Friend	2	0	3	5
	Healthcare professional	21	18	10	49
	Others	0	9	15	24
	Parent	438	103	126	667
	Relative	29	19	43	91
	Self	17	99	920	1036
	Teacher	2	0	1	3
Total		509	248	1118	1875

Table 5: ASD Class

		Screening Category			
		Children	Adolescence	Adult	Total
ASD Class	Yes	257	127	358	742
	No	252	121	760	1133
Total		509	248	1118	1875

Table 6: Summarized findings

	Dataset			
Factor	Children	Adolescents	Adults	Combined
Ethnicity	√	√	√	√

√ = *There is a significant difference in ASD scores based on ethnicity*

Table 7: Results from children's dataset

N= 509		Frequency	Percentage	Median	Mean ranks	α
Ethnicity	Aboriginal	6	1.2	7.0000	288.58	
	Asian	99	19.4	6.0000	246.02	
	Black	25	4.9	7.0000	271.04	
	Hispanic	17	3.3	7.0000	292.09	
	Latino	16	3.1	7.0000	285.56	0.000
	Middle eastern	107	21.0	5.0000	197.40	
	South Asians	23	4.5	6.0000	227.37	
	White	198	38.9	7.0000	288.27	
	Others	18	3.5	5.0000	220.50	

Table 8 : Results from adolescents' dataset

N= 509		Frequency	Percentage	Median	Mean ranks	α
Ethnicity	Aboriginal	3	1.2	4.0000	120.33	
	Asian	24	9.7	7.0000	139.94	
	Black	20	8.1	5.0000	91.23	
	Hispanic	10	4.0	5.0000	113.95	
	Latino	8	3.2	5.0000	110.25	0.000
	Middle eastern	46	18.5	4.0000	83.68	
	South Asians	3	1.2	7.0000	142.83	
	White	118	47.6	7.0000	141.08	
	Others	16	6.5	7.0000	149.06	

Table 9: Results from adults' dataset

N= 509		Frequency	Percentage	Median	Mean ranks	α
Ethnicity	Aboriginal	21	1.9	5.0000	539.14	
	Asian	162	14.5	4.0000	464.71	
	Black	58	5.2	6.0000	652.55	
	Hispanic	23	2.1	5.0000	571.76	
	Latino	36	3.2	7.0000	732.17	0.000
	Middle eastern	210	18.8	4.0000	401.37	
	South Asians	39	3.5	4.0000	377.12	
	White	524	46.9	6.0000	641.26	
	Others	44	3.9	5.0000	577.85	

Table 10 : Results from the combined datasets

N= 509		Frequency	Percentage	Median	Mean ranks	α
Ethnicity	Aboriginal	30	1.6	5.00	909.62	
	Asian	285	15.2	5.00	852.92	
	Black	103	5.5	6.00	1001.41	
	Hispanic	50	2.7	6.00	993.86	
	Latino	60	3.2	7.00	1118.04	0.000
	Middle eastern	363	19.4	4.00	690.24	
	South Asians	65	3.5	5.00	738.02	
	White	840	44.8	6.50	1062.43	
	Others	78	4.2	5.50	969.44	

Based on the results depicted on ethnicities in each of the tables 7-10, it can be concluded that the symptoms of ASD measured based on numerical values of ASD scores (i.e. Median and Mean rank) are statistically significantly higher in the groups having higher scores and vice versa. In other words, the group having the highest ASD scores indicates the ethnicity to be considered as manifesting more symptoms of ASD.

The results depicted in Table 7 includes differences in ASD Scores based on Ethnicity from the Children dataset. The differences are statistically significant (α<0.001) with each of Aboriginals, Blacks, Hispanics, Latinos, and Whites recorded the highest median scores of 7.0 and Middle Eastern recorded the lowest median score of 5.0. Considering the results from Table 8, Asians, South Asians, and Whites have the highest median scores of 7.0 each, while each of Aboriginals and Middle Eastern recorded the lowest scores of 4.0. The differences recorded from the Adolescents dataset as depicted in Table 8 are statistically significant (α<0.001). Furthermore, Table 9 shows differences in ASD Scores based on Ethnicity from the Adults dataset. The differences are statistically significant (α<0.001) with Latino having the highest score (Median=7.0) and each of Asians, Middle Eastern, and South Asians recorded the lowest scores (Median=4.0).

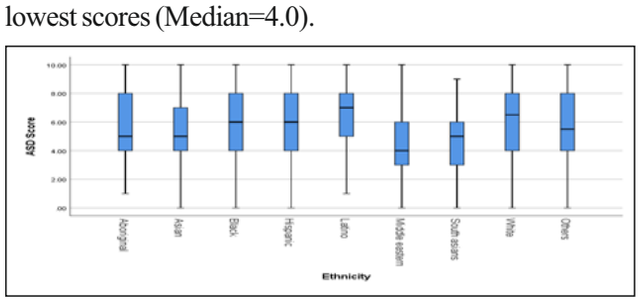

Figure 1: Differences in ASD Scores based on Ethnicity

Taking the three datasets as a whole, Table 10 and Figure 1 indicated that Latino recorded the highest ASD score

with Mean rank of 1118.04 and Median of 7.0, followed by White (Mean rank=1062.43, Median=6.5), Black (Mean rank=1001.41, Median=6.0) and Hispanic (Mean rank= 993.86, Median=6.0). While Middle Eastern recorded the lowest score (Mean rank=690.24, Median=4.0) followed by South Asians (Mean rank=738.02, Median=5.0), Asian (Mean rank=852.92, Median=5.0) and Aboriginal (Mean rank=909.62, Median=5.0). The significance level ($\alpha<0.0001$) indicated that the differences in ASD scores based on Ethnicity as depicted in Table 10 and Figure 1 are statistically significant.

CONCLUSION

Previous studies investigated the influence of ethnicity on the symptoms of ASD from samples of either children, adolescents, adults, or uncategorized samples. This study examined differences in Autism Quotient scores based on ethnicity from large samples of children, adolescents, and adults screened for at-risk of ASD. The results indicated the significant influence of ethnicity on ASD symptoms in children, adolescents as well as adults. Adults' responses, most of which are self-ratings were found to have higher internal consistency based on the computed Cronbach's Alpha; an indicator that self-rating are much reliable than third-party ratings in determining the true symptoms of ASD. Further research on the influence of demographics on ASD symptoms will aid in clearing the misconceptions about the prevalence of ASD. Definitive explanations on the association between ethnicity and ASD requires standard and accessible screening instruments, as well as centralized data for comparative analyses. Future studies should employ Artificial Intelligence modeling in AQ scoring and address the biases in third-party ratings of ASD symptoms. There is also a need to further investigate the influence of other demographic, biological and environmental factors on the symptoms and prevalence of ASD.

Conflict of Interest

The authors declare that they have no conflict of interest.

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