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Disparity in autism spectrum disorder prevalence among Taiwan National Health Insurance enrollees: Age, gender and urbanization effects

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ABSTRACT

The present study aims to characterize the prevalence of autism spectrum disorders (ASDs) in Taiwan while examining the effects of age, gender, and urbanization on ASD occurrence. A cross-sectional study was conducted to analyze data from 895,639 random health insurance claimants who claimed medical services in the year 2007. Autism was defined using the ICD-9-CM Diagnosis Code 299.0 (autism, current or active). The prevalence of autistic cases was found to be 12.3‰ (10,868/884,771) in the general population, with the prevalence among males (19.2‰) significantly higher than that among females (6‰). With regards to age distribution, we found that the autistic group (mean age = 16.0 years) was significantly younger than the general population (mean age = 37.2 years). A logistic regression analysis found that age, gender, residence urbanization level and Bureau of National Health Insurance regional division all constituted influence factors for autistic occurrence. The results demonstrate the importance of taking into account age, gender, and geographical disparities in autistic prevalence in order to implement appropriate public health policies for the ASD population.

1. Introduction

The autism spectrum disorders (ASDs) are a set of developmental disabilities characterized by atypical development in socialization, communication, and behavior (American Psychiatric Association, 2000; CDC, 2009; Matson, 2007). ASD is not a disease but a syndrome with multiple causes, both genetic and non-genetic. The number of genes involved, as well as their identity, remain unknown (Muhle, Trentacoste, & Rapin, 2004). Many studies have discussed the methodological issues involved in the differential diagnosis of ASD (Matson, Gonzalez, & Wilkins, 2009; Matson, Gonzalez, Wilkins, & Rivet, 2008; Matson, Nebel-Schwalm, & Matson, 2007; Woolfenden, Sarkozy, Ridley, & Williams, 2011), and various revisions have recently been proposed to the diagnostic criteria in the DSM-V. However, further modification is needed in various areas, including social imagination and diagnosis in infancy and adulthood. Moreover, autism in females may continue to be misdiagnosed or unrecognized under the new criteria (Wing, Gould, & Gillberg, 2011).

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The observed prevalence of ASD has increased over the past few decades (Leonard et al., 2010; Lin, Hung, Lin, & Lai, 2011; Lin, Lin, & Wu, 2009; Lin, Sung, et al., 2011; Lingam et al., 2003; Matson & Kozlowski, 2011; Nassar et al., 2009). This observed increase may be due to various factors, including changes in diagnostic criteria, the development of a more expansive notion of ASD, different methods used in studies, and growing awareness among the public about ASD combined with greater availability of professional services. It is also possible that the prevalence in the population has actually increased (Wing & Potter, 2002). After reviewing 40 studies of ASD prevalence, Williams, Higgins, and Brayne (2006) reported an overall random effects prevalence estimate for typical autism of 7.1 per 10,000; the comparable value for all ASD was 20.0 per 10,000.

The US Center of Disease Control (2009) reported an increased prevalence of ASDs among US children and underscored the need to regard the syndrome as an urgent public health concern (CDC, 2009). An increase in prevalence would suggest directing more attention and funding toward improving services and alleviating environmental risk factors for children with ASD instead of the label of ASD (Lin et al., 2009). Our previous study found that individuals with ASD had more frequent hospital admissions compared to the general population; accordingly, we suggested that health care decision makers develop appropriate health policies for these individuals (Lin, Hung, et al., 2011; Lin, Sung, et al., 2011). Many studies have also reported the presence of comorbidities among ASD individuals; however, the nature and prevalence of these conditions remain poorly understood (Bauman, 2010; Lauritsen, Mors, Mortensen, & Ewald, 2002). An accurate understanding of the relationship between autism severity and healthcare and education needs is also necessary in order to improve the quality of service for people with ASD (Lin, Hung, et al., 2011; Lin, Sung, et al., 2011). Due to the importance of obtaining accurate demographic data on ASD individuals for formulating public health policy, the present study sought to characterize ASD prevalence in Taiwan. We also examined the effects of age, gender, and urbanization on ASD occurrence.

2. Methods

The present study sought to examine the prevalence of autism in Taiwan by means of a cross-sectional analysis of a national health insurance dataset provided by the National Health Research Institute. The dataset included 895,639 random health insurance claimants who claimed medical services in the year 2007. Among the claimants, 10,868 people had a principal diagnosis of autism spectrum disorder (ICD-9-CM Diagnosis Code 299.0: Autism, current or active).

The following variables were included in the analysis to identify the demographic characteristics associated with autism prevalence: autistic population number, age, gender, urbanization level and regional division of the client's residence, as categorized by the Bureau of National Health Insurance (BNHI). The statistical methods utilized include frequencies, percentages, population pyramids, *t*-tests, ANOVA, and logistic regression to examine the relationship between autism prevalence and age, gender, and urbanization in Taiwan.

The definition of autism used in the study was that of the US National Center for Health Statistics (1993): autistic disorder beginning in childhood is marked by the presence of notably abnormal or impaired development in social interaction and communication as well as a markedly restricted repertoire of activity and interest. Manifestations of the disorder vary greatly depending on the developmental level and chronological age of the individual. In Taiwan, autism is one of 16 officially registered disabilities (Physically and Mentally Disabled Citizens Protection Act, 1997), and persons with autism are characterized by impaired social interaction, problems with verbal and nonverbal communication, and unusual, repetitive, or severely limited activities and interests (Taiwan Department of Health, 2006).

Urbanization in the study was stratified into four levels – I, II, III and IV – ranging from greater to lower degrees of urbanization of the residential area. The classification was defined based on the following criteria: population density (people/km^2), proportion of residents with at least a college education, proportion of elderly people older than 65, proportion of agricultural workers and number of physicians per 100,000 residents (Lin, Hsieh, Chiou, Wu, & Huang, 2010).

3. Results

The demographic characteristics of the autistic and the general populations are presented in Table 1 and Fig. 1. The prevalence of autistic cases was 12.3‰ (10,868/884,771) in the general population with the prevalence among males (19.2‰) significantly higher than that among females (6‰). With regards to the age distribution, we found the autistic group (mean age = 16.0 years) was significantly younger than the general population (mean age = 37.2 years). The more populous metropolitan areas had a higher prevalence of autistic cases than the rural areas in Taiwan.

Table 2 reveals age disparities in the autistic population by demographic characteristics. Generalized linear tests found that male cases (mean age = 15.1 years) were significantly younger than female cases (mean age = 18.4 years). Cases in more urbanized areas were also significantly younger than cases in less urbanized areas (mean age = 15.6 years in level I versus mean age = 19.7 years in level IV). Analyses based on client's residence in BNHI regional division similarly indicated that autistic cases in metropolitan cities were significantly younger than those living in less metropolitan areas.

Table 3 provides the results of a logistic regression analysis of autism prevalence in Taiwan. We found that age, gender, residence urbanization level and BNHI regional division were all factors that affected autistic prevalence cases were less common among females than in males (OR = 0.339, 95% CI = 0.324–0.354), whereas individuals living in level I urbanized areas reported greater prevalence than individuals living in level IV urbanized areas (OR = 1.151, 95% CI = 1.016–1.303). In

Table 1
Demographic characteristics of the autistic and the general populations.

Variables	General population, *N* (%)	Autistic population, *N* (%)	χ^2 test
Gender			3100.4***
Female	463,606 (52.4)	2777 (25.6)	
Male	421,165 (47.6)	8091 (74.4)	
Age group (mean ± SD)	37.2 ± 20.8	16.0 ± 11.0	t = 106.3***, 20,160.3***
0–5	37,136 (4.2)	603 (5.6)	
6–10	60,257 (6.8)	2952 (27.2)	
11–15	64,778 (7.3)	3331 (30.7)	
16–20	62,193 (7.0)	1696 (15.6)	
21–25	60,823 (6.9)	887 (8.2)	
26–30	75,632 (8.6)	494 (4.6)	
31–35	71,334 (8.0)	283 (2.6)	
36–40	70,926 (8.0)	196 (1.8)	
41–45	73,462 (8.3)	130 (1.2)	
46–50	69,467 (7.9)	101 (0.9)	
51–55	64,142 (7.3)	48 (0.4)	
56–60	48,185 (5.5)	34 (0.3)	
61–65	31,161 (3.5)	36 (0.3)	
≥66	95,275 (10.8)	78 (0.7)	
Urbanization level of residence			119.9***
I	511,347 (57.8)	6841 (62.9)	
II	299,537 (33.9)	3280 (30.2)	
III	45,968 (5.2)	465 (4.3)	
IV	27,919 (3.2)	283 (2.6)	
BNHI regional division of residence			362.3***
Taipei division	318,979 (36.1)	4785 (44.0)	
Northern division	126,913 (14.3)	1454 (13.4)	
Central division	163,157 (18.4)	1584 (14.6)	
Southern division	163,157 (14.1)	1182 (10.9)	
Kaoping division	131,613 (14.9)	1620 (14.9)	
Eastern division	19,426 (2.2)	244 (2.2)	

*** $p < 0.001$.

terms of the geographic correlates of autistic occurrence, the analyses showed that clients residing in the Taipei BNHI regional division had a significantly higher autistic prevalence than those residing in eastern areas (OR = 1.186, 95% CI = 1.035–1.359). However, the central (OR = 0.735, 95% CI = 0.639–0.845) and southern areas (OR = 0.764, 95% CI = 0.663–0.880) had lower prevalence than the eastern areas. We also found that autism was more prevalent among younger people, with individuals younger than age 50 reporting higher autistic prevalence than those older than 65 years. Prevalence was especially elevated among the following age groups: 0–5 years (OR = 18.869, 95% CI = 14.898–23.899), 6–10 years (OR = 57.014, 95% CI = 45.540–71.446), 11–15 years (OR = 60.016, 95% CI = 47.931–75.147), 16–20 years (OR = 32.447, 95% CI = 25.849–40.720), and 21–25 years (OR = 19.293, 95% CI = 15.300–24.329).

4. Discussions

Autism is a condition that manifests in early childhood and is characterized by qualitative abnormalities in social interactions, markedly aberrant communication skills, and restricted, repetitive and stereotyped behaviors. The autism spectrum is broad, and there are significant differences between high-functioning autism or Asperger's syndrome and the more severe manifestations of this disorder (Levy & Perry, 2011). A major public health concern for children with autism and

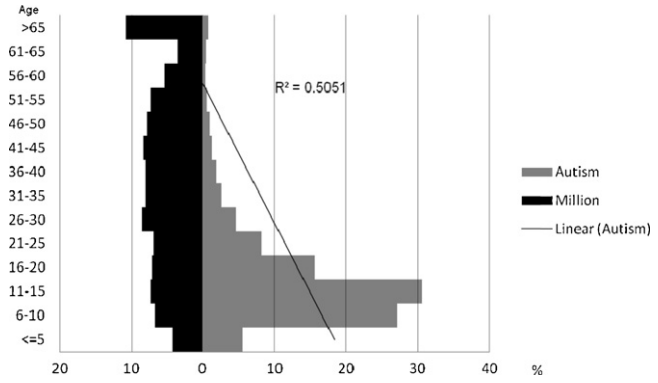

Fig. 1. Population pyramid types of autism and the general.

Table 2
Age disparity in autistic population by demographic characteristics (generalized linear model, GLM test).

Variables	Age (mean ± SD)	*F* value	Scheffe's test
Gender			
1. Female	18.4 ± 14.0	196.8***	1 > 2
2. Male	15.1 ± 9.6		
Urbanization level			
1. I	15.6 ± 10.4	9.3***	4 > 1, 2
2. II	16.1 ± 11.3		3 > 1, 2
3. III	18.4 ± 13.8		
4. IV	19.7 ± 14.4		
BNHI regional division			
1. Taipei division	14.9 ± 10.2	31.7***	5 > 3, 4 > 1, 2
2. Northern division	15.0 ± 10.1		6 > 1, 2
3. Central division	16.2 ± 11.0		4 > 1, 2
4. Southern division	16.6 ± 11.1		3 > 1, 2
5. Kaoping division	19.0 ± 12.8		
6. Eastern division	17.9 ± 12.8		

*** $p < 0.001$.

Table 3
Logistic regression analysis of autistic population occurrence in Taiwan ($N = 895{,}639$).

Variables	Odds ratio	95% CI	*p* value
Gender			
1. Female	0.339	0.324–0.354	<0.001
2. Male (ref.)			
Urbanization level			
1. I	1.151	1.016–1.303	0.0270
2. II	1.034	0.912–1.171	0.604
3. III	1.087	0.934–1.266	0.0282
4. IV (ref.)			
BNHI regional division			
1. Taipei division	1.186	1.035–1.359	0.011
2. Northern division	0.877	0.762–1.011	0.070
3. Central division	0.735	0.639–0.845	<0.001
4. Southern division	0.764	0.663–0.880	0.002
5. Kaoping division	1.004	0.878–1.156	0.951
6. Eastern division (ref.)			
Age group			
1. 0–5	18.869	14.898–23.899	<0.001
2. 6–10	57.014	45.540–71.446	<0.001
3. 11–15	60.016	47.931–75.147	<0.001
4. 16–20	32.447	25.849–40.720	<0.001
5. 21–25	19.293	15.300–24.329	<0.001
6. 26–30	8.096	6.374–10.283	<0.001
7. 31–35	4.815	3.747–6.189	<0.001
8. 36–40	3.329	2.560–4.329	<0.001
9. 41–45	2.126	1.605–2.816	<0.001
10. 46–50	1.740	1.294–2.338	0.002
11. 51–55	0.892	0.623–1.278	0.534
12. 6–60	0.845	0.564–1.264	0.411
13. 61–65	1.411	0.951–2.095	0.088
14. ≥66 (ref.)			

other pervasive developmental disorders is the inconsistent diagnosis of autism (American Psychiatric Association, 2000; National Center for Health Statistics, 1993). The present paper provides data on ASD prevalence based on Taiwanese national health insurance claimants and examines the effects of age, gender and urbanization on ASD occurrence. The results show that the prevalence of autistic cases was 12.3‰ in the general population, with the prevalence among males (19.2‰) significantly higher than that among females (6‰).

In comparing our results with those obtained by other studies of autistic prevalence, approximately 1% was classified as having an ASD in a survey of 11 US sites in the Autism and Developmental Disabilities Monitoring Network (CDC, 2009). In the state of New Jersey, ASD prevalence was 10.2/1000, higher in boys than in girls (16 versus 4/1000) and higher in wealthier census tracts, perhaps due to differential access to pediatric and developmental services (Thomas et al., 2011). In the UK, Baron-Cohen et al. (2009) estimated the prevalence of ASD to be 157 per 10,000 based on a survey of autism-spectrum conditions using the Special Educational Needs (SEN) register in Cambridgeshire. In Asian countries, the average prevalence of ASD before 1980 was around 1.9/10,000 while it was 14.8/10,000 from 1980 to the present (Sun & Allison,

2010). In South Korea, Kim et al. (2011) estimated the prevalence of ASDs to be 2.64%; with 1.89%, the male-to-female ratios were 2.5:1 and 5.1:1 in the general-population sample and 0.75% in the high-probability group.

Age, gender and geographical disparities exist in the autistic population in Taiwan. A logistic regression analysis in the present study found that the influence factors of autistic occurrence include age, gender, residence urbanization level and BNHI regional division. ASD varied geographical region. Similarly, Roelfsema et al. (2011) found that ASD was more prevalent in an information-technology region based on a school-based study of three regions in the Netherlands. Our previous study reported the administrative prevalence of ASD among various age groups in Taiwan from 2000 to 2007 as follows: 2.4–7.8/10,000 among those aged 0–5 years, 5.0–17.3/10,000 among those aged 6–11 years, and 2.1–10.4/10,000 among those aged 12–17 years (Lin et al., 2009).

Gender differences in symptoms representing the triad of impairments of ASD remain unclear. Sipes, Matson, Worley, and Kozlowski (2011) found that gender differences in a sample of toddlers occurred only in regards to the restricted interests and repetitive behavior domain, with females with an average developmental quotient having significantly fewer endorsements on items related to restrictive and repetitive behaviors. However, gender differences in prevalence rates emerged in community or clinical populations (Worley, Matson, Sipes, & Kozlowski, 2011). Baron-Cohen et al. (2011) reported that ASD is much more common in males, citing the extreme male brain (EMB) theory, which views ASD as an extreme manifestation of the male brain, as the likeliest explanation. Our previous analysis concluded that in the ASD disability level difference by gender, the male cases occupied most of the autistic numbers in the study. The reported male/female ratio was 7.3–8.4 in mild disability group, 5.9–7.5 in moderate disability group, 4.1–4.7 in severe disability group, and 2.7–4.4 in profound disability group (Lin, Hung, et al., 2011; Lin, Sung, et al., 2011).

The awareness of ASDs has resulted in increasing numbers of children being diagnosed at young ages (Fernell & Gillberg, 2010). Matson and Kozlowski (2011) suggested that different research methodologies and diagnostic criteria, increased ASD awareness, cultural factors, and environmental contributions might also play roles in the increase in ASD diagnoses. However, Muhle et al. (2004) argued that the increase is most likely attributable to heightened awareness and changing diagnostic criteria rather than to new environmental influences. Williams et al. (2006) found that diagnostic criteria, age of the sampled individuals, and urban or rural location were all associated with estimated prevalence of all ASD. Many countries have adopted the policy of early-age detection in ASD case identification (Dababnah, Parish, Brown, & Hooper, 2011; Loa Jonsdottir, Saemundsen, Antonsdottir, Sigurdardottir, & Olason, 2011; Lung, Chiang, Lin, & Shu, 2011). However, the question of how early is too early with respect to early identification and diagnosis of ASD in young children and infants remains open to debate (Matson, Wilkins, & Gonzalez, 2008).

To implement appropriate public health policies for the ASD population, it is important to take into account the broader developmental profiles of ASD children, the need for repeated assessment of cognitive functions and follow-up over time and the required medical/neurological consideration and work-up (Fernell & Gillberg, 2010). Future research should be conducted using diagnostic criteria and assessment instruments that are as uniform as possible (Matson & Kozlowski, 2011). As suggested by Kim et al. (2011), rigorous screening and comprehensive population coverage are necessary to produce more accurate ASD prevalence estimates, a fact that only underscores the need for better detection, assessment, and services.

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