J Autism Dev Disord (2015) 45:4135–4139
DOI 10.1007/s10803-015-2521-7

BRIEF REPORT

Brief Report: Forecasting the Economic Burden of Autism in 2015 and 2025 in the United States

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Published online: 17 July 2015

Abstract Few US estimates of the economic burden of autism spectrum disorders (ASD) are available and none provide estimates for 2015 and 2025. We forecast annual direct medical, direct non-medical, and productivity costs combined will be $268 billion (range $162–$367 billion; 0.884–2.009 % of GDP) for 2015 and $461 billion (range $276–$1011 billion; 0.982–3.600 % of GDP) for 2025. These 2015 figures are on a par with recent estimates for diabetes and attention deficit and hyperactivity disorder (ADHD) and exceed the costs of stroke and hypertension. If the prevalence of ASD continues to grow as it has in recent years, ASD costs will likely far exceed those of diabetes and ADHD by 2025.

Keywords Costs · Non-medical services · Prevalence

Introduction

Efficient allocation of scarce healthcare resources requires estimates of current and future costs for diseases and disorders. Whereas many studies estimate the economic burden for numerous diseases and disorders and frequently update these estimates annually, few estimate costs for autism spectrum disorders (ASD) (American Diabetes Association 2013; Buescher et al. 2014; Doshi et al. 2012; Ganz 2006; Knapp et al. 2009). Moreover, even among the ASD cost studies in the US, the focus is on per-person lifetime costs rather than national economic burden rendering comparisons with other diseases problematic (Buescher et al. 2014; Ganz 2006). This study forecasts ASD burden to 2015 and 2025 in the US. Forecasts for ASD are especially salient owing to the rapid increases in annual estimates of prevalence that have occurred over the past 10–20 years (Buescher et al. 2014).

Method

Economic burden using the cost-of-illness method is estimated by multiplying the annual prevalence of the disease by the annual per-person cost for the disease. Measuring economic burden is similar to measuring the contribution of some economic activity—for example, output of the healthcare industry—to gross domestic product (GDP) for a given year. Because both the burden and GDP grow over time, we do not apply discount rates. We assume a societal perspective.

Our forecasts rely on estimates of growth in a number of factors: the number of persons with ASD; expenditures on medical care and non-medical care; and lost productivity for parents and persons with ASD. We first generate base-case estimates that maintain the assumptions in Buescher et al. (2014). Second, we generate estimates with varying assumptions for a sensitivity analysis. Assumptions involve percent of ASD persons with intellectual disability (ID), ASD prevalence and growth rates, and benefits of early

Electronic supplementary material The online version of this article (doi:10.1007/s10803-015-2521-7) contains supplementary material, which is available to authorized users.

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interventions among children and youths. Calculations for the base-case and sensitivity analyses are available in an appendix from the first author. Following Buescher et al. (2014), we stratify our estimates by three age groups, 0–5, 6–17, 18+ and by two disability categories: with ID and without ID. Our estimates begin with the following equations:

$$TB = N^{ID}_{0-5}B^{ID}_{0-5} + N^{ID}_{6-17}B^{ID}_{6-17} + N^{ID}_{18+}B^{ID}_{18+} + N^{WOID}_{0-5}B^{WOID}_{0-5} + N^{WOID}_{6-17}B^{WOID}_{6-17} + N^{WOID}_{18+}B^{WOID}_{18+}; \quad (1)$$

$$B = BS + BP = (AC + SE + ES + MS + NMS) + (PP + OP) \quad (2)$$

TB indicates total burden. N is the number of people with ASD. For example, N^{ID}_{0-5} is the number of 0–5 year olds with ID. N^{WOID}_{0-5} is the number of 0–5 year olds without ID. *B* is the economic burden per person, and includes services, *BS,* and productivity, *BP*. Services, *BS,* in turn, include costs of accommodation or residential care (*AC*), special education (*SE*), employment support (*ES*), medical services (*MS*), and non-medical services (*NMS*). Productivity, *BP,* includes parents' productivity loss (*PP*) and own productivity loss (*OP*), that is, productivity of the person with ASD. *OP* is only available for adults (18+) and is set to zero for children (0–5, 6–17 years old).

To estimate the "Ns" above, we begin with data on projections for the US Census population projections (2014) within the Buescher et al. (2014) age brackets. Percentages of the population assumed to have ASD are drawn from Buescher et al. (2014) (1.1 % in 2011), from the Centers for Disease Control and Prevention (2014) (0.67 % in 2000 and 1.47 % in 2010), and from Fombonne (1999) (0.52 % in 1960s–1990s). Following Buescher et al. (2014), we assume 40 % of the ASD population has ID and 60 % do not in the base-case to estimate numbers of persons in the "ID" and "WOID" categories above.

The estimation of the benefits per-person, the "Bs" above, is a little more involved. We begin with the Buescher et al. (2014) cost-per-person for 2011 within three age brackets, two ID categories, as well as seven spending categories. We next project dollar increases per-person from 2011 to 2015 and from 2015 to 2025. In making these projections, we first consider services per-person and second, lost productivity per-person. In making our forecast, and using 2015 as an example, we note that:

$$BS_{2015} = (AC_{2011} + SE_{2011} + ES_{2011} + MS_{2011})(1 + GMS_{2015}) + NMS_{2011}(1 + GNMS_{2015}) \quad (3)$$

AC_{2011}, SE_{2011}, ES_{2011}, and MS_{2011} represent the 2011 dollar values per-person for: accommodation or residential care; special education; employment support; and medical services found in Buescher et al. (2014). GMS_{2015} represents the forecasted growth rates in per-person spending for all US medical services from 2011 to 2015. NMS_{2011} represents the 2011 dollar value per-person for non-medical services in Buescher et al. (2014). $GNMS_{2015}$ represents the growth rate in per-person spending for non-medical services from 2011 to 2015 .

The growth rates (*GMS* and *GNMS*) are calculated based on information on forecasted per-capita annual growth in medical and non-medical expenditures, GDP, and population. Our forecasts are drawn from the Office of the Actuary in the Centers for Medicare and Medicaid Services (2014). We assume that growth rates in the first four service categories—accommodation or residential care, special education, employment support, and medical services—will be adjusted by the growth rate of medical expenditures. The first three are not technically medical services, but we nevertheless applied a medical care growth rate reasoning that spending growth for these three services would more closely resemble those of medical services than non-medical services. We assume that the growth in ASD non-medical expenditures will equal the growth in all non-medical US expenditures. Faster growth is forecasted for medical than non-medical services, consistent with historical trends and current projections (Bodenheimer and Grumback 2012; Sisko et al. 2014). Projected growth rates in expenditures, however, are not expressed per-person in our sources; we therefore estimate per-person forecasts with Eqs. 4 and 5, again using 2015 as an example:

$$GMS_{2015} = \text{Growth rate in medical service expenditures} - \text{Growth rate in population} \quad (4)$$

$$GNMS_{2015} = \text{Growth rate in non-medical service expenditures} - \text{Growth rate in population.} \quad (5)$$

Calculations for lost productivity, *PP* and *OP*, follow the structure of Eq. 3. For example, for parents' productivity per-person in 2015,

$$PP_{2015} = PP_{2011}x(1 + \text{economy wide growth rate in productivity per person}) \quad (6)$$

PP_{2011}, again, is drawn from Buescher et al. (2014). Economy-wide growth is based on estimates from the Bureau of Labor Statistics' Employment Cost Index which includes wages, salaries, and fringe benefits (Congressional Budget Office 2014). This index may be applied as a per-person measure so that population growth need not be subtracted as above for service expenditures.

A sensitivity analysis considers five scenarios with alternative assumptions. Following Buescher et al. (2014), we allow for 60 % rather than 40 % of persons with ASD to also have ID in scenario #1. In scenario #2, we apply the most recent CDC prevalence rate of 1.47 % rather than the 1.1 % in Buescher et al. (2014). We allow for growth in prevalence from 2011 to 2015 and then to 2025 based on CDC estimates of growth from 2000 to 2010 in scenario #3. For scenario #4, we assume that current spending treatment and schooling for children and youth will result in better functioning (and therefore lower costs) among adults age 18–27 in 2025. Scenario #5 uses a lower prevalence rate (0.52 %) for adults in 2015 and 2025. This 0.52 % was drawn from a review of studies of predominately children and youth that applied to the 1960s–1990s cohorts who had grown to be adults in the 2000s (Fombonne 1999). There is a counter-argument for scenario #5: ASD may be significantly under-diagnosed among adults but these adults nevertheless may generate costs similar to those with diagnosed ASD.

An appendix detailing every calculation and assumption—including those from the sensitivity analysis—is available from the first author.

Results

Table 1 presents results for base-case estimates in the first row of numbers and alternative, sensitivity analysis estimates, in the remaining rows of numbers. We forecast that the economic burden in 2015 will be $268.3 billion and in 2025 will be $460.8 billion representing 1.5 and 1.6 %, respectively, of GDP. These estimates range from $161.6 billion (0.9 % of GDP) to $367.3 billion (2.0 % of GDP) in 2015 and from $275.6 billion (1.0 % of GDP) to $1,010.6 billion (3.6 % of GDP) in 2025.

Discussion

Our 2015 and 2025 estimates begin with the 2011 estimates in Buescher et al. (2014). We account for forecasted growth patterns in a number of parameters including the number of persons with ASD, expenditures on medical care and non-medical care, and lost productivity for parents and persons with ASD. Scenarios 1–5 address some limitations of our base-case estimates. There are additional limitations. Following Buescher et al. (2014) we allow for only one age bracket for all adults and assume that non-medical per-person costs for children, youth, and adults are identical within ASD and ID categories. A strength is our transparent method detailed in an appendix.

Our $268 billion estimate for 2015 (and Buescher et al's $236 billion in 2011) for ASD is on a par with the $245 billion for diabetes in 2012 and the $205 billion mid-value for ADHD in 2010 (American Diabetes Association 2013; Doshi et al. 2012). Our $268 billion estimate substantially exceeds the $36.5 billion and $46.4 billion for stroke and hypertension in 2010 (Go et al. 2014). If the prevalence of ASD continues to grow as it has in recent years, the burden of ASD will likely far exceed that of either diabetes or

Table 1 Estimates of the burden of autism in 2015 and 2025

Description	2015 absolute dollar amount; % of GDP	2015 absolute dollar (%) more or less than base-case	2025 absolute dollar amount; % of GDP	2025 absolute dollar (%) more or less than base-case
Base-case estimate: 1.1 % of population with ASD for all ages and both years	$268.2991 billion; 1.467 % of GDP		$460.8002 billion; 1.649 % of GDP	
Sensitivity analysis				
Scenario #1: Assume ID to be 60 % rather than 40 %	$298.8861 billion; 1.634 % of GDP	$30.5870 billion (+11.40 %)	$514.6718 billion; 1.833 % of GDP	$53.8716 billion; (+11.69 %)
Scenario # 2. Assume the prevalence of autism is 1.47 % in both years	$358.5452 billion; 1.961 % of GDP	$90.2461 billion (+33.64 %)	$615.7966 billion; 2.194 % of GDP	$154.9964 billion (+33.64 %)
Scenario #3. Assume the rate of increase from 2011 to 2025 and from 2015 to 2025 is adjusted by the CDC prevalence estimates over 10 years (1.47 and 0.67 %)	$367.3283 billion; 2.009 % of GDP	$99.0292 billion (+36.91 %)	$1010.5809 billion; 3.600 % of GDP	$549.7807 billon (+119.31 %)
Scenario #4. Assume high spending on people <18 in 2015 will cut future costs by ½ for cohort age 18–27 in 2025 and that this cohort comprises 16.2864 % of all adults with ASD	Applies only to 2025	Applies only to 2025	$432.7023 billion; 1.541 % of GDP	−$28.0979 billion (−6.10 %)
Scenario #5. Assume prevalence is less for adults: 0.52 % rather than 1.1 %	$161.5873 billion; 0.884 % of GDP	−$106.7118 billion (−39.77 %)	$275.6098 billion; 0.982 % of GDP	−$185.1905 billion (−40.19 %)

ADHD by 2025 even after accounting for forecasted growth rates of the prevalence of diabetes and ADHD.

The burden of ASD is significant for 2015 but alarming for 2025 and, in our opinion, invites debate about policy responses. The first response is that research into the possible modifiable causes of ASD should become a priority as great as other major diseases; prevention is cheaper than cure or than improving the functioning of persons with ASD. If modifiable causes can be found, for example, a toxin, then another policy response would be to eliminate or reduce the amount of that toxin in the environment. A third response is a call for additional research into cost-effective treatments to improve functioning. The paucity of cost-effectiveness or cost-benefit studies is remarkable. Knapp and Buescher (2014) in their review of the economic aspects of autism list two studies; Amendah et al. (2011) list three; our own literature search found two more for a total of seven. In contrast, we conducted a separate literature search for cost-effectiveness and cost-benefit studies involving diabetes and counted over 200 studies within the past 15 years. Three of the ASD cost-effectiveness studies suggest additional policy responses. Penner et al. (2015) expanded on an earlier study by Motiwala et al. (2006) that analyzed applying Early Intensive Behavioral Interventions (EIBI) to narrow versus wider groups of children along the autism spectrum. Penner et al. (2015) compared the Early Start Denver Model (ESDM) with the Ontario Status Quo (OSQ) model for toddlers. Both provided EIBI, but the OSQ provided them only to toddlers with the most severe conditions. The ESDM won by providing additional one-half dependency-free life years for $45,000 (Canadian) less than the OSQ. Chasson et al. (2007) analyzed children in Texas and found that EIBI over a 3-year interval was more cost-effective than special education over an 18-year period. Mavranezoul et al. (2014) investigated adults in the UK and found that employment support programs that are known to improve employment rates were more cost-effective than standard care ("day services"). These studies suggest policy responses that direct more funding to early childhood interventions and employment support programs may ultimately help bend the cost curve for ASD.

The largest component in our cost estimate for children and youths is education. We agree with McMahon and Cullinan (2014) that rigorous evaluations, and we would add cost-effectiveness evaluations, are called for to identify best practices to educate children with ASD. Productivity loss for parents is another significant cost in our estimates. Parents often have to skip work to care for their children. Private firms and governments should consider parents' productivity losses and work-family balance as they develop flexible work schedule policies. Dunbar (2013) finds that the 1993 US Family and Medical Leave Act (FMLA), which allows parents to take up to 12 weeks per-year of unpaid leave to care of their sick children, increased parental productivity by 5 %. An extension of this Act to 18 or 24 weeks might yield even greater increases in parental productivity. Our estimates may also inform the debate about whether political initiatives to expand charter schools or permit tax-dollars to pay for vouchers to attend private schools would benefit children with ASD given that charter schools and private schools typically do not have resources to accommodate students with ASD. Finally, there are implications for future funding levels at public schools, employment support programs, and state agencies. Assuming future levels grow at the same 2.4 % rate of inflation used in our calculations, our estimates indicate that future levels will fall short of projected levels in the Table 1. Our base-case estimate suggests a $77 billion (2015 dollars) shortfall from 2015 to 2025 and our scenario #3 suggests a $510 billion (2015 dollars) shortfall (see appendix).

Acknowledgments First author acknowledges partial support from Autism Speaks (7636) and the National Institute for Occupational Safety and Health (U54OH007550).

Author contribution Both authors contributed to the inception, design, writing, calculations, and organization of the research and manuscript.

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