THE COST OF LOST PRODUCTIVITY DUE TO FETAL ALCOHOL SPECTRUM DISORDER-RELATED PREMATURE MORTALITY

Brian Easton[1], Larry Burd[2], Anna Sarnocinska-Hart[3], Jürgen Rehm[4,5,6], Svetlana Popova[4,5,7]*

[1]Social and Health Outcomes Research and Evaluation (SHORE), Massey University, Auckland, New Zealand; [2]Department of Pediatrics, University of North Dakota School of Medicine, Grand Forks, North Dakota, United States; [3]Institute for Work & Health, Toronto, ON, Canada; [4]Social and Epidemiological Research Department, Centre for Addiction and Mental Health, Toronto, ON, Canada; [5]Dalla Lana School of Public Health, University of Toronto, Toronto, ON, Canada; [6]Epidemiological Research Unit, Klinische Psychologie und Psychotherapie, Technische Universität Dresden, Dresden, Germany; [7]Factor-Inwentash Faculty of Social Work, University of Toronto, Toronto, ON Canada

ABSTRACT

Background
Individuals with Fetal Alcohol Spectrum Disorder (FASD) have increased mortality as compared to the general population.

Objectives
To estimate the productivity losses due to premature mortality of individuals with FASD in Canada in 2011.

Methods
A demographic approach with a counterfactual scenario in which nobody in Canada is born with FASD was used. Population estimates were calculated using data on the labour force, unemployment rate, and average weekly wage obtained from Statistics Canada. The number of FASD-related deaths, coded in the International Classification of Diseases, version 10, was estimated based on data from Statistics Canada and pooled prevalence estimates of the major disease conditions associated with FASD were obtained from a meta-analysis. The estimates of FASD-related mortality rates served as a basis for the length of working life span estimation. Once the number of working years lost to premature deaths was derived, productivity losses were computed.

Results
It was estimated that in total 327 individuals with FASD aged 20 to 69 (almost twice as many men as women) died in Canada in 2011. As a result, there were 2,877 years of potential employment lost, which translated to a loss ranging from $88 million to $126 million. This amount represents the increase in national income, had there been no premature mortality from FASD and the workers with FASD had been typical members of the labour force (without compromised productivity due to FASD).

Conclusions
The estimates of productivity losses further reinforce the value of FASD prevention as a primary strategy.

Key Words: *Fetal Alcohol Spectrum Disorder; productivity losses; mortality; demographic approach; Canada*

Maternal alcohol consumption during pregnancy is an established cause of Fetal Alcohol Spectrum Disorder (FASD), a group of disorders where alcohol exposure causes congenital damage to the central nervous system and other systems and organs of the fetus that subsequently lead to a number of adverse health consequences. These are highly variable disorders with age and development dependent changes in phenotype.[1;2] However, FASD is considered as a "hidden"

disability and it is quite difficult to diagnose. It was roughly estimated that FASD occurs in about 1% of live births in the general population, which is higher than the prevalence of autism or Down syndrome in North America.[3] However, a more recent study suggests that the prevalence of FASD among school children may be as high as 2-5% in the US and some Western European countries.[4]

Also, high risk populations with higher drinking rates have increased likelihoods of alcohol-exposed pregnancies.[5,6]

FASD is associated with a vast number and wide range of health and behavioural problems with increased premature mortality (shorter life expectancy and higher mortality rates) as compared to the general population.[7-13] In a recent review of mortality in individuals with FASD, the two leading causes of death were malformations of the central nervous system and congenital cardiac abnormalities. The three other leading causes of death were sepsis, kidney malformations and cancer.[14] This study also revealed that over half of the reported deaths (54%) occurred in the first year of life.

In addition, because of difficulties "fitting into" mainstream life, the attempted suicide rate is much higher among persons with FASD (22%) as compared to the rate of the general US adult population (3%), and among persons with intellectual disabilities (8%).[15] Thus, it is expected that FASD is a substantial burden to society in production terms due to the disabilities and premature mortality of members in the labour force affected by this disorder.

FASD is a public health priority in Canada, and has significant potential for prevention, both for future births of infants prenatally exposed to alcohol and for the lifelong disabilities associated with FASD. The purpose of this study was to estimate the productivity losses of individuals with FASD due to their premature mortality as one dimension of the total cost of FASD on Canadian society.

METHODS

This method compares the current actual situation in Canada to a counterfactual scenario in which nobody is born with FASD. It uses the demographic method[16], and focuses only on the impact of market production (the productivity loss) from the premature mortality of individuals with FASD.

The choice of the counterfactual avoids some of the issues which bedevil the estimation of social costs such as how to deal with inflation, economic change and time discounting. It produces a spot estimate for a particular year (2011) as the result of effects back through time instead of the outcome through time (possibly discounted to a single aggregate) of the effects in a particular year. A consequence of this particular counterfactual is that the total will vary through time as a result of economic and population change, and it takes into consideration the business cycle (unemployment) and price changes (inflation). However in the medium term these will not change the order of magnitude.

The number of FASD-related deaths coded in the International Classification of Diseases, version 10 were estimated based on "Causes of Death" tables from Statistics Canada[17] and pooled prevalence estimates of the major disease conditions associated with FASD obtained from the meta-analysis conducted by Popova and colleagues.[18] A list of these disease conditions with the pooled prevalence estimates is available from the authors.

Estimated number of deaths by age group with FASD in Canada in 2011 was used to project past deaths in previous years for individuals with FASD and hence the total number who would have been alive in 2011 had they not had FASD.The 2011 FASD-related working life years lost estimate was used to calculate productivity losses for 2011.The value of that loss was estimated according to our earlier estimates of productivity due to disability.[19]

Canadian data on the labour force, unemployment rate and average weekly wage were obtained from Statistics Canada for the most recent available year (i.e., 2011).[20-24] All cost figures are presented in Canadian dollars.

RESULTS

Estimated Number of Deaths and Years of Potential Employment Lost of Individuals with FASD

There were an estimated 280 deaths of individuals with FASD among the population aged 20 to 69, and 327 of individuals with FASD aged 0 to 69 (almost twice as many men as women die from FASD-related conditions) in Canada in 2011 (Table 1).

Table 2 presents the years of potential employment lost for individuals with FASD as a result of premature mortality. We totalled up the number of years from the premature death to retirement age (62 years, the median age for retirement[22]) to obtain an estimate of 5,739 years of potential life lost as a result of the premature mortality of individuals with FASD.

These 5,739 years of potential life lost are spread out over the 62 years following 2011, a loss of 92.6 years from the cohort in an average year. However, each of the 61 previous years (before 2011) had some premature mortality that would contribute to the loss of potential employment in 2011. Because of population growth, the earlier cohorts are smaller, so the average 92.6 years loss of employment for 2011 was scaled back in line with the smaller population. The total loss of years of potential employment in 2011 from all the past cohorts would be 3,774 years (2,276 years for men and 1,498 years for women).

TABLE 1 Estimated number of deaths of individuals with FASD in Canada in 2011

Age Group	Men	Women	Total
0-19	27	20	47
20-29	17	13	29
30-44	32	23	55
45-59	80	30	110
60-69	54	31	86
0-69	209	118	327

TABLE 2 Estimated years of potential employment lost of individuals with FASD in Canada in 2011

Age Group	Men	Women	Total
0-19	1,246	927	2,173
20-29	619	464	1,083
30-44	784	574	1,358
45-59	795	303	1,098
60-69	17	10	27
0-69	3,461	2,278	5,739

Potential Years of Actual Employment Lost

Men spend on average 84% of the years between the ages of 15 and 62 in the paid labour force and women 80%.[22] Applying these ratios to the years of potential employment lost, the actual years of lost time in the labour force amounts to 3,107 years. This leaves 677 years when individuals were not in paid employment, though they may have been involved in contributions to the non-market economy (which are not included in these calculations). The unemployment rate in Canada in 2011 was 7.4%.[23] This gives the years of potential employment lost from premature mortality in 2011 as 2,877 (i.e., 3,107 x 92.6%).

The Value of the Productivity Loss

The estimates of productivity loss in worker number terms can be converted into market value by multiplying the effective reduction in workers by their marginal dollar product. The standard neo-classical assumption is that a worker's marginal product is the average wage.

The average weekly wage in Canada in 2011 was $840.07, equivalent to $43,804 annually.[24] However, it could be argued that the average worker with FASD comes from a more socially deprived background with a lower average wage than a typical member of the labour force. In order to provide a more conservative estimate, it was assumed that in the “low” estimate the actual wages for a person from a background which generates FASD is 30% lower than average, or $30,663 annually. The discount was calculated by noting that the Canadian minimum wage is about 40% of the average wage, and taking the midpoint between the two[20], so the chosen figure is halfway between the average and minimum wage.

This gives a range for the productivity loss from the premature mortality of individuals with FASD of $88 million to $126 million, for 2011. Thus, the national income of Canada would have been this much higher had there been no premature mortality from FASD and the workers with FASD had been typical members of the labour force (without compromised productivity due to FASD). This loss from premature mortality due to FASD is equivalent to 0.012-0.017% of wages and salaries paid to all employees in Canada in 2011.

DISCUSSION

These economic estimates of the monetary burden associated with premature mortality due to FASD may help policymakers to determine the allocation of funds on FASD prevention. As previous research has noted, failure to include these costs in decision-making (mostly due to a lack of available data) leads to an underestimation of societal costs.[25;26] Moreover, combined with other direct costs[27-31] such estimates provide an important measure of the total economic burden of FASD on society.

There are several limitations of this study. First, the *International Guidelines for Estimating the Costs of Substance Abuse* recommended using relative aetiological fractions in estimates of social costs.[16] However, these fractions do not exist for FASD. Therefore, the aetiological fractions were proxied by using deaths caused by FASD-related conditions. Further, the number of deaths of individuals with FASD was calculated by using mortality data for one single year (2008). Because the numbers are small, the numbers of deaths are likely to be volatile from year to year, and the standard errors of the resulting estimates large. The larger labour force would have induced additional investment, further adding to Canadian output (Gross Domestic Product; GDP). The estimates do not include this effect. Thus, the estimate of the productivity loss from premature mortality from FASD is a conservative one, but it is also subject to a wide margin of error.

These economic estimates of productivity losses associated with premature mortality due to FASD might be underestimated due to the following reasons. First, only deaths among individuals with FASD of productive age were considered, as all computations were performed based on a prevalence-based model. Thus, many FASD-related infant deaths were not included.

The reason for this is that current criteria for FASD are substantially age dependent. It is difficult to determine a diagnosis of FASD in infants and young children[1;2]: the criteria appear to be optimal for children ages 4 to mid-adolescence. Documentation of brain impairments in infants and young children is difficult.[2;32] For older children or adults, the determination of exposure is

complex since the mothers may not have ongoing contact with the child or adult. This makes mortality estimates for FASD almost certainly underestimates. For example, deaths in the first weeks of life may occur before FASD can be diagnosed; they may be attributed to sudden infant death syndrome or death from birth defects as examples. In addition the diagnostic criteria for FASD appear to be rarely used in Child Death Review teams or by medical examiners.[14;33]

In addition, the deaths of individuals with FASD, whose labour market participation was close to null (i.e., those over 69), were not included in this analysis.

Despite these limitations, the results of this study have confirmed that FASD is a significant burden to Canadian society. The productivity losses due to premature mortality are in addition to the productivity losses due to disability of individuals with FASD, which were estimated previously and were between $418 million and $1.23 billion for 2011.[19] The sum of these productivity losses totals between $506 million and $1.36 billion in 2011, reinforcing our conclusion that there is likely to be a good return from measures that reduce the incidence of FASD births.

Acknowledgements and Funding

This work was supported by the Public Health Agency of Canada (PHAC).

Corresponding Author: lana.popova@camh.ca

REFERENCES

1. Burd L, Cotsonas-Hassler TM, Martsolf JT, Kerbesian J. Recognition and management of fetal alcohol syndrome. Neurotoxicol Teratol 2003a;25(6):681-688.
2. Paintner A, Williams AD, Burd L. Fetal Alcohol Spectrum disorders-implications for child neurology, Part 2: Diagnosis and management. J Child Neurol 2012;27(3):355-362.
3. Substance Abuse and Mental Health Services Administration (SAMHSA), Fetal Alcohol Spectrum Disorders Center for Excellence. Fact Sheet: The Language of Fetal Alcohol Spectrum Disorders, 2004. Available from: http://www.fasdcenter.samhsa.gov/documents/WYNKLanguageFASD2.pdf
4. May PA, Gossage P, Kalberg WO, Robinson LK, Buckley D, Manning M, et al. Prevalence and epidemiologic characteristics of FASD from various research methods with an emphasis on recent in-school studies. Developmental Disabilities Research Reviews 2009;15:176-192.
5. Barry KL, Caetano R, Chang G, et al. Reducing Alcohol-Exposed Pregnancies: A Report of the National Task Force on Fetal Alcohol Syndrome and Fetal Alcohol Effect. U. S. Department of Heal Human Services, 2009. Available from: http://www.cdc.gov/ncbddd/fasd/documents/redalcohpreg.pdf
6. Nelson DE, Naimi TS, Brewer RD, Bolen J, Wells HE. Metropolitan-area estimates of binge drinking in the United States. Am J Public Health 2004;94:663–671.
7. Astley SJ, Clarren SK. Diagnostic Guide for Fetal Alcohol Syndrome and related conditions: The 4-digit Diagnostic Code. 2nd edition. Seattle, WA: University of Washington, 1999.
8. Burd L, Klug MG, Martsolf JT. Increased sibling mortality in children with fetal alcohol syndrome. Addict Biol 2004;9:179–86.
9. Burd L, Klug MG, Bueling R, et al. Mortality rates in subjects with fetal alcohol spectrum disorders and their siblings. Birth Defects Res Part A 2008;82:217–23.
10. Habbick BF, Nanson JL, Snyder RE, Casey RE. Mortality in fetal alcohol syndrome. Can J Public Health 1997;88:181–83.
11. Iyasu S, Randall LL, Welty TK, Hsia J, Mandell F, et al. Risk factors for sudden infant death syndrome among northern plains Indians. J Am Med Assoc 2002;288:2717–23.
12. Lemoine P, Harousseau H, Borteryu JP, Menuet JC. Les enfants de parents alcooliques: Anomalies observee a propos de 127 cas [The children of alcoholic parents: anomalies observed in 127 cases]. Quest Med 1968;21:476–82.
13. Stratton K, Howe C, Battaglia F. Fetal Alcohol Syndrome: Diagnosis, Epidemiology, Prevention, and Treatment. Washington, DC: National Academy Press, 1996.
14. Thompson A, Hackman D, Burd L. Mortality in fetal alcohol spectrum disorders. Journal of Pediatrics 2014;4:21-33.
15. Dubovsky D, Whitney N. Modifying approaches to improve outcomes for women in treatment who have Fetal Alcohol Spectrum Disorder. Paper presented at the 4th National Conference on

Women, Addiction and Recovery, Chicago, IL, 2010.
16. Single E, Collins D, Easton B. Harwood H, Lapsley H, Kopp P, et al. International Guidelines for Estimating the Costs of Substance Abuse (2nd ed.). Geneva, Switzerland: World Health Organization, 2003. Available from: http://apps.who.int/bookorders/anglais/detart1.jsp?codlan=1&codcol=15&codcch=561
17. Statistics Canada. Causes of deaths, 2008. CANSIM tables. Ottawa, Canada: Statistics Canada, 2008.
18. Popova S, Lange S, Shield K, Mihic A, Mukherjee RAS, Chudley AE, Bekmuradov D, Rehm J. Comorbidity of Fetal Alcohol Spectrum Disorder: A systematic literature review and meta-analysis. Presented to the 3rd European Conference on FASD. Rome, Italy, October 20-22, 2014.
19. Easton B, Burd L, Sarnocinska-Hart A, Rehm J, Popova S. Productivity losses because of morbidity attributable to fetal alcohol spectrum disorder in Canada: a demographic approach. J Stud Alcohol Drugs 2014;75(6):1011-7.
20. Statistics Canada. Perspectives on labour and income (Cat. no. 75-001-X). Ottawa, Canada: Statistics Canada, 2010.
21. Statistics Canada. Canada at a glance 2012: Population. CANSIM table 051-0005 (Cat. no. 89-645-X). Ottawa, Canada: Statistics Canada, 2012a. Available from: http://www.statcan.gc.ca/pub/12-581-x/12-581-x2012000-eng.htm
22. Statistics Canada. Canada at a glance 2012: Labour force characteristics, by sex (Table 18). CANSIM table 282-0002. Ottawa, Canada: Statistics Canada, 2012b. Available from: http://www.statcan.gc.ca/pub/12-581-x/2012000/l-t-eng.htm#t18
23. Statistics Canada. Canada at a glance 2012. Unemployment rate (Chart 11). CANSIM table 282-0002. Ottawa, Canada: Statistics Canada, 2012c. Available from: http://www.statcan.gc.ca/pub/12-581-x/2012000/c-g/desc/desc-c-g11-eng.htm
24. Statistics Canada. Canada at a glance 2012. Average weekly wage rate, by industry (Table 19). CANSIM table 282-0002. Ottawa, Canada: Statistics Canada, 2012d. Available from: http://www.statcan.gc.ca/pub/12-581-x/2012000/c-g/desc/desc-c-g11-eng.htm
25. Lupton C, Burd L, Harwood R. Cost of fetal alcohol spectrum disorders. Am J Med Genet C Semin Med Genet 2004;127C:42–50.
26. Popova S, Stade B, Bekmuradov D, Lange S, Rehm J. What do we know about the economic impact of fetal alcohol syndrome and fetal alcohol spectrum disorders?: a systematic literature review. Alcohol and Alcoholism 2011;46(4):490-497.
27. Popova S, Lange S, Burd L, Rehm J. Health care burden and cost associated with fetal alcohol syndrome: based on official Canadian data. PLoS ONE 2012;7(8):e43024. Available from http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0043024#close
28. Popova S, Lange S, Burd L, Chudley AE, Clarren SK, Rehm J. Cost of Fetal Alcohol Spectrum Disorder diagnosis in Canada. PLoS ONE 2013a;8(4):e60434. Available from:http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0060434.
29. Popova S, Lange S, Burd L, Urbanoski K, Rehm J. Cost of specialized addiction treatment of clients with Fetal Alcohol Spectrum Disorder in Canada. BioMed Central Public Health 2013b;13:570. Available from: http://www.biomedcentral.com/content/pdf/1471-2458-13-570.pdf.
30. Popova S, Lange S, Burd L, Rehm J. Canadian children and youth in care: The cost of Fetal Alcohol Spectrum Disorder. Child Youth Care Forum 2014a;43:83-96. Available from: http://link.springer.com/article/10.1007%2Fs10566-013-9226-x.
31. Popova S, Lange S, Burd L, Shield K, Rehm J. Cost of speech-language interventions for children and youth with Fetal Alcohol Spectrum Disorder in Canada. Int J Speech Lang Pathol 2014b;43:83-96. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3905182/pdf/10566_2013_Article_9226.pdf
32. Burd L, Klug MG, Martsolf JT, Kerbeshian J. Fetal alcohol syndrome: neuropsychiatric phenomics. Neurotoxical Teratol 2003b;25(6):697-705.
33. Burd L, Wilson H. Fetal, infant and child mortality in a context of alcohol use. Am J Med Genet C Semin Med Genet 2004;127C:51-58.