
Article

The Economic Burden of Fetal Alcohol Spectrum Disorder in Canada in 2013

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Abstract

Aim: To estimate the economic burden and cost attributable to Fetal Alcohol Spectrum Disorder (FASD) in Canada in 2013.

Methods: This cost-of-illness study examined the impact of FASD on the material welfare of the Canadian society in 2013 by analyzing the direct costs of resources expended on health care, law enforcement, children and youth in care, special education, supportive housing, long-term care, prevention and research, as well as the indirect costs of productivity losses of individuals with FASD due to their increased morbidity and premature mortality.

Results: The costs totaled approximately \$1.8 billion (from about \$1.3 billion as the lower estimate up to \$2.3 billion as the upper estimate). The highest contributor to the overall FASD-attributable cost was the cost of productivity losses due to morbidity and premature mortality, which accounted for 41% (\$532 million–\$1.2 billion) of the overall cost. The second highest contributor to the total cost was the cost of corrections, accounting for 29% (\$378.3 million). The third highest contributor was the cost of health care at 10% (\$128.5–\$226.3 million).

Conclusions: FASD is a significant public health and social problem that consumes resources, both economic and societal, in Canada. Many of the costs could be reduced with the implementation of effective social policies and intervention programs.

INTRODUCTION

The most recent Global Burden of Disease and Injury study reports that alcohol was the fifth leading contributor to disability and mortality—3.9% of global disability-adjusted life years and 5.2% of all global deaths were attributable to alcohol in 2010 (Lim *et al.*, 2012). However, alcohol consumption affects not only the drinker, but also other people associated with the drinker. A classic, and the

most dramatic example of such harm are the consequences of drinking during pregnancy such as Fetal Alcohol Spectrum Disorder (FASD).

The World Health Organization global strategy to monitor and reduce the harmful use of alcohol, endorsed by the Sixty-third World Health Assembly, highlights the importance of the prevention and identification of the harmful use of alcohol among pregnant women and women of childbearing age, and the treatment and care for

individuals and families affected by FASD (World Health Organization (WHO), 2010). Despite attempts to increase public awareness of the risks associated with drinking during pregnancy, a significant portion of pregnancies in Canada are alcohol-exposed: about 10% of women among the general population (Lange *et al.*, 2015), about 25% of women among a First Nations population in northwestern Ontario (Kelly *et al.*, 2011) and more than 60% of Inuit women in Arctic Quebec (Muckle *et al.*, 2011) drink during pregnancy.

Maternal alcohol consumption during pregnancy increases the risk for a wide range of adverse outcomes for both the mother and developing fetus, and is recognized to be the most common preventable cause of mental impairment in the western world (Stratton *et al.*, 1996). It is also an established cause of FASD, which is the non-diagnostic umbrella term used to characterize the full range of damage caused by prenatal alcohol exposure, varying from mild to severe and encompassing a broad array of deficits (Chudley *et al.*, 2005). FASD includes three alcohol-related categorical diagnoses: Fetal Alcohol Syndrome (FAS), Partial FAS (pFAS) and Alcohol-Related Neurodevelopmental Disorder (ARND; Chudley *et al.*, 2005), with FAS being the most severe and visibly identifiable form of FASD. Alcohol is a teratogen and therefore, prenatal alcohol exposure can affect any organ or system of the fetus. As a result, individuals with FASD may have a broad array of physical defects, cognitive, behavioral, emotional and adaptive functioning deficits, as well as congenital anomalies, such as malformations and dysplasia of the cardiac, skeletal, renal, ocular, auditory and other systems. A recent study revealed that over four hundred co-morbid conditions co-occur among individuals with FASD. Some of these co-morbid conditions (e.g. language, auditory, visual and mental and behavioral problems) are highly prevalent among individuals with FAS, ranging from 50 to 91% (Popova *et al.*, 2016). These impairments are likely to have lifelong implications.

Crude prevalence estimates suggest that approximately 1% of individuals in Canada may have FASD (Roberts and Nanson, 2000). However, the prevalence of FASD among special populations appears to be much higher: from 3.3% (Burge, 2007) to 11.3% (Fuchs *et al.*, 2005) among children in care, 0.9% (Burd *et al.*, 2003) to 23.4% (Fast *et al.*, 1999) among prisoners and 10.1% (Kowlessar, 1997) to 42.5% (Asante and Nelms-Matzke, 1985) among populations in isolated Northern communities.

Damage to the central nervous system is a unifying concept for nearly all of the FASD diagnoses (Chudley *et al.*, 2005; Burd *et al.*, 2009; Paintner *et al.*, 2012). Thus, FASD imparts a large burden on society through the health care system, mental health and substance abuse treatment services, foster care, criminal justice system and the long-term care of individuals with intellectual and physical disabilities.

To date, there are only a few FASD cost studies that have been conducted in Canada (Stade *et al.*, 2006, 2009; Thanh and Jonsson, 2009) and the United States (Harwood *et al.*, 1984, 1998; Harwood and Napolitano, 1985; Abel and Sokol, 1987, 1991a,b; Weeks, 1989; Rice *et al.*, 1990, 1991; Rice, 1993; Harwood, 2000, 2003). However, a comprehensive cost estimate with sound methodology is needed (Popova *et al.*, 2011b).

The purpose of the current study was to estimate the economic burden and cost attributable to FASD in Canada in 2013.

METHODS

This study was conducted within the framework of the revised *International Guidelines for Estimating the Costs of Substance Abuse* (Single *et al.*, 2003), and can be characterized as a cost-of-illness

study. In addition, the guidelines generated during the first National Roundtable held by the Public Health Agency of Canada were also employed (Public Health Agency of Canada (PHAC), 2008a,b), and the methodologies of the few existing studies listed above on the economic cost of FASD from Canada and the United States were taken into consideration.

In the current study, the impact of FASD on the material welfare of the Canadian society was examined by analyzing the direct costs of resources expended on health care, law enforcement, children and youth in care, special education, supportive housing, long-term care, prevention and research, as well as the indirect costs of productivity losses of individuals with FASD due to their increased morbidity and premature mortality. As a general principle, the most conservative approach (using the lower cost alternative where appropriate alternatives exist) was always used. Also, sensitivity analyses on the main assumptions used for each individual cost component were conducted wherever possible, which will allow the readers and policy makers to determine costs for alternative assumptions. In order to estimate the number of FASD cases in Canada in a specific year, the most commonly cited rough estimate of the prevalence of FAS (1 per 1000; Public Health Agency of Canada (PHAC), 2003) and FASD (9 per 1000; Roberts and Nanson, 2000) was applied to the general population of Canada.

The present study employed the economic model, which was developed to calculate a comprehensive, evidence-based picture of the economic impact of FASD in Canada (Popova *et al.*, 2012b,c). The estimation of each cost driver in this study was based on its own methodology and set of assumptions, and expert opinions were sought wherever data was not readily available. Short descriptions of the methodology for each cost driver will follow; however, for a detailed description of the methodology, please see the full report by Popova *et al.* (2015a).

All cost figures estimated in this study are presented in Canadian dollars. Each cost component was estimated for the most recent year of available data (from 2008 to 2012), and then adjusted for inflation to 2013, using the Bank of Canada inflation calculator (<http://www.bankofcanada.ca/rates/related/inflation-calculator/>). It should be noted that the total cost estimated in the current study is not a lifetime cost, but instead is the cost that FASD imparts on Canadian society in a given year.

Direct costs

Direct health care costs

Acute inpatient care, psychiatric care, emergency department visits and day surgery visits. As a result of the increased morbidity (Popova *et al.*, 2016), FASD is a substantial burden to society in relation to the health care costs involved in caring for affected individuals. Given that FAS is the only FASD diagnosis coded in the International Classification of Diseases [ICD; in the ICD, Ninth Revision, Clinical Modification—Alcohol affecting fetus or newborn via placenta or breast milk 760.71, and in the ICD, Tenth Revision (ICD-10)—Fetal alcohol syndrome (dysmorphic) Q86.0], it is the only diagnosis that can be extracted from health records/databases. Data on acute inpatient care, psychiatric care, emergency department visits and day surgery visits where a diagnosis of FAS was captured as either the most responsible diagnosis (defined as the single diagnosis that describes the most significant condition of the patient that is responsible for his or her stay in hospital), secondary or other diagnosis, were directly obtained from the Canadian Institute for Health Information (CIHI; <http://www.cihi.ca>) for the 2008/09 fiscal year. The average cost per day in

acute and psychiatric care and the average cost per hospitalization for emergency department visits and day surgery by province and territory were obtained from CIHI. The cost of each health care service type was calculated by multiplying the average cost for each service by the respective number of hospital days/visits. For additional methodological details, please see [Popova et al. \(2012a\)](#).

Screening and diagnosis. The diagnosis of FASD is a complex task and currently in Canada, the recommendation is that diagnosis be achieved through a comprehensive, multidisciplinary assessment involving a wide range of specialists ([Chudley et al., 2005](#)). The number of hours required by each specialist involved in the diagnostic process was estimated, based on experts' opinion. The average rate per hour for each respective specialist was then estimated based on hourly costs across Canada. The number of FASD assessment slots available for diagnostic purposes per year in Canada was obtained from the 2011 survey conducted by the Canada Northwest FASD Research Network ([Clarren et al., 2011](#)). In order to estimate the number of cases diagnosed per year, it was assumed (based on [Clarren and Lutke, 2008](#)) that at most, about 70% (used as the upper estimate) of all individuals referred and evaluated are actually diagnosed with FASD in Canada. Fifty percent was then used as the lower estimate as a sensitivity analysis. The cost of FASD diagnosis per person was then applied to the number of cases diagnosed per year in Canada. For details on the methodology, please see [Popova et al. \(2013a\)](#).

Specialized addiction treatment. Individuals with FASD constitute a special population that may be at particularly high risk for substance use ([Famy et al., 1998](#)). Data on specialized addiction treatment services (SATS) by lifetime mental disorder status were obtained from the Drug and Alcohol Treatment Information System (DATIS; <http://www.datis.ca>) in Ontario, Canada for 2010/11. The number of clients with FASD, who received SATS in Ontario in 2010/11 was estimated, assuming that approximately 37% [95% confidence interval (CI): 21.6–54.5%; weighted pooled prevalence calculated by the authors, based on the available epidemiological literature] of individuals with FASD abuse or are addicted to alcohol and/or drugs and that their utilization rate of SATS is the same as those for people with a lifetime mental disorder. The data from DATIS were then projected to the respective provincial and territorial populations. For the detailed methodology, please see ([Popova et al., 2013b](#)).

Prescription drugs. As a result of the increased morbidity ([Popova et al., 2016](#)), individuals with FASD are frequent prescription drug users. In order to estimate the number of individuals with FASD who use prescription drugs in Canada, the percentage of individuals with FASD using prescription drugs (66.4%; [Brownell et al., 2013](#)) was applied to the total number of individuals with FASD in Canada in 2012. The average annual per person cost of prescription medication (\$232, which does not include dispensing fees; [Fuchs et al., 2009](#)) was applied to the total estimated number of individuals with FASD who use prescription drugs.

Speech-language interventions. Speech-language disorders (SLD) appear to occur at a disproportionately high rate among individuals with FASD ([Church et al., 1997](#)). The number of children and youth with FASD with SLD was estimated using the pooled prevalence of 59.6% (95% CI: 43.4–74.8%), calculated by the authors, based on the available epidemiological and medical literature. The distribution of the level of severity and the number of hours needed to treat were also estimated using data from the available literature ([Law et al.,](#)

[2003](#); [Coggins et al., 2007](#)). The cost of one-on-one speech-language interventions among children and youth with FASD was computed using the average cost per hour for a speech-language pathologist [\$75 (lower estimate) to \$149 (upper estimate), obtained from a survey conducted by the Canadian Association of Speech-Language Pathologists and Audiologist]. For a detailed methodology, please see [Popova et al. \(2014b\)](#).

Direct law enforcement costs

Corrections. Individuals with FASD have a higher-risk of being involved in the legal system, either as offenders or victims, due to their organic brain damage ([LaDue and Dunne, 1997](#)). To estimate the number of youth and adults with FASD in custody, the prevalence of FASD in the Canadian correctional system, obtained from the current epidemiological literature ([Popova et al., 2011a](#)), was applied to the average number of youths and adults in the correctional system in 2011/12 ([Statistics Canada, 2013a,b,c](#)). The average daily cost to imprison an inmate for provincial and territorial custody and federal custody, obtained for the [Canadian Centre for Justice Statistics \(2012\)](#), was then applied to the estimated number of incarcerated youths and adults with FASD. It was assumed that youths and adults were in custody for one year. For details on the methodology, please see [Popova et al. \(2015b\)](#).

Other direct costs

Children in care. Children in care are considered to be at higher-risk for having been prenatally exposed to alcohol and thus, the risk of FASD in this population is envisioned to be high ([Herrick et al., 2011](#)). The prevalence of children in care by province/territory was obtained from the Centre for Research on Children and Families' Canadian Child Welfare Research Portal ([Centre for Research on Children and Families \(CRCF\), 2011](#)). To estimate the total number of children in care with FASD for each province and territory, the existing prevalence estimates [33 per 1000 ([Burge, 2007](#)) and 113, per 1000 ([Fuchs et al., 2005](#))] were applied (as the lower and the upper estimates, respectively) to the total number of children in care in Canada. In order to calculate the total cost, the cost per individual per day, by age group ([Fuchs et al., 2008](#)) was multiplied by 365 (number of days in the year) and applied to the respective number of children in care with FASD. For the methodological details, please see [Popova et al. \(2014a\)](#).

Special education. FASD is associated with learning and behavioral problems, developmental disabilities and speech-language deficits, all of which increase the need for special education services, and the risk of poor academic achievement if such services are not received ([Streissguth et al., 2004](#)). In order to estimate the number of children in Canada receiving special education, the proportion of children with disabilities receiving special education by sex and age group, obtained from the *Participation and Activity Limitation Survey 2006* ([Statistics Canada, 2008b](#)), was applied to the number of children with disabilities in each Canadian province and territory in 2011/12. Then, in order to estimate the number of children with FASD receiving a special education and cost of special education per child per year, a short survey was sent to the Minister of Education for each province and territory. Lastly, in order to estimate the cost of special education among children with FASD, the average estimated cost of special education per child for each province and territory was applied to the estimated number of children with FASD receiving special education. For the detailed methodology, please see [Popova et al. \(2015c\)](#).

Supportive housing and long-term care. Many people with FASD cannot live independently due to their mental and physical disabilities, as well as many other problems including addiction and poverty (Streissguth *et al.*, 1996). The number of adults with FASD who use supportive housing or long-term care services was estimated based on data from Streissguth *et al.* (1996), and expert opinion. The daily cost of supportive housing and long-term care per person was obtained from the *Turning the Key* report (Trainor *et al.*, 2013). The respective daily costs were applied to the estimated number of adults with FASD in the each respective service category/facility. For the detailed methodology, please see Popova *et al.* (2015a).

Prevention and research. Given that there are no systematic sources that report on the direct costs of prevention and research associated with FASD in Canada, the data were requested from major federal and provincial agencies, as well as from key informants.

Indirect costs

Productivity losses due to morbidity and premature mortality

The estimations adopt a counterfactual scenario in which no individual in the population was born with FASD. It uses the 'demographic' method (Single *et al.*, 2003), and focuses only on the impact of market production (the productivity loss) from the morbidity and premature mortality of individuals with FASD. Canadian data on population by province and territory, the labor force, unemployment rate and the average weekly wage were obtained from Statistics Canada (2010, 2012a,b,c,d).

Productivity losses due to morbidity. A significant portion of the societal economic burden from FASD results from lost productivity and decreased participation in the workforce. Assumptions made regarding the level of impairment that would affect the ability of individuals with FASD to participate in the workforce or reduce their productivity were based on data obtained from the current epidemiological literature and experts' opinion. For the methodological details, please see Easton *et al.* (2014).

Productivity losses due to premature mortality. The number of FASD-related deaths, coded in the ICD-10, was estimated based on data from Statistics Canada (2008a). Pooled prevalence estimates of the major disease conditions associated with FASD were obtained from meta-analyses (Popova *et al.*, 2016). 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. For the detailed methodology, please see Easton *et al.* (2015).

RESULTS

Direct costs

Direct health care costs

Acute inpatient care, psychiatric care, emergency department visits and day surgery visits. Based on official data from CIHI in 2008/09 there were 7974 acute care hospital days, 2905 psychiatric care hospital days, 43 day surgery visits and 45 emergency department visits that occurred among individuals diagnosed with FAS. Subsequently, it was estimated that the cost for acute care hospital days, psychiatric care hospital days and day surgery hospitalizations associated with a diagnosis of FAS was approximately \$5.5 million, \$1.2 million and \$6.7 thousand, respectively. The cost of emergency department visits associated with a diagnosis of FAS in Ontario was \$8.5 thousand. The total direct health care cost of acute care, psychiatric care, day surgery and emergency department services associated with FAS, was about \$6.7 million (Table 1). The vast majority of the most responsible diagnoses (which account for the majority of a patient's length of stay in hospital) among individuals with FAS fell within the ICD-10 category Mental and Behavioral Disorders (F00–F99).

Screening and diagnosis. It was estimated that a complete multidisciplinary FASD diagnostic evaluation requires 32–47 h for one individual to be screened, referred, admitted and diagnosed [1–2 h for screening and referral, 2–4 h for intake, 23–33 h for diagnosis (physical, dysmorphology and neurobehavioral assessments, as well as obtaining information related to prenatal alcohol exposure) and 6–8 h for general support]. The complete evaluation was estimated to cost a total of \$3110–\$4570 per person. Based on the existing clinical capacity, it was estimated that the total cost of FASD diagnostic services in Canada ranges from \$3.6 to \$5.2 million (lower estimate), up to \$5.0–\$7.3 million (upper estimate) per year.

Specialized addiction treatment. It was estimated that there were 546 admissions resulting in 5526 visits to outpatient treatment services, 189 admissions resulting in 7335 days in residential treatment services and 856 admissions resulting in 2194 days in residential withdrawal management services among clients with FASD in Canada in 2010/11. Overall, it was estimated that 1591 admissions, 5526 outpatient visits and 9529 residential care days were among clients with FASD

Table 1. Number of recorded acute care and psychiatric care hospital days and day surgery and emergency department visits associated with a diagnosis of FAS, and the associated cost in Canada in 2008/09, and adjusted for inflation for 2013

Level of care	Age groups (years)							Total number of days/visits	Cost	
	0–14	15–29	30–44	45–59	60–69	70–79	80+		2008/09	2013 ^a
Number of acute care hospital days	2911	3628	973	356	32	74	0	7974	\$5,458,123	\$5,802,336
Number of psychiatric care hospital days	308	1353	1230	14	0	0	0	2905	\$1,198,545	\$1,273,805
Number of day surgery visits ^b	26	9	5	<5	0	0	0	42.5	\$6693	\$7092
Number of emergency department visits (Ontario only)	18	24	<5	0	0	0	0	44.5	\$8500	\$9220
Total									\$6,671,861	\$7,092,453

Note. In instances where there were fewer than five cases (<5), a midpoint of 2.5 was imputed for those cells. Due to rounding errors, columns may not add up to the total reported.

^aAdjusted for inflation, to 2013 cost figures, using the Bank of Canada inflation calculator.

^bData from Quebec and Alberta are not included.

who received SATS. The total cost of SATS for clients with FASD ranged from \$1.65 to \$3.59 million, based on 5526 outpatient visits and 9529 resident days in 2010/11 (Table 2).

Prescription drugs. It was estimated that 177 316 individuals, 0–64 years of age, with FASD used prescription drugs in Canada in 2012, which totaled \$41.1 million (Supplementary Table S1).

Speech-language interventions. It was estimated that there were 37 928 children with FASD and SLD in Canada in 2011 (Supplementary Table S2). There were 17 067 children with FASD who had mild SLD (8757 boys and 8311 girls), and 20 860 children with FASD who had moderate-to-severe SLD (10 703 boys and 10 157 girls). The total cost associated with one-to-one speech-language interventions for children with FASD with mild SLD ranged from \$25.6 to \$50.9 million. For children with FASD with moderate-to-severe SLD, the total costs associated with one-to-one speech-language interventions ranged from \$46.9 to \$94.8 million. Therefore, the total annual cost of one-to-one speech-language interventions for children with FASD ranged from \$72.5 to \$144.1 million.

Direct law enforcement costs

Corrections. It was estimated that there were 183–374 (mean: 278; 16.6%) youths with FASD and 3870 adults with FASD in custody on any given day in Canada in 2011/12. Accordingly, the cost of corrections among youths with FASD was calculated to be approximately \$17.5 million (\$13.6 million for males and \$3.8 million for females) and among adults with FASD was estimated to be about \$356.2 million (\$140 million for provincial and territorial custody and \$216.2 million for federal custody; Supplementary Table S3).

Other direct costs

Children in care. The estimated number of children in care with FASD ranged from 2225 to 7620 in Canada in 2011. The overall cost attributable to FASD among children in care ranged from \$57.9 to \$198.3 million (boys: \$36.0–\$123.4 million; girls: \$21.9–\$75.0 million; Supplementary Table S4).

Special education. It was estimated that there were 2465 children (1603 boys and 862 girls) with FASD between the ages of 5–9 years and 4055 children (2563 boys and 1492 girls) with FASD between the ages of 10–14 years receiving some form of special education in Canada in 2011/12 (Supplementary Table S5). The cost for special

education among children 5–9 years of age with FASD was \$20.2 million (\$13.2 million for boys with FASD and \$7.1 million for girls with FASD), and the cost for special education among children 10–14 years of age with FASD was \$33.3 million (\$21.0 million for boys with FASD and \$12.2 million for girls with FASD). Therefore, the total cost of special education among children with FASD in elementary and middle school (i.e. children 5–14 years of age) was estimated to be \$53.3 million (\$34.2 million among boys with FASD and \$19.3 million among girls with FASD) in Canada in 2011/12.

Supportive housing and long-term care. It was estimated that 7992 adults with FASD were in supportive housing or long-term care in Canada in 2012. Forty percent of them (3197) resided in supportive housing with low supports, 40% (3197) resided in supportive housing with high supports and 20% (1598) resided in long-term care. The cost of supportive housing for adults with FASD was estimated to range from \$22.2 to \$134.2 million (\$22.2–\$51.3 million for supportive housing with low support, and \$95.7–\$134.2 million for supportive housing with high support), and the cost of long-term care among adults with FASD was estimated to be approximately \$78.2 million in Canada in 2012.

Prevention and research. Based on data from the largest Canadian agencies only (Canada FASD Research Network, Canadian Foundation on Fetal Alcohol Research, Canadian Institute of Health Research, NeuroDevNet and the Public Health Agency of Canada), it was estimated that approximately \$7.5 million was spent on FASD prevention and research in Canada in 2013.

Indirect costs

Productivity losses due to disability. It was estimated that if there were no cases of FASD in Canada, then the effective workforce would increase by the equivalent of 13 647–28 082 individuals. As such, the estimated national income of Canada would increase between \$418 million and \$1.08 billion, if Canada had no cases of FASD. The compromised work productivity of individuals with FASD resulted in an average annual loss of \$6885–\$17 868 (or 24.2–49.9% of potential wages) for each person with FASD.

Productivity losses due to premature mortality. It was estimated that 327 individuals with FASD aged 20–69 died in Canada in 2011. As a result, there were 2877 years of potential employment lost, which translated to a loss ranging from \$88 to \$126 million. This amount represents the increase in national income, had there been no

Table 2. Estimated number of admissions, outpatient visits, resident days and cost of SATS among clients with FASD in Canada in 2010/11, and adjusted for inflation for 2013

Number of admissions, outpatient visits and resident days; associated cost	Types of SATS among clients with FASD			
	Outpatient	Residential	Withdrawal	Total
Number of admissions	546	189	856	1591
Number of visits	5526	–	–	5526
Number of days	–	7335	2194	9529
Cost (lower estimate), 2010/11	\$331,569	\$1,012,177	\$302,825	\$1,646,571
Cost (upper estimate), 2010/11	\$602,350	\$2,303,069	\$689,037	\$3,594,456
Cost (lower estimate), 2013 ^a	\$349,506	\$1,066,741	\$319,137	\$1,735,384
Cost (upper estimate), 2013 ^a	\$634,925	\$2,427,186	\$726,224	\$3,788,335

Note. Due to rounding errors, rows may not add up to the total reported.

^aAdjusted for inflation, to 2013 cost figures, using the Bank of Canada inflation calculator.

FASD, fetal alcohol spectrum disorder; SATS, specialized addiction treatment services.

premature mortality from FASD and the workers with FASD had been typical members of the labor force (without compromised productivity due to FASD).

Total cost associated with FASD in Canada in 2013

The cost associated with FASD (based on the cost drivers included in this study) totaled approximately \$1.8 billion (from about \$1.3 as the lower estimate up to \$2.3 billion as the upper estimate) in Canada in 2013 (Table 3).

The highest contributor to the overall FASD-attributable cost was the cost of productivity losses due to morbidity and premature mortality, which accounted for 41% (\$532 million to \$1.2 billion) of the overall cost. The second highest contributor to the total cost was the cost of corrections, accounting for 29% (\$378.3 million). The third highest contributor was the cost of health care at 10% (\$128.5–\$226.3 million; Fig. 1).

DISCUSSION

FASD is clearly a significant public health and social problem that consumes a large amount of resources, both economic and societal, in Canada. Behind the cost figures is the dramatic toll FASD has on the affected individuals themselves, measured in terms of years lost due to premature mortality, years of productive life lost due to primary disabilities (such as health problems) and a low quality of life due to the secondary disabilities (for example, unemployment, poverty, homelessness, incarceration, etc.; Streissguth *et al.*, 1996). However many 'costs' associated with FASD are non-monetary (or intangible) costs such as pain, suffering and stress, associated with the numerous

disabilities of individuals with FASD, which are very difficult to quantify. The intangible costs are borne not only by the individuals with FASD themselves, but also by their parents/caregivers, siblings and other family members (for example, guilt of mother, bereavement and stigmatization). However, many of the costs associated with FASD can be reduced with the implementation of effective social policies and intervention programs (see, for example, Grant and Casey Family Programs, 2013).

There were two major challenges associated with estimating the FASD-attributable burden and cost in Canada. First, the prevalence of FASD is currently unknown in Canada, and therefore, as stated above, the most commonly cited rough estimates of the prevalence of FAS and FASD in the general population of Canada were used in the current study, which may not be accurate. Second, several cost drivers were not possible to include in the study (e.g. courts and policing, productivity losses of parents and caregivers and respite care) because the minimum required data are simply not available to make a comprehensive or reliable cost estimate. As such, there is an urgent need for a centralized reporting system in which FASD-specific data from various sectors can be stored and shared.

Furthermore, as stated above, this study used the most conservative assumptions, which means that the estimated costs are the minimal costs associated with FASD for Canadian society. Therefore, the total cost is most likely an underestimation of the actual economic burden of FASD in Canada. This study used the best available data and provides a working estimate of the cost attributable to FASD. However, when better data become available, further research can refine these estimates over time.

To conclude, these cost figures, as powerful arguments, should not be misused for the further stigmatization of mothers with alcohol

Table 3. A summary of the costs attributable to FASD in Canada in 2013

Cost component	Cost ^a	
	Lower estimate	Upper estimate
Direct costs		
Direct health care costs		
Speech-language interventions	\$74,410,300	\$147,828,462
Prescription drugs	\$41,646,377	\$41,646,377
Acute inpatient care, psychiatric care, emergency department visits and day surgery visits (FAS only)	\$7,092,453	\$25,532,832
Screening and diagnosis	\$3,649,751	\$7,508,394
Specialized addiction treatment	\$1,735,384	\$3,788,335
Total	\$128,534,266	\$226,304,401
Direct law enforcement costs		
Corrections: youth	\$17,711,057	\$17,711,057
Corrections: adults	\$360,603,927	\$360,603,927
Total	\$378,314,984	\$378,314,984
Other direct costs		
Children and youth in care	\$59,413,222	\$203,445,276
Supportive housing	\$22,279,783	\$134,851,320
Long-term care	\$78,565,552	\$78,565,552
Special education	\$54,192,788	\$54,192,788
Prevention and research	\$7,508,000	\$7,508,000
Total	\$221,959,345	\$478,562,936
Indirect costs		
Productivity losses due to morbidity	\$428,798,333	\$1,102,462,562
Productivity losses due to premature mortality	\$103,100,666	\$128,620,632
Total	\$531,898,999	\$1,231,083,194
Overall cost	\$1,287,707,594	\$2,341,265,515

Note. Due to rounding errors, columns may not add up to the total reported.

^aAdjusted for inflation, to 2013 cost figures, using the Bank of Canada inflation calculator.

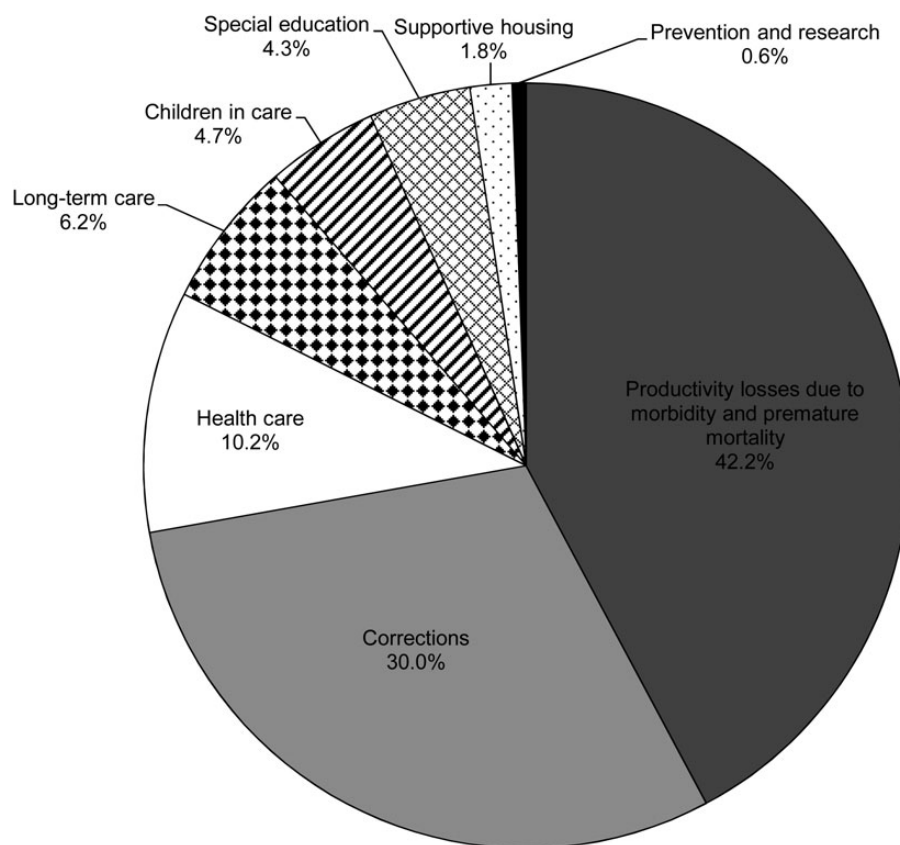


Fig. 1. Contributing percentage of each main cost component attributable to the overall cost of FASD in Canada in 2013. Note. Proportions are based on the lower cost estimates, wherever available.

dependence. Rather, they should be used as strong scientific evidence demonstrating the burden and cost associated with FASD for policy makers formulating policies on programs and funding support for the numerous activities required to improve the lives of people with FASD and their families, and to prevent further alcohol-exposed pregnancies.

SUPPLEMENTARY MATERIAL

Supplementary Material is available at *Alcohol and Alcoholism* online.

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CONFLICT OF INTEREST STATEMENT

None declared.

REFERENCES

- Abel EL, Sokol RJ. (1987) Incidence of fetal alcohol syndrome and economic impact of FAS-related anomalies. *Drug Alcohol Depend* 19:51–70.
- Abel EL, Sokol RJ. (1991a) A revised estimate of the economic impact of fetal alcohol syndrome. In Glanter M (ed). *Recent Developments in Alcoholism: Children of Alcoholics*, Vol. 9. New York: Plenum Press, 117–25.
- Abel EL, Sokol RJ. (1991b) A revised conservative estimate of the incidence of FAS and its economic impact. *Alcohol Clin Exp Res* 15:514–24.
- Asante KO, Nelms-Maztke J. (1985) Report on the survey of children with chronic handicaps and Fetal Alcohol Syndrome in the Yukon and Northwest British Columbia. Whitehorse, YT: Council for Yukon Indians 1985.
- Brownell MD, de B Hanlon-Dearman AC, MacWilliam LR, et al. (2013) Use of health, education, and social services by individuals with fetal alcohol spectrum disorder. *J Popul Ther Clin Pharmacol* 20:e95–106.
- Burd L, Selfridge R, Klug M, et al. (2003) Fetal alcohol syndrome in the Canadian corrections system. *J FAS* 1:e14.
- Burd L, Carlson C, Kerbeshian J. (2009) Mental health disorders comorbid with fetal alcohol spectrum disorders. In Sher L, Kandel I, Merrick J (eds). *Alcohol-related Cognitive Disorders*. New York, US: Nova Science Publishers, Inc, 111–23.

- Burge P. (2007) Prevalence of mental disorders and associated service variables among Ontario children who are permanent wards. *Can J Psychiatry* 52:305–14.
- Canadian Centre for Justice Statistics. Adult correctional statistics in Canada, 2010/2011 (85-002-X). (2012) Ottawa, ON: Statistics Canada, Canadian Centre for Justice Statistics.
- Centre for Research on Children and Families (CRCF). (2011) *Statistics*. Canadian Child Welfare Research Portal: CRCF. Available from <http://www.cwrp.ca/statistics> (10 February 2012, date last accessed).
- Chudley A, Conry J, Cook J, et al. (2005) Fetal alcohol spectrum disorder: Canadian guidelines for diagnosis. *Can Med Assoc J* 172(Suppl 5):S1–21.
- Church MW, Eldis F, Blakley BW, et al. (1997) Hearing, language, speech, vestibular, and dentofacial disorders in fetal alcohol syndrome. *Alcohol Clin Exp Res* 21:227–37.
- Clarren SK, Lutke J. (2008) Building clinical capacity for fetal alcohol spectrum disorder diagnoses in western and northern Canada. *Can J Clin Pharmacol* 15:e223–37.
- Clarren SK, Lutke J, Sherbuck M. (2011) The Canadian guidelines and the interdisciplinary clinical capacity of Canada to diagnose fetal alcohol spectrum disorder. *J Popul Ther Clin Pharmacol* 18:e494–9.
- Coggins TE, Timler GR, Olswang LB. (2007) A state of double jeopardy: Impact of prenatal alcohol exposure and adverse environments on the social communicative abilities of school-age children with fetal alcohol spectrum disorder. *Lang Speech Hear Serv Sch* 38:117–27.
- Easton B, Burd L, Sarnocinska-Hart A, et al. (2014) Productivity losses because of morbidity attributable to fetal alcohol spectrum disorder in Canada: a demographic approach. *J Stud Alcohol Drugs* 75:1011–7.
- Easton B, Burd L, Sarnocinska-Hart A, et al. (2015) The cost of lost productivity due to fetal alcohol spectrum disorder-related premature mortality. *J Popul Ther Clin Pharmacol* 22:e3–8.
- Famy C, Streissguth AP, Unis AS. (1998) Mental illness in adults with fetal alcohol syndrome or fetal alcohol effects. *Am J Psychiatry* 155:552–4.
- Fast DK, Conry J, Look CA. (1999) Identifying fetal alcohol syndrome among youth in the criminal justice system. *J Dev Behav Pediatr* 20:370–2.
- Fuchs D, Burnside L, Marchenski S, et al. (2005) *Children with Disabilities Receiving Services From Child Welfare Agencies in Manitoba*. Ottawa, ON, Canada: Centre of Excellence for Child Welfare.
- Fuchs D, Burnside L, Marchenski S, et al. (2008) *Economic Impact of Children in Care with FASD, Phase 1: Cost of Children in Care with FASD in Manitoba*. Ottawa, ON, Canada: Centre of Excellence for Child Welfare.
- Fuchs D, Burnside L, DeRiviere L, et al. (2009) *The Economic Impact of Children in Care with FASD and Prenatal Alcohol Issues. Phase II: Costs and Service Utilization of Health Care, Special Education and Child Care*. Ottawa, ON, Canada: Centre of Excellence for Child Welfare.
- Grant T, Casey Family Programs. (2013) *Parent-Child Assistance Program Outcomes Suggest Sources of Cost Savings for Washington State*. Seattle, US: University of Washington.
- Harwood H. (2000) *Updating estimates of the economic costs of alcohol abuse in the United States: Estimates, Update Methods, and Data*. Report prepared by the Lewin Group for the National Institute on Alcohol Abuse and Alcoholism 2000. Based on estimates, analyses, and data reported in Harwood H., Fountain D., Livermore G. The Economic Costs of Alcohol and Drug Abuse in the United States 1992. Report prepared for the National Institute on Drug Abuse and the National Institute on Alcohol Abuse and Alcoholism. National Institutes of Health, Department of Health and Human Services, NIH Publication No. 98–4327. Rockville, MD, US: National Institutes of Health.
- Harwood H. (2003) *Economic costs of fetal alcohol syndrome* [Power Point Presentation]. Prepared for the Lewin Group. Bethesda, MD, US: National Institute on Alcohol Abuse and Alcoholism.
- Harwood H, Napolitano DM. (1985) Economic implications of the fetal alcohol syndrome. *Alcohol Health Res World* 10:38–43.
- Harwood H, Napolitano DM, Kristiansen PL. (1984) *Economic Costs to Society of Alcohol and Drug Abuse and Mental Illness: 1980*. Rockville, MD, US: Alcohol Drug Abuse and Mental Health Administration.
- Harwood H, Fountain D, Livermore G. (1998) *The Economic costs of alcohol and drug abuse in the United States 1992*. Report prepared for the National Institute on Drug Abuse and the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health, Department of Health and Human Services, NIH Publication No. 98–4327. Rockville, MD, US: National Institutes of Health.
- Herrick K, Hudson L, Burd L. (2011) The elephant in the cradle: fetal alcohol spectrum disorders. *Zero Three J* 31:44–50.
- Kelly L, Dooley J, Cromarty H, et al. (2011) Narcotic-exposed neonates in a First Nations population in northwestern Ontario. Incidence and implications. *Can Fam Physician* 57:e441–7.
- Kowlessar DL. (1997) An examination of the effects of prenatal alcohol exposure on school-age children in a Manitoba First Nation community: A study of fetal alcohol syndrome prevalence and dysmorphology [Master's thesis]. Winnipeg, MB: University of Manitoba.
- LaDue RA, Dunne T. (1997) Legal issues and FAS. In Streissguth AP, Kanter J (eds). *The Challenges of Fetal Alcohol Syndrome: Overcoming Secondary Disabilities*. Seattle, US: University of Washington Press, 146–61.
- Lange S, Quere M, Shield K, et al. (2015) Alcohol use and self-perceived mental health status among pregnant and breastfeeding women in Canada: a secondary data analysis. *BJOG*. [epub ahead of print].
- Law J, Garrett Z, Nye C. (2003) Speech and language therapy interventions for children with primary speech and language delay or disorder (Review). *Cochrane Database of Syst Rev* 3:CD004110.
- Lim SS, Vos T, Flaxman AD, et al. (2012) A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 380:2224–60. (Errata published in 2013 *Lancet* 381: 628, and 2013 *Lancet* 381: 1276).
- Muckle G, Laflamme D, Gagnon J, et al. (2011) Alcohol, smoking, and drug use among Inuit women of childbearing age during pregnancy and the risk to children. *Alcohol Clin Exp Res* 35:1081–91.
- Paintner A, Williams AD, Burd L. (2012) Fetal alcohol spectrum disorders—implications for child neurology, part 1: prenatal exposure and dosimetry. *J Child Neurol* 27:258–63.
- Popova S, Lange S, Mihic A, et al. (2011a) Fetal alcohol spectrum disorder prevalence estimates in correctional systems: a systematic literature review. *Can J Public Health* 102:336–40.
- Popova S, Stade B, Bekmuradov D, et al. (2011b) What do we know about the economic impact of fetal alcohol syndrome and fetal alcohol spectrum disorders: a systematic literature review. *Alcohol Alcohol* 46:490–7.
- Popova S, Lange S, Burd L, et al. (2012a) Health care burden and cost associated with fetal alcohol syndrome in Canada: based on official Canadian data. *PLoS One* 7:e43024.
- Popova S, Stade B, Lange S, et al. (2012b) *Methodology for Estimating the Economic Impact of Fetal Alcohol Spectrum Disorder*. Toronto, ON, Canada: Centre for Addiction and Mental Health, ISBN: 978–1–77052–990–8.
- Popova S, Stade B, Lange S, et al. (2012c) A model for estimating the economic impact of Fetal Alcohol Spectrum Disorder. *J Popul Ther Clin Pharmacol* 19:e51–65.
- Popova S, Lange S, Burd L, et al. (2013a) Cost of fetal alcohol spectrum disorder diagnosis in Canada. *PLoS One* 8:e60434.
- Popova S, Lange S, Burd L, et al. (2013b) Cost of specialized addiction treatment of clients with fetal alcohol spectrum disorder in Canada. *BMC Public Health* 13:570.
- Popova S, Lange S, Burd L, et al. (2014a) Canadian children and youth in care: the cost of fetal alcohol spectrum disorder. *Child Youth Care Forum* 43:83–96.
- Popova S, Lange S, Burd L, et al. (2014b) Cost of speech-language interventions for children and youth with foetal alcohol spectrum disorder in Canada. *Int J Speech Lang Pathol* 16:571–81.
- Popova S, Lange S, Burd L, et al. (2015a) *The Burden and Economic Impact of Fetal Alcohol Spectrum Disorder in Canada*. Toronto, ON, Canada: Centre for Addiction and Mental Health. ISBN: 978-1-77114-227-4.
- Popova S, Lange S, Burd L, et al. (2015b) Cost attributable to fetal alcohol spectrum disorder in the Canadian criminal justice system. *Int J Law Psychiatry* 38:6.

- Popova S, Lange S, Burd L, *et al.* (2015c) Special education of children with fetal alcohol spectrum disorder. *Exceptionality*, doi: 10.1080/09362835.2015.1064415
- Popova S, Lange S, Shield K, *et al.* (2016) Comorbidity of fetal alcohol spectrum disorder: A systematic literature review and meta-analysis. *Lancet* 387:978–87.
- Public Health Agency of Canada (PHAC). (2003) *Fetal Alcohol Spectrum Disorder (FASD): A Framework for Action*. Ottawa, ON, Canada: PHAC.
- Public Health Agency of Canada (PHAC). (2008a) *The Development of A Model for Calculating the Economic Impact of Fetal Alcohol Spectrum Disorder (FASD). A Discussion Paper*. Ottawa, ON: PHAC.
- Public Health Agency of Canada (PHAC). (2008b) *National Roundtable on the Development of A Canadian Model for Calculating the Economic Impact of FASD. A Discussion Paper*. Ottawa, ON, Canada: PHAC.
- Rice DP. (1993) The economic cost of alcohol abuse and alcohol dependence: 1990. *Alcohol Health Res World* 17:10–1.
- Rice D, Kelman S, Miller L. (1990) *The economic costs of alcohol and drug abuse and mental illness*. 1985. DHHS Publication No (ADM) 90–1694. Rockville, MD, USA: U.S. Department of Health and Human Services.
- Rice D, Kelman S, Miller L. (1991) Estimates of economic costs of alcohol and drug abuse and mental illness, 1985 and 1988. *Public Health Rep* 106:280–92.
- Roberts G, Nanson J. (2000) *Best Practices. Fetal Alcohol Syndrome/ Fetal Alcohol Effects and the Effects of Other Substance use During Pregnancy*. Ottawa, ON, Canada: Canada's Drug Strategy Division, Health Canada.
- Single E, Collins D, Easton B, *et al.* (2003) *International Guidelines for Estimating the Costs of Substance Abuse*, 2nd edn. Geneva, Switzerland: World Health Organization.
- Stade B, Ungar W, Stevens B, *et al.* (2006) The burden of prenatal exposure to alcohol: measurement of cost. *J FAS Int* 4:1–14.
- Stade B, Ali A, Bennett D, *et al.* (2009) The burden of prenatal exposure to alcohol: revised measurement of cost, 2007. *Can J Clin Pharm* 16:e91–102.
- Statistics Canada. (2008a) *Causes of deaths, 2008*. CANSIM tables. Ottawa, ON, Canada: Statistics Canada.
- Statistics Canada. (2008b) *Participation and activity limitation survey 2006: a profile of education for children with disabilities in Canada*. Ottawa, ON, Canada: Statistics Canada.
- Statistics Canada. (2010) *Perspectives on labour and income*. Catalogue no. 75-001-X. Ottawa, ON, Canada: Statistics Canada.
- Statistics Canada. (2012a) Table 051–0001—*estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual (persons unless otherwise noted)*. CANSIM (database). Ottawa, ON, Canada: Statistics Canada.
- Statistics Canada. (2012b) Table 051–0005—*Canada at a glance 2012—population*. CANSIM (database) Catalogue no. 89-645-X. Ottawa, ON, Canada: Statistics Canada.
- Statistics Canada. (2012c) Table 282–0002—*Canada at a glance 2012—labour force characteristics, by sex*. Ottawa, ON, Canada: Statistics Canada.
- Statistics Canada. (2012d) Table 282–0002—*Canada at a glance 2012—unemployment rate*. Ottawa, ON, Canada: Statistics Canada.
- Statistics Canada. (2013a) Table 251–0005. Adult correctional services, average counts of offenders in provincial and territorial programs, annual, CANSIM (database).
- Statistics Canada. (2013b) Table 251–0006. Adult correctional services, average counts of offenders in federal programs, annual, CANSIM (database).
- Statistics Canada. (2013c) Table 251–0008. Youth correctional services, average counts of young persons in provincial and territorial correctional services, annual, CANSIM (database).
- Stratton KR, Howe CJ, Battaglia FC. (1996) *Fetal Alcohol Syndrome—Diagnosis, Epidemiology, Prevention, and Treatment*. Washington, DC, USA: National Academy Press.
- Streissguth AP, Barr HM, Kogan J, *et al.* (1996) *Understanding the occurrence of secondary disabilities in clients with Fetal Alcohol Syndrome (FAS) and Fetal Alcohol Effects (FAE)*. Final Report to the Centers for Disease Control and Prevention (CDC), Tech. Rep. No. 96–06. Seattle, WA, USA: University of Washington, Fetal Alcohol & Drug Unit.
- Streissguth AP, Bookstein FL, Barr HM, *et al.* (2004) Risk factors for adverse life outcomes in fetal alcohol syndrome and fetal alcohol effects. *J Dev Behav Pediatr* 25:228–38.
- Thanh N, Jonsson E. (2009) Costs of fetal alcohol spectrum disorder in Alberta, Canada. *J Popul Ther Clin Pharmacol* 16:e80–90.
- Trainor J, Taillon P, Pandalangat N. (2013) *Turning the key: Assessing Housing and Related Supports for Persons Living with Mental Health Problems and Illness*. Ottawa, ON, Canada: Mental Health Commission of Canada.
- Weeks M. (1989) *Economic impact of fetal alcohol syndrome; IR #89–100015, Memorandum to Senator John E. Binkley*. Juneau, Alaska: Senate Advisory Council, Alaska State Legislature.
- World Health Organization (WHO). (2010) *Sixty-Third World Health Assembly*. Geneva, Switzerland: WHO.