

COSTS OF HEALTH SERVICES UTILIZATION OF PEOPLE WITH FETAL ALCOHOL SPECTRUM DISORDER BY SEX AND AGE GROUP IN ALBERTA, CANADA

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ABSTRACT

Objectives

To estimate the annual health services utilization (HSU) cost per person with FASD by sex and age; the lifetime HSU cost per person with FASD by sex, and the annual HSU cost of FASD for Alberta by sex.

Methods

The HSU costs of FASD including physician, outpatient, and inpatient services were described by sex and age. The costs per person-year were estimated by multiplying the average number of hospitalizations, outpatient visits, and physician visits per person-year by the average cost of each service. The annual HSU cost of FASD for Alberta was estimated by multiplying the annual HSU cost per person with FASD by the number of people living with FASD in Alberta in 2012. The lifetime HSU cost per person with FASD was estimated by sex for several lifespans ranging from 10 to 70 years.

Results

The annual cost of HSU for people with FASD in Alberta was \$259 million, of which FAS accounted for 26%. The annual HSU cost per person with FAS and FASD were \$6,200 and \$5,600, respectively. The incremental annual HSU cost per person with FAS is \$4,100 and with FASD is \$3,400 as compared to the general population. The lifetime (70 years) HSU cost per person with FAS was \$506,000 and with FASD was \$245,000. Males had higher HSU costs than females. HSU costs of FAS and FASD varied greatly by age group.

Conclusion

The findings suggest that FASD is a public health issue in Alberta and can be used for economic evaluations of FASD intervention and/or prevention in the province.

Key Words: *FASD, cost, health services utilization, Alberta, Canada*

As a consequence of prenatal exposure to alcohol, fetal alcohol spectrum disorder (FASD), a lifelong disability, often comes with a wide range of problems, both physically and mentally. People with FASD often need several kinds of service, including health care, special education, justice, correctional, family and community support services, and the societal costs for those services can be enormous.

In Canada, there are recently 3 original studies about economics of FASD that include the comprehensive health care or health services utilization (HSU) costs of people with FASD (by “comprehensive” we mean that not to count studies of cost for diagnostic service¹ or cost for specialized addiction treatment service² that do not show the whole picture of health services utilization costs of FASD).

Stade et al (2006)³ interviewed caregivers of children with FASD aged 1-21 years to estimate annual cost per case, and used a prevalence rate of 3 FASD cases per 1000 live births to estimate the annual costs of FASD for Canada. The study included direct costs (medical, education, social services, and out-of-pocket) and indirect costs (productivity losses of the caregivers). The results showed that the annual cost per person with FASD in Canada was estimated at CA\$14,342 (CA\$17,500 in 2014 based on the Bank of Canada's inflation calculator)⁴ and the annual costs of FASD for Canada was estimated at CA\$344.2 million (CA\$420 million in 2014).

Stade et al (2009)⁵ used a similar method but a different target population (aged 0-53 years) and a higher prevalence rate (10 FASD cases per 1000) to revised the previous estimates. The revised annual cost per person with FASD in Canada was estimated at CA\$21,642 (CA\$24,330 in 2014) and the revised annual costs of FASD for Canada was estimated at CA\$5.3 billion (CA\$5.96 billion in 2014). Of these costs, health care accounts for the largest share (35%), that is followed by educational services (28%), and social services (20%).

In Manitoba, using child and family services administrative database, Fuchs et al (2009)⁶ estimated the annually incremental costs (compared to the cost of the general population) of health care (e.g. hospital, physician visits and prescription drugs), education, and social services for children with FASD aged 0-21 years who resided in a permanent ward, at \$1,206, \$6,053, and \$292, respectively (in 2014 Canadian dollars).

However, all of these studies are cross-sectional and did not take into account variations over time (e.g. differences between years). Therefore, the results are for a specific year when the studies were implemented rather than annual. Furthermore, Stade et al. used an interview method to ask about health services utilization of people with FASD in a period of time prior to the time of interview (e.g. 6 months for hospitalizations, 3 months for physician visits, and 1 month for prescription medications)^{3,5}, so recall biases seem to be possible. Additionally, none of above mentioned studies estimated costs of health

services utilization of people with FASD for sex and age groups specifically.

In Alberta, there is no original but 02 modeling studies about costs of FASD.^{7,8} As used the annual costs per case with FASD estimated by Stade et al (2006 and 2009)^{3,5}, these modeling studies also have the limitations of interview.

In the current study, we used a longitudinal design analysing 10 consecutive years of administrative health data in the province of Alberta to estimate: a) the annual HSU cost per person with FASD by sex and age group; b) the lifetime HSU cost per person with FASD by sex; and c) the annual HSU cost of FASD for Alberta by sex.

METHODS

We included all patients recorded in the Alberta Health databases of inpatients, outpatients, and physician claims from 2003 to 2012. People with FASD, and their HSU costs, were calculated from available data on fetal alcohol syndrome (FAS) (ICD-9 code 760.71 and ICD-10 codes Q86.0 and P04.3) and estimates of the prevalence of FASD in individuals diagnosed with 21 FASD-related conditions (identified by a literature review) for which there are ICD codes, such as learning disability, oppositional defiant disorder, mental retardation, nervous system defects, etc. (Table 1). Fractions of the FASD-related conditions that can be attributed to alcohol were estimated by a systematic review of cohort and case-control studies. We included peer-reviewed primary research articles which reported the incidence of the FASD-related conditions in both the alcohol exposed and non-exposed groups from which relative risk and proportion of exposed individuals could be calculated. We applied a random effects meta-analysis to estimate the Mantel-Haenszel pooled relative risk from different relative risks extracted from reviewed studies. Of 21 FASD-related conditions, 12 with a statistically significant fraction of cases attributable to alcohol were included. The alcohol-attributable (FASD) fraction of each of the 12 FASD-related conditions was estimated by using the formula $PAF(\%) = P_e(RR-1) / [1 + P_e(RR-1)] \times 100$, in which PAF is population attributable fraction, P_e is

proportion of exposed individuals, and RR is relative risk. P_e was calculated as the total number of exposed to alcohol divided by the total number of both exposed and not exposed to alcohol.

Details about materials and methods for identifying people with FAS and FASD have been published elsewhere.⁹

HSU was estimated based on average numbers of hospitalizations, inpatient nights, outpatient visits, and physician visits per person-year. The time of follow-up (person-year) was the time between the date of diagnosis and the date of death (for those who died) or the date of the last data available (for those who were alive). To avoid outliers, we used an average of 0.5 person-year for people whose time of follow-up was less than 1 year. To obtain HSU for people with FASD, we estimated the HSU for each FASD-related condition (Table 1) and then weighted it based on the number of cases in each of the FASD-related conditions.

The HSU costs per person-year were estimated by multiplying the average number of hospitalizations, outpatient visits, and physician visits per person-year by the average cost for each of these services. The average cost per hospitalization was estimated as the average cost per hospitalization among the costed inpatient cases between 2003 and 2008 (~30% of the dataset). The average cost per outpatient visit was estimated as the average cost among the costed outpatient cases between 2003 and 2010 (~30% of the dataset). The average cost per physician visit was estimated as the average paid amount per visit/claim between 2003 and 2012 (100% of the dataset). HSU costs were estimated by sex and age group. All costs were converted to 2014 Canadian dollars using the Bank of Canada's inflation calculator.⁴

The annual HSU cost of FASD for Alberta was estimated by multiplying the annual HSU cost per person with FASD by the number of people who were living with FASD in Alberta in 2012. The lifetime HSU cost per person with FASD was estimated by sex for several lifespans ranging from 10 years to 70 years. We applied the cost per person-year by age group to the lifespans to get the lifetime cost. Of note, the cost per person-year was average for all individuals,

including health service users (any levels of usage) and none-users for each age group. That is, all individuals in one age group had the same cost per person-year. As it was present cost for each age group, we did not apply a discount.

Since there was no information about the costs of drug utilizations in the Alberta health administrative databases, the cost of these have been estimated from studies published in the scientific literature. According to Fuchs et al. (2009)⁶ and Stade et al. (2009)⁵, drugs/medications accounted for 31% and 25% of the total health services utilization cost of people with FASD, respectively. After weighting based on sample sizes, the proportion of drug cost was estimated at 30%. We inflated the cost of health services utilization estimated from the administrative databases by 30% to get the total costs of health services utilization, which includes the cost for inpatient, outpatient, and physician services and for drugs/medications.

Of note, we could not find any studies reporting the proportion of drug costs in Canada other than those 2 studies to strengthen the finding. As data regarding drug costs by sex and age were unavailable, we assumed the same proportion (30%) for both sexes and for all age groups. Stata MP 11.2 was used for the analyses.

TABLE 1 Diagnostic codes of FASD-related conditions

Conditions	ICD-9 codes	ICD-10 codes	Pooled RR (95%CI)	PAF% (95%CI)*	Weight**
Significant RR					
Nervous system defects	740-742	Q00-Q07	2.41 (1.75, 3.31)	26.52 (15.12, 37.92)	0.0673
Learning disability	315	F81, F83	1.77 (1.09, 2.86)	26.28 (4.07, 48.48)	0.4305
Anomalies of eyes	743	Q10-Q15	1.65 (1.29, 2.10)	23.17 (11.90, 34.44)	0.0407
Anomalies of ear, face, neck	744	Q16-Q18	2.02 (1.52, 2.70)	20.95 (12.39, 29.51)	0.0715
Anomalies of circulatory system	747	P29.3, Q25-Q28	2.62 (1.57, 4.37)	17.40 (8.15, 26.65)	0.0518
Mental retardation	317-319	F70-F79	1.44 (1.23, 1.68)	14.26 (8.16, 20.36)	0.0271
Anomalies of heart	745-746	Q20-Q24	1.18 (1.02, 1.36)	10.89 (1.43, 20.35)	0.0714
Anomalies of upper alimentary tract	750	Q38-Q40	1.31 (1.06, 1.62)	10.50 (2.25, 18.75)	0.0663
Congenital musculoskeletal deformities	754-756	Q65-Q79, R29.4	1.23 (1.08, 1.41)	7.98 (2.84, 13.12)	0.1575
Oppositional defiant disorder	313.81	F91.3	1.54 (1.21, 1.95)	6.61 (2.96, 10.26)	0.0077
Cleft palate/Cleft lip	749.0-749.2	Q35-Q37	1.10 (1.03, 1.18)	3.24 (0.93, 5.55)	0.0061
Other & unspecified anomalies	237.7, 759.0-759.6, 759.9	Q85, Q89.0-Q89.4, Q89.9	1.66 (1.11, 2.48)	5.65 (1.17, 10.13)	0.0020
Not significant RR					
Attention-deficit hyperactivity disorder	314	F90	2.29 (0.94, 5.55)		
Developmental disability	783.4	R62	2.00 (0.77, 5.16)		
Anomalies of respiratory system	748	Q30-Q34	1.56 (0.51, 4.79)		
Other anomalies of digestive system	751	Q41-Q45	1.58 (0.61, 4.09)		
Anomalies of genital organs	752	Q50-Q56	1.31 (0.72, 2.37)		
Anomalies of urinary system	753	Q60-Q64	1.03 (0.83, 1.28)		
Multiple anomalies	759.7-759.8	Q86.1-Q86.8, Q87, Q89.7-Q89.8	1.03 (0.58, 1.85)		
Anomalies of the integument	228, 757	D18, Q80-Q84	0.52 (0.23, 1.17)		
Chromosomal anomalies	758	Q90-Q99	0.32 (0.07, 1.52)		

*PAF(%)=P_e(RR-1)/[1+P_e(RR-1)]x100, where PAF is population attributable fraction, P_e is proportion of exposed individuals, and RR is relative risk; **weight was based on the number of cases

RESULTS

Annual HSU Cost of FAS

Excluding cost of drugs

On average, the annual HSU cost per person with FAS was \$4,365 of which inpatient services accounted for 89.2%, outpatient services 6.1%, and physician services 4.7% (Table 2). The highest HSU cost (\$6,666) was found in the 50+ age group, followed by age groups 20 to 29 (\$6,195), 0 to 9

(\$4,326), 40 to 49 (\$3,877), 30 to 39 (\$3,840), and 10 to 19 (\$3,832). The cost for males was higher than for females in every age group (e.g., \$4,933 for males versus \$3,689 for females for all ages).

Including cost of drugs

When drug cost was added, the annual HSU cost per person with FAS would be \$6,236 for both sexes, \$7,046 for males and \$5,271 for females (Table 2).

TABLE 2 Annual health services utilization costs per person with FAS by sex, age group, and type of service (2014 Canadian dollars)

	Age groups						All ages	Added*
	0 to 9	10 to 19	20 to 29	30 to 39	40 to 49	50+		
<i>Inpatient</i>								
Female	\$3,199	\$2,904	\$4,942	\$2,891	\$1,929	\$1,409	\$3,260	\$4,657
Male	\$4,433	\$3,448	\$6,735	\$4,006	\$5,376	\$16,070	\$4,430	\$6,328
Both sexes	\$3,840	\$3,308	\$5,845	\$3,294	\$3,483	\$6,493	\$3,893	\$5,562
<i>Outpatient</i>								
Female	\$234	\$339	\$174	\$159	\$115	\$64	\$240	\$343
Male	\$328	\$259	\$184	\$375	\$174	\$259	\$285	\$408
Both sexes	\$287	\$289	\$177	\$264	\$156	\$105	\$267	\$381
<i>Physician</i>								
Female	\$180	\$198	\$170	\$319	\$344	\$88	\$188	\$269
Male	\$216	\$259	\$176	\$243	\$118	\$43	\$218	\$312
Both sexes	\$199	\$234	\$173	\$283	\$237	\$69	\$205	\$293
<i>Total</i>								
Female	\$3,613	\$3,440	\$5,286	\$3,369	\$2,388	\$1,560	\$3,689	\$5,271
Male	\$4,977	\$3,964	\$7,096	\$4,623	\$5,668	\$16,372	\$4,933	\$7,046
Both sexes	\$4,326	\$3,832	\$6,195	\$3,840	\$3,877	\$6,666	\$4,365	\$6,236

*The last column includes cost of drugs.

Annual HSU Cost of FASD

Excluding cost of drugs

The annual HSU cost per person with FASD was \$3,904, of which inpatient services accounted for 88.0%, outpatient services 6.6%, and physician services 5.4% (Table 3). The highest cost (\$6,626) was found in the age group 0 to 9, followed by age groups 50+ (\$2,016), 20 to 29 (\$1,877), 40 to 49 (\$1,609), 10 to 19 (\$1,600), and 30 to 39 (\$1,383).

The cost over all ages was greater for females than for males (\$4,048 versus \$3,871). Of note, the cost for males was higher than for females in the 20+ age groups.

Including cost of drugs

When cost of drugs is added, the annual HSU cost per person with FASD would be \$5,576 for both sexes, \$5,530 for males and \$5,782 for females

TABLE 3 Annual health services utilization costs per person with FASD by sex, age group, and type of service (2014 Canadian dollars)

	Age groups						all ages	Added*
	0 to 9	10 to 19	20 to 29	30 to 39	40 to 49	50+		
<i>Inpatient</i>								
Female	\$6,648	\$1,234	\$1,405	\$897	\$993	\$1,231	\$3,589	\$5,126
Male	\$5,701	\$1,074	\$1,702	\$1,221	\$1,711	\$3,083	\$3,386	\$4,837
Both sexes	\$6,028	\$1,197	\$1,531	\$1,034	\$1,295	\$1,774	\$3,434	\$4,906
<i>Outpatient</i>								
Female	\$349	\$246	\$139	\$117	\$123	\$84	\$260	\$371
Male	\$341	\$236	\$160	\$225	\$130	\$121	\$265	\$378
Both sexes	\$342	\$238	\$149	\$167	\$126	\$94	\$260	\$371
<i>Physician</i>								
Female	\$242	\$156	\$200	\$161	\$211	\$134	\$200	\$285
Male	\$271	\$170	\$197	\$204	\$168	\$162	\$221	\$316
Both sexes	\$256	\$164	\$198	\$183	\$188	\$148	\$210	\$300
<i>Total</i>								
Female	\$7,240	\$1,636	\$1,745	\$1,175	\$1,327	\$1,450	\$4,048	\$5,782
Male	\$6,313	\$1,481	\$2,058	\$1,650	\$2,007	\$3,365	\$3,871	\$5,530
Both sexes	\$6,626	\$1,600	\$1,877	\$1,383	\$1,609	\$2,016	\$3,904	\$5,576

*The last column includes cost of drugs.

Lifetime HSU Cost

Excluding cost of drugs

Lifetime HSU costs per person with FAS and FASD by sex and lifespan are shown in Table 4. Generally, the longer the lifetime the higher the cost for both FAS and FASD. For FAS, males had higher lifetime costs than females in all lifespans. For FASD, females incurred higher costs than males if the lifespan was less than 50 years, but males had higher costs than females if the lifespan was 50 years or longer.

For example, with a lifespan of 70 years, a person with FAS (or FASD) incurred lifetime HSU costs of approximately \$354,000 (or \$171,000 for FASD). This cost was \$591,000 (or \$202,000) for males and \$212,000 (or \$160,000) for females. If the lifespan was 60 years, the cost was \$287,000 (or \$151,000) for both sexes, \$427,000 (or \$169,000) for males, and \$197,000 (or \$146,000) for females. If the lifespan was 40 years, the cost

was \$182,000 (or \$115,000) for both sexes, \$207,000 (or \$115,000) for males, and \$157,000 (or \$118,000) for females.

FAS incurred higher cost than FASD if the lifespan was longer than 20 years, whereas FASD cost more for shorter lifespans. For example, if the lifespan was 10 years, the cost of FASD was \$66,000 compared to \$43,000 for FAS. If the lifespan was 20 years, the cost of FASD was \$82,000 compared to \$81,600 for FAS; if lifespan was 30 years, the cost of FASD was \$101,000 compared to \$144,000 for FAS; if lifespan was 40 years, the cost of FASD was \$115,000 compared to \$182,000 for FAS; and so on.

Including cost of drugs

If drug cost is added, the lifetime (70 years) HSU cost per person with FAS and FASD would be \$506,000 and \$245,000, respectively (Table 4).

TABLE 4 Lifetime HSU costs per person with FAS and FASD by sex (2014 Canadian dollars)

	Lifespan						
	10 years	20 years	30 years	40 years	50 years	60 years	70 years
Excluding cost of drugs							
FAS							
Female	\$36,127	\$70,530	\$123,391	\$157,078	\$180,956	\$196,560	\$212,166
Male	\$49,767	\$89,415	\$160,370	\$206,596	\$263,276	\$426,998	\$590,719
Both sexes	\$43,263	\$81,579	\$143,536	\$181,936	\$220,702	\$287,368	\$354,035
FASD							
Female	\$72,399	\$88,753	\$106,196	\$117,954	\$131,224	\$145,722	\$160,221
Male	\$63,130	\$77,939	\$98,523	\$115,020	\$135,096	\$168,749	\$202,402
Both sexes	\$66,261	\$82,256	\$101,024	\$114,856	\$130,948	\$151,104	\$171,260
Including cost of drugs							
FAS							
Female	\$51,610	\$100,758	\$176,273	\$224,397	\$258,508	\$280,800	\$303,094
Male	\$71,095	\$127,736	\$229,100	\$295,137	\$376,109	\$609,997	\$843,885
Both sexes	\$61,804	\$116,541	\$205,051	\$259,909	\$315,289	\$410,526	\$505,764
FASD							
Female	\$103,426	\$126,790	\$151,709	\$168,505	\$187,463	\$208,174	\$228,887
Male	\$90,186	\$111,342	\$140,746	\$164,315	\$192,994	\$241,070	\$289,146
Both sexes	\$94,658	\$117,509	\$144,321	\$164,080	\$187,069	\$215,863	\$244,657

HSU costs of FAS and FASD for Alberta

Excluding cost of drugs

By multiplying the number of people living with FAS and FASD in Alberta by the annual HSU costs per person, we obtained the HSU costs of these conditions (Table 5). In total, cost of health services for people with FASD, excluding medications is \$181 million annually for Alberta. Males accounted for 55% of this cost and FAS accounted for 26%. People with FASD aged 0 to

9 accounted for 65% of the costs, followed by age groups 10 to 19 (13%), 50+ (8%), 20 to 29 (6%), 40 to 49 (2%), and 30 to 39 (2%).

Including cost of drugs

When drug cost is added, the annual HSU cost of FASD for the province of Alberta would be \$259 million (Table 5).

TABLE 5 Annual HSU costs (millions) of FASD in Alberta (2014 Canadian dollars)

	Female	Male	Both sexes
Excluding cost of drugs			
FAS	\$9.89	\$16.69	\$26.57
FASD-related	\$72.62	\$82.09	\$154.81
Total FASD	\$82.50	\$98.78	\$181.28
Including cost of drugs			
FAS	\$14.12	\$23.83	\$37.97
FASD-related	\$103.73	\$117.28	\$221.15
Total FASD	\$117.86	\$141.11	\$258.97

DISCUSSION

This is the first retrospective longitudinal study using 10 years of administrative health data to evaluate the HSU costs of people with FAS and FASD in Alberta. We estimated the annual HSU cost for FAS at \$6,200 per person and for FASD at \$5,600 per person. The annual HSU cost for FAS is higher than for FASD can be explained by the fact that FAS is the most medically severe condition within FASD.¹⁰

These estimates are slightly lower than a previous estimate of (~30% of \$25,000)⁸, which was based on a cross-sectional survey of services used by people with FASD.⁵ If not including the cost for drugs, our estimates (\$4,400 for FAS and \$3,900 for FASD) are also lower than a US estimate which was based on a cross-sectional study among people with FAS from ages 0 to 21, which excluded cost of drugs.¹¹

The differences observed, albeit relatively small, between our findings and the results from earlier published studies can be explained by different study methodology. Cross sectional studies are based on a limited time period, while our study is longitudinal and capture potential changes in HSU over a long period of time. For example in our study we observed for example that 690 patients with FAS were identified in 2003, and of these 23% used health services in 2004, which dropped to 18% in 2005, 14% in 2006, and to 11% in 2007. This indicates that the annual HSU, based on cross-sectional data, may overestimate health services utilization if they are used to project costs over a longer period of time. A longitudinal study, such as ours, shows more reliable estimates in this respect.

The lifetime (70 years) HSU cost for FAS and FASD was estimated in our study at \$506,000 and \$245,000, respectively. These costs seem to

be comparable to the previous estimate of the incremental lifetime cost per person with FAS, which was estimated at \$742,000 in 2009 (~\$814,000 in 2014 dollars), of which health care accounted for about 30% (~\$244,000).⁸

The annual HSU cost of FASD for Alberta estimated in our study (\$259 million in 2014 CA\$) is higher than the previous estimate of \$520 million for FASD in 2009 (~\$570 million in 2014 CA\$), of which health care accounted for about 30% (~\$171 million).⁸ This can be explained by the fact that the number of people with FASD, estimated in this study, is higher than the one used in the previous estimate; 36,000 versus the updated prevalence of 46,000 people living with FASD in Alberta.⁹

Based on the estimate that HSU accounts for 30% of the total cost of FASD and our estimate that the annual HSU cost of FASD of \$259 million, the total cost of FASD for Alberta would be \$863 million per year (~\$259 million*100/30). Compared to the cost of health services utilization of all Alberta's population in 2009 which was about \$8 billion, the HSU cost of FASD estimated in the current study accounts for about 3% while the prevalence of FASD was about 1.2%.⁹

Of note, the costs presented above are not incremental, that is they are not the difference between the cost per person with and without FASD. As data on the cost per person without FASD are unavailable, we used the cost per average person in general population as a proxy. This would be overestimated for none-FASD individuals as FASD individuals were also included in general population. However, this bias is likely small as FASD individuals account for only 1.2% of the population.⁹

Using the Alberta Health data between 2004 and 2009, we estimated that the HSU cost per average person in general population per year was \$2,200 (in 2014 Canadian dollars). This number was \$1,800 for men and \$2,500 for women. This cost includes the cost for inpatient, outpatient, and practitioner services inflated by 10% for drugs (we assumed that the proportion of drug cost among the total health care cost for general population is a third of that for FASD population). Accordingly, the incremental HSU

cost per person with FASD was estimated at \$3,400 for both sexes, \$3,700 for men and \$3,200 for women. The corresponding numbers for FAS were \$4,100, \$5,200, and \$2,700. These incremental costs can be used for economic evaluations of FASD preventions.

Our study showed that the youngest age group is consuming more of health services and thereby have the highest HSU cost. It also shows that males draw more resources in health care as compared to females. There are no previous studies published of HSU cost per sex and age groups, which could confirm or reject our findings. However, the age and sex distribution reported in our study on incidence and prevalence of FASD in Alberta⁹ is in agreement with the results presented here.

In conclusion, the annual cost of health services utilization by people with FASD in Alberta is \$259 million, of which FAS accounts for 26%. The annual HSU cost per person with FAS is \$6,200 and with FASD is \$5,600. The incremental annual HSU cost per person with FAS is \$4,100 and with FASD is \$3,400 as compared to the general population. The lifetime (70 years) HSU cost per person with FAS is \$506,000 and with FASD is \$245,000. Males have higher HSU costs than females. The HSU costs of FAS and FASD vary greatly by age group.

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REFERENCES

1. Popova S, Lange S, Burd L, Chudley AE, Clarren SK, et al. (2013) Cost of Fetal Alcohol Spectrum Disorder Diagnosis in Canada. *PLoS ONE* 8(4): e60434. doi:10.1371/journal.pone.0060434
2. Popova S, Lange S, Burd L, Urbanoski K, Rehm J. Cost of specialized addiction treatment of clients with fetal alcohol spectrum disorder in Canada. *BMC Public Health* 2013;13:570.
3. Stade B, Ungar WJ, Stevens B, Beyene J, Koren G. The burden of prenatal exposure to alcohol: measurement of cost. *JFAS Int* 2006 Feb;4:e5.
4. Bank of Canada. Inflation Calculator, available at: www.bankofcanada.ca/rates/related/inflation-calculator/?page_moved=1 (accessed October 29, 2014).

5. Stade B, Ali A, Bennett D, Campbell D, Johnston M, Lens C, Tran S, Koren G. The burden of prenatal exposure to alcohol: revised measurement of cost. *Can J Clin Pharmacol* 2009;16(1):e91-e102.
6. Fuchs D, Burnside L, De Riviere L, Brownell M, Marchenski S, Mudry A, and Dahl M. Economic impact of children in care with FASD and parental alcohol issues Phase 2: Costs and service utilization of health care, special education, and child care. Ottawa: Centre of Excellence for Child Welfare 2009.
7. Thanh NX, Jonsson E. Costs of fetal alcohol spectrum disorder in Alberta, Canada. *Canadian Journal of Clinical Pharmacology* 2009;16:e80-e90.
8. Thanh NX, Jonsson E, Dennett L, Jacobs P. Costs of FASD. In: Riley EP, Clarren S, Weinberg J, Jonsson E (Eds). *Fetal alcohol spectrum disorder: Management and policy perspectives of FASD*. Wiley Blackwell 2011.
9. Thanh NX, Jonsson E, Salmon A, Sebastianski M. Incidence and prevalence of Fetal Alcohol Spectrum Disorder by sex and age group in Alberta, Canada. *J Popul Ther Clin Pharmacol* Vol 21(3):e395-e404;October 29, 2014.
10. Stratton KR, Howe CJ, Battaglia FC. *Fetal alcohol syndrome diagnosis, epidemiology, prevention, and treatment*. Washington DC: Institute of Medicine, National Academy Press, 1996.
11. Klug MG, Burd L. Fetal alcohol syndrome prevention: annual and cumulative cost savings. *Neurotoxicology and Teratology* 2003;25:763-765.