Productivity losses associated with Fetal Alcohol Spectrum Disorder in New Zealand

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ABSTRACT

AIM: To estimate the productivity losses due to morbidity and premature mortality of individuals with Fetal Alcohol Spectrum Disorder (FASD) in New Zealand (NZ).

METHODS: A demographic approach with a counterfactual scenario in which nobody in NZ is born with FASD was used. Estimates were calculated using (Census Year) 2013 data for the NZ population, the labour force, unemployment rate and average weekly wage, all of which were obtained from Statistics NZ.

In order to estimate the number of FASD cases in 2013 and the related morbidity, the prevalence of FASD, obtained from the available epidemiological literature, was applied to the general population of NZ. Assumptions made on the level of impairment that would affect the ability of individuals with FASD to participate in the workforce or would reduce their productivity were based on data obtained from the current epidemiological literature.

RESULTS: In 2013, approximately 0.03% of the NZ workforce experienced a loss of productivity due to FASD-attributable morbidity and premature mortality, which translated to aggregate losses ranging from $NZ49 million to $NZ200 million – that is, 0.03% to 0.09% of the annual gross domestic product in NZ.

These costs represent estimates for lost productivity attributable to FASD and do not include additional costs incurred by governmental and private entities including social costs, such as both higher costs and or less effective spending by the education, health and justice systems.

CONCLUSION: The estimated productivity losses associated with FASD further reinforces that effective FASD prevention as a primary public health strategy may be of significant value.

Across the world, alcohol is the fifth leading contributor to disability and mortality, accounting for over 3% of worldwide mortality and nearly 4% of disability-adjusted life years. Furthermore, alcohol consumption often results in harm both to the drinker as well as to individuals associated with the drinker. One example of such harm is that caused by the consumption of alcohol during pregnancy. Prenatal alcohol exposure is an established cause of Fetal Alcohol Spectrum Disorder (FASD). A safe level of alcohol exposure during pregnancy has yet to be identified, nevertheless it is widely accepted that heavy drinking confers the greatest risk of FASD. Prenatal alcohol exposure results in a highly variable expression of adverse outcomes. As a result, the term FASD encompasses a group of disorders where alcohol exposure can affect any organ system.

FASD is comprised of four categorical disorders: Fetal Alcohol Syndrome (FAS), Partial FAS (pFAS), Alcohol-Related Neurodevelopmental Disorder (ARND) and Alcohol-Related Birth Defects (ARBD). The FASD phenotype is variably expressed, and comorbidities are common. These are highly variable disorders, with age and development dependent upon changes in phenotype. However, FASD is considered a ‘hidden’ disability and a complex diagnosis. Damage to the central nervous system is a unifying concept for nearly all of the FASD diagnoses.
Although no research has confirmed the prevalence of FASD in New Zealand, it is generally assumed that the prevalence is approximately 1% of live births, an assumption that is based on multiple prevalence studies in other countries (acknowledging, however, that there may be variations in the patterns of alcohol consumption during pregnancy in different countries/cultures). More recent prevalence studies have reported prevalence rates well above 1% of live births in some locations across the world using a screening protocol for school-age children (i.e., active case ascertainment). Also, and unsurprisingly, high-risk populations with higher drinking rates have an increased likelihood of having alcohol-exposed pregnancies. The FASD rates are well above prevalence rates for Autism Spectrum Disorder or Down syndrome.

The prevalence of FASD is currently unknown in both the general population and, in some high-risk communities of New Zealand. Therefore, for the purpose of this study, the most commonly cited rough estimates of the prevalence of FAS (1 per 1,000) and FASD (9 per 1,000) among the general population in Canada were used. Since the exact prevalence of FAS/FASD is unknown, it was assumed that the prevalence was constant across all birth cohorts.

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. This study also revealed that over half of the reported deaths (54%) occurred in the first year of life. Other studies have demonstrated that FASD is associated with a vast number and wide range of health and behavioural problems including increased premature mortality rates compared to the general population. Additionally, the phenotype for FASD is highly variable and as affected people age, the rates of comorbidity tend to increase, which ultimately increases both complexity and severity of the phenotype.

Because of difficulties “fitting into” mainstream life, the attempted suicide rate for persons with FASD has been reported to be higher (22%) than the rate for the general US adult population (3%) and persons with intellectual disabilities (8%).

Thus, since FASD begins in the prenatal period, the disorders cause a large burden of lifelong duration on society. The costs change across age groups and only recently have costs incurred by adolescents and adults been considered. The costs in this age group are incurred primarily through the health care system, mental health and substance abuse treatment services, the criminal justice system, and the long-term care of individuals with intellectual and physical disabilities.

A significant portion of the societal economic burden from FASD results from lost productivity and decreased participation in the workforce (the labour force less those who are unemployed) including those losses resulting from early mortality. Surprisingly, given the significance, the existing cost estimates of FASD have neglected to examine the productivity losses caused by reduced participation in the workforce.

FASD has not yet emerged as a public health priority in New Zealand, although the Ministry of Health is paying more attention to it. Canada has already placed importance on this issue. The Canadian approach is due in part to their recognition of the costs associated with FASD-affected individuals’ need for specialized care and services, but also due to their increased awareness of costs may potentially be reduced by implementing effective prevention programs. Such prevention efforts need to focus on reducing the number of affected individuals, the severity of the resulting impairments, and the premature mortality due to prenatal alcohol exposure. These efforts could be accomplished by eliminating prenatal alcohol exposure or, at the very least, by reducing the number of women who drink heavily during pregnancy.

The purpose of this study was to estimate the productivity losses of individuals with FASD due to morbidity and premature mortality, as one aspect of the total costs of FASD in New Zealand.
Method

The counterfactual scenario

All cost estimates involve a counterfactual scenario, which compares the actual state of affairs with an alternative one, the costs reflecting the economic differences between them valued at appropriate prices.

This report adopts a counterfactual scenario in which no individual in the population was born with FASD. It uses the “demographic” method, and focuses only on the impact of market production (the productivity loss) resulting from the morbidity and premature mortality of individuals with FASD.

This counterfactual scenario was chosen because it is readily understandable and because it and its consequential estimation method involve fewer—often contentious—assumptions. It avoids some issues that make the estimation of social costs challenging, such as dealing with inflation, economic change and time discounting. It produces an estimate for a particular year (2013) as a result of effects earlier in time, instead of an estimate of the effects in a particular year. A consequence of this particular counterfactual scenario is that the total will vary through time as a result of economic and population changes, and the scenario takes into consideration such variables as business cycle (unemployment) and price changes (inflation). However in the medium-term these will not change the order of magnitude.

An alternative to the “demographic” approach is the “human capital” approach, which would be more applicable if the alternative scenario involved a phasing-out of FASD (eg, if an effective prevention program was introduced over time). Whereas the counterfactual scenario used here assumes an effective program was introduced many decades ago; the estimate represents the long-term equilibrium. It may be taken as an indication of the eventual long-term productivity gains from effective prevention.

Population estimates of individuals with FASD

New Zealand data on population of the labour force, unemployment rate, and the average weekly wage were obtained from Statistics New Zealand for the most recent available year (i.e., 2013).

For the purpose of this analysis, three groups of individuals with: 1) Fetal Alcohol Syndrome (FAS; the most recognisable form of FASD); 2) other-FASD (pFAS, ARND and ARBD); and 3) FASD overall (FAS, pFAS, ARND, and ARBD) were analysed separately. In order to estimate the number of individuals with FAS and other-FASD, the most commonly cited prevalence of FAS (0.1%) and FASD (0.9%) in North America was applied to the general population of New Zealand in 2013.

It is possible that those with FASD are more likely to be unemployed; however, because such no estimate exists, we have assumed the proportion of individuals with FASD that are unemployed is the same as that of the general population.

All cost figures are presented in New Zealand dollars for the 2013 year.

Severity levels of intellectual impairment attributable to FASD

As described below and in Easton et al., population estimates of individuals with FASD can be stratified by the severity of intellectual impairment attributable to FASD, so as to account for its effect on both the level of participation in the workforce and productivity of individuals with FASD. Disabilities attributed to birth defects, vision or hearing problems or any other physical disabilities were not included.

Individuals with FAS and other-FASD will have multiple areas of brain impairment when measured on standardised tests. For the purposes of this study, the domain of intellectual impairment will represent the relevant impairment. Individuals with FASD can be classified into four groups according to their level of impairment.
1. Broad cognitive impairment (does not meet criteria for intellectual disability). The term minimal brain dysfunction (MBD) has also been used previously to describe this population, and includes individuals with learning disabilities, speech and language disorders, attention deficit hyperactivity disorder, and other similar disorders.

2. Mild intellectual disability. Previously known as mild mental retardation, this category includes individuals with an Intelligence Quotient (IQ) and adaptive behaviour scores between 50 and 75. Individuals within this category can often acquire academic skills up to the 6th grade level, can become fairly self-sufficient and in some cases live independently with episodic or ongoing community and social supports.

3. Moderate intellectual disability. This category includes individuals who have an IQ and adaptive behaviour score of 35–49. They can typically carry out work and self-care tasks with ongoing supervision at moderate levels. They typically acquire communication skills in childhood and are able to live and function successfully within the community in a staffed and supervised environment such as a group home.

4. Severe intellectual disability. This category includes individuals with an IQ and adaptive behaviour score below 35. Such individuals may master very basic self-care skills and some communication skills. Their intellectual disability is often accompanied by neurological disorders, and they most commonly require continuous supervision, assistance and high levels of structure.

It was assumed that 100% of individuals with FAS are impaired and only about 25% of individuals with other-FASD are impaired. Such individuals would be expected to have different levels of reduction in productivity due to their intellectual impairment. The distribution of levels of mental impairment severity among individuals with other-FASD was assumed to be the same as that for individuals with FAS (50% with broad cognitive impairment, 33% with mild intellectual disability, 12% with moderate intellectual disability, and 5% with severe intellectual disability).

The percent reduction in productivity of individuals with FAS and other-FASD was adapted from Harwood and colleagues and modified based on the expert opinion of Drs. Larry Burd and Albert Chudley (personal communication).

Mortality

As described above, individuals with FASD have a higher mortality rate. The effects can be measured by using cause-of-death data combined with pooled prevalence estimates of the major disease conditions associated with FASD, as obtained from a recent meta-analysis conducted by Popova and colleagues.

For a detailed methodology on estimation productivity losses due to premature mortality of individuals with FASD, please see Easton et al.

However, it is unnecessary to add a separate assessment for the purposes of this paper. If FASD rates at birth are the ones assumed (ie one percent of the cohort), then the rates in the labour force will be lower (because of the higher mortality rate). The counterfactual scenario requires the addition to the labour force of those individuals with FASD who die from premature mortality relative to those without FASD. Subject to a very small effect, this is equivalent to assuming that the rate of FASD for the labour force is the same as the rate for the birth cohort. Ignoring this small difference means the estimates provided here are slightly on the conservative side.

Results

Population estimates of individuals with FASD

Using data on the general population in New Zealand (4.43 million in 2013) and assuming a prevalence of 0.1% for FAS and 0.9% for other-FASD, the number of individuals with FASD was estimated as follows: 4,400 individuals with FAS and 39,900 with other-FASD, for a combined total of 44,300 individuals with FASD in New Zealand in 2013 (Table 1).
Approximately 54.4% (2.41 million) of New Zealand’s general population participated in the paid labour force in 2013. By applying this percentage to the number of individuals with FASD, it was estimated that about 24,100 individuals with FASD were in the New Zealand labour force in 2013 (or 0.03% of the total labour force). Based on the assumption that all individuals with FAS and 25% of individuals with other-FASD have some level of intellectual impairment, it was estimated that 7,800 individuals with FASD who are in the workforce (the labour force less the unemployed) have decreased productivity (Table 2).

### Productivity losses of individuals with FASD due to morbidity

It was assumed that the magnitude of productivity losses for individuals with FASD was directly related to their level of intellectual impairment. Table 2 presents the proportions of individuals with FASD by the levels of intellectual impairment, as well as the lower and upper boundary for their percent of reduction in productivity by categorical level of impairment. In order to estimate a weighted average of the lower (24%) and the upper (50%) boundaries, the percent of reductions in productivity were combined across severity levels and weighted by the number of individuals in each respective group (Table 2).

Since 6.2% of the labour force was unemployed, the estimated loss of productivity by the effective workforce was applied to only 93.8% of those with FASD who were assumed to be in the labour force (the workforce equals the labour force minus those unemployed).

### Estimating the effect of the counterfactual scenario of no FASD in New Zealand

If there were no cases of FASD in New Zealand (the counterfactual scenario), then the effective workforce would increase by

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**Table 1:** Model parameters for the calculation of productivity losses due to FASD-attributable morbidity and premature mortality in New Zealand 2013.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Number of Individuals</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total population in New Zealand</td>
<td>4.43 Million</td>
<td></td>
</tr>
<tr>
<td>Population participating in labour force (54.4%)</td>
<td>2.41 Million</td>
<td></td>
</tr>
<tr>
<td>Population with FAS (0.1% of the total population)</td>
<td>4,400</td>
<td>Source: Statistics New Zealand from Infoshare.46</td>
</tr>
<tr>
<td>Population with other-FASD (0.9% of the total population)</td>
<td>39,900</td>
<td></td>
</tr>
<tr>
<td>Population with FAS (1% of the total population)</td>
<td>44,300</td>
<td></td>
</tr>
<tr>
<td>Population with other-FASD (54.4% of the total population with FAS)</td>
<td>2,400</td>
<td>Expert opinion (personal communication)</td>
</tr>
<tr>
<td>Population with other-FASD (54.4% of the total population with other-FASD)</td>
<td>21,700</td>
<td></td>
</tr>
<tr>
<td>Population with FAS (54.2% of the total population with FAS)</td>
<td>24,100</td>
<td></td>
</tr>
<tr>
<td>Compromised productivity of the workforce with FAS (100% of the population with FAS participating in labour force)</td>
<td>2,400</td>
<td>Expert opinion (personal communication)</td>
</tr>
<tr>
<td>Compromised productivity of the workforce with other-FASD (25% of the population with other-FASD participating in labour force)</td>
<td>5,400</td>
<td>Expert opinion (personal communication)</td>
</tr>
<tr>
<td>Compromised productivity of the workforce with FASD (sum of population with FAS and other-FASD participating in labour force with compromised productivity)</td>
<td>7,800</td>
<td></td>
</tr>
</tbody>
</table>

FAS: Fetal Alcohol Syndrome
FASD: Fetal Alcohol Spectrum Disorder

Statistics New Zealand from Infoshare (http://www.stats.govt.nz/infoshare/).46
Table 2: Percentage and number of individuals with FAS and other-FASD by level of intellectual impairment and their percentage of reduction in productivity in New Zealand in 2013.

<table>
<thead>
<tr>
<th>Impairment Category</th>
<th>Percentage of individuals with FAS and other-FASD&lt;sup&gt;a,b&lt;/sup&gt;</th>
<th>Estimated number of individuals with FAS and other-FASD in New Zealand</th>
<th>Percentage reduction in productivity of individuals with FAS and other-FASD Lower Boundary&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Percentage reduction in productivity of individuals with FAS other-FASD Upper Boundary&lt;sup&gt;d&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broad cognitive impairment</td>
<td>50%</td>
<td>3,900</td>
<td>10%</td>
<td>40%</td>
</tr>
<tr>
<td>Mild intellectual impairment</td>
<td>33%</td>
<td>2,575</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>Moderate intellectual impairment</td>
<td>12%</td>
<td>935</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>Severe intellectual impairment</td>
<td>5%</td>
<td>390</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>7,800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighted Average</td>
<td></td>
<td></td>
<td>24.25%</td>
<td>49.9%</td>
</tr>
</tbody>
</table>

FAS: Fetal Alcohol Syndrome
FASD: Fetal Alcohol Spectrum Disorder

<sup>a</sup>Estimated based on expert opinion (Larry Burd and Albert Chudley)
<sup>b</sup>Based on the assumption that 100% of individuals with FAS are intellectually impaired and only about 25% of individuals with other-FASD are intellectually impaired (Albert Chudley, expert opinion)
<sup>c</sup>Based on Harwood et al.<sup>48</sup>
<sup>d</sup>Estimated based on expert opinion (Larry Burd and Albert Chudley)

Table 3: Model of potential increases in income using a counterfactual scenario (no one is born with FASD) in New Zealand 2013.

<table>
<thead>
<tr>
<th></th>
<th>Lower Boundary</th>
<th>Upper Boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equivalent number of productivity-compromised individuals with FASD in labour force</td>
<td>1,880</td>
<td>3,840</td>
</tr>
<tr>
<td>Equivalent number of productivity-compromised individuals with FASD in workforce (ie allowing for unemployment)</td>
<td>1,760</td>
<td>3,600</td>
</tr>
<tr>
<td>Average annual wage in relevant population of NZ</td>
<td>$28,000</td>
<td>$55,660</td>
</tr>
<tr>
<td>Loss of annual income per person with FASD in labour force</td>
<td>$2,270</td>
<td>$9,230</td>
</tr>
<tr>
<td>Loss of annual income per productivity-compromised person with FASD in labour force</td>
<td>$6,990</td>
<td>$28,410</td>
</tr>
<tr>
<td>Productivity losses due to FASD-attributable morbidity and premature mortality (additional economy-wide income)</td>
<td>$49 Million</td>
<td>$200 Million</td>
</tr>
</tbody>
</table>

FASD: Fetal Alcohol Spectrum Disorder

Notes: Statistics New Zealand from Infoshare (http://www.stats.govt.nz/infoshare/).<sup>44</sup>
Numbers are rounded.
Lower boundary based on weighted average reduction in productivity of 24%; upper boundary based on weighted average reduction in productivity of 50%. Lower boundary assumes all workers are working for minimum wage rather than halfway between it and the average wage.
the equivalent of 1,760 to 3,600 full time workers (derived by applying a weighted average of reduction in productivity—24% [lower estimate] and 50% [upper estimate]; see Table 2) to the number of individuals with FASD with compromised productivity within the workforce—ie the labour force minus the unemployed (about 7,800 people; Table 1). The additional worker effect represents a boost of between 0.08% and 0.16% to the New Zealand workforce of 2.26 million individuals in 2013, if, as the counterfactual scenario posits, there were no cases of FASD in New Zealand (Table 3).

Estimated value of the productivity losses of individuals with FASD due to morbidity

Estimates of productivity losses resulting from decreased labour force participation can then be converted into dollar value by multiplying the effective reduction in the number of participating workers with FASD by their marginal dollar product. The standard assumption is that a worker’s marginal product is comparable to the average wage.45

The average weekly wage (ordinary plus overtime) in New Zealand was $1,066, which is equivalent to $55,660 per year. However, it could be argued that the average worker with FASD comes from a more socially-deprived background, and as a result, have a lower average wage than a typical member of the labour force. In order to provide the most conservative estimate, it was assumed that, as a conservative estimate, the actual wages for a person from a background that gives rise to FASD is the minimum wage of $28,000 (in 2013). This amounts to an average annual reduction of $2,270 to $9,230 for each worker with FASD (including those that are unemployed). This represents 7.8% to 16.2% of the wages they would earn if they did not have FASD. When this wage is applied to the difference in the effective workforce, the estimated national income of New Zealand would increase between $49 million and $200 million, if New Zealand had no cases of FASD.

Discussion

Conservatively, around 0.03% of the New Zealand workforce experiences a loss of productivity due to FASD-attributable morbidity and premature mortality. This markedly reduces their remuneration and, consequently has a dampening effect on the overall New Zealand economy. The immediate effect of FASD-attributable morbidity and premature mortality is confined to a small proportion of the population; the estimated aggregate loss ranged from $49 million to $200 million in New Zealand in 2013.

These estimates of productivity losses due to morbidity and premature mortality attributable to FASD are, by design, equally conservative and probably underestimated in terms of the total social costs of FASD. However, there is some level of confidence that the estimates of the aggregate productivity losses due to FASD are within a plausible range. The reported estimates do not include the additional productivity losses of those caring for individuals with FASD who are, as a result, unable to work in the paid labour force due to their caregiving or from inefficient or otherwise unnecessary expenditure in the education, health or justice systems. Without such cost pressures resulting from FASD, these resources could be diverted to other areas of private and public spending in order to benefit New Zealand as a whole.

Policy makers could utilize the estimates of productivity losses due to FASD-attributable morbidity and premature mortality in order to evaluate the potential benefits of FASD prevention programs. There are several studies from Canada and the United States that have reported on cost-effectiveness/cost-comparisons of a number of preventive strategies, namely: i) prevention of unintended pregnancy and alcohol use during pregnancy, ii) early interventions for children and adults with FASD, iii) early and cost-effective approaches to diagnosing FASD, and iv) prevention of secondary disabilities.50–53 For example, a study by Thanh et al.52 (2013) investigated the break-even effectiveness...
of the Alberta FASD Service Networks in reducing secondary disabilities including the productivity cost of unemployment, shelter cost of homelessness, educational cost of school disruption, criminal justice cost of crime and medical cost of mental health problems. The total costs for the service network were derived from the actual spending of the service networks and estimated to be $6.12 million Canadian dollars annually including costs for diagnostic services, support services, prevention services and operational costs. The study found that the benefits of the service network would range from $8.87 million to $17.73 million Canadian dollars annually. Accordingly, the return for every Canadian dollar invested in the service network would range from $1.45 to $2.90.

A cost-effective prevention effort to eliminate FASD in New Zealand would produce, over the long term, an economic benefit from productivity gains alone. Such benefits would not, of course, accrue immediately, because the newly born do not immediately enter the workforce. Additionally, targeted prevention efforts need to include reducing the severity of the resulting impairments of those born with FASD, as well as the premature mortality due to prenatal alcohol exposure.

In terms of the productivity losses alone, New Zealand could ultimately spend up to $190,000 per day (i.e., $49 million per year) or more on an effective prevention program to prevent new cases of FASD. However the benefit to cost ratio would be considerably higher than one, because of reduced (or more effective) spending in other parts of the economy such as health care, special education, and corrections.43,44,49,54-58

There are several limitations of the current study. Firstly, the prevalence of FASD in New Zealand is currently unknown, either among the general population, special populations (eg, children in care, criminal justice population), and/or other specific communities. Therefore, the prevalence commonly reported for Canada was used, which may not be accurate. Secondly, it was assumed that the prevalence of FASD is the same across all socio-economic groups in New Zealand, which is also not known and may not be correct. Thirdly, the prevalence of FASD by age group is also currently unavailable and therefore, it was not possible to calculate productivity losses by age group. Fourthly, due to the lack of data, it was assumed that the proportion of individuals with FASD that are unemployed is the same as that of the general population. Lastly, only intellectual impairment attributable to FASD was accounted for in this study. Other disabilities attributed to birth defects, vision or hearing problems, or any other physical disabilities were not included in the estimated costs.

Despite these limitations, the results of this study have confirmed that FASD is a significant burden to New Zealand. However, it must be noted that this cost study did not estimate potential savings, since the estimates include both avoidable and unavoidable costs. Also, this study should not be confused with a cost-benefit or cost-effectiveness analysis. However, the estimates of the burden and costs associated with FASD presented here can contribute to a meaningful cost-effectiveness analyses and, eventually, cost-benefit analyses of FASD policies and programs.

The scope and accuracy of the cost figures presented in this study are contingent on the current data availability. As more data become available, this study has the potential to be expanded.
Competing interests:
Nil.

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