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Increased Mortality Risk in Children with Fetal Alcohol Spectrum Disorders: A Scoping Review

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Abstract

Objective: Fetal Alcohol Spectrum Disorders (FASDs) are common, often undiagnosed, lifelong developmental disorders that result from prenatal alcohol exposure. FASD is present at birth and typically identified around seven years of age. The most severe outcome in cases of FASD is mortality. The purpose of this scoping review is to 1) use a systematic review to provide an estimated mortality proportion for children with FASD, and 2) update a study published in 2014 by reviewing published reports of mortality in individuals diagnosed with FASD. **Method:** A search of PubMed, CINAHL, and Google Scholar for reports published between 2013 and 2023 on mortality in individuals with FASD. **Results:** Three population-based studies have reported on all-cause mortality rates, finding a combined mortality rate of 10.9%, a 2.63 fold (95% CI: 2.61 to 2.65) increase in mortality risk over the general population. Since 2016, this review identified only eight new cases meeting the study inclusion criteria. The reported causes of death were five cases of pneumonia, and one case each of failure to thrive and dehydration, intestinal dilatation and asphyxiation caused by overeating due to pica, and acute gastric volvulus. **Discussion:** While current research suggests a diagnosis of FASD is associated with a 2.6-fold increase in mortality risk, this is likely an underestimation, as most cases of FASD-related mortality go unreported. Globally, about 1 new case is reported every 15 months. However, in the United States alone, between 1752 to 4400 FASD related deaths occur annually. Our review suggests that FASD is rarely identified as a causal or contributing factor in deaths of children and adolescents, resulting in a substantial undercount of FASD-related deaths. Increased attention to the role of FASD in infant and child mortality case reviews, child death review committee reports, and mortality reviews is needed.

Keywords

Fetal Alcohol Spectrum Disorders, Mortality, Birth Defects, Death, Exposure,

Pneumonia

1. Introduction

Fetal Alcohol Spectrum Disorders (FASD) are a highly variable group of disorders that result from exposure to alcohol in utero. Fetal alcohol syndrome (FAS), partial fetal alcohol syndrome (pFAS), alcohol-related neurological disorder (ARND), and alcohol-related birth defect (ARBD) are all disorders that are included within FASD [1]. FASD was defined in this review as FAS, pFAS, ARND or ARBD. These four different diagnoses under the FASD umbrella have overlapping diagnostic criteria. A diagnosis of FAS requires the abnormal facial anomalies often seen in patients with FASD (thin upper lip, indistinct or absent philtrum, upturned nose, shortened palpebral fissures), growth deficiency, and neurobehavioral impairments. PFAS only requires an individual to have two of the facial anomalies and neurobehavioral impairments associated with alcohol exposure. ARND is diagnosed when three or more areas of brain impairment are present and there is documented exposure to alcohol in utero. ARBD is comprised of birth defects associated with prenatal alcohol exposure. The category of ARBD is rarely used [2].

2. Prevalence of Exposure

Alcohol use during pregnancy continues to be an important public health problem [3]. The magnitude of this problem is evidenced by the rates of alcohol consumption in nonpregnant women. 53.7% of nonpregnant women of child-bearing age in the United states report alcohol use [3]. Since many pregnancies are unplanned, this increases the possibility of exposure in early pregnancy. Among pregnant women, 12% report still using alcohol at the end of pregnancy [4]. These values reflect the increased risk for prenatal alcohol exposure during pregnancy. In addition, these rates may be underestimated since pregnant women may be hesitant to report alcohol use due to stigma surrounding alcohol consumption during pregnancy. Fetal exposure to alcohol can cause physiological, neurological, emotional, and behavioral changes within individuals. These effects vary in severity and persist throughout the lifespan [1].Thus, considering a context of alcohol exposure may be important in obstetrics, neonatology, pediatrics, pediatric neurology and psychiatry [5]. Prenatal alcohol exposure is a common etiologic concern in the assessment of many common neurodevelopmental disorders of childhood.

3. Prevalence of FASD

Recent systematic reviews report that the global prevalence rate of FASD is 0.77%, while the prevalence of FASD in Europe and North America is 1% - 5% [6]. In 2021, 3.6 million babies were born in the United States. A minimum es-

timate of children with FASD from birth through 18 years of age would be 3.6 million × 0.01 = 36,000 × 18 annual birth cohorts = 648,000 cases of FASD. A study performed in 2018 examined four different schools at four Midwestern sites to estimate FASD prevalence. First graders were screened for FASD to determine a population estimate [7]. This study found that the prevalence rate of FASD was about 5%. Using this prevalence estimate, the population estimate for FASD would closer to 3,240,000 children and adolescents [7]. This magnifies the importance of research in the field of FASD, as well as better understanding of how FASD presents in individuals with the disorder.

The phenotype for FASD is very broad [1]. The clinical features of FASD can vary widely between individuals. Abnormal facial features can include a smooth or flat philtrum, thin or narrow upper lip vermillion, short palpebral fissures, epicanthal folds, and midface hypoplasia, along with several other minor physical abnormalities [6]. While the assessment of facial features is useful, about 85% of cases of FASD do not present abnormal facial features or growth impairments. FASD is most frequently a neurodevelopmental disorder, and behavioral abnormalities are the most common feature of the disorder. These behavioral issues include developmental delay, sleep disorders, sensory impairments, and speech and language delays [8]. FASD also has high rates of comorbid neurodevelopmental disorders, including Attention-Deficit Hyperactivity Disorder (ADHD), Learning Disabilities, Intellectual Disability, Conduct Disorder, Oppositional Defiant Disorder, and Autism Spectrum Disorders [8]. The variability in phenotype and the high rates of comorbidity, combined with a low level of awareness and concern about FASD among clinicians, contributes to both underdiagnosis and misdiagnosis of the disorder [9].

The prevalence of FASD, together with the lifelong duration of the disorder, results in significant economic impacts. A recent study reported that the mean annual cost of caring for a child with FASD was $22,810, and for adults with FASD the mean annual cost was $24,308 [10]. Strategies focused on early identification, early intervention and utilization of a more comprehensive approach to prevention of FASD could have a profound economic impact.

4. Mortality Estimates for FASD

Several mortality estimates for FASD have been published. In 1997, Habbick *et al.* reported an FASD case fatality rate of 5% - 6% in Saskatchewan, Canada [11]. In a population-based sample, Burd *et al.* reported that the FASD case mortality rate was 2.4%, with an age standardized mortality ratio of 4.9 [12]. When compared to North Dakota residents matched by age and year of death, FASD accounted for 14% of all childhood deaths in North Dakota. A recent study from South Korea examined health care impacts of FASD, utilizing a case definition of FASD [13]. The burden of FASD on the health care system was enormous. People with FASD accounted for 51.0% of all hospitalizations in the study population. FASD was associated with 387 mortality events, 34.5% of all deaths in the

study population. In this sample, 20% of the hospitalizations and 21% of the mortality events were attributable to FASD. People with FASD had a 1.25-fold increased risk for hospitalizations (HR: 1.25, 95% CI: 1.05 - 1.49, p = 0.0114) and a 1.33-fold increase in risk for all-cause mortality (HR: 1.33, 95% CI: 1.07 - 1.67, p = 0.0118) [13]. Some reports have identified increased risk for congenital malformations, including heart malformations such as atrial septal defect, patent ductus arteriosus, and Tetralogy of Fallot, as well as central nervous system malformations such as holoprosencephaly, porencephaly, microcephaly, or hydrocephalus [14].

Deaths of people with FASD should be considered as occurring in a context of alcohol use [5]. An example of this effect is observed when the behavior abnormalities commonly seen in patients with FASD increase the likelihood of death (e.g., deaths from accidents or suicide). A study from Canada found that 44% of deaths in people with FASD were attributable to external causes of mortality like suicide, accident, poisoning by drugs or alcohol, or other external causes [15]. FASD related deaths were 8% from diseases of the nervous system, 8% from diseases of the respiratory system, 7% from diseases of the digestive system, 7% from congenital malformations, and 7% from chromosomal abnormalities [15]. The life expectancy of people with FASD in Canada was only 34 years [15]. The mortality rate of individuals with FASD was higher than the general population in every age group from age 0 to over 60 years old [15]. This data demonstrates that mortality is increased among people with FASD, mortality is underreported, and many people with FASD die before a diagnosis of FASD can be made.

In order to examine current trends in FASD and mortality, we sought first to estimate an all-cause-case fatality rate for people with FASD from birth through 18 years of age, and secondly to update a 2014 systematic review and meta-analysis of the cause of deaths among people with FASD conducted by Thompson *et al.* in 2014 [14].

5. Methods

To estimate an all-cause fatality rate for people with FASD from birth through 18 years of age, we first searched for studies reporting population-based mortality estimates for FASD. To update the review and meta-analysis, we modeled our search strategy after the Thompson *et al.* search, using updated controlled vocabulary and narrowing the parameters to focus on studies conducted on children from birth to age 18 in a review of research published since December 2012.

5.1. Methods/Literature Search

A librarian (EJ) was enlisted to develop a search strategy for PubMed, CINAHL, and Google Scholar using a combination of keywords and controlled vocabulary terms. Searches were performed on these platforms in June 2023 (see **Table 1**). The same search strategy was used on each search platform, with minor adaptations to conform to the functionality of each platform. Concepts included in the

Table 1. Description of the search terms used within the literature review, the databases that the searches were performed in, as well as how many articles were found after performing each search. The numbers of cases found from each search are indicated in the last column.

Date	Database	Search strategy	# Results	Cases (N)
6/20/2023	PubMed	(child * [Title/Abstract]) AND ((mortality [Title/Abstract] OR death [Title/Abstract] OR "mortality" [MeSH Subheading]) AND (("fetal alcohol" [Title/Abstract]) OR (("fetal alcohol spectrum disorders" [MeSH Terms])))) AND (2013:2023 [pdat]))	24	0
6/20/2023	CINAHL	"fetal alcohol" AND (mortality OR death) Filters: from 2013-2023	45	1
6/22/2023	Google Scholar	"fetal alcohol" mortality child Filters: from 2013-2023	16100	6
6/22/2023	Google Scholar	"fetal alcohol" mortality child postmortem Filters: 2013-2023	1670	1

search were mortality in children, fetal alcohol spectrum disorders (FASD), and fetal alcohol syndrome (FAS). All results from PubMed and CINAHL were examined, and the first 40 articles (4 screens) from the Google Scholar searches were included in the initial set of papers. Search results from each database were limited to papers published between 2013 and 2023. A bibliography search was also performed in the articles that were examined, as this was a method used in the previous review. However, many of the cases found in the bibliography searches were previously used by Thompson *et al.* and were contained in articles published prior to 2013.

5.2. Screening and Analysis

The Zotero software program was used to identify and remove duplicate papers. Abstracts remaining after de-duplication were examined for inclusion. Eligible studies met the following inclusion criteria: 1) included children diagnosed with FASD or FAS; 2) reported on all-cause mortality. Papers published prior to 2013 and those written in a language other than English were excluded.

Table 1 presents the search terms used in this study and the number of articles examined. After de-duplication, the authors reviewed 67 articles to identify cases of all-cause mortality in individuals with FASD. After a review of each abstract, the papers that met the inclusion criteria were retrieved for full manuscript review. After the authors examined each manuscript and applied the study inclusion and exclusion criteria, 3 papers reporting on 8 cases were included in the review.

6. Results

The first objective was to provide a case fatality rate for children with FASD using mortality estimates from published literature on FASD. We estimated the case fatality rate from three published studies (Table 2). Two rows are reported for Habbick, giving both the proportion of expected deaths in the general popu-

lation (3.43%) and in the Aboriginal population (6.71%), which was the majority of the population studied.

The proportion of children with FASD who died ranged from 2.3% (95% CI 0.62% to 3.99%) in North Dakota [11], 5.8% (95% CI 2.61% to 8.98%) in Saskatchewan [10], and 12.47% (95% CI 11.31 to 13.63%) in Korea [12]. The combined case fatality rate in children with FASD was 10.94% (95% CI 9.95% to 11.93%). The number of FASD deaths ranged from 1.79-times greater than expected (in an Aboriginal population) to 4.9 times greater (for North Dakota). The estimated mortality risk for people with FASD is increased by 2.63-fold (95% CI 2.61 to 2.65).

Table 2. Summary of the three studies reporting population-based mortality estimates in people with Fetal Alcohol Spectrum Disorders (FASD).

	N FASD	n of FASD who died	% of FASD who died	Expected FASD deaths in general population	Ratio of n FASD who died to expected
[12]	304	7	2.30	1.429	4.90
[11]	207	12	5.80	3.430	3.50
[11]			5.80	6.710*	1.79
[13]	3,103	387	12.47	147.206	2.63
Total	3821	418	10.94	158.78	2.63

*Aboriginals only.

The second objective was to update the study by Thompson *et al.* from 2014. We identified only 8 new mortality reports meeting the study inclusion criteria (**Table 3**). These 8 cases were found in 3 separate articles published within the last 10 years, and included cases of confirmed all-cause mortality events in individuals aged 0-18 years with a confirmed diagnosis of FASD.

The cases were broken down into age at death, sex, physical abnormalities, neurocognitive abnormalities, and cause of death (**Table 3**). Out of the 8 cases, 5 were female and 3 were male. The cases ranged from 5 weeks old to 15.5 years old, with only one case in an individual under the age of one year. In Thompson's review, 54.4% of cases were infants who died before one year of age, and the most common cause of death was congenital heart disease [14]. In this review the most common cause of death was pneumonia.

Out of the eight cases reviewed, 5 reported pneumonia as the cause of death. In this sample, 3 of the pneumonia cases had an unspecified etiology. The remaining two cases listed the cause of death as aspiration pneumonia and adenovirus pneumonia. The 3 non-pneumonia causes of death were recorded as failure to thrive and dehydration due to many congenital anomalies including cardiac abnormalities, acute gastric volvulus, and massive intestinal dilatation causing asphyxiation.

Individuals with fetal alcohol exposure may present with specific physical

Table 3. Description of the cases found during review. Age, sex, physical and neurocognitive abnormalities, and cause of death were included in the table. The first column indicates the source the case was found in.

Source	Age at death	Sex	Physical abnormalities	Neurocognitive abnormalities	Cause of death
Jarmasz *et al.*, 2017	5 weeks	Male	Typical facial dysmorphism (poorly formed philtrum, thin upper lip, short palpebral fissures, low set ears, as well as complex cardiac abnormalities, and dysplastic right kidney	Brain weighed 421 grams (10th percentile)	Failure to thrive and dehydration due to many congenital anomalies
Jarmasz *et al.*, 2017	2 years	Female	Facial dysmorphism (microcephaly, smooth upper lip, epicanthal folds), cardiac defects (ventricular septal defect, posterior overriding aorta)	Lissencephaly with abnormally thick neocortex, poor distinction with underlying white matter, Miller-Dieker phenotype	Adenovirus pneumonia
Jarmasz *et al.*, 2017	3.5 years	Female	Scoliosis, congenital dysplasia of left hip	Brain weighed 420 grams (<5th percentile), frontal ulegyria, occipital microgyria with laminar necrosis, unilateral ventricular enlargement, hippocampal atrophy, and severe Purkinje neuron loss	Pneumonia
Jarmasz *et al.*, 2017	7 years	Female		Microcephaly and hypertelorism. Brain weighs 750 grams (<5th percentile), atrophy and discoloration bilateral cerebral white matter with cystic destruction in left frontal lobe, hydrocephalus and severe neuron loss in hippocampi	Pneumonia
Jarmasz *et al.*, 2017	9.5 years	Female	Abnormal head shape and scoliosis	Abnormally large brain (1380 grams, >95th percentile), severe ventriculomegaly due to cerebral aqueduct stenosis with destructive changes in the white matter secondary to the ventricular enlargement and mesial temporal sclerosis	Pneumonia
Jarmasz *et al.*, 2017	15.5 years	Female			Acute gastric volvulus
Wygant & Cohle, 2019	8 years	Male	Smooth philtrum, thin upper lip, abdominal distention	Diagnosis of pica, ventricles moderately enlarged, old bilateral cystic infarcts of inferior temporal lobes	Massive intestinal dilatation causing asphyxiation
Tangsermkij sakul, 2016	6 months	Male	Growth retardation, indistinct philtrum, thin upper lip, low nasal bridge, and short upturn nose	Agenesis of corpus callosum, brain weighed 400 grams (average weight for 6 month old is 839 grams)	Aspiration pneumonia

features. Only 6 of the reported cases included details about the physical features of the individual. The most common physical abnormalities described were a smooth or indistinct philtrum (4/8, 50%), narrow vermillion (3/8,

37.5%), scoliosis (2/8, 25%), and cardiac abnormalities (2/8, 25%). Some other physical abnormalities that were described were short palpebral fissures, low set ears, dysplastic right kidney, epicanthal folds, congenital hip dysplasia, abnormal head shape, abdominal distention, low nasal bridge, and a short upturned nose. Many of these features are commonly present in individuals with FASD.

Another common adverse outcome of fetal alcohol exposure is neurocognitive abnormality. Of the 8 cases reported, 7 described neurocognitive abnormalities in the individual. The most common neurocognitive abnormalities seen in the cases we reported on were microcephaly (5/8, 62.5%), ventricular enlargement (bilateral and unilateral) (3/8, 37.5%) and hippocampal atrophy/neuron loss (2/8, 25%). Other neurocognitive features that were seen were lissencephaly with thickening of the neocortex, frontal ulegyria, occipital microgyria with laminar necrosis, severe Purkinje neuron loss, hypertelorism, bilateral atrophy and discoloration of cerebral white matter with cystic destruction of brain matter, hydrocephalus, agenesis of the corpus callosum, and bilateral cystic infarcts of the inferior temporal lobes.

One case exhibited traits that are not normally considered common in FASD. This individual had an abnormally large brain (>95 percentile) with severe ventriculomegaly due to cerebral aqueduct stenosis. This was accompanied by destructive changes in the white matter secondary to the ventricle enlargement.

7. Discussion

A previous population-based study reported that the estimated all-cause case fatality rate for children and adolescents with FASD was 5% - 6% in Saskatchewan, Canada, and that the age-standardized mortality ratio was 4.9:1 in North Dakota [11] [12]. The results from the current study estimate mortality risk to be increased by 2.63 fold by FASD (95% CI 2.61 to 2.65). We estimate that the combined FASD case fatality rate for children is 10.94% (95% CI 9.95% to 11.93%). This review demonstrates that less than 1% of predicted deaths among people with FASD were reported in the last decade. An example of this issue is that a review of reported mortality in FASD from 2013 to 2022 found only 8 cases of all-cause mortality in patients with a confirmed diagnosis of FASD. These events were from only 3 papers. Currently, global reporting of deaths among people with FASD occurs at about one case every 15 months. The very low detection rates for FASD-related mortality highlight the need for this review to demonstrate that enhanced FASD surveillance and improved reporting of mortality events among people with FASD.

The low number of cases found in our scoping literature review may be indicative of a larger issue related to the diagnosis and recognition of FASD. Previous studies have determined that the prevalence of FASD is between 2% and 5%, or 1 in every 20 - 50 births in the United States and Western Europe [6]. In com-

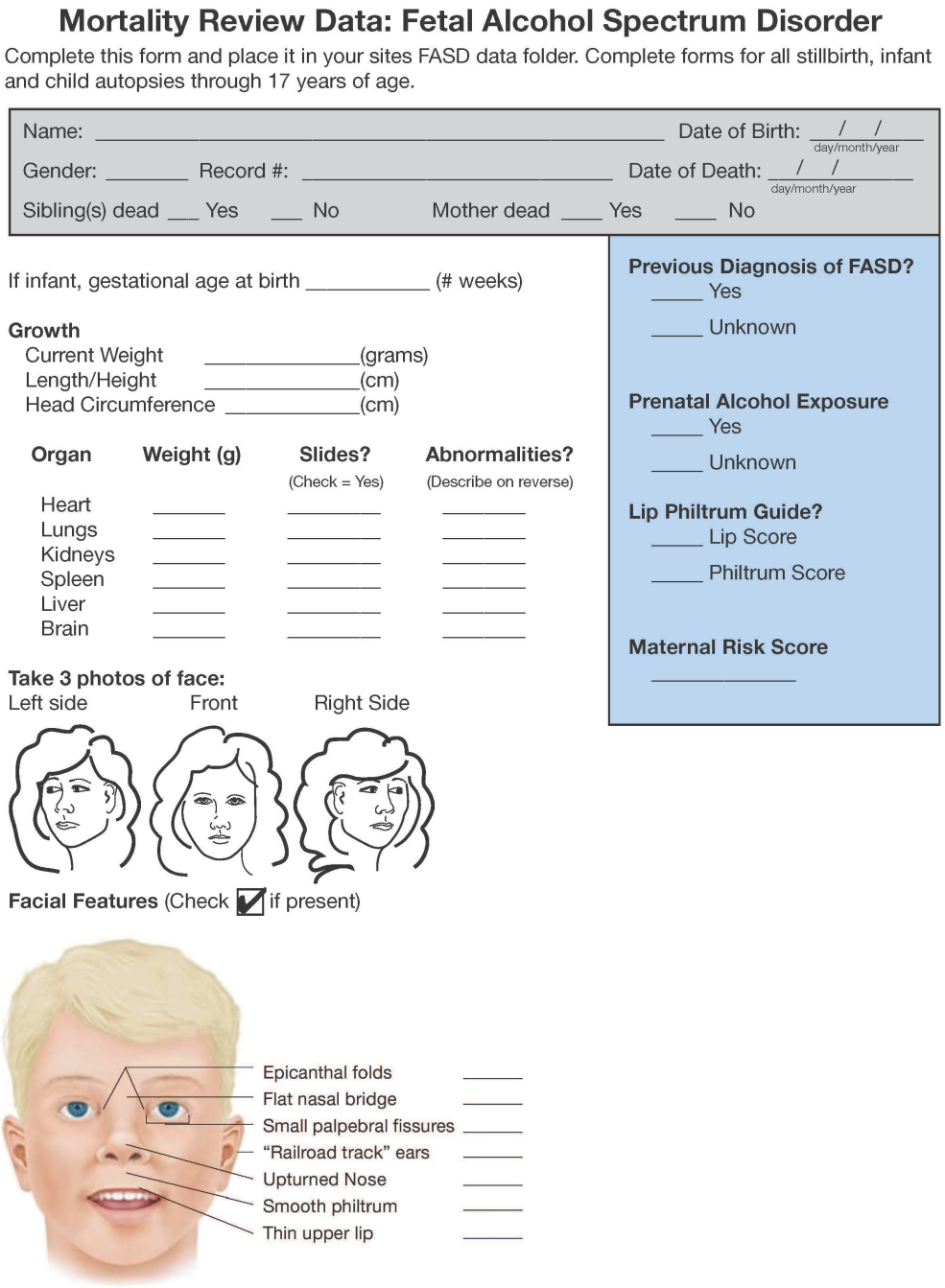
parison, about 1 in every 758 liveborn babies in the United States has Down syndrome [16]. Therefore, according to the data, FASD is approximately 15 - 38 times more prevalent in the United States than Down syndrome. We estimate that in the United States in any given year, between 1752 - 4400 FASD-related deaths may occur. We estimate that between 4 - 12 deaths of people with FASD occur daily just in the United States. These numbers alone are concerning, and they do not take into account the number of stillbirths and miscarriages that occur due to prenatal alcohol exposure [17].

FASD goes underreported for several reasons. One of those reasons is that diagnoses depend on a history of prenatal alcohol exposure. Confirmation of prenatal alcohol exposure, in most cases, relies Maternal self-reports which are often hard to elicit because of the negative connotation associated with drinking while pregnant. Another potential explanation for FASD's under-representation in mortality research is that FASD encompasses a broad spectrum of disorders, each of which has many different symptoms and clinical presentations, which adds to the complexity and difficulty of diagnosis [18]. Increased attention to improving mortality reporting is needed, and sources of mortality data may need some revision to improve identification of cases of FASD. Methods for improving identification of mortality events among people with FASD might include use of tools such as the Child Death Mortality Review Protocol from the North Dakota Fetal Alcohol Spectrum Center (**Figure 1**).

Diagnosis of FASD is complicated by clinicians' use of multiple diagnostic criteria, and the absence of an internationally recognized standard diagnostic tool to allow for reliable measurements among different practitioners and disciplines [18]. Physicians, especially within the United States, may not screen for prenatal alcohol exposure because doing so is time consuming, and because of concerns about upsetting the mother by asking about alcohol use during pregnancy. The average primary care exam is 18 minutes long [19], and with packed schedules and broad scopes of practice, primary care physicians may not have time to consistently screen their patients for FASD symptoms or prenatal alcohol use. As a result of these time constraints, many FASD patients go unrecognized and undiagnosed, and are prevented from receiving the services and interventions they need. The literature shows that these patients are at a higher risk of death from a multitude of causes; however, if they are diagnosed at a young age and interventions and plans are set in place, they have a much higher chance of survival as well as success throughout their lives.

This present study, based on a review of cases of FASD and mortality, had several limitations. First, the search identified a very limited number of published cases. The lack of reported cases limited the conclusions that could be drawn from this review. It is not clear if the reported cases accurately describe what is seen in the larger population.

Another limitation of our study is that journals written in languages other than English were not included. This may have excluded some cases reported in



Mortality Review Data: Fetal Alcohol Spectrum Disorder

Complete this form and place it in your sites FASD data folder. Complete forms for all stillbirth, infant and child autopsies through 17 years of age.

Name: _____ Date of Birth: __/__/____ day/month/year

Gender: _____ Record #: _____ Date of Death: __/__/____ day/month/year

Sibling(s) dead ___ Yes ___ No Mother dead ____ Yes ____ No

If infant, gestational age at birth _____ (# weeks)

Growth

Current Weight _____(grams)
Length/Height _____(cm)
Head Circumference _____(cm)

Organ	Weight (g)	Slides? (Check = Yes)	Abnormalities? (Describe on reverse)
Heart	_____	_____	_____
Lungs	_____	_____	_____
Kidneys	_____	_____	_____
Spleen	_____	_____	_____
Liver	_____	_____	_____
Brain	_____	_____	_____

Take 3 photos of face:

Left side Front Right Side

Facial Features (Check ☑ if present)

Epicanthal folds _____
Flat nasal bridge _____
Small palpebral fissures _____
"Railroad track" ears _____
Upturned Nose _____
Smooth philtrum _____
Thin upper lip _____

Previous Diagnosis of FASD?
_____ Yes
_____ Unknown

Prenatal Alcohol Exposure
_____ Yes
_____ Unknown

Lip Philtrum Guide?
_____ Lip Score
_____ Philtrum Score

Maternal Risk Score
_____

Figure 1. Mortality case review data for fetal alcohol spectrum disorder (FASD).

other languages.

Finally, the search strategy did not include several important databases, including results of infant child mortality review committees, jurisdiction-specific medical examiners, coroners, and hospital records. As a result, our findings may underestimate the number of FASD and mortality events reported. However, given the magnitude of underreporting found in our review, it is unlikely that several thousand cases have been reported and gone unnoticed.

The lack of cases found in published literature may be a limitation to our

study, but it also underlines a greater problem that we found during review. Given the limited exposure of fetal alcohol spectrum disorders in medical literature, it may be that pathologists are attributing deaths caused by fetal alcohol exposure to other causes, particularly if they are not aware of the patient's history, or if the patient has never been diagnosed with FASD.

The causes of death in the cases reviewed—pneumonia (adenovirus, aspiration, and unspecified), intestinal dilatation causing asphyxiation due to overeating, and acute gastric volvulus [20]-[22]—are somewhat narrow, which may be indicative of one of the weaknesses of the present study. A larger sample size would likely reveal a broader array of causes of death, more in line with the established literature on infant and child mortality. Thompson *et al.* in 2014 found that the two most prevalent likely causes of death among persons with FASD were malformations of the heart and brain [14]. This differs from the cases in our report, likely because over half of the deaths in the previous review occurred in the first year of life, where congenital malformations could cause death very prematurely. Our review identified 5 deaths in patients with FASD that were attributed to pneumonia. This also differs from other literature, but is understandable clinically. A 2015 study demonstrated that prenatal alcohol exposure disrupts the developing fetus's immune system [23].

Increased reporting of mortality events among people with FASD is needed to expand the available literature on both cause and manner of death. Understanding these mortality events has the potential to improve the care offered for both mothers and children with FASD. One compelling example that has been reported is that mothers who have a child with FASD have a 44.82 fold increase in mortality risk compared to mothers who had children without FASD [24]. These mothers are not only at increased risk of premature death, but they are also more likely to birth more children with FASD. This data demonstrates the importance of enhanced information on mortality risk in FASD and the potential public health application of this information for enhancing care for families impacted by FASD.

Data Availability

All the data used in this study are publicly available and derived from the references listed.

Authors' Contributions

DE, TM, MK, EJ, and LB each contributed to drafting the original manuscript and in some of the subsequent revisions. MK performed the statistical analysis. EJ devised the search strategy.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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List of Abbreviations

ARBD	Alcohol-related birth defect
ARND	Alcohol-related neurological disorder
FAS	Fetal alcohol syndrome
FASD	Fetal alcohol spectrum disorders
PFAS	Partial fetal alcohol syndrome