Surveillance for Fetal Alcohol Syndrome in Colorado

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SYNOPSIS

THE AUTHORS PERFORMED surveillance for fetal alcohol syndrome with an existing birth defects registry. Fetal alcohol syndrome cases were identified from multiple sources using passive surveillance and from two selected medical sites using enhanced surveillance.

Between May 1992 and March 1994, a total of 173 cases were identified, and the medical records of the cases were reviewed to determine whether the cases met a surveillance case definition for fetal alcohol syndrome. Of these cases, 37 (21 percent) met either definite (28) or probable (9) criteria for fetal alcohol syndrome, 76 met possible criteria (44 percent), and 60 (35 percent) were defined as not fetal alcohol syndrome. Enhanced surveillance had the highest sensitivity for definite or probable cases, 31 of 37 (84 percent), followed by hospital discharge data, 14 of 37 (38 percent).

The authors also compared birth certificate information for 22 definite or probable cases in children born between 1989 and 1992 to birth certificate information for all Colorado births for that period.

The proportion of mothers of children with fetal alcohol syndrome was statistically significantly greater (as determined by exact binomial 95 percent confidence limits) than the proportion of all mothers for the following characteristics: black race (0.23 versus 0.05), unmarried (0.55 versus 0.22), not employed during pregnancy (0.86 versus 0.43), and started prenatal care in the third trimester (0.18 versus 0.04).

Surveillance for fetal alcohol syndrome can be accomplished with an existing registry system in combination with additional case finding and verification activities. Through followup investigation of reported cases, data can be gathered on the mothers of children with fetal alcohol syndrome. These data could be used to target fetal alcohol syndrome prevention programs.

The prevalence of fetal alcohol syndrome (FAS) in the western world is estimated to range between 0.33 and 2 per 1,000 live births (*1,2*), although estimates are difficult to determine because of subjective interpretation of diagnostic criteria, differences in study methodology (retrospective versus prospective), and failure to recognize the syndrome. In addition, estimates among specific study popula-

tions vary widely, due in part to differences between populations in socioeconomic status, race, and social group norms for alcohol consumption (*1,3,4*).

In Colorado, little is known about the prevalence of FAS. This knowledge is needed to determine the scope of the problem in the State, to target and evaluate prevention efforts, and to plan for services. Information about the mothers who give birth to children with FAS is also needed.

This report describes (*a*) the methods used to perform surveillance for FAS in Colorado, (*b*) the effectiveness of a variety of reporting sources, (*c*) the number of FAS cases identified by record review in Colorado between May 1992 and March 1994, and (*d*) the demographic characteristics and prenatal history of mothers of children with FAS.

Methods

The Colorado Registry for Children with Special Needs (CRCSN), located in the Colorado Department of Public Health and Environment, is a centralized, statewide system for epidemiologic monitoring of birth defects and developmental disabilities. CRCSN has been in operation since late 1988.

To be included in the Registry, a child must be a Colorado resident younger than age three years who has been reported as having one of the following eligible conditions: an established medical diagnosis (congenital anomaly, chromosomal abnormality, genetic disease, endocrine or metabolic disease), a medical risk factor for developmental delay (infection, head injury, or other reasons including FAS or prenatal drug exposure), or one of two environmental (maternal) risk factors for developmental delay (maternal age less than 15 or education less than 12 years combined with no prenatal visits).

Children meeting these criteria are identified from Colorado birth and death certificates, Colorado hospital discharge data, the Health Care Program for Children with Special Needs (a program serving children from birth to 21 years who meet specific medical and financial eligibility requirements), the Newborn Genetics Screening Program, the Mountain States Regional Genetics Screening Network (a group of genetic service providers hereafter referred to as genetic clinics), epidemiology reports, and voluntary physician reports.

To strengthen FAS surveillance, State regulations were modified in 1991 to require health care providers to report suspected or confirmed cases of FAS in children who were younger than age seven years. These reports then came under statutory confidentiality safeguards and allowed health department staff members access to medical records without parental consent.

Potential FAS cases are identified in children reported to the Registry with a diagnosis of FAS, fetal alcohol effects (FAE), "rule out" FAS or FAE, or a coded diagnosis using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code 760.71. In addition, FAS cases are identified by an enhanced surveillance method involving frequent communication with providers at two medical sites: a neonatology practice at a large, Denver hospital serving low-income patients and a clinic-based developmental unit at a Denver pediatric hospital.

For each identified case of FAS, a trained medical records reviewer abstracts records from the original reporting source or the enhanced surveillance site. The child's birth record, the mother's delivery record, additional hospitalization records of the child, the child's referral clinic records, and the childs' developmental assessment records are also reviewed if available. Information collected includes more than 100 data items from the following areas: growth (height, weight, and head circumference); central nervous system abnormalities; dysmorphology; congenital anomalies; maternal drug and alcohol use; and maternal social factors related to alcohol use. A complete list of the data items collected is included in the box.

To link reported Registry cases to birth certificate data, possible match lists are generated from the birth certificate files using the child's date of birth, first name, middle initial, surname (or various iterations thereof to account for spelling differences), hospital of birth, and zip code of residence, when available. Possible matches are then examined by hand against paper records to determine individual matches. Existing case records are updated when new information is obtained from any source.

Surveillance case definition. A surveillance case definition was developed based on published reports of FAS (*5–7*) and consultation with a select panel of experts consisting of pediatricians, neonatologists, and geneticists in Colorado. Information abstracted from the medical records of the first 100 identified FAS cases was applied to the surveillance case definition, and the case definition was then modified with special attention to agreement with clinical diagnoses by geneticists and developmental specialists. The following four categories of criteria were used in the surveillance case definition:

1. *Growth deficiency* (*a*) Evidence of intrauterine growth retardation (IUGR), defined as less than or equal to the 10th percentile of birth weight after correction for gestational age of the newborn; or (*b*) evidence of postnatal growth retardation, defined as height and weight less than or equal to the 10th percentile of height and weight at any age.

2. *Central nervous system abnormalities* Evidence of microcephaly, defined as head circumference less than or equal to the 10th percentile of head circumference at any age; or evidence of at least two of the following features suggestive of central nervous system dysfunction—*(a)* persistent irritability in infants, *(b)* hyperactivity or short attention/learning deficit in children, *(c)* poor suck or weak sucking reflex, *(d)* mild to moderate mental retardation, *(e)* poor coordination.

3. *Dysmorphology* Evidence of at least two of the following dysmorphic facial features:(*a*) short palpebral fissures; (*b*) low or flat nasal bridge; (*c*) short, upturned nose (anteverted nostrils); (*d*) hypoplastic maxilla; (*e*) hypoplastic philtrum; (*f*) thin upper vermillion.

4. *Maternal history of alcohol use* History of alcohol use during pregnancy documented in the medical record. Consideration of amount, frequency and trimester of drinking was desirable but not required.

The following definitions were used to designate varying levels of certainty: a definite case met all four criteria for FAS (1-2-3-4); a probable case met the dysmorphology criteria plus any two other criteria (1-2-3, 2-3-4, or 1-3-4); and a possible case had history of maternal alcohol use and any one of the other three FAS criteria (1-4, 2-4, 3-4). Cases that did not meet the definite, probable, or possible definitions were designated as not FAS. A computer program was developed with a statistical software package (*8*) to assign one of the foregoing definitions for each case.

Determination of maternal characteristics. To describe the characteristics of the mothers of children diagnosed with FAS, we performed a followup investigation by matching definite or probable cases of FAS in children born in Colorado between January 1, 1989, and December 31, 1992, with their Colorado birth certificate. Maternal demographic and prenatal care information on the birth certificate for definite or probable cases was compared with the same information for the 214,499 live births that occurred during the same period. The years 1989–92 were chosen because reporting was more complete for those years than for previous (1985–88) or later (1993) birth years.

Among FAS cases, exact binomial 95 percent confidence limits were determined within each categorical level using SABER software (*9*). Confidence limits were chosen as a method of comparing the two groups instead of hypothesis testing because the limits demonstrated how the rates were affected by small numbers, which would not have been reflected by a *P*-value. Confidence limits were not determined for all live births, since the entire population was represented.

Results

Assignment of case status. A total of 173 potential FAS cases were identified from the Registry or enhanced surveillance between May 1992 and March 1994 (table 1). Of these cases, 37 (21 percent) met either definite (28) or probable (9) criteria for FAS; 76 (44 percent) met possible criteria; 60 (35 percent) were defined as not FAS, 21 of which had no documentation of maternal alcohol consumption in the medical record.

Reporting source. A total of 228 reports were obtained, representing the 173 individual cases (table 1). Twelve different combinations of sources identified cases to the CRCSN and 27 percent of cases (47 of 173) were identified by more than one source. Enhanced surveillance had the highest sensitivity for definite or probable cases (31 of 37, or 84 percent), followed by hospital discharge data (14 of 37, or 38 percent). The sensitivity of other sources was 11 percent or less. Thirteen of the 31 (42 percent) definite or probable cases identified from enhanced surveillance were also identified from an additional source or sources. With the exception of genetics clinics, which reported only five cases and had a positive predictive value of 60 percent, the positive predictive value of sources ranged from 18 percent to 27 percent.

Table 1. Number and classification of reports on 173 potential fetal alcohol syndrome (FAS) cases identified from the Registry or enhanced surveillance between May 1992 and March 1994, by source

Source	Definite (28 cases)	Probable (9 cases)	Possible (76 cases)	Not FAS (60 cases)	Total (173 cases)	Sensitivity[2] (percent)	Positive[1] predictive value (percent)
Birth certificate	3	1	5	13	22	11	18
Hospital discharge data	11	3	21	16	51	38	27
Physician	0	2	6	1	9	5	22
Genetic clinic	3	0	0	2	5	8	60
Enhanced surveillance[3]	24	7	68	42	141	84	22
Totals[4]	41	13	100	74	228	...	24

[1]Number of definite or probable cases identified from a source divided by the total number of cases identified from that source, multiplied by 100.

[2]Number of definite or probable cases identified from a source divided by the total number of definite or probable cases, multiplied by 100.

[3]Enhanced surveillance involves frequent communication with providers at two medical sites: a neonatology practice at a large Denver hospital serving low-income patients and a clinic-based developmental unit at a Denver pediatric hospital.

[4]Totals exceed number of cases because the cases may be reported by more than source.

Concordance with geneticist's diagnoses. A total of 78 identified cases were also evaluated by a geneticist. Of the 28 definite cases, 21 were seen by a geneticist. Fourteen of these received a diagnosis of FAS or "consistent with" FAS, two had a diagnosis of "rule-out" FAS, one was diagnosed as having FAE and one was diagnosed as "possible FAE". The remaining three did not receive an FAS-related diagnosis. Five of the nine probable cases were seen by a geneticist; one of these received a diagnosis of FAS and two were diagnosed with FAE. Two probable cases evaluated by a geneticist did not receive an FAS-related diagnosis.

Of the 76 cases defined as possible, 38 were seen by a geneticist. One received a diagnosis of consistent with FAS, two received a diagnosis of possible FAS, and four received a diagnosis of FAE, possible FAE, or rule-out FAE. The remaining 31 cases did not receive an FAS-related diagnosis. Fourteen of the 60 cases defined as not FAS were seen by a geneticist and only two were given an FAS-related diagnosis of possible FAS.

Age of cases at the time diagnostic information was collected. Approximately one-third (35 percent, 61 of 173) of all potential FAS cases were seen only at birth. This included 14 percent (5 of 37) of definite and probable cases, and 41 percent (56 of 136) of possible and not FAS cases. Of definite and probable cases for whom diagnostic information was collected after birth, the oldest age at the time data was collected was between 1 day and 12 months of age for 41 percent (versus 37 percent for possible and not FAS), older than 12 months and up to 24 months of age for 24 percent (versus 12 percent for possible and not FAS), and older than 24 months and up to 7 years of age for 22 percent (versus 10 percent for possible and not FAS).

Criteria met by definite and probable cases (table 2). The most common features among definite and probable cases combined were maternal alcohol use, microcephaly, and thin upper vermillion. All 28 definite cases met the case definition for CNS abnormalities by evidence of microcephaly; none met the criteria for CNS abnormalities by evidence of CNS dysfunction. Of the nine probable cases, five met the case definition by evidence of microcephaly, dysmorphology, and maternal alcohol use; two met the case definition by evidence of growth deficiency, dysmorphology and maternal alcohol use; and two met the case definition by evidence of CNS dysfunction, dysmorphology, and maternal alcohol consumption.

Maternal characteristics of definite or probable FAS cases versus maternal characteristics of the Colorado birth cohort from 1989 to 1992 (table 3). Twenty-two of 29 (76 percent) definite or probable cases with birth years between 1989 and 1992 could be matched to a Colorado birth certificate. Of the seven cases that could not be matched to a Colorado birth certificate, four were born in other States, and the remaining three were in foster care.

Mothers of definite or probable FAS cases were more likely to be black, to be unmarried, and to be unemployed during pregnancy. They were more likely to be ages 30–39, and to have given birth to at least five children. Mothers of definite or probable cases were more likely to have begun prenatal care in the third trimester and had fewer prenatal

Table 2. Specific case definition criteria for fetal alcohol syndrome (FAS) met by 173 potential FAS cases

Abnormality	Definite (N=28)	Probable (N=9)	Possible (N=76)	Not FAS (N=60)	Total cases (N=173)
Growth deficiency:					
Intrauterine growth retardation	61	11	62	8	40
Growth deficiency	79	11	32	12	31
Central nervous system:					
Microcephaly	100	56	50	10	45
Infant irritability, attention deficit disorder, or hyperactivity	36	33	25	15	24
Poor or weak sucking reflex	18	11	16	2	11
Poor coordination	18	22	8	0	8
Mild or moderate mental retardation	11	11	3	2	4
Dysmorphology:					
Short palpebral fissure	46	67	7	5	16
Low or flat nasal bridge	50	56	11	2	16
Short, upturned nose	36	22	3	3	9
Hypoplastic maxilla	61	33	4	2	14
Hypoplastic philtrum	64	67	12	0	19
Thin upper vermillion	71	67	11	5	21
Maternal alcohol use	100	100	100	65	88

Table 3. Selected maternal and birth characteristics of definite and probable fetal alcohol syndrome (FAS) cases and Colorado birth cohort, birth years 1989–92

Maternal or birth characteristic	Percent of FAS cases (N=22)	95 percent CI	Percent of birth cohort (N=214,499)
Maternal race-ethnicity:			
White, non-Hispanic	50	29, 71	73
Hispanic	14	3, 35	17
Black	23	8, 45	5
Native American	9	1, 29	1
Other	0	0, 15	2
Unknown	5	0, 23	1
Maternal age (years):			
Younger than 20	9	1, 29	12
20–29	32	14, 55	54
30–39	59	36, 79	33
Older than 39	0	0, 15	1
Maternal education (highest grade completed):			
Less than 12th	27	11, 50	18
12th	41	21, 64	35
13th–15th	27	11, 50	22
16th or more	5	0, 23	23
Unknown	0	0, 15	2
Married:			
Yes	45	24, 68	78
No	55	32, 76	22
Unknown	0	0, 15	0
Employed during pregnancy:			
Yes	14	3, 35	56
No	86	65, 97	43
Unknown	0	0, 15	2
Birth order:			
First	27	11, 50	41
Second	18	5, 40	33
Third	23	8, 45	16
Fourth	14	3, 35	6
Firth or more	18	5, 40	3
Unknown	0	0, 15	2
Number of prenatal visits:			
0	18	5, 40	1
1–3	18	5, 40	3
4–8	32	14, 55	16
9–14	27	11, 50	59
More than 14	0	0, 15	20
Unknown	5	0, 23	2
Trimester prenatal care began:			
First	32	14, 55	77
Second	32	14, 55	17
Third	18	5, 40	4
No care	14	3, 35	1
Unknown	5	0, 23	1
Cigarettes per day			
0	23	8, 45	81
1–5	23	8, 45	5
6–10	14	3, 35	6
11–15	9	1, 29	1
16–20	14	3, 35	3
More than 20	5	0, 23	1
Unknown	14	3, 35	3
Drinks per week:			
0	45	24, 68	94
1–3	32	14, 55	3
4–6	5	0, 23	< 1
7–12	5	0, 23	< 1
13–20	0	0, 15	< 1
21–98	0	0, 15	< 1
More than 98	9	1, 29	< 1
Unknown	5	0, 23	3
Weight gain (pounds):			
Less than 16	0	0, 15	6
16–25	36	17, 59	11
26–35	14	3, 35	46
36–45	5	0, 23	18
46–55	5	0, 23	6
More than 55	0	0, 15	2
Unknown	41	21, 64	11
Medical risk factors for pregnancy:			
Yes	[1]50	28, 72	23
No	50	28, 72	77
Complications of labor and delivery:			
Yes	[2]55	32, 76	33
No	46	24, 68	67
Abnormal conditions of the newborn:			
Yes	[3]32	14, 55	6
No	68	45, 86	94

[1]Includes two previous preterm or small for gestational age infants, one anemia, and 10 other risk factors.

[2]Includes five fever, one moderate-heavy meconium, one abruptio placenta, three precipitous labor, two prolonged labor, one placental previa, three other excessive bleeding, three seizures during labor, one breech/malpresentation, one cephalopelvic disproportion, three cord prolapse, two fetal distress, two anesthetic complications, and two other complications.

[3]Includes three fetal alcohol syndrome, two meconium aspiration syndrome, one assisted ventilation for more 30 minutes, one seizure, and one birth injury.

NOTES: Disorders do not sum to the total number of FAS cases with a characteristic because one case may have more than one disorder. CI = confidence interval.

visits than mothers in the birth cohort. They were also more likely to smoke and drink alcohol during pregnancy, although the birth certificate indicated that almost half did not drink during pregnancy. Medical risk factors for the pregnancy and abnormal conditions of the newborn were noted more often for mothers of definite or probable cases than for the birth cohort.

Discussion

Defining FAS for the purposes of surveillance, an activity integral to the development and evaluation of public health policy and prevention activities related to FAS, is fraught with difficulty. As in many public health surveillance systems, surveillance sources for FAS in Colorado are diverse and of varying accuracy. Although systematic screening programs (*4*) may be more complete at case ascertainment, they may also be more expensive and time consuming. We found that an existing birth defects registry system, supplemented with enhanced surveillance, can be used to provide surveillance information for FAS.

Although the accuracy of our surveillance case definition for FAS cannot be compared to the "gold standard" (since there is none for FAS), we did find that our surveillance definition compared favorably to geneticists' diagnoses. The case definition that we devised is specific for children younger than age seven years, and the surveillance sources of the Registry target children from birth to age three. Older children, adolescents, and adults manifest FAS characteristics differently (*10*) and may not be well-targeted by our case definition or our surveillance sources.

Several issues became apparent when we applied our case definition to identified cases. First, growth deficiency was a difficult diagnosis to monitor because we often had only one growth measurement available. Since growth is inherently a characteristic that is defined over time, an ideal surveillance system would collect information about this characteristic over time. In other instances, birth height and birth weight measurements were inconsistently corrected for gestational age, or the medical record did not document whether the measurements were corrected for gestational age. Other issues include the lack of palpebral fissure (*11*) or growth measurement standards for non-white races and the lack of standardization between reporting sources.

In a screening clinic designed for the purpose of diagnosing FAS, standard information on all data collection items would be complete. In a multiple reporting source system such as ours, however, not all sources record information in the medical record for all data collection items of interest. If documentation did not address a trait, we assumed a negative finding, but it is also possible that the trait was not evaluated or was evaluated and not documented. These differences between screening and surveillance probably lead to differences in the reported frequencies of specific criteria (table 2). For example, Hanson and coworkers (*12*) reported that short palpebral fissures were observed in 92 percent of children with FAS examined. With our surveillance methods, only 46 percent of definite FAS cases were noted to have short palpebral fissures.

The number of children identified with definite or probable FAS in Colorado underestimates the true number for several reasons. First, FAS is most likely underdiagnosed by clinicians. Although data from the Birth Defects Monitoring Program of the Centers for Disease Control and Prevention suggests that the recognition of FAS has improved in recent years (*2*), other data suggest that the syndrome may be missed by clinicians (*13*).

Secondly, not all diagnosed cases are identified through existing sources. Enhanced surveillance, which identified the most definite and probable cases, is carried out at only two sites in the Denver metropolitan area (where approximately 50 percent of the Colorado population resides). Therefore, there is still a significant proportion of the population that is not covered by enhanced surveillance. And lastly, since the data used to determine case status was often collected when the child was in infancy, younger cases may not have had a chance to be diagnosed yet or may have not developed characteristics (attention deficit disorder or mental retardation, for example) which may lead to diagnosis.

Through ongoing surveillance, additional information may become available on existing cases and lead to their reclassification. For the preceding reasons, we did not calculate a prevalence rate using these data.

Birth certificates were the source for only 3 of 37 (8 percent) definite or probable cases, while enhanced surveillance, which represented only cases seen at two selected sites, was the source for 31 of 37 (84 percent) definite or probable cases. Birth certificates have previously been shown to be poor sources of information about congenital anomalies and about FAS specifically (*14,15*).

Hospital discharge data had the second highest sensitivity for definite or probable cases. Cases were identified from this source if a discharge diagnosis of ICD-9-CM code 760.71 was used. Although the ICD-9-CM code 760.71 is intended to be used for all infants affected by maternal alcohol use and is not specific for FAS (personal communication, August 28, 1992, from Patricia S. Robinson, A.R.T., Assistant Director, Central Office, on ICD-9- CM), it does appear to be useful for identifying FAS cases if further medical record review is done to eliminate false positive cases.

Individual sources had low positive predictive values, with the exception of genetics clinics where few cases were identified. The low positive predictive value of most surveillance sources necessitates verification of the diagnosis from these sources through either medical record review, as done here, or through independent examination of the child by a diagnostician.

There has been little systematic study of the women who bear children with FAS and no published comparisons of these women with a population-based group of mothers. Of three studies published (*16–18*), one involved eight mothers (*18*), one five mothers (*16*), and one was a retro-

Data Collection Items Used for Fetal Alcohol Syndrome Surveillance

A. *Growth deficiency data*: intrauterine growth retardation; birth weight; estimated gestational age; current or most recent weight and height.

B. *Central nervous system abnormalities*: head circumference at birth, current or most recent head circumference; hyperacusia; poor or weak sucking reflex; irritability in infant; specified developmental delay (coordination, fine motor, speech, global, or other specified delay); developmental delay not otherwise specified; mental retardation (mild, moderate, severe, or otherwise specified); other reduction deformities of brain, other central nervous system conditions or malformations (including seizures); feeding problems or failure to thrive; short attention span or learning deficit; hyperactivity; other specified behavior condition.

C. *Dysmorphology*: hypoplastic maxilla or flat midface; short or small palpebral fissures; widely spaced eyes (intercanthal, outercanthal, and interpupillary distance measurements); epicanthal folds or flat suborbital ridges; other specified feature or malformation of the eye; low nasal bridge; flat nasal bridge; short, upturned nose; other specified feature of the nose; hypoplastic philtrum; smooth or flat philtrum; long philtrum; narrow or smooth or thin vermilion; other specified feature of the mouth; malformed ear not otherwise specified; prominent helical root; protruding auricle; other specified feature or malformation of the ear; micrognathia; other specified feature or malformation of the face; finger or hand malformation not otherwise specified; clinodactyly; camptodactyly; small finger or toe nails; sharply angulated distal palmar crease; other specified malformation of fingers, toes, or hand; dysmorphic features not elsewhere classified; hirsutism; other medical condition, malformation, or feature not elsewhere classified.

D. *Newborn drug and alcohol exposure*: other specified drug effects noted in child; newborn drug test; fetal exposure to alcohol; newborn positive alcohol or drug test.

E. *Maternal alcohol or drug use*: alcohol abuse prior or subsequent to pregnancy; alcohol abuse or treatment; confirmed alcoholism; alcohol use during pregnancy (frequency, volume and type specified); alcohol screen test positive, alcohol use during pregnancy denied by mother; current alcohol or drug use; alcohol use unknown or undocumented in record; liver function tests; recovered alcoholic; other illicit drug use during pregnancy.

F. *Other maternal information*: smoking during pregnancy; poor nutrition during pregnancy; mental health problem.

G. *Social information*: alcohol abuse prior or during pregnancy by significant other; history of alcohol abuse in family; history of illicit drug use in family; present domestic violence; past domestic violence; adoption or foster care.

spective analysis of 311 case reports published in the literature (*17*).

Studies have suggested that FAS mothers receive little or no prenatal care (*17,18*) have a higher than expected maternal age (*4,16,17*), are likely to be unemployed (*16*), and have many health-related problems (*17*). The literature also suggests that children with FAS are more likely to be later-born than first-born (*19*). Our data, although based on small numbers, support these findings from the literature.

Because many of these mothers were unemployed and unmarried during pregnancy, they may be likely to use social service programs even before they receive prenatal care (only 32 percent received prenatal care in the first trimester). One potential intervention would be to identify at-risk women using such services and provide them with early pregnancy diagnosis and prenatal care. The relatively large proportion of smokers in the FAS mother group also suggests that the children of these mothers are put at risk by multiple environmental sources and interventions need to address multiple risk factors for poor prenatal outcomes.

Because we were unable to match 24 percent of definite or probable cases to Colorado birth certificates, and because case ascertainment was undoubtedly incomplete to some degree, these findings based on analysis of birth certificate data should be verified.

Public health surveillance for FAS is not a simple task. There are no definitive laboratory tests or pathognomonic clinical features. However, surveillance can be accomplished utilizing an existing registry system in combination with additional case finding and verification activities. Through followup investigation of reported cases, data can be gathered on the mothers of FAS cases. These data could be used to target FAS prevention programs.

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