

ESTIMATING PREVALENCE OF FETAL ALCOHOL SYNDROME IN OREGON

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BACKGROUND, POPULATION & DEFINITIONS

What is Fetal Alcohol Syndrome (FAS)?

- A disorder of permanent birth defects that occur in the offspring of women who drink alcohol during pregnancy. FAS is typified by a constellation of
 - Growth deficiency in height, weight, or both;
 - Craniofacial abnormalities (smooth philtrum, thin upper lip, short palpebral fissures); and
 - Clinically significant structural, neurological, or functional central nervous system impairment.
- Manifestation of birth defects depends on the amount, frequency, and timing of maternal alcohol consumption.

Oregon FAS Surveillance System

- Geographic coverage**
 - Statewide surveillance
- Case inclusion criteria**
 - Mother of child – Oregon resident at time of birth, and
 - Child – Born between 1/1/2001 and 12/31/2006 (inclusive)
- Case definition** (see Positive Phenotype Table below)

OREGON FAS SURVEILLANCE SYSTEM POSITIVE PHENOTYPE			
FAS DIAGNOSTIC CATEGORY	FACE	CENTRAL NERVOUS SYSTEM (CNS)	GROWTH
CONFIRMED	ABNORMAL FACIAL FEATURES consistent with FAS OR 2 OF 3 FEATURES: <ul style="list-style-type: none"> Short palpebral fissures Abnormal philtrum Thin upper lip 	At least 1 STRUCTURAL or FUNCTIONAL anomaly in utero or after birth STRUCTURAL Head circumference <10 th percentile at birth or any age postnatally FUNCTIONAL <ul style="list-style-type: none"> Developmental delay Mental retardation ADD / ADHD 	GROWTH DELAY in utero or after birth INTRAUTERINE Weight or Height corrected for gestational age <10 th percentile POSTNATAL <ul style="list-style-type: none"> Weight for Height <10th percentile for age Weight for Height <10th percentile
PROBABLE	Must meet FACE criteria	Must meet EITHER CNS OR GROWTH criteria	
PENDING	Must meet predetermined criteria from the specific referral source		

See Hymbaugh et al., *Teratology* 2002, 66:S41-S49; Druschel and Fox, *Pediatrics* 2007, Vol. 119(2):e384-e390.

Case-Finding Strategies

- FAS (ICD-9 760.71) OR a combination of ICD-9 codes
 - Central Nervous System (CNS) diagnoses -- microcephaly (ICD-9 742.1) AND developmental delay (ICD-9 315.xx) OR mental retardation (ICD-9 317.xx, ICD-9 318.xx)
 - PLUS 1 growth-related diagnosis -- small for gestational age (ICD-9 764.xx) OR low birth weight (ICD-9 765.xx) OR failure to thrive (ICD-9 783.x)

Data Sources

- Oregon Birth Certificates
- Medicaid Management Information System (MMIS) claims data
- Medical records
 - 57 hospitals and hospital pediatric clinics
 - Child Development and Rehabilitation Center clinics, specialty pediatric clinics
 - Genetics clinics

Case-Finding Methods

- Use birth certificates and MMIS claims data to identify children with certain diagnostic codes
- Make requests to hospitals and clinics for medical records on children that
 - Have FAS or the ICD-9 760.71 diagnostic code in the medical record or hospital discharge summary
 - Have a ICD-9 759.x diagnostic code for congenital anomalies
 - Fit surveillance system criteria (specific combinations of ICD-9 codes)
 - Were identified by birth certificate and/or Medicaid claim

PREVALENCE ESTIMATION METHODS

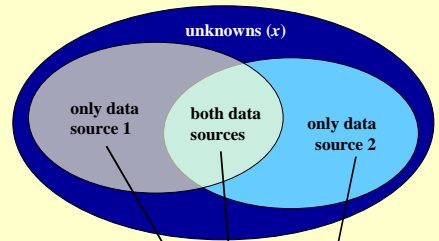
Dual- and Multiple-Record System (DRS / MRS) Estimation Methods

- More commonly known as “capture-recapture”
- Applied to human populations in the 1940s
- First epidemiologic application of methods in 1969
- Modified for use in human populations to estimate
 - Population size
 - Incidence and/or prevalence of disease (primarily chronic diseases)
 - Completeness of surveillance systems or disease registries
- Adapted to different types of data sources
 - Medical records
 - Laboratory results
 - Registries

See IWGDMF, *Am J Epidemiol* 1995, 142:1047-58, 1059-68.

Estimation methods can have as few as 2 sources of data. DRS estimation methods stem from 2 primary techniques

- Peterson Estimator** for large sample sizes, uses a maximum likelihood estimation method, or
- Chapman Estimator** for small sample sizes, uses a nearly unbiased estimation method



2 nd Data Source	1 st Data Source	
	Present	Absent
Present	a	b
Absent	c	x

Figure 1. 2 x 2 Table Layout for 2-source Estimation Method using Peterson and Chapman Estimators.

Method Assumptions for 2-source Models

- Closed population** – is the individual in the population for the duration of the study?
- Identifiability** – can an individual be identified and matched from 1 data source to the next data source?
- Equal catchability** – is the probability of being “captured” the same for all individuals?
- Independence** – is the probability of an individual being captured in any 1 sampling event independent of other sampling events?

3 rd Data Source	1 st Data Source			
	Present		Absent	
	2 nd Data Source Present	2 nd Data Source Absent	2 nd Data Source Present	2 nd Data Source Absent
Present	a	b	e	f
Absent	c	d	g	x

Figure 2. 3-way Table Layout for 3-source Estimation Method using Log-Linear Modeling.

See Chao et al., *Statist Med* 2001, 20:3123-57.

Why use more than 2 sources of data and MRS estimation methods?

- All models are under a unified framework
- Model selection can be easily implemented and carried out in a flexible manner based on data and informed by prior knowledge
- Tests are available for comparing models
- Dependence can be incorporated into models by adding appropriate interaction terms
- All inference is within the mainstream of statistical data analysis

See IWGDMF, *Am J Epidemiol* 1995, 142:1047-58, 1059-68. Chao et al., *Statist Med* 2001, 20:3123-57.

Why use DRS or MRS estimation methods for estimating prevalence of FAS?

- The Centers for Disease Control and Prevention framework for the FAS surveillance system was specifically built upon the premise that case ascertainment relies on data from multiple data sources – a hallmark trait of DRS and MRS estimation.
- DRS / MRS estimation methods do not require complete enumeration of populations and provide a formal means for estimation and adjustment for under-ascertainment.
- FAS is the type of condition that should lend itself well to this type of estimation method, i.e., chronic, detectable.

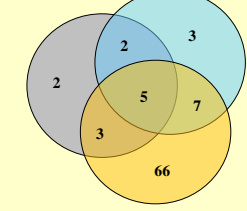
Violations of Method Assumptions

- Closed population**
 - Not a true closed population – births, deaths, migration
- Identifiability**
 - 98% matching
- Equal catchability**
 - Subjective nature of the diagnosis
 - Poor, inconsistent documentation in medical records
 - Difficulty in locating diagnostic information
 - Phenotypic variation by age
- Independence**
 - Lack of independence can be addressed via log-linear modeling through the use of interaction terms
 - Residual heterogeneity – Are diagnoses carried forward without independent assessment? Or, are cases independently verified or re-assessed?

RESULTS & LIMITATIONS

Scenario 1. Estimating FAS prevalence (2001-2006) using MRS estimation methods.

BC	HOSP	MEDI
12	17	81

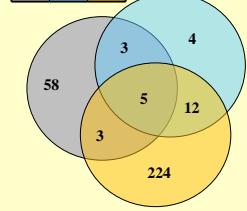


Model* Data Sources***	N	95% CI	Deviance	Prevalence Estimate**
Chapman 2-source model: MEDI-HOSP	117	96, 182	---	0.4
3-source model: μ MEDI-HOSP = μ BC-HOSP	373	134, 1862	3.9	1.4
3-source model: μ BC-MEDI = μ BC-HOSP	360	126, 2017	5.2	1.3

* Uses confirmed, probable + pending, but excludes any records with missing information
 ** Per 1,000 live births; Oregon resident births (2001-2006) N = 275,719
 *** BC=birth certificates, MEDI=Medicaid claims, HOSP=medical records

Scenario 2. Estimating FAS prevalence (2001-2006) using MRS estimation methods.

BC	HOSP	MEDI
69	24	244



Model* Data Sources***	N	95% CI	Deviance	Prevalence Estimate**
Chapman 2-source model: MEDI-HOSP	339	289, 456	---	1.2
3-source model: BC-MEDI, BC-HOSP interactions	384	334, 529	15.0	1.4
3-source model: BC-MEDI, MEDI-HOSP interactions	386	329, 610	17.9	1.4

* Uses all available information (including pending); combines confirmed + probable
 ** Per 1,000 live births; Oregon resident births (2001-2006) N = 275,719
 *** BC=birth certificates, MEDI=Medicaid claims, HOSP=medical records

Scenario 3. Estimating FAS prevalence (2001-2006) using MRS estimation methods.

BC	HOSP	MEDI
69	17	244



Model* Data Sources***	N	95% CI	Deviance	Prevalence Estimate**
Chapman 2-source model: MEDI-HOSP	338	283, 482	---	1.2
3-source model: BC-MEDI, BC-HOSP interactions	406	336, 648	17.1	1.5
3-source model: BC-MEDI, MEDI-HOSP interactions	396	327, 724	22.1	1.4

* Uses all available information for confirmed, probable, and pending
 ** Per 1,000 live births; Oregon resident births (2001-2006) N = 275,719
 *** BC=birth certificates, MEDI=Medicaid claims, HOSP=medical records

Case Ascertainment Challenges / Limitations of Data Sources

- Pediatric developmental / rehabilitation clinics rarely use ICD code 760.71, more apt to use 759.x
- General reluctance of clinicians to “label” children
- No birth defects registry – surveillance from “scratch”
- No FAS diagnostic clinics -- lack of consistent, standardized use of FAS diagnostic criteria
- Difficulty finding supporting documentation for children with “FAS” on birth certificate or Medicaid claim
- Low ascertainment for children who are not on Medicaid
- Target population is “young” in terms of timing of identification and diagnosis
- NE and E geographic regions of Oregon may seek services in Washington or Idaho
- General sentiment against “surveillance”
- Recording errors on birth certificates
- Medicaid billing errors
- “Duplication” of children in surveillance system who had name changes