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Urban-Rural Residence and the Occurrence of Cleft Lip and Cleft Palate in Texas, 1999-2003

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PURPOSE: The etiology of orofacial clefts is complex and relatively unknown. Variation in cleft lip with or without palate (CLP) and cleft palate alone (CP) was examined in Texas across urban-rural residence (1999 to 2003).

METHODS: Cases came from the Texas Birth Defects Registry (1,949 CLP and 1,054 CP) and denominator data came from vital records (254 counties; 1,827,317 live births). Variation in maternal residence was measured using four classification schemes: Rural Urban Continuum Codes, Urban Influence Codes, percentage of county in cropland, and Rural Urban Commuting Areas. Poisson regression was used to calculate rate ratios, adjusted for infant sex, plurality, gestational age, maternal parity, age, race/ethnicity, and education.

RESULTS: Compared to the most urban referent category, living in more rural areas was associated with an increased adjusted risk of CLP. For example, the Rural-Urban Continuum Codes demonstrated elevated risks for CLP in "thinly populated areas" compared to "metropolitan-urban areas" (adjusted prevalence ratio = 1.9; 95% confidence intervals (CI) 1.2–2.8); CP was not similarly associated. Percentage of county cropland was not consistently associated with any outcome.

CONCLUSION: The association patterns between non-urban residence and risk of CLP, except for percentage of cropland, suggests a constellation of exposures that may differ across urban-rural residence.
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KEY WORDS: Cleft Palate, Cleft Lip, Orofacial Clefts, Urban, Rural, Texas.

INTRODUCTION

Cleft lip, with or without cleft palate (CLP), occurs with a birth prevalence of 5 to 18 cases per 10,000 live births. The prevalence of cleft palate alone (CP) is 3 to 14 cases per 10,000 live births (1). Although cleft lip and palate can differ with respect to embryology, etiology, candidate genes, associated abnormalities and recurrence (2), they are often reported in combination as "oral cleft defects".

Geographic variability for a variety of birth conditions has been noted in the literature, including neural tube defect rates (3) and infant mortality due to congenital anomalies (4). In Colorado, Amidei et al. (5) found non-metropolitan residence associated with increased odds of any oral cleft abnormality at birth, and residence in rural geographic regions, specifically the Western slope and Eastern plains, associated with increased odds of orofacial clefts.

Residential proximity to other potential heath risks has also been implicated as a risk factor for orofacial clefts. Among older mothers (≥35 years of age), residential proximity within 1 mile of industrial facilities, especially smelters, was associated with oral clefts, but not among younger mothers (6). Residence in socioeconomically deprived areas has been associated with increased orofacial clefts (7).

Parental agricultural work has been associated with increased risk of oral clefts. Hanke and Jurewicz (8) reported that parental agricultural employment was associated with increased risk of orofacial clefts, as well as other birth defects. A recent meta-analysis found that maternal occupational exposure to pesticides was associated with increased risk of clefts, but paternal occupational or residential exposure was not (9). Residential proximity to, and employment in agriculture may be correlated.

Prevalence differences in urban compared with rural areas may suggest potential risk factors for birth defects, including those related to aspects of the physical environment, aspects of the social environment, and access to health and social services (10). Frequently, urban and rural are considered to be opposite ends of a single spectrum and studied in a dichotomized fashion. "Rural" is most frequently defined as the absence of "urban" and because

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Selected Abbreviations and Acronyms

CLP = cleft lip with or without palate
CP = cleft palate alone
TBDR = Texas Birth Defects Registry
USDA = U.S. Department of Agriculture
RUCC = rural-urban continuum code
UIC = urban influence code
RUCA = rural-urban commuting area
PR = prevalence ratio

"urban" can be defined in a variety of ways, comparing classifications across studies can be difficult (11). Furthermore, the categories "urban" and "rural" are unlikely to be homogeneous; therefore a more nuanced approach to urban-rural classification may be helpful (10).

The current study will contribute to the birth defects literature and ongoing discussions about residential descriptions by answering the following questions: 1) What is the association of CLP and CP with urban, compared to rural residence? 2) Does this association differ by measure of urban-rural status? Texas data were selected to address this question because the state has (a) a large and diverse population living in urban and rural areas, (b) extensive agricultural industry, (c) a single birth defects registry covering the entire state, and (d) 254 counties, of approximately equal size in square acres, which facilitates examination of county-based measures of urban/rural status, such as percentage of cropland.

METHODS

Study Design

This registry-based linkage study examined birth prevalence of oral clefts across Texas areas classified along several rural-urban continua. Six measures based on four methods of urban-rural classification were employed to characterize residence across Texas geography. Two cleft outcomes, CLP and CP, were considered.

Data Sources

The Texas Birth Defects Registry (TBDR) at the Texas Department of State Health Services provided case data for 1,054 infants/fetuses with cleft palate and 1,949 with cleft lip, with or without cleft palate, delivered from January 1, 1999 through December 31, 2003. The TBDR is an active surveillance system, in which staff routinely visits all facilities in Texas where affected children are delivered or treated. Case numbers resulted from live births (CLP = 92.6%; CP = 95.6%), spontaneous fetal deaths (CLP = 4.6%; CP = 1.8%), and elective terminations (CLP = 2.7%; CP = 2.5%); the registry also contains information on coexisting structural birth defects diagnosed for each case. Isolated cases were defined as cases having either of the cleft codes alone or together with minor defects as listed by the National Birth Defects Prevention Study (12).

Denominator information, comprising all live births within the state of Texas, came from birth certificate data for the years 1999–2003. Live births are regularly used as the population denominator for birth defects data because the majority of birth defects occur among live births and no comprehensive registry of pregnancy outcomes exist. These data are maintained by the Vital Statistics Unit at the Texas Department of State Health Services. Case prevalence (expressed as cases per 10,000 live births) was calculated as cases divided by the number of live births multiplied by 10,000 (13).

Urban/rural status was determined by maternal residence at time of delivery; this was derived from vital records (birth certificate or fetal death certificate) or, if missing, from medical records. County of residence was identified from the address information. The year 2000 U.S. census tract location was obtained from geocoding the addresses of cases and live births. Percentage of land area dedicated to crops in each Texas county was determined by the 2002 Census of Agriculture from the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service using the Agriculture Query Tool (14).

Exposure Definitions

Four basic methods were used to assess urban/rural status, including the rural-urban continuum code, the urban-influence code, the percentage of county land in crops, and the rural-urban commuting area. The rural-urban continuum code (RUCC), constructed at the county-level (15), categorizes counties from urban to rural based on a combination of county population and adjacency to a metropolitan area. When RUCC areas are categorized, the entire urban population of the county is considered, not just the city or town of largest size (as is the case with the urban-influence code [UIC], defined below) (10). The codes range from 1 (counties within a metropolitan area of $\geq$1 million population) to 9 (completely rural or $<$2500 urban population and not adjacent to a metropolitan area). For this analysis, the nine RUCC codes were condensed to four categories, as follows: 1) metropolitan urbanized counties (RUCC 1, 2, 3); 2) nonmetropolitan urbanized (RUCC 4, 5); 3) less urbanized (RUCC 6, 7); and 4) thinly populated (RUCC 8, 9).

The UIC classification scheme was developed to describe characteristics of rural areas; it distinguishes metropolitan counties by size and nonmetropolitan counties by size of the largest city or town and proximity to metropolitan and micropolitan areas (16). Micropolitan areas are called "non-core" and are further subdivided based on adjacency to a town of at least 2,500 population. Adjacency is defined