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National population-based estimates for major birth defects, 2016–2020

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Abstract

Background: We provide updated crude and adjusted prevalence estimates of major birth defects in the United States for the period 2016–2020.

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AUTHOR CONTRIBUTIONS

R. E. R., E. B. S., and T. S. drafted the introduction. E. B. S. wrote the methods and results sections. E. B. S., L. J. P., J. L. I., and E. N. contributed to the discussion section. J. L. I. and E. B. S. performed all analyses. J. L. I. created all figures and tables. All authors provided meaningful contributions to the project plan and paper revisions. All authors reviewed the manuscript.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Methods: Data were collected from 13 US population-based surveillance programs that used active or a combination of active and passive case ascertainment methods to collect all birth outcomes. These data were used to calculate pooled prevalence estimates and national prevalence estimates adjusted for maternal race/ethnicity for all conditions, and maternal age for trisomies and gastroschisis. Prevalence was compared to previously published national estimates from 1999 to 2014.

Results: Adjusted national prevalence estimates per 10,000 live births ranged from 0.63 for common truncus to 18.65 for clubfoot. Temporal changes were observed for several birth defects, including increases in the prevalence of atrioventricular septal defect, tetralogy of Fallot, omphalocele, trisomy 18, and trisomy 21 (Down syndrome) and decreases in the prevalence of anencephaly, common truncus, transposition of the great arteries, and cleft lip with and without cleft palate.

Conclusion: This study provides updated national estimates of selected major birth defects in the United States. These data can be used for continued temporal monitoring of birth defects prevalence. Increases and decreases in prevalence since 1999 observed in this study warrant further investigation.

Keywords

birth defects; congenital anomalies; national; NBDPN; prevalence; surveillance

1 | INTRODUCTION

Approximately 3%–5% of births are affected by a birth defect (Bower et al., 2010; Centers for Disease Control and Prevention, 2008) and birth defects are a major cause of perinatal mortality along with neonatal and infant morbidity and mortality (Decouflé et al., 2001; Xu et al., 2016). The United States does not have a national birth defects surveillance system to estimate birth defect prevalence on a national scale. However, most states have birth defects surveillance systems to monitor these conditions. Data from these programs have been used to estimate the prevalence of birth defects in the United States. In 2006, Canfield et al. (2006) published national birth defect prevalence estimates for deliveries from 1999 to 2001. Parker et al. (2010) published estimates for deliveries from 2004 to 2006, and Mai et al. (2019) published estimates for deliveries from 2010 to 2014.

Historically, the collective prevalence of major birth defects has been stable over time. However, increasing and decreasing trends have been observed for selected conditions. For example, reports have shown an increase in the prevalence of gastroschisis (Jones et al., 2016; Kirby et al., 2013; Short et al., 2019) and trisomy 18 (Langlois et al., 2011) and a decrease in the prevalence of neural tube defects (NTDs) (Canfield et al., 2006; Parker et al., 2010). Williams et al. (2015), however, found that the prevalence of NTDs plateaued in the years following mandatory folic acid fortification of US enriched cereal grain products, in agreement with another recent report (Mai et al., 2019).

Systematic birth defects surveillance is crucial for informing public health action and allocation of resources. It facilitates the identification of teratogenic exposures and emerging

threats, allows program to assess the effectiveness of prenatal screening and preventive efforts at the population level, and supports adequate provision of services to individuals living with birth defects. We provide updated crude and adjusted prevalence estimates (by maternal race/ethnicity and maternal age) of major birth defects in the United States for the period 2016–2020. Comparisons to prevalence estimates from 1999 to 2014 are also made.

2 | METHODS

This paper presents national population-based birth defects prevalence estimates for the period of 2016–2020. In March of 2023, the National Birth Defects Prevention Network (NBDPN) distributed a call for data to all US-based birth defects surveillance programs. Of the programs that responded to the call for data, we limited our analysis to 13 programs that used active or a combination of active plus passive case ascertainment methods and ascertained all birth outcomes (live births, fetal deaths, and terminations): California (10 counties), Delaware, Hawaii (2016–2017 only), Iowa, Massachusetts, metropolitan Atlanta (3 counties), North Carolina, Oklahoma, Puerto Rico, Rhode Island, South Carolina, Texas (2016–2019 only), and Utah.

Active case ascertainment methods include the review of discharge diagnostic codes and hospital-specific case lists from obstetrical, neonatal, surgical, and pathology sources. Following initial identification of cases, medical records were abstracted from hospitals and other sources (e.g., genetics laboratories), which were then reviewed to ensure accurate birth defect classification. Surveillance programs identified birth defect cases using the diagnosis guidelines outlined in Table 1 based on diagnostic codes from the International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) and Centers for Disease Control and Prevention/British Pediatric Association (CDC/BPA) coding systems (Table 1). We requested information on birth defect cases including year of delivery, maternal race/ethnicity, maternal age at delivery, and pregnancy outcome.

For this study, we selected birth defects from the NBDPN birth defect list (National Birth Defects Prevention Network, 2004) based on public health importance and consistency in diagnostic accuracy at birth or soon after birth using methodology similar to previously published national estimates analyses (Canfield et al., 2006; Mai et al., 2019; Parker et al., 2010). The conditions selected for analysis included the following organ systems: central nervous (anencephaly, encephalocele, spina bifida without anencephaly); eye (anophthalmia/microphthalmia); cardiovascular (atrioventricular septal defect [AVSD], coarctation of the aorta, common truncus/truncus arteriosus, double outlet right ventricle [DORV], Ebstein anomaly, hypoplastic left heart syndrome [HLHS], interrupted aortic arch [IAA], pulmonary valve atresia—with and without stenosis, single ventricle, tetralogy of Fallot [TOF], total anomalous pulmonary venous connection [TAPVC], transposition of the great arteries [TGA]—any type and specifically dextro-TGA [d-TGA], and tricuspid valve atresia—with and without stenosis); orofacial (cleft lip with and without cleft palate, cleft lip with cleft palate, cleft lip alone, cleft palate alone); gastrointestinal (esophageal atresia/tracheoesophageal fistula, rectal and large intestinal atresia/stenosis); musculoskeletal (clubfoot, diaphragmatic hernia, gastroschisis, limb deficiencies, omphalocele); and

chromosomal (trisomy 13, trisomy 18, trisomy 21 [Down syndrome]). Infants with multiple birth defects were included in each applicable birth defect category.

2.1 | Analyses

Data were pooled across programs and crude prevalence estimates for each birth defect were calculated as the number of reported cases within the 5-year period divided by the total live birth population from the corresponding period. We then applied a multiplier of 10,000 to create crude prevalence per 10,000 live births. Crude prevalence estimates were calculated overall and stratified by five race/ethnicity categories: non-Hispanic White, non-Hispanic Black, Hispanic, non-Hispanic Asian/Pacific Islander, and non-Hispanic American Indian/Alaska Native. For trisomy and gastroschisis cases, data were also stratified by maternal age categories (<20, 20–24, 25–29, 30–34, 35–39, and 40+ years). Confidence intervals for prevalence estimates were calculated using exact Poisson methodology (Daly, 1992).

For each specific birth defect, comparisons were made among the maternal race/ethnicity categories using non-Hispanic White as the referent category. For trisomies and gastroschisis, comparisons were made among the maternal age categories using 25–29 years old as the referent category. In our age-based analyses, two methods were used to compare the comparison category to the referent category: Method 1—when the count in either the comparison category or the referent category was <30, the confidence intervals around the two prevalence estimates were compared to determine if they overlapped; Method 2—if counts in the comparison category and the referent category were ≥30, a prevalence difference and confidence interval were calculated. If the confidence intervals did not overlap (Method 1) or the confidence interval around the prevalence difference did not cross zero (Method 2), then the comparison indicated a difference in the prevalence estimates of the comparison category compared to the referent category (National Birth Defects Prevention Network, 2004).

We used direct standardization to create an estimated count of cases in the US population within each maternal race/ethnicity strata—and within each maternal age strata for trisomies and gastroschisis—by applying the crude prevalence for each birth defect to the US live birth population for the 5-year period. These estimated case counts within each stratum were then summed. To create adjusted prevalence, the resulting summed estimated case counts were divided by the total US live birth population and multiplied by 10,000 (National Birth Defects Prevention Network, 2004). Data analysis was performed using SAS Version 9.4 (SAS Institute, Cary, NC).

3 | RESULTS

We obtained case-level data from 13 US population-based birth defects surveillance programs. These programs covered 4,141,961 total live births from 2016 to 2020, which account for 22% of all births occurring in the United States during birth years 2016–2020 (Martin et al., 2018a, 2018b, 2019, 2021; Osterman et al., 2021). When data were stratified by maternal race/ethnicity (Table 2) and maternal age (Table 3), variations in prevalence rates were observed. For 16 of the conditions observed, births to non-Hispanic Asian/Pacific Islander mothers had the lowest prevalence, including encephalocele, spina bifida, AVSD,

coarctation of the aorta, DORV, HLHS, IAA, pulmonary valve atresia and stenosis, TGA, tricuspid valve atresia—with and without stenosis, esophageal atresia/tracheoesophageal fistula, clubfoot, gastroschisis, limb deficiencies, omphalocele, and trisomy 21 (Down syndrome). By contrast, births to non-Hispanic American Indian/Alaska Native mothers and Hispanic mothers had the highest prevalence for 10 and 9 conditions each, respectively. Conditions that had the highest prevalence among births to non-Hispanic American Indian/Alaska Native mothers include coarctation of the aorta, DORV, Ebstein anomaly, pulmonary valve atresia and stenosis, tricuspid valve atresia—with and without stenosis, cleft palate alone, rectal and large intestinal atresia/stenosis, diaphragmatic hernia, gastroschisis, and limb deficiencies. Births to Hispanic mothers had the highest prevalence for anencephaly, spina bifida, anophthalmia/microphthalmia, common truncus, single ventricle, TAPVC, cleft lip with and without cleft palate, cleft lip with cleft palate, and trisomy 21 (Down syndrome) (Table 2). Mothers 40 years of age or older had the highest prevalence for most defects, while mothers less than 20 years of age had the highest prevalence for five birth defects: anencephaly, encephalocele, IAA, gastroschisis, and limb deficiencies (Table 3; Table S1). However, mothers 40 years of age or older also had the lowest prevalence for two birth defects: anencephaly and gastroschisis.

Table 4 shows national prevalence estimates (per 10,000 live births) adjusted for maternal race/ethnicity across four time periods, reflecting deliveries from 1999 to 2001 (Canfield et al., 2006), 2004 to 2006 (Parker et al., 2010), 2010 to 2014 (Mai et al., 2019), and 2016 to 2020 from this analysis. The most prevalent conditions observed overall for this analysis were clubfoot (18.65 cases per 10,000 live births), trisomy 21 (Down syndrome) (15.55 cases per 10,000 live births), pulmonary valve atresia and stenosis (10.29 cases per 10,000 live births), and cleft lip with and without cleft palate (9.69 cases per 10,000 live births). The conditions with the lowest observed prevalence were common truncus (0.63 cases per 10,000 live births), single ventricle (0.65 cases per 10,000 live births), Ebstein anomaly (0.77 per 10,000 live births), and tricuspid valve atresia (0.88 per 10,000 live births). Table 5 shows national prevalence estimates (per 10,000 live births) across the same four time periods adjusted for maternal age for gastroschisis, trisomy 13, trisomy 18, and trisomy 21 (Down syndrome).

The estimated national prevalence adjusted for maternal race/ethnicity remained relatively stable for approximately half of the conditions across the four time periods. However, AVSD, TOF, omphalocele, and trisomies 18 and 21 increased over time while anencephaly, common truncus, TGA, and cleft lip with and without cleft palate decreased across the four time periods, although for selected birth defects confidence intervals did overlap between some time periods (Table 4). We observed a similar pattern of increased prevalence over time when trisomies 18 and 21 were adjusted for maternal age (Table 5). When adjusted for maternal race/ethnicity, prevalence of gastroschisis increased over the first three cohorts; however, prevalence decreased in the current cohort (Table 4). Data were not available for prevalence of gastroschisis adjusted by maternal age for all four cohorts; however, Table 5 shows a similar decrease across the latest two time periods for this birth defect. For selected conditions, prevalence adjusted for maternal race/ethnicity (Table 4) was only reported across two of the time periods (Mai et al. (2019) and this current analysis). For those birth defects where only two cohorts of data were available, DORV, IAA, pulmonary valve atresia

and stenosis, and clubfoot increased when comparing prevalence adjusted for maternal race/ethnicity from the current time to the previous cohort. The prevalence of d-TGA decreased across the two time periods.

4 | DISCUSSION

This NBDPN report provides an update to previous national estimates of selected birth defects based on data from 1999 through 2001 (Canfield et al., 2006), from 2004 through 2006 (Parker et al., 2010), and from 2010 through 2014 (Mai et al., 2019). Results from this study highlight the diversity of prevalence estimates, co-variates, and temporal changes across individual birth defects. Adjusted prevalence estimates ranged from 0.63 per 10,000 live births for common truncus to 18.65 per 10,000 live births for clubfoot in this updated analysis based on data from 2016 through 2020. The most prevalent birth defects observed in this analysis were clubfoot, trisomy 21 (Down syndrome), pulmonary valve atresia and stenosis, and cleft lip with and without cleft palate, similar to the ones observed in the previous analyses (Canfield et al., 2006; Mai et al., 2019; Parker et al., 2010). It is important to acknowledge this diversity as specialized clinical care and developmental and social services needed to support infants and families impacted by birth defects can vary across conditions. Understanding the prevalence of individual birth defects, in addition to birth defects as a whole, can help clinical, developmental, and social service providers anticipate and plan for resources to adequately support families.

The prevalence of many of the observed birth defects varied by maternal race/ethnicity and maternal age, consistent with other reports (Aggarwal et al., 2015; Canfield et al., 2006, 2014; Egbe, 2014; Heinke et al., 2021; Le et al., 2019; Mai et al., 2019, 2022; Stallings et al., 2019, 2022; Williams et al., 2015). Maternal race/ethnicity and maternal age might serve as independent risk factors resulting from genetic or biologic differences across populations or they might serve as markers for prenatal risk factors such as prenatal vitamin supplementation, maternal health conditions, and/or exposure to environmental toxins. Thus, evaluation of prevalence rates by maternal race/ethnicity may improve our understanding of these factors for specific subpopulations and could prove useful when trying to target and implement prevention efforts.

We also examined prevalence changes over four distinct birth cohort periods (Canfield et al., 2006; Mai et al., 2019; Parker et al., 2010). Of the birth defects monitored over all four time periods, nine demonstrated increases ($n = 5$) or decreases ($n = 4$) in prevalence. Increases in AVSD, TOF, omphalocele, trisomy 18, trisomy 21, and the decrease in cleft lip with or without cleft palate were also noted by Mai et al. (2019). The current analysis demonstrated continued increases in AVSD and trisomy 21. The adjusted prevalence of TOF and omphalocele increased from the 2010 to 2014 cohort to the current time period, and the prevalence of cleft lip with or without cleft palate decreased over the same period, but confidence intervals overlapped across periods. The prevalence of trisomy 18 was stable from the 2010 to 2014 cohort to the current time period.

Increases in the prevalence of some birth defects in this study might reflect increases in maternal age in the US population (Osterman et al., 2021). In our study, the prevalence

of most birth defects was higher among mothers 40+ years. Advancing maternal age is a recognized risk factor for trisomies 13, 18, and 21 (Cuckle & Morris, 2021) and each of these syndromes is associated with various other birth defects included in this analysis. NBDPN defines syndromes as "a pattern of anomalies that form a specific diagnosis for which the natural history and recurrence risk are usually known. Use of the term 'syndrome' implies that the anomalies have a common specific etiology" (National Birth Defects Prevention Network, 2004). For example, among infants with Down syndrome, 17% also have AVSD and 3% also have TOF (Heinke et al., 2021). Furthermore, 6% of infants with trisomy 18 and 11% of infants with trisomy 13 have omphalocele (Springett et al., 2015). As a result, increasing maternal age could indirectly affect the prevalence of syndromic cases of congenital heart defects and/or other associated birth defects.

For non-syndromic cases, changes might be related to the increased prevalence of other known risk factors, such as maternal diabetes and obesity (Antonio-Villa et al., 2022; Centers for Disease Control and Prevention, 2023; Gregory & Ely, 2022; Hales et al., 2020). These conditions have been associated with AVSD, TOF, and omphalocele in previous studies (Helle & Priest, 2020; Liu et al., 2013; Marchincin et al., 2023; Tinker et al., 2020). However, associations have also been observed between these maternal conditions and other birth defects that did not increase over the four study periods. Further studies could help to determine if increases are observed for both syndromic and non-syndromic cases.

Mai et al. (2019) noted an increase in the prevalence of gastroschisis across the three previous time periods (Canfield et al., 2006; Mai et al., 2019; Parker et al., 2010). However, in our study, the prevalence of gastroschisis declined substantially. Gastroschisis is epidemiologically unique among birth defects as it is more common among younger mothers. While the etiology of gastroschisis remains unknown, studies have shown associations with a variety of maternal factors beyond young maternal age, including low body mass index, diabetes, maternal race/ethnicity, smoking, alcohol use, substance use, and other risk factors (Bhat et al., 2020; Kirby et al., 2013). This observed change in prevalence could offer additional insights to guide future studies.

Three additional birth defects demonstrated decreases in prevalence not noted in the previous analyses: anencephaly, common truncus, and TGA. Williams et al. (2015) and Mai et al. (2019) both noted a leveling in the prevalence of anencephaly following folic acid fortification of the US grain supply. It is not known if the decrease observed in our study reflects a one-time decrease in prevalence or perhaps the beginning of a sustained decline, which could result from concerted efforts to increase folic acid consumption, particularly among Hispanic mothers who are at increased risk for NTDs (Canfield et al., 2009; Long et al., 2010).

Of the birth defects for which prevalence was analyzed only in the Mai et al. (2019) analysis and this analysis, four demonstrated increases (DORV, IAA, pulmonary valve atresia and stenosis, clubfoot) and one demonstrated a decrease (d-TGA). While analysis of two time periods is insufficient to demonstrate a trend, ongoing prevalence monitoring is warranted to assess if changes are sustained.

Our study utilized data from 13 US population-based birth defects programs with active or a combination of active and passive case ascertainment methods that included data on all birth outcomes. Inclusion of elective pregnancy terminations, particularly given known differences in the rates of elective terminations among racial/ethnic groups and among certain severe birth defects types (Mai et al., 2019), increases the accuracy of the prevalence estimates in this study. More accurate prevalence estimates allow for improved research, screening, prevention efforts, and resource allocation. Adjusting the estimates to the US live birth population by maternal race/ethnicity for all conditions allows the birth prevalence estimates to be more generalizable to the US population, and the additional adjustment for maternal age accounts for its impact on the prevalence for trisomies and gastroschisis.

The specific birth cohort included in this study, 2016–2020, provides an important contribution to the literature for two reasons. Our current study utilized data collected after the transition from the ICD-9 clinical modification (ICD-9-CM) to ICD-10-CM that occurred on October 1, 2015. Salemi et al. (2019) noted significant increases in nine birth defects and decreases in five birth defects within the first year following the transition from ICD-9-CM to ICD-10-CM. The fact that our birth cohort does not overlap this transition period suggests that any potential impact by this transition in the individual programs' case ascertainment and thus in the national prevalence estimates presented in the current study is minimized (Salemi et al., 2019). Among other changes, Salemi et al. identified a significant increase in AVSD and a significant decrease in common truncus, in line with changes we observed in our analysis compared to previous national estimates (Canfield et al., 2006; Mai et al., 2019; Parker et al., 2010; Salemi et al., 2019). This analysis could also serve as a critical reference point for examining the impact of the COVID-19 pandemic on the prevalence of birth defects, as it includes only the very beginning of the pandemic period and could help to serve as a baseline measure for future studies examining the effects of COVID-19 on pregnancy outcomes.

This study is subject to several limitations. Our analysis included limited covariates and lacked data on risk factors. These additional covariates could contribute to differences in prevalence estimates observed across different racial/ethnic groups and/or time periods. Additionally, doubts have been raised regarding the reliability of self-reported race/ethnicity and whether self-reported racial/ethnic data correlates with differences in actual biological ancestry (Mersha & Abebe, 2015). We were unable to adjust for maternal race/ethnicity and maternal age simultaneously. We did perform a sensitivity analysis examining prevalence by maternal age categories for all included conditions and found prevalences to be largely consistent when comparing prevalence adjusted by maternal race/ethnicity with those adjusted by maternal age. Our analysis also could not separate cases based on whether the birth defect was isolated, one of multiple birth defects, or considered syndromic. Future studies could assess changes in the prevalence of birth defects among non-syndromic cases. Caution should be used when directly comparing the three previous cohorts to the current cohort. Methodology was generally similar between this paper and the previous paper; however, this analysis used stricter criteria for the inclusion of programs when considering pregnancy outcomes, which could affect the observed prevalence (Mai et al., 2019). Additionally, while this study utilized data entirely collected during the period after the transition to ICD-10-CM, it may make our estimates less comparable to those collected

during the previous time periods (Canfield et al., 2006; Mai et al., 2019; Parker et al., 2010). Changes in knowledge and technology (e.g., prenatal screening, pulse oximetry) between the current cohort and earlier cohorts may have improved the timeliness of diagnosis, which could improve the accuracy of reported prevalence. As a result, no formal trend test was performed to examine variations across the four time periods. Finally, while pooling data across programs using similar methodologies should have attenuated individual program variations, changes in ascertainment methods for these conditions within individual surveillance programs over time could have occurred that would affect prevalence estimates.

5 | CONCLUSION

This study provides updated national estimates of selected major birth defects in the United States. These data can be used for continued temporal monitoring of birth defects trends. The increases and decreases in prevalence since 1999 observed in this study warrant further investigation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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DATA AVAILABILITY STATEMENT

Research data are not shared.

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TABLE 1

Birth defect diagnosis codes.

Birth defects	ICD-10-CM codes	CDC/BPA codes
Central nervous system		
Anencephaly	Q00.0–Q00.1	740.00–740.10
Encephalocele	Q01.0-Q01.9	742.00–742.09
Spina bifida without anencephaly	Q05.0–Q05.9, Q07.01, Q07.03 without Q00.0–Q00.1	741.00–741.99 without 740.00–740.10
Eye		
Anophthalmia/microphthalmia	Q11.0–Q11.2	743.00–743.10
Cardiovascular		
Atrioventricular septal defect (endocardial cushion defect)	Q21.2	745.60–745.69, 745.487
Coarctation of aorta	Q25.1	747.10–747.19
Common truncus (truncus arteriosus or TA)	Q20.0	745.00 (excluding 745.01)
Double outlet right ventricle (DORV)	Q20.1	745.13–745.15
Ebstein anomaly	Q22.5	746.20
Hypoplastic left heart syndrome	Q23.4	746.70
Interrupted aortic arch (IAA)	Prior to October 1, 2016: Q25.2, Q25.4; post October 1, 2016: Q25.21	747.215–747.217, 747.285
Pulmonary valve atresia and stenosis	Q22.0, Q22.1	746.00, 746.01
Pulmonary valve atresia[a]	Q22.0	746.00
Single ventricle	Q20.4	745.3
Tetralogy of Fallot (TOF)	Q21.3	745.20–745.21, 747.31
Total anomalous pulmonary venous connection (TAPVC)	Q26.2	747.42
Transposition of the great arteries (TGA)	Q20.3, Q20.5	745.10–745.12, 745.18–745.19
Dextro-transposition of great arteries (d-TGA)[a]	Q20.3	745.10, 745.11, 745.18, 745.19
Tricuspid valve atresia and stenosis	Q22.4	746.100, 746.106 (excluding 746.105)
Tricuspid valve atresia[a]	Q22.4	746.100
Orofacial		
Cleft lip with cleft palate[b]	Q37.0–Q37.9	749.20–749.29
Cleft lip alone[b]	Q36.0–Q36.9	749.10–749.19
Cleft palate alone	Q35.1-Q35.9	749.00–749.09
Gastrointestinal		

Birth defects	ICD-10-CM codes	CDC/BPA codes
Esophageal atresia / tracheoesophageal fistula	Q39.0–Q39.4	750.30–750.35
Rectal and large intestinal atresia/stenosis	Q42.0–Q42.9	751.20–751.24
Musculoskeletal		
Clubfoot	Q66.0, Q66.89	754.50, 754.73 (excluding 754.735)
Diaphragmatic hernia	Q79.0, Q79.1	756.60, 756.610–756.617
Gastroschisis	Q79.3	756.71
Limb deficiencies (reduction defects)	Q71.0–Q71.9, Q72.0–Q72.9, Q73.0–Q73.8	755.20–755.49
Omphalocele	Q79.2	756.70
Chromosomal		
Trisomy 13	Q91.4-Q91.7	758.10–758.19
Trisomy 18	Q91.0–Q91.3	758.20–758.29
Trisomy 21 (Down syndrome)	Q90.0–Q90.9	758.00–758.09

Abbreviations: CDC/BPA, Centers for Disease Control and Prevention/British Pediatric Association; ICD-10-CM, International Classification of Diseases, 10th revision, Clinical Modification.

[a]Select birth defect categories (pulmonary valve atresia, dextro-transposition of the great arteries, and tricuspid valve atresia) are subsets of other birth defects reported in the table (pulmonary valve atresia and stenosis, transposition of the great arteries, and tricuspid valve atresia and stenosis). These subsets are reported in addition to the larger categories because they are considered critical congenital heart defects.

[b]The NBDPN list of birth defects was modified in 2014. The category cleft lip with and without cleft palate was subdivided into cleft lip with cleft palate and cleft lip alone. In order to compare across time periods, the case counts for cleft lip with cleft palate and cleft lip alone are summed to replicate the category cleft lip with and without cleft palate.

TABLE 2

Birth defects counts, prevalence (per 10,000 live births), and 95% confidence intervals by maternal race/ethnicity, 13 population-based programs, 2016–2020.

	Maternal race/ethnicity											
	Non-Hispanic White[a]		Non-Hispanic Black		Hispanic		Non-Hispanic Asian or Pacific Islander		Non-Hispanic American Indian or Alaska Native		Total[b]	
Birth defects	**Count**	**Prevalence (95% CI)**	**Count**	**Prevalence (95% CI)**	**Count**	**Prevalence (95% CI)**	**Count**	**Prevalence (95% CI)**	**Count**	**Prevalence (95% CI)**	**Count**	**Prevalence (95% CI)**
Central nervous system												
Anencephaly	320	1.75 (1.56–1.95)	105	1.77 (1.45–2.14)	317	**2.34↑ (2.09–2.61)**	46	1.90 (1.39–2.54)	9	1.99 (0.91–3.78)	944	2.28 (2.14–2.43)
Encephalocele	160	0.87 (0.74–1.02)	91	**1.54↑ (1.24–1.89)**	131	0.97 (0.81–1.15)	11	0.45 (0.23–0.81)	3	0.66 (0.14–1.94)	432	1.04 (0.95–1.15)
Spina bifida without anencephaly	674	3.68 (3.40–3.96)	139	**2.35↓ (1.97–2.77)**	570	**4.21↑ (3.87–4.57)**	47	**1.94↓ (1.43–2.58)**	11	2.43 (1.22–4.36)	1510	3.65 (3.47–3.84)
Eye												
Anophthalmia/ microphthalmia	318	1.73 (1.55–1.94)	109	1.84 (1.51–2.22)	353	**2.61↑ (2.34–2.89)**	44	1.82 (1.32–2.44)	9	1.99 (0.91–3.78)	860	2.08 (1.94–2.22)
Cardiovascular												
Atrioventricular septal defect (endocardial cushion defect)	1058	5.77 (5.43–6.13)	462	**7.80↑ (7.10–8.54)**	709	**5.23↓ (4.86–5.63)**	101	**4.17↓ (3.40–5.07)**	29	6.42 (4.30–9.22)	2414	5.83 (5.60–6.07)
Coarctation of the aorta	1206	6.58 (6.21–6.96)	259	**4.37↓ (3.85–4.94)**	774	**5.71↓ (5.32–6.13)**	84	**3.47↓ (2.77–4.30)**	38	8.41 (5.95–11.54)	2399	5.80 (5.57–6.04)
Common truncus (truncus arteriosus or TA)	110	0.60 (0.49–0.72)	38	0.64 (0.45–0.88)	97	0.72 (0.58–0.87)	12	0.50 (0.26–0.87)	2	0.44 (0.05–1.60)	267	0.65 (0.57–0.73)
Double outlet right ventricle (DORV)	410	2.24 (2.03–2.46)	154	2.60 (2.20–3.04)	344	2.54 (2.28–2.82)	51	2.11 (1.57–2.77)	13	2.88 (1.53–4.92)	1008	2.44 (2.29–2.59)
Ebstein anomaly	138	0.75 (0.63–0.89)	23	0.39 (0.25–0.58)	138	**1.02↑ (0.86–1.20)**	20	0.83 (0.50–1.28)	7	1.55 (0.62–3.19)	334	0.81 (0.72–0.90)
Hypoplastic left heart syndrome	482	2.63 (2.40–2.87)	172	2.90 (2.48–3.37)	339	2.50 (2.24–2.78)	25	**1.03↓ (0.67–1.53)**	11	2.43 (1.22–4.36)	1073	2.59 (2.44–2.75)
Interrupted aortic arch (IAA)	185	1.01 (0.87–1.17)	87	**1.47↑ (1.18–1.81)**	117	0.86 (0.71–1.04)	9	**0.37↓ (0.17–0.71)**	2	0.44 (0.05–1.60)	406	0.98 (0.89–1.08)
Pulmonary valve atresia and stenosis[c]	1722	9.78 (9.32–10.25)	661	**11.42↑ (10.57–12.33)**	1303	**11.09↑ (10.49–11.71)**	189	8.72 (7.52–10.06)	52	11.95 (8.92–15.67)	3996	10.41 (10.09–10.74)

Birth defects	Maternal race/ethnicity											
	Non-Hispanic White[a]		Non-Hispanic Black		Hispanic		Non-Hispanic Asian or Pacific Islander		Non-Hispanic American Indian or Alaska Native		Total[b]	
	Count	Prevalence (95% CI)	Count	Prevalence (95% CI)	Count	Prevalence (95% CI)	Count	Prevalence (95% CI)	Count	Prevalence (95% CI)	Count	Prevalence (95% CI)
Pulmonary valve atresia[d]	243	1.33 (1.16–1.50)	114	**1.92 ↑ (1.59–2.31)**	195	1.44(1.24–1.66)	48	**1.98 ↑ (1.46–2.63)**	8	1.77 (0.76–3.49)	617	1.49 (1.38–1.61)
Single ventricle	108	0.59 (0.48–0.71)	43	0.73 (0.53–0.98)	109	**0.80 ↑ (0.66–0.97)**	11	0.45 (0.23–0.81)	2	0.44 (0.05–1.60)	283	0.68 (0.61–0.77)
Tetralogy of Fallot (TOF)	824	4.49 (4.19–4.81)	347	**5.86 ↑ (5.26–6.51)**	647	4.78 (4.41–5.16)	124	5.12 (4.26–6.11)	23	5.09 (3.23–7.64)	2025	4.89 (4.68–5.11)
Total anomalous pulmonary venous connection (TAPVC)	196	1.07 (0.92–1.23)	76	1.28 (1.01–1.61)	248	**1.83 ↑ (1.61–2.07)**	38	1.57 (1.11–2.16)	7	1.55 (0.62–3.19)	573	1.38 (1.27–1.50)
Transposition of the great arteries (TGA)[c]	583	3.31 (3.05–3.59)	144	**2.49 ↓ (2.10–2.93)**	342	2.91 (2.61–3.24)	42	**1.94 ↓ (1.40–2.62)**	9	2.07 (0.95–3.93)	1141	2.97 (2.80–3.15)
Dextro-transposition of great arteries (d-TGA)[d,e]	481	2.86 (2.61–3.13)	108	**2.10 ↓ (1.73–2.54)**	304	**2.29 ↓ (2.04–2.56)**	43	**1.82 ↓ (1.32–2.45)**	7	1.57 (0.63–3.23)	962	2.48 (2.33–2.65)
Tricuspid valve atresia and stenosis[c]	277	1.57 (1.39–1.77)	138	**2.38 ↑ (2.00–2.82)**	236	**2.01 ↑ (1.76–2.28)**	34	1.57 (1.09–2.19)	12	2.76 (1.42–4.82)	703	1.83 (1.70–1.97)
Tricuspid valve atresiad[d,e]	132	0.78 (0.66–0.93)	62	**1.21 ↑ (0.93–1.55)**	128	0.96 (0.80–1.15)	14	0.59 (0.32–0.99)	7	1.57 (0.63–3.23)	348	0.90 (0.81–1.00)
Orofacial												
Cleft lip with and without cleft palate[f]	1849	10.09 (9.63–10.56)	393	**6.63 ↓ (5.99–7.32)**	1440	10.63 (10.09–11.19)	241	9.96 (8.74–11.30)	46	10.18 (7.45–13.58)	4114	9.94 (9.64–10.25)
Cleft lip with cleft palate[f]	1165	6.35 (5.99–6.73)	245	**4.13 ↓ (3.63–4.69)**	1030	**7.60 ↑ (7.15–8.08)**	149	6.16 (5.21–7.23)	32	7.08 (4.84–10.00)	2704	6.54 (6.29–6.79)
Cleft lip alone[f]	684	3.73 (3.46–4.02)	148	**2.50 ↓ (2.11–2.93)**	410	**3.03 ↓ (2.74–3.33)**	92	3.80 (3.06–4.66)	14	3.10 (1.69–5.20)	1410	3.41 (3.23–3.59)
Cleft palate alone	1265	6.90 (6.52–7.29)	283	**4.78 ↓ (4.24–5.37)**	772	**5.70 ↓ (5.30–6.12)**	172	7.11 (6.09–8.25)	39	8.63 (6.14–11.80)	2590	6.26 (6.02–6.51)
Gastrointestinal												
Esophageal atresia/ tracheoesophageal fistula[g]	501	2.74 (2.50–2.99)	121	**2.04 ↓ (1.70–2.44)**	262	**2.11 ↓ (1.86–2.38)**	40	**1.65 ↓ (1.18–2.25)**	9	1.99 (0.91–3.78)	950	2.36 (2.21–2.52)
Rectal and large intestinal atresia/ stenosis[g]	803	4.39 (4.09–4.70)	211	**3.56 ↓ (3.10–4.08)**	654	**5.26 ↑ (4.86–5.67)**	111	4.59 (3.78–5.53)	29	6.42 (4.30–9.22)	1845	4.59 (4.38–4.80)

	Maternal race/ethnicity											
	Non-Hispanic White[a]		Non-Hispanic Black		Hispanic		Non-Hispanic Asian or Pacific Islander		Non-Hispanic American Indian or Alaska Native		Total[b]	
Birth defects	Count	Prevalence (95% CI)	Count	Prevalence (95% CI)	Count	Prevalence (95% CI)	Count	Prevalence (95% CI)	Count	Prevalence (95% CI)	Count	Prevalence (95% CI)
Musculoskeletal												
Clubfoot[h]	2754	19.25 (18.53–19.98)	918	18.52 (17.35–19.76)	2106	18.99 (18.19–19.82)	264	**13.08 ↓ (11.55–14.76)**	75	18.39 (14.47–23.06)	6292	18.87 (18.41–19.34)
Diaphragmatic hernia	590	3.22 (2.96–3.49)	157	**2.65 ↓ (2.25–3.10)**	421	3.11 (2.82–3.42)	77	3.18 (2.51–3.98)	19	4.20 (2.53–6.57)	1311	3.17 (3.00–3.35)
Gastroschisis	778	4.24 (3.95–4.55)	177	**2.99 ↓ (2.56–3.46)**	666	**4.92 ↑ (4.55–5.30)**	55	**2.27 ↓ (1.71–2.96)**	28	6.20 (4.12–8.96)	1765	4.27 (4.07–4.47)
Limb deficiencies (reduction defects)	850	4.64 (4.33–4.96)	328	**5.53 ↑ (4.95–6.17)**	696	**5.14 ↑ (4.76–5.53)**	85	**3.51 ↓ (2.81–4.34)**	37	**8.19 ↑ (5.77–11.29)**	2098	5.07 (4.86–5.29)
Omphalocele	472	2.57 (2.35–2.82)	165	2.78 (2.38–3.24)	298	**2.20 ↓ (1.96–2.46)**	53	2.19 (1.64–2.86)	11	2.43 (1.22–4.36)	1090	2.63 (2.48–2.80)
Chromosomal												
Trisomy 13	272	1.48 (1.31–1.67)	101	1.70 (1.39–2.07)	165	**1.22 ↓ (1.04–1.42)**	32	1.32 (0.90–1.87)	3	0.66 (0.14–1.94)	642	1.55 (1.43–1.68)
Trisomy 18	553	3.02 (2.77–3.28)	191	3.22 (2.78–3.71)	381	2.81 (2.54–3.11)	76	3.14 (2.47–3.93)	9	1.99 (0.91–3.78)	1353	3.27 (3.10–3.45)
Trisomy 21 (Down syndrome)	2762	15.06 (14.51–15.64)	826	**13.94 ↓ (13.00–14.92)**	2461	**18.17 ↑ (17.45–18.90)**	328	13.55 (12.13–15.10)	72	15.93 (12.47–20.07)	6756	16.33 (15.94–16.72)

Note: Program inclusion criteria: Programs that used active case-finding or a combination of active and passive case-finding for their methodology. Programs had to collect all outcomes of pregnancy to be included. Birth defect surveillance programs and delivery years that are included in the table: California (10 counties), Delaware, Hawaii (2016–2017), Iowa, Massachusetts, Metropolitan Atlanta (3 counties), North Carolina, Oklahoma, Puerto Rico, Rhode Island, South Carolina, Texas (2016–2019), and Utah (total live births covered = 4,141,961).

Abbreviation: CI, confidence interval calculated using exact Poisson methodology.

[a]For each individual birth defect, Non-Hispanic Black, Hispanic, Non-Hispanic Asian or Pacific Islander, and Non-Hispanic American Indian or Alaska Native (i.e., comparison categories) were compared to Non-Hispanic White (i.e., referent category). Two methods were used to compare the comparison category to the referent category. Method 1: When the count in either the comparison category or the referent category was less than 30, then the confidence intervals around the two prevalences were compared to see if they overlapped. Method 2: If counts in the comparison category and the referent category were 30 or greater, then a prevalence difference and confidence interval were calculated. For Method 1 if the confidence intervals did not overlap and for Method 2 if the confidence interval around the prevalence difference did not cross zero, then the comparison suggests that there could be a difference in the prevalence of the comparison category versus the referent category. This is indicated in the table by bolded text and an arrow indicating whether the comparison category prevalence was higher or lower than the referent category.

[b]Total includes other/unknown maternal race/ethnicity (not shown).

[c]Excludes California.

[d]Select birth defect categories (pulmonary valve atresia, dextro-transposition of the great arteries, and tricuspid valve atresia) are subsets of other birth defects reported in the table (pulmonary valve atresia and stenosis, transposition of the great arteries, and tricuspid valve atresia and stenosis). These subsets are reported in addition to the larger categories because they are considered critical congenital heart defects.

[e] Excludes South Carolina.

[f] The NBDPN list of birth defects was modified in 2014. The category cleft lip with and without cleft palate was subdivided into cleft lip with cleft palate and cleft lip alone. In order to compare across time periods, the case counts for cleft lip with cleft palate and cleft lip alone are summed to replicate the category cleft lip with and without cleft palate. The resulting prevalence for cleft lip with and without cleft palate is used when doing direct adjustment.

[g] Excludes Puerto Rico.

[h] Excludes California, South Carolina, and Utah.

TABLE 3

Birth defects counts, prevalence (per 10,000 live births), and 95% confidence intervals by maternal age (years), 13 population-based programs, 2016–2020.

	Maternal age groups													
	<20		20–24		25–29[a]		30–34		35–39		40+		Total[b]	
Birth defects	**Count**	**Prevalence (95% CI)**	**Count**	**Prevalence (95% CI)**	**Count**	**Prevalence (95% CI)**	**Count**	**Prevalence (95% CI)**	**Count**	**Prevalence (95% CI)**	**Count**	**Prevalence (95% CI)**	**Count**	**Prevalence (95% CI)**
Musculoskeletal														
Gastroschisis	410	**16.93↑ (15.33–18.65)**	723	**8.24↑ (7.65–8.87)**	407	3.35 (3.04–3.70)	168	**1.50↓ (1.28–1.74)**	46	**0.83↓ (0.60–1.10)**	9	**0.73↓ (0.33–1.38)**	1765	4.27 (4.07–4.47)
Chromosomal														
Trisomy 13	16	0.66 (0.38–1.07)	84	0.96 (0.76–1.19)	103	0.85 (0.69–1.03)	157	**1.40↑ (1.19–1.63)**	169	**3.03↑ (2.59–3.53)**	106	**8.58↑ (7.03–10.38)**	642	1.55 (1.43–1.68)
Trisomy 18	29	1.20 (0.80–1.72)	111	1.27(1.04–1.52)	189	1.56 (1.34–1.80)	263	**2.34↑ (2.07–2.64)**	399	**7.16↑ (6.48–7.90)**	353	**28.59↑ (25.68–31.73)**	1353	3.27 (3.10–3.45)
Trisomy 21 (Down syndrome)	185	7.64 (6.58–8.82)	563	**6.42↓ (5.90–6.97)**	934	7.70 (7.21–8.21)	1388	**12.36↑ (11.71–13.02)**	2171	**38.98↑ (37.35–40.65)**	1491	**120.74↑ (114.69–127.03)**	6756	16.33 (15.94–16.72)

Note: Program inclusion criteria: Programs that used active case-finding or a combination of active and passive case-finding for their methodology. Programs had to collect all outcomes of pregnancy to be included. Birth defect surveillance programs and delivery years that are included in the table: California (10 counties), Delaware, Hawaii (2016–2017), Iowa, Massachusetts, Metropolitan Atlanta (3 counties), North Carolina, Oklahoma, Puerto Rico, Rhode Island, South Carolina, Texas (2016–2019), and Utah (total live births covered = 4,141,961).

Abbreviation: CI, confidence interval calculated using exact Poisson methodology.

[a]For each individual birth defect, the maternal age ranges at delivery <20 years, 20–24 years, 30–34 years, 35–39 years, 40+ years (i.e., comparison categories) were compared to 25–29 years (i.e., referent category). Two methods were used to compare the comparison category to the referent category. Method 1: When the count in either the comparison category or the referent category was less than 30, then the confidence intervals around the two prevalences were compared to see if they overlapped. Method 2: If counts in the comparison category and the referent category were 30 or greater then a prevalence difference and confidence interval were calculated. For Method 1 if the confidence intervals did not overlap and for method 2 if the confidence interval around the prevalence difference did not cross zero, then the comparison suggest that there could be a difference in the prevalence of the comparison category versus the referent category. This is indicated in the table by bolded text and an arrow indicating whether the comparison category prevalence was higher or lower than the referent category.

[b]Total includes other/unknown maternal age (not shown).

TABLE 4

National prevalence estimates (per 10,000 live births) adjusted for maternal race/ethnicity and 95% confidence intervals across four time periods: 1999–2001, 2004–2006, 2010–2014, and 2016–2020.

	1999–2001 (Canfield et al.)[a]	2004–2006 (Parker et al.)[b]	2010–2014 (Mai et al.)[c]	2016–2020 (current analysis)[d]		
Birth defects	**Estimated national prevalence (95% CI)**	**Estimated national prevalence (95% CI)**	**Estimated national prevalence (95% CI)**	**Estimated national prevalence (95% CI)**	**Cases per births**	**Estimated national count of cases annually (95% CI)**
Central nervous system						
Anencephaly	2.51 (2.31–2.70)	2.06 (1.92–2.20)	2.15 (2.03–2.28)	1.91 (1.84–1.97)	1 in 5246	700 (677–724)
Encephalocele	0.93 (0.82–1.05)	0.82 (0.73–0.91)	0.95 (0.87–1.04)	0.95 (0.92–1.01)	1 in 10,365	354 (338–371)
Spina bifida without anencephaly	3.68 (3.45–3.92)	3.50 (3.31–3.68)	3.63 (3.46–3.80)	3.48 (3.39–3.56)	1 in 2875	1278 (1246–1309)
Eye						
Anophthalmia/microphthalmia	2.08 (1.90–2.26)	1.87 (1.73–2.01)	1.91 (1.79–2.03)	1.97 (1.91–2.03)	1 in 5078	723 (700–747)
Cardiovascular						
Atrioventricular septal defect (Endocardial cushion defect)	4.36 (4.10–4.62)	4.71 (4.48–4.94)	5.38 (5.17–5.59)	5.84 (5.73–5.95)	1 in 1712	2145 (2105–2186)
Coarctation of the aorta	–	–	5.57 (5.36–5.79)	5.84 (5.73–5.95)	1 in 1712	2146 (2105–2187)
Common truncus (truncus arteriosus or TA)	0.82 (0.71–0.93)	0.72 (0.63–0.81)	0.64 (0.57–0.71)	0.63 (0.59–0.66)	1 in 15,984	230 (217–243)
Double outlet right ventricle (DORV)	–	–	1.67 (1.55–1.79)	2.36 (2.29–2.43)	1 in 4237	867 (841–893)
Ebstein anomaly	–	–	0.77 (0.69–0.85)	0.77 (0.73–0.82)	1 in 12,916	284 (270–300)
Hypoplastic left heart syndrome	2.43 (2.24–2.63)	2.30 (2.15–2.45)	2.60 (2.46–2.75)	2.53 (2.46–2.60)	1 in 3955	929 (902–956)
Interrupted aortic arch (IAA)	–	–	0.62 (0.55–0.70)	0.99 (0.95–1.04)	1 in 10,058	365 (349–382)
Pulmonary valve atresia and stenosis	–	–	9.51 (9.23–9.78)	10.29 (10.14–10.44)	1 in 972	3779 (3726–3833)
Pulmonary valve atresia[e]	–	–	1.41 (1.30–1.52)	1.49 (1.44–1.55)	1 in 6708	548 (527–569)
Single Ventricle	–	–	0.75 (0.67–0.83)	0.65 (0.61–0.69)	1 in 15,356	239 (226–253)
Tetralogy of Fallot (TOF)	3.92 (3.67–4.17)	3.97 (3.77–4.17)	4.61 (4.42–4.80)	4.81 (4.71–4.92)	1 in 2077	1768 (1732–1806)
Total anomalous pulmonary venous connection (TAPVC)	–	–	1.28 (1.18–1.38)	1.32 (1.27–1.38)	1 in 7552	486 (467–506)
Transposition of the great arteries (TGA)	4.73 (4.46–5.00)	3.00 (2.83–3.17)	3.71 (3.54–3.89)	2.99 (2.91–3.07)	1 in 3348	1097 (1068–1127)
Dextro-transposition of great arteries (d-TGA)[e]	–	–	2.93 (2.78–3.09)	2.53 (2.46–2.60)	1 in 3957	928 (902–955)
Tricuspid valve atresia and stenosis	–	–	1.68 (1.57–1.81)	1.81 (1.75–1.87)	1 in 5527	665 (642–688)
Tricuspid valve atresia[e]	–	–	1.03 (0.93–1.13)	0.88 (0.84–0.93)	1 in 11,309	325 (309–341)

Birth defects	1999–2001 (Canfield et al.)[a]	2004–2006 (Parker et al.)[b]	2010–2014 (Mai et al.)[c]	2016–2020 (current analysis)[d]		
	Estimated national prevalence (95% CI)	Estimated national prevalence (95% CI)	Estimated national prevalence (95% CI)	Estimated national prevalence (95% CI)	Cases per births	Estimated national count of cases annually (95% CI)
Orofacial						
Cleft lip with and without cleft palate[f]	10.47 (10.08–10.87)	10.63 (10.32–10.95)	10.00 (9.71–10.30)	9.69 (9.55–9.84)	1 in 1032	3560 (3508–3613)
Cleft lip with cleft palate[f]	–	–	6.40 (6.18–6.63)	6.32 (6.20–6.43)	1 in 1583	2321 (2279–2363)
Cleft lip alone[f]	–	–	3.56 (3.39–3.74)	3.38 (3.29–3.46)	1 in 2963	1240 (1209–1271)
Cleft palate alone	6.39 (6.08–6.71)	6.35 (6.11–6.60)	5.93 (5.71–6.15)	6.32 (6.20–6.43)	1 in 1583	2321 (2279–2363)
Gastrointestinal						
Esophageal atresia/tracheoesophageal fistula	2.37 (2.18–2.56)	2.17 (2.02–2.32)	2.41 (2.27–2.56)	2.40 (2.33–2.47)	1 in 4167	882 (856–908)
Rectal and large intestinal atresia/stenosis	4.81 (4.54–5.08)	4.68 (4.45–4.91)	4.46 (4.27–4.66)	4.50 (4.41–4.60)	1 in 2220	1654 (1619–1690)
Musculoskeletal						
Clubfoot	–	–	16.87 (16.46–17.30)	18.65 (18.45–18.85)	1 in 536	6850 (6778–6923)
Diaphragmatic hernia	2.94 (2.73–3.15)	2.61 (2.45–2.77)	2.79 (2.64–2.94)	3.11 (3.03–3.19)	1 in 3214	1143 (1113–1173)
Gastroschisis	3.73 (3.49–3.97)	4.49 (4.28–4.69)	5.12 (4.92–5.32)	4.10(4.01–4.19)	1 in 2439	1506 (1472–1540)
Limb deficiencies (reduction defects)	–	–	5.15 (4.95–5.35)	4.84 (4.74–4.95)	1 in 2064	1779 (1743–1817)
Omphalocele	2.09 (1.91–2.27)	1.86 (1.73–1.99)	2.40 (2.26–2.54)	2.49 (2.42–2.56)	1 in 4021	914 (887–940)
Chromosomal						
Trisomy 13	1.31 (1.17–1.45)	1.28 (1.18–1.39)	1.35 (1.25–1.46)	1.44 (1.38–1.49)	1 in 6967	527 (507–548)
Trisomy 18	2.31 (2.12–2.50)	2.64 (2.48–2.80)	3.02 (2.86–3.18)	3.00 (2.92–3.08)	1 in 3336	1101 (1072–1131)
Trisomy 21 (Down syndrome)	12.78 (12.34–13.22)	13.56 (13.20–13.92)	14.14 (13.81–14.48)	15.55 (15.37–15.73)	1 in 643	5713 (5647–5779)

[a] Canfield et al. (2006). Inclusion criteria: 11 programs that used active case-finding methodology. Program list: Alabama (selected counties), Arkansas, California (population sample), Hawaii, Iowa, Massachusetts, Metropolitan Atlanta (five counties), North Carolina, Oklahoma, Texas, and Utah.

[b] Parker et al. (2010). Inclusion criteria: 14 programs that used active case-finding or passive case-finding with follow-up for their methodology. Programs had to collect more than live births to be included. Program list: Arkansas, Arizona, California (eight county Central Valley), Iowa, Massachusetts, Metropolitan Atlanta (five counties), North Carolina, Oklahoma, Puerto Rico, Texas, and Utah.

[c] Mai et al. (2019) Inclusion criteria: 14 programs that used active case-finding methodology. Programs had to collect more than live births to be included. Program list: Arizona (2010–2013), Arkansas (2010–2013), California (population sample), Delaware, Metropolitan Atlanta (until 2012, data are for five counties, 2012 and beyond data are for three counties), Hawaii (2012), Iowa, Massachusetts, North Carolina, Oklahoma, Puerto Rico, South Carolina, Texas, and Utah.

[d] Program inclusion criteria: Programs that used active case-finding or a combination of active and passive case-finding for their methodology. Programs had to collect all outcomes of pregnancy to be included. Birth defect surveillance programs and delivery years that are included in the current analysis: California (10 counties), Delaware, Hawaii (2016–2017), Iowa, Massachusetts, Metropolitan Atlanta (3 counties), North Carolina, Oklahoma, Puerto Rico, Rhode Island, South Carolina, Texas (2016–2019), and Utah.

[e] Select birth defect categories (pulmonary valve atresia, dextro-transposition of the great arteries, and tricuspid valve atresia) are subsets of other birth defects reported in the table (pulmonary valve atresia and stenosis, transposition of the great arteries, and tricuspid valve atresia and stenosis). These subsets are reported in addition to the larger categories because they are considered critical congenital heart defects.

[f] The NBDPN list of birth defects was modified in 2014. The category cleft lip with and without cleft palate was subdivided into cleft lip with cleft palate and cleft lip alone. In order to compare across time periods, the case counts for cleft lip with cleft palate and cleft lip alone are summed to replicate the category cleft lip with and without cleft palate. The resulting prevalence for cleft lip with and without cleft palate is used when doing direct adjustment.

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TABLE 5

National prevalence estimates (per 10,000 live births) adjusted for maternal age and 95% confidence intervals across four time periods: 1999–2001, 2004–2006, 2010–2014, and 2016–2020.

	1999–2001 (Canfield et al.)[a]	2004–2006 (Parker et al.)[b]	2010–2014 (Mai et al.)[c]	2016–2020 (current analysis)[d]		
Birth defects	**Estimated national prevalence (95% CI)**	**Estimated national prevalence (95% CI)**	**Estimated national prevalence (95% CI)**	**Estimated national prevalence (95% CI)**	**Cases per births**	**Estimated national count of cases annually (95% CI)**
Musculoskeletal						
Gastroschisis	–	–	4.94 (4.76–5.13)	3.96 (3.87–4.05)	1 in 2523	1503 (1469–1537)
Chromosomal						
Trisomy 13	1.33 (1.19–1.47)	1.26 (1.16–1.37)	1.49 (1.38–1.60)	1.60 (1.54–1.66)	1 in 6249	607 (585–629)
Trisomy 18	2.41 (2.23–2.60)	2.66 (2.50–2.81)	3.43 (3.26–3.60)	3.44 (3.36–3.53)	1 in 2905	1305 (1273–1337)
Trisomy 21 (Down syndrome)	13.65 (13.22–14.09)	14.47 (14.11–14.83)	15.74 (15.39–16.10)	17.19 (17.01–17.38)	1 in 582	6517 (6446–6588)

[a] Canfield et al. (2006). Inclusion criteria: 11 programs that used active case-finding methodology. Program list: Alabama (selected counties), Arkansas, California (population sample), Hawaii, Iowa, Massachusetts, Metropolitan Atlanta (five counties), North Carolina, Oklahoma, Texas, and Utah.

[b] Parker et al. (2010). Inclusion criteria: 14 programs that used active case-finding or passive case-finding with follow-up for their methodology. Programs had to collect more than live births to be included. Program list: Arkansas, Arizona, California (eight county Central Valley), Iowa, Massachusetts, Metropolitan Atlanta (five counties), North Carolina, Oklahoma, Puerto Rico, Texas, and Utah.

[c] Mai et al. (2019). Inclusion criteria: 14 programs that used active case-finding methodology. Programs had to collect more than live births to be included. Program list: Arizona (2010–2013), Arkansas (2010–2013), California (population sample), Delaware, Metropolitan Atlanta (until 2012 data is for five counties, 2012 and beyond data is for three counties), Hawaii (2012), Iowa, Massachusetts, North Carolina, Oklahoma, Puerto Rico, South Carolina, Texas, and Utah.

[d] Program inclusion criteria: Programs that used active case-finding or a combination of active and passive case-finding for their methodology. Programs had to collect all outcomes of pregnancy to be included. Birth defect surveillance programs and delivery years that are included in the current analysis: California (10 counties), Delaware, Hawaii (2016–2017), Iowa, Massachusetts, Metropolitan Atlanta (3 counties), North Carolina, Oklahoma, Puerto Rico, Rhode Island, outh Carolina, Texas (2016–2019), and Utah.