Increasing Prevalence of Gastroschisis — 14 States, 1995–2012

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Gastroschisis is a serious congenital defect in which the intestines protrude through an opening in the abdominal wall. Gastroschisis requires surgical repair soon after birth and is associated with an increased risk for medical complications and mortality during infancy. Reports from multiple surveillance systems worldwide have documented increasing prevalence of gastroschisis since the 1980s, particularly among younger mothers (*1,2*); however, since publication of a multistate U.S. report that included data through 2005 (*1*), it is not known whether prevalence has continued to increase. Data on gastroschisis from 14 population-based state surveillance programs were pooled and analyzed to assess the average annual percent change (AAPC) in prevalence and to compare the prevalence during 2006–2012 with that during 1995–2005, stratified by maternal age and race/ethnicity. The pooled data included approximately 29% of U.S. births for the period 1995–2012. During 1995–2012, gastroschisis prevalence increased in every category of maternal age and race/ethnicity, and the AAPC ranged from 3.1% in non-Hispanic white (white) mothers aged <20 years to 7.9% in non-Hispanic black (black) mothers aged <20 years. These corresponded to overall percentage increases during 1995–2012 that ranged from 68% in white mothers aged <20 years to 263% in black mothers aged <20 years. Gastroschisis prevalence increased 30% between the two periods, from 3.6 per 10,000 births during 1995–2005 to 4.9 per 10,000 births during 2006–2012 (prevalence ratio = 1.3, 95% confidence interval [CI]: 1.3–1.4), with the largest increase among black mothers aged <20 years (prevalence ratio = 2.0, 95% CI: 1.6–2.5). Public health research is urgently needed to identify factors contributing to this increase.

To follow up on a study that included gastroschisis prevalence data from 15 states and reported a near doubling of gastroschisis prevalence during 1995–2005 (*1*), CDC requested updated data from each of these states for 1995–2012. Fourteen states* provided data on gastroschisis cases crosstabulated by maternal age groups (<20 years, 20–24 years, 25–29 years, 30–34 years, and ≥35 years) and race/ethnicity (white, black, and Hispanic,

with all other racial/ethnic groups included in the total). The gastroschisis case definition was based on the British Pediatric Association Classification of Diseases code (756.71) or the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code for gastroschisis (756.73, or before 10/1/2009, 756.79, with verification to confirm cases of gastroschisis, because the previous code was shared with omphalocele). Gastroschisis cases included live births, fetal deaths,[†] and elective terminations.[§]

Data were pooled at CDC, and gastroschisis prevalence was calculated for each year, maternal age group, and race/ethnicity. Prevalence was calculated as number of gastroschisis cases among all birth outcomes divided by the total number of live births. The denominators of total number of live births in the same catchment area as the birth defects surveillance program were reported by states or obtained from public use data files. Poisson exact methods were used to calculate 95% CIs for each prevalence estimate. Prevalence ratios were calculated by dividing the prevalence during 2006–2012 by the prevalence during 1995–2005, and CIs for the prevalence ratios were calculated using Poisson regression.

Because the comparison of prevalence between the two study periods involved an artificial breakpoint during the 18-year data span and only examined pooled prevalence within those periods, joinpoint regression analysis was used to identify statistically significant changes in the annual prevalence of gastroschisis over the course of the entire study period (1995–2012). Joinpoint regression initially models annual trend data by fitting a straight line (i.e., zero joinpoints). Then, joinpoints are added, one at a time, and a Monte Carlo permutation test is used to determine the optimal number of joinpoints. Each joinpoint in the final model corresponds to a significant change in the trend, and an AAPC and its 95% CI are calculated to describe how the rate changes within each time interval (*3*). The estimated overall percent change was calculated by first converting the AAPC to the projected single year change in prevalence and then exponentiating to the number of years studied minus one to estimate the total increase throughout the 18 years. This gives the magnitude of the increase, which

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* The 14 states that provided data on gastroschisis and the years for which data were provided were Arizona (1995–2012), Arkansas (1995–2012), California (1995–2012), Colorado (1997–2012), Georgia (1995–2012), Iowa (1995–2012), Kentucky (1998–2012), New Mexico (1998–2012), New York (1995–2012), North Carolina (1999–2012), Oklahoma (1995–2012), Rhode Island (2002–2012), Texas (1996–2012), and Utah (1997–2012).

† Fetal deaths were not reported from Rhode Island, Kentucky during 1998–2003, or New York during 2008–2012.
§ Elective terminations were not reported from Arizona, Colorado, Kentucky, New York, North Carolina, and Rhode Island.

is then converted to a percent increase. For example, an AAPC of 5 represents a projected single year change of 1.05, which would correspond to a 2.29-fold increase over the entire study period ($1.05^{17} = 2.29$). This corresponds to an overall change of 129% ([2.29–1] x 100). The Joinpoint Regression Program, version 4.2.0 (National Cancer Institute), was used to conduct joinpoint regression.

During 1995–2005, 4,369 gastroschisis cases were detected among 12,014,244 live births (prevalence = 3.6 per 10,000 live births, 95% CI: 3.5–3.7), and during 2006–2012, 4,497 gastroschisis cases were detected among 9,264,540 live births (prevalence = 4.9 per 10,000 live births, 95% CI: 4.7–5.0). Comparing the two periods, gastroschisis prevalence increased 30% (prevalence ratio = 1.3, 95% CI: 1.3–1.4) during 2006–2012 compared with 1995–2005. The prevalence of gastroschisis increased over the course of the study period in each of the five maternal age groups (Figure).

Because fewer cases were detected among older maternal age groups, maternal age was collapsed into three groups (<20 years, 20–24 years, and ≥25 years) to stratify the data simultaneously by maternal age and race/ethnicity. A significant increase in gastroschisis prevalence occurred in each maternal age group from the first period (1995–2005) to the second (2006–2012) (Table). Statistically significant increases comparing the two periods were seen in eight of the nine categories of maternal age and race/ethnicity assessed. Among mothers aged <20 years and 20–24 years, significant increases were seen in all racial/ethnic groups examined. The prevalence of gastroschisis during 2006–2012 among mothers aged <20 years was higher among white mothers (18.1 per 10,000 live births, 95% CI: 16.7–19.7) and Hispanic mothers (16.1 per 10,000 live births, 95% CI: 14.9–17.3) than among black mothers (10.2 per 10,000 live births, 95% CI: 8.7–11.9); however, black mothers in this age group experienced the largest increase in prevalence,

FIGURE. Trends in gastroschisis prevalence, by maternal age group — 14 states,* 1995–2012
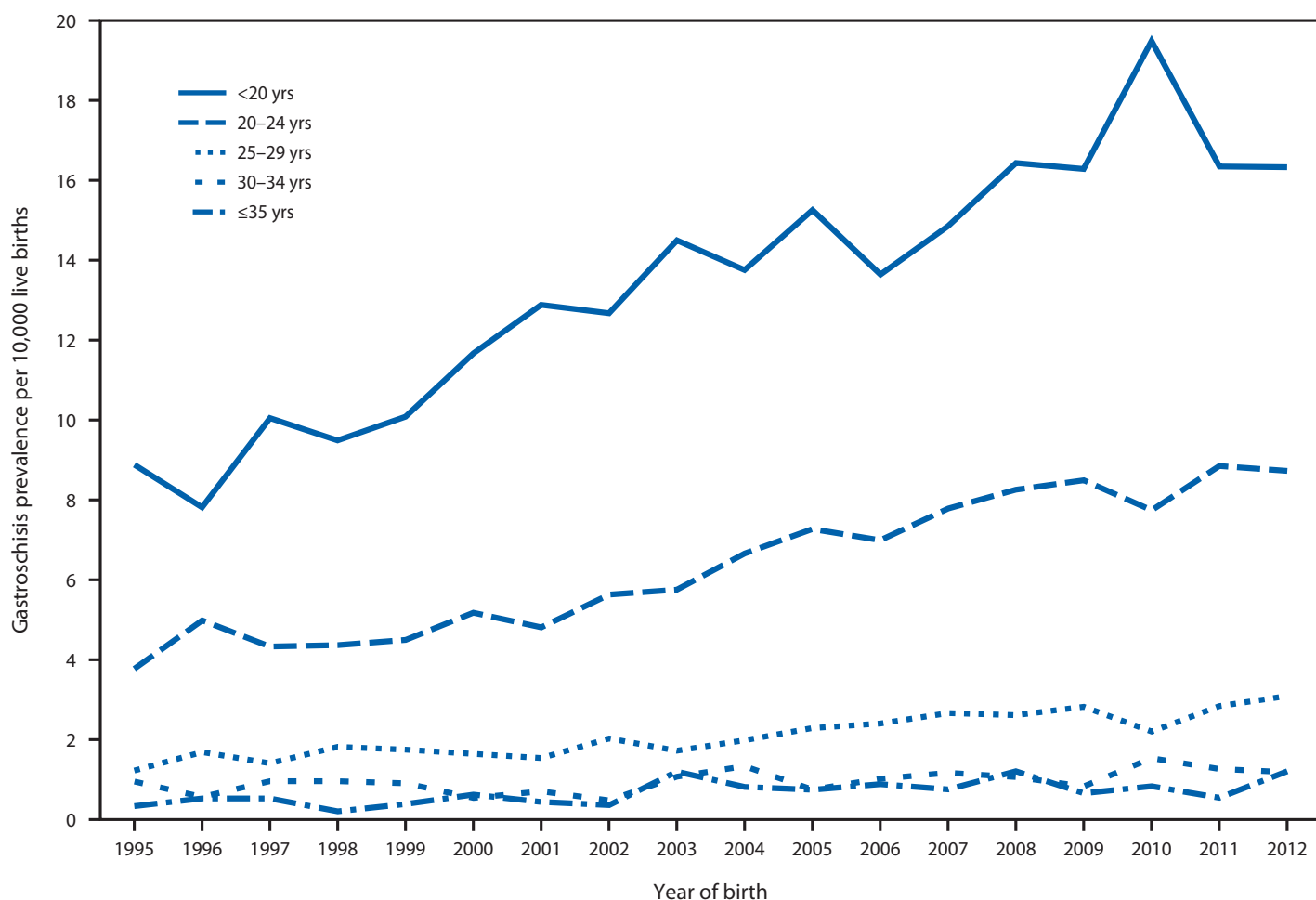
* States contributing data and years for which data are provided: Arizona (1995–2012), Arkansas (1995–2012), California (1995–2012), Colorado (1997–2012), Georgia (1995–2012), Iowa (1995–2012), Kentucky (1998–2012), New Mexico (1998–2012), New York (1995–2012), North Carolina (1999–2012), Oklahoma (1995–2012), Rhode Island (2002–2012), Texas (1996–2012), Utah (1997–2012). Total live births = 21,278,784.

which doubled between the two study periods (prevalence ratio = 2.0, 95% CI: 1.6–2.5).

Using Joinpoint regression to assess temporal trends within strata of maternal age and race/ethnicity, the AAPC indicated a significant increase in prevalence for all nine groups (Table). Zero joinpoints were identified for each of the nine strata, indicating that a single AAPC estimate was appropriate for the entire study period for each group. The two highest AAPCs among these strata were in black mothers aged <20 years and 20–24 years. The AAPCs ranged from a low of 3.1 in white mothers aged <20 years to a high of 7.9 in black mothers aged <20 years. These corresponded to overall percent increases from 1995 to 2012 that ranged from 68% in white mothers aged <20 years to 263% in black mothers aged <20 years.

Discussion

The prevalence of gastroschisis increased significantly during the study period, and prevalence has continued to increase beyond 2005, the end of the period included in the previous multistate report (1). Gastroschisis is associated with young maternal age, with the highest prevalence among mothers aged <20 years; however, significant increases in prevalence were seen in all age groups during 2006–2012 compared with 1995–2005. The greatest increases in prevalence occurred among younger, black mothers, but the prevalence in black mothers remains lower than in white and Hispanic mothers. Joinpoint analyses demonstrated a steady and significant increase in prevalence across all assessed categories of maternal age and race/ethnicity.

Increases in gastroschisis prevalence have been reported both in the United States and internationally, but the current evidence has not led to the identification of the underlying cause or causes of these increases (1,2). The association between young maternal age and gastroschisis was first reported in the late 1970s, and this risk factor has been documented consistently in subsequent studies (4–6). However, the increased prevalence of gastroschisis is not because of an increase in teen births, which have declined in recent years, or to a change in the distribution of births to teen mothers, as birth rates have decreased among women of all ages <20 years (7). Investigators in Norway reported an independent association of young paternal age with gastroschisis, after accounting for maternal age (6). In addition, year of delivery, mother's year of birth, and father's year of birth were each significantly associated with increasing gastroschisis prevalence from 1967 to 1998 (6). Epidemiologic patterns indicate that lifestyle behaviors, environmental exposures, or other risk factors disproportionately affecting young women might play a role. A 2008 review noted that risk factors associated with gastroschisis, after adjusting for maternal age, have included lower socioeconomic status, lower body mass index and other indicators of poor nutrition (lower intake of high quality nutrients and dietary fats), smoking, use of illicit drugs, alcohol, or analgesic medications, and genitourinary infections (5). Additionally, among multiparous and multigravida mothers, a change in paternity since the previous pregnancy has been associated with gastroschisis (5). Studies have also indicated possible age-specific associations between gastroschisis and prior pregnancy loss (8), as well as with certain infections (9).

TABLE. Number of cases and gastroschisis prevalence, prevalence ratio, and average annual percent change, by maternal age group and race/ethnicity — 14 states,* 1995–2012

Maternal age group (yrs)[†]	Maternal race/ethnicity	1995–2005		2006–2012			Joinpoint analysis	
		No.	Prevalence[§] (95% CI)	No.	Prevalence[§] (95% CI)	PR[¶] (95% CI)	Average annual percent change (95% CI**)	Overall percent change[††]
<20	Non-Hispanic white	816	15.4 (14.3–16.5)	574	18.1 (16.7–19.7)	1.2 (1.1–1.3)	3.1 (1.5–4.7)	68
	Non-Hispanic black	137	5.2 (4.3–6.1)	169	10.2 (8.7–11.9)	2.0 (1.6–2.5)	7.9 (5.7–10.1)	263
	Hispanic	698	11.6 (10.7–12.5)	710	16.1 (14.9–17.3)	1.4 (1.2–1.5)	4.4 (3.1–5.7)	108
	Total[§§]	1,749	11.9 (11.3–12.4)	1,562	16.1 (15.3–16.9)	1.4 (1.3–1.5)	4.3 (3.3–5.3)	105
20–24	Non-Hispanic white	846	6.0 (5.6–6.4)	889	8.8 (8.2–9.4)	1.5 (1.3–1.6)	4.6 (3.5–5.7)	115
	Non-Hispanic black	135	2.9 (2.4–3.4)	193	5.4 (4.7–6.2)	1.9 (1.5–2.3)	7.0 (3.7–10.4)	216
	Hispanic	601	5.5 (5.1–6.0)	706	8.3 (7.7–8.9)	1.5 (1.3–1.7)	5.6 (4.3–6.8)	151
	Total[§§]	1,687	5.3 (5.1–5.6)	1,899	8.1 (7.7–8.4)	1.5 (1.4–1.6)	5.2 (4.4–6.0)	137
≥25	Non-Hispanic white	501	1.2 (1.1–1.3)	541	1.7 (1.6–1.9)	1.4 (1.3–1.6)	4.1 (2.6–5.6)	99
	Non-Hispanic black	71	0.9 (0.7–1.1)	77	1.2 (1.0–1.5)	1.4 (1.0–1.9)	3.5 (0.4–6.8)	81
	Hispanic	213	1.2 (1.0–1.3)	314	1.9 (1.7–2.1)	1.6 (1.3–1.9)	4.7 (2.4–7.2)	120
	Total[§§]	853	1.2 (1.1–1.2)	1,014	1.7 (1.6–1.8)	1.5 (1.3–1.6)	4.5 (3.5–5.4)	111

Abbreviations: CI = confidence interval, PR = prevalence ratio.
* States contributing data and years for which data are provided: Arizona (1995–2012), Arkansas (1995–2012), California (1995–2012), Colorado (1997–2012), Georgia (1995–2012), Iowa (1995–2012), Kentucky (1998–2012), New Mexico (1998–2012), New York (1995–2012), North Carolina (1999–2012), Oklahoma (1995–2012), Rhode Island (2002–2012), Texas (1996–2012), Utah (1997–2012). Total live births = 21,278,784.
† Cases missing information on maternal age are not included in this table.
§ Prevalence per 10,000 live births.
¶ Prevalence during 2006–2012 divided by the prevalence during 1995–2005.
** Statistically significant differences from zero percent change.
†† Overall percent change is calculated using the average annual percent change and represents the estimated overall change in prevalence during 1995–2012.
§§ Total includes non-Hispanic white, non-Hispanic black, Hispanic, all other reported racial/ethnic groups and other/unknown maternal race/ethnicity.

Summary

What is already known on this topic?

Gastroschisis is strongly associated with young maternal age, and a previous U.S. report indicated that the prevalence of gastroschisis nearly doubled from 1995 to 2005.

What is added by this report?

Gastroschisis prevalence has increased for all maternal age groups. Significant increases as measured by the average annual percent change were observed for all assessed categories of maternal age and race/ethnicity. The largest estimated increase over the 18 year period (263% overall percent change) was observed for non-Hispanic black mothers aged <20 years.

What are the implications for public health practice?

The observed increases in gastroschisis prevalence are not explained by demographic changes in maternal age or race/ethnicity. Public health research is urgently needed to identify the causal factor(s) contributing to this increase.

The findings in this report are subject to at least three limitations. First, because no information on risk factors other than maternal age and race/ethnicity was requested from state surveillance programs, potential causes for the increase in prevalence could not be examined. Second, not all states were able to provide data as far back as 1995. However, incomplete data for the earlier years of the study is unlikely to affect the results. Because data were pooled for 1995–2005, the prevalence estimates for that earlier study period are more heavily influenced by the later years of that time frame. Previous research has demonstrated an increase in prevalence from 1995 to 2005; therefore, the missing data from earlier years in this study is likely to result in prevalence ratios that are biased slightly and conservatively toward the null. Finally, it is possible that the increase in prevalence could be due to improved ascertainment of gastroschisis cases over time. However, this is unlikely because gastroschisis is immediately apparent at birth. Additionally, omphalocele, a defect that has a similar presentation at birth and previously shared an ICD-9-CM code with gastroschisis, is not increasing in prevalence, making it implausible that the increase observed is due to any confusion between these defects (10).

These findings have implications for prioritizing public health research on gastroschisis to identify factors contributing to the high risk associated with young maternal age and factors associated with the increasing prevalence over the past 20 years. Gastroschisis is unusual among birth defects in that it disproportionately affects younger mothers, a vulnerable population. The continued increase in age-adjusted prevalence and the pace of the increase suggests that unidentified risk factors might be contributing. Identification of these risk factors is needed to inform public health interventions and reduce prevalence. Ongoing surveillance is essential to monitor any further increases in prevalence.

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