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Full-Term Small-for-Gestational-Age Newborns in the U.S.: Characteristics, Trends, and Morbidity

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Abstract

Objectives—The magnitude, characteristics, and morbidity of term (≥37 weeks gestation) newborns that are small-for-gestational-age (SGA) in the U.S. are underexplored. We sought to examine characteristics and trends for SGA-coded term newborns in the U.S.

Methods—Data were obtained from the Nationwide Inpatient Sample, a nationally representative database of hospital stays in the U.S. from 2002 to 2011. Term, singleton newborns with SGA codes were identified and examined over the study period. Demographic characteristics were compared for term newborns according to presence of SGA codes using χ^2 tests. Odds ratios (OR) were calculated to compare morbidities between the two groups, adjusting for relevant demographic and clinical variables.

Results—In 2011, 15 per 1000 term newborns in the U.S. were coded as SGA, a 29.9 % increase since 2002. Compared with other term newborns, SGA term newborns were significantly ($p < 0.05$) more likely to be female, receive public insurance, and reside in lower income zip codes. Comorbidities, including perinatal complications, metabolic disorders, central nervous system diseases, infection, and neonatal abstinence syndrome were more common among SGA-coded term newborns. These newborns also had higher odds of in-hospital death (OR = 3.0 95 % confidence interval: 2.0, 4.4), longer mean length of stay (3.7 vs. 2.3 days, $p < 0.001$), and higher mean hospital charges ($12,621 vs. $5012, $p < 0.001$).

Conclusions for practice—Term newborns coded as SGA have higher morbidity, mortality, and incur higher hospital charges than other term newborns. More research is needed to understand causes of SGA so its incidence and effects can be reduced.

Keywords

Newborn infant; Maternal and fetal medicine; Morbidity; Neonatology; Healthcare utilization

Compliance with Ethical Standards

Conflict of interest The authors have no conflicts of interest relevant to this article to disclose.

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

Introduction

The neonatal period carries higher morbidity and mortality than the rest of infancy and childhood combined (McCormick 1985; Hamilton et al. 2013). It is thus important to identify populations of newborns at high risk for adverse outcomes. Two important measures associated with neonatal outcomes are gestational age and birthweight (McCormick 1985; Hamilton et al. 2013). While the importance of premature birth for neonatal morbidity and mortality is well-characterized, the influence of low birthweight independent of prematurity is less so (Wilcox 2001; Malin et al. 2014). Another measure used in clinical practice, based on gestational age and birthweight, is “small for gestational age” (SGA).

SGA is variously defined using growth curves and/or observed clinical characteristics, including fundal height, various body proportions, soft tissue measurements, and others (Chard et al. 1992; Lubchenco et al. 1966; Campbell and Thoms 1977; Clayton et al. 2007; Belizan et al. 1978; Hadlock et al. 1983; Weiner and Robinson 1989; Gardeil et al. 1999). <10th, <5th and <3rd percentile birthweight for gestational age are commonly used in research addressing this issue, although there are no standards directing physicians or coders to use a specific birthweight percentile cutoff to diagnose newborns as SGA and coded as such in the medical record (Malin et al. 2014; McIntire et al. 1999; Kristensen et al. 2007; Ananth and Vintzileos 2009). In preterm infants, SGA was originally considered an adaptation to a stressful intrauterine environment (Gluck and Kulovich 1973; Usher 1970) and protective against morbidity and mortality (Warshaw 1985; Yoon et al. 1980), a view that has changed over the years (McIntire et al. 1999; Bernstein et al. 2000; Grisaru-Granovsky et al. 2012; Katz et al. 2013; Paranjothy et al. 2013). The existing data on the effects of SGA in infants born at ≥37 weeks are contradictory (Malin et al. 2014; Blair 1994; Minior and Divon 1998). It has been argued that as gestational age increases, the proportion of infants who experience pathological slow growth, or “intrauterine growth restriction” (IUGR), decreases, while the proportion who are constitutionally small, and not at increased risk of morbidity, increases (Ananth and Vintzileos 2009). Nevertheless, some studies have shown increased morbidity and mortality among term SGA infants, especially when using more restrictive cutoff points than the commonly used <10th percentile (McIntire et al. 1999; Kristensen et al. 2007). There are many gaps in our knowledge about the characteristics and morbidity of term SGA newborns, including how best to differentiate between pathologically and constitutionally small newborns, demographic characteristics, associated morbidities experienced, and how these characteristics and morbidities are changing over time, if at all.

In this study we examine the burden suffered by newborns coded as SGA among a nationally representative sample of full term newborns in the U.S. We estimate what percentage of newborns receive an SGA code, and describe the distribution and demographic characteristics of term birth hospitalizations with these codes over 10 years (2002–2011) in the U.S. In addition, we compared morbidity outcomes, in-hospital deaths, length of hospital stay (LOS) and hospital charges between term newborns with and without SGA codes, and examined the trends of these parameters over time.

Methods

Study Design

This is a retrospective, serial, cross-sectional analysis of a nationally representative sample of term (≥37 weeks of gestation) newborns with SGA codes, compared with term newborns without SGA codes in the United States from 2002 to 2011.

Data Source

We used hospital discharge data obtained from the Health-care Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS). The HCUP NIS is a nationally representative, all-payer database of hospital discharges from a 20 % probability sample of U.S. community hospitals, defined by the American Hospital Association as non-federal, short-term (average length of stay <30 days) general and specialty hospitals whose facilities are open to the public (HCUP 2011). The hospitals are stratified according to five criteria: geographic region, rural/urban location, number of beds, teaching status, and ownership. All discharge records from each selected hospital for the year in question are included in the NIS sample. The sample is weighted to allow the creation of nationally representative estimates. The 10 years of NIS data we used in this analysis (2002–2011) contain 7,736,756 records from more than 1000 hospitals, and when weighted represent 37,568,326 live, singleton, term births.

The discharge records in the NIS database contain administrative data, including International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnostic codes, procedure codes, length of stay (LOS), discharge disposition, and hospital charges. In this analysis, SGA is classified according to ICD-9-CM codes that are in turn based on medical providers' diagnoses (Medicare Cf, Services M 2011). Birthweight is not available in the HCUP NIS; neither are the specific criteria used by medical providers to make their diagnoses.

During the period analyzed—2002 to 2011—the NIS underwent several revisions. Relevant to this analysis is the modification of the zip code income variable. In 2002, this variable is defined in relation to the poverty level. For 2003 and later, the zip code income variable is a quartile classification of the estimated median household income of residents in the patient's ZIP Code (HCUP 2014). To avoid using differently defined variables, zip code income results for 2003, instead of 2002, are presented for comparison of 2002 to the other 3 years analyzed. This study was considered exempt from IRB review because it utilized de-identified data.

Population

The individual unit of analysis in the NIS database is the discharge record, and we restricted to only those records indicating a live singleton birth. To accomplish this we included only infants with an ICD-9-CM code of V30, and excluded infants with any code indicative of multiple births (V31–V39). This allowed the selection of unique events, birth hospitalizations, while limiting double counting of individuals and excluding multiple births and stillbirths. Due to this selection method, post-transfer data are not available for

newborns who were transferred to another facility after birth. To limit the sample to term live births, newborns classified as preterm (ICD-9-CM codes 362.20, 362.22–362.27, 765.00–765.19, 765.20–765.28) were excluded. ICD-9-CM codes that indicated a birthweight <1500 g (ICD-9-CM codes V21.31, V21.32, V21.33, 764.01–764.05, 764.11–764.15, 764.21–764.25, 764.91–764.95) were also excluded due to the high likelihood of misclassification.

SGA newborns were defined through the use of the 764 series of ICD-9-CM codes ("Light-for-dates infant without mention of fetal malnutrition," "Light-for-dates infant with signs of fetal malnutrition," "Fetal malnutrition without mention of light-for-dates," and "Fetal growth retardation unspecified").

Comorbidities and Procedures

We used ICD-9-CM codes to identify the following select morbidities and procedures: (1) birth trauma, including hypoxia and asphyxia (ICD-9-CM codes 767, 768); (2) seizures, central nervous system (CNS) diseases and feeding disorders (ICD-9-CM codes 779.0–779.3); (3) perinatal complications, including maternal conditions and complications, and complications of the placenta, cord and amniotic membranes (ICD-9-CM codes 760–763); (4) congenital anomalies (ICD-9-CM codes 740–759, 795.2, V13.6); (5) metabolic disorders (ICD-9-CM code 775), including (6) neonatal hypoglycemia (ICD-9-CM code 775.6); (6) neonatal abstinence syndrome (NAS) (ICD-9-CM code 779.5); (8) respiratory distress and other respiratory conditions (ICD-9-CM codes 769, 770); (9) congenital and neonatal infections (ICD-9-CM codes 771.0–771.89); (10) cesarean delivery (ICD-9-CM code V30.01); (11) and endotracheal intubation and continuous positive airway pressure (CPAP) (ICD-9-CM procedure codes 96.04, 96.05, 93.90–93.91, 96.7).

Data Analysis

Demographic, morbidity, discharge status (including inhospital death) and hospitalization data for 2002 and 2011 provided by HCUP were used to produce descriptive statistics describing the term SGA-coded and non-SGA-coded populations. To compare to the total number of term newborns in the United States classified as SGA according to a birthweight percentile cutoff, the total number of term births with SGA codes in HCUP were expressed as a proportion of <3rd percentile SGA term births identified in CDC Vital Records data (National Center for Health Statistics 2011), calculated using growth curves based on recent (1998–2006) U.S. data from 33 states (Olsen et al. 2010).

We used χ^2 tests to compare the proportional distributions of term SGA coded newborns with term non-SGA coded newborns according to the following variables: sex, expected primary payer, urban or rural location of the hospital, geographic region of the hospital, zip code income quartile and disposition of the patient. We also calculated total and mean length of stay (LOS), and total and mean hospital charges associated with the hospitalization; means for the two groups were compared using Student's t tests. Rates of morbidities per 1000 term births were calculated for 2002 and 2011, and compared according to presence of SGA diagnosis using multivariable logistic regression, adjusting for sex, expected primary payer, mode of delivery and presence of congenital anomalies. To assess trends in

morbidities, hospital charges, and LOS among the SGA coded and non-SGA coded groups, the change in outcome per year from 2002 to 2011 was calculated using multivariable logistic and multiple linear regressions for binary and continuous outcomes, respectively, adjusting for sex, expected primary payer and presence of congenital anomalies. All statistical analyses were carried out using survey procedures SAS 9.3 and replicated with SAS callable SUDAAN (SAS Institute, Cary NC), which use the weights and the stratification and cluster variables provided by HCUP to account for the sample design when calculating variances.

As a sensitivity analysis, we produced crude odds ratios for the relationships between SGA and the outcomes studied corrected for various levels of SGA misclassification(Greenland 1996) as follows: (1) high specificity (99 %) and misclassification due to non-differential low sensitivity (from 95 to 30 %); (2) high sensitivity (95 %) and differential misclassification due to low sensitivity (95 to 30 %) only among those who did not suffer from the outcomes studied.

To estimate costs associated with the hospitalization, we used year-specific Cost-to-Charge Ratios (CCR) provided by the Agency for Healthcare Research and Quality using data from the Centers for Medicare and Medicaid Services (Friedman et al. 2001). Hospital-specific CCRs—the availability of which increased from 67 % of hospitals in 2002 to 88 % in 2011—were used where possible. When unavailable, the weighted group average CCR was used, where group was defined based on state, urban/rural, investor owned/other, and number of beds. All charges and costs are expressed in 2011 dollars.

Results

In 2002 and 2011, respectively, there were an estimated 44,161 and 51,956 birth hospitalizations of singleton, term newborns with SGA codes. These comprised 12 per 1000 hospital term births (2002) and 15 per 1000 hospital term births (2011) (Fig. 1). In 2011, the 51,956 SGA coded term births identified in HCUP data is approximately half as large as the total number of <3rd percentile births in CDC Vital Records data (101,329).

In 2011, SGA-coded term newborns were more likely to be female, have public insurance, and reside in the lowest zip income quartile areas than their non-SGA-coded counterparts (Table 1). The distribution of term births by hospital location (urban/rural) and geographic region was not significantly different according to coded SGA status. SGA-coded term newborns were also more likely to have been delivered by cesarean delivery, and were more likely to die during the birth hospitalization or to be transferred or have other non-routine dispositions.

Hospital charges were significantly higher, and length of stay significantly longer, for SGA-coded, compared with non-SGA-coded term newborns. In 2011, mean length of stay for birth hospitalizations of SGA-coded term newborns was 3.7 versus 2.3 days for non-SGA coded term newborns, and mean hospital charges were $12,621 versus $5013 for term newborns with and without SGA diagnosis, respectively. Hospital costs in 2011 for SGA

coded term newborns ($3753) were also higher than for non-SGA-coded term newborns ($1489).

SGA term newborns had consistently higher odds of having several comorbidities, even after adjusting for sex, expected primary payer, mode of delivery and presence of congenital anomalies. Birth trauma was the only comorbidity investigated for which there was no difference in odds between term newborns with and without SGA codes (Table 2). During 2002 and 2011, the comorbidities with the greatest magnitudes of association with SGA diagnosis were seizures/CNS diseases/feeding disorders, metabolic disorders and NAS (Table 2). SGA diagnosis was also strongly associated with perinatal complications, congenital anomalies, respiratory distress and other respiratory conditions, congenital/neonatal infections, and intubation and CPAP procedures, and with in-hospital mortality, with adjusted odds ratios (ORs) of 1.9 or larger. These associations persisted for each of our study years (data from interim years not shown).

Trends Over Time

The number of SGA-coded term newborn hospitalizations increased from 2002 to 2011 (Table 3), even though CDC vital records did not show a corresponding increase in births <3rd percentile for gestational age. Among SGA-coded term newborns, two comorbidities showed consistent and significant increases over the study period: neonatal abstinence syndrome and congenital anomalies. Odds of these comorbidities also increased among non-SGA coded term newborns and these increases did not differ significantly according to presence of SGA diagnosis. Odds of metabolic disorders increased among term newborns without SGA codes, but did not for those with SGA codes. Rates of select outcomes over the study period are presented in Fig. 2.

Over the study period, adjusted mean hospital charges for SGA-coded term newborns increased by 40 %, from $8714 in 2002 to $12,242 in 2011; those of the non-SGA group increased by 57 %, from $3125 in 2002 to $4906 in 2011 (Table 3). Costs, however, did not significantly increase for either group over the study period (data not shown).

Discussion

There is a paucity of evidence on the disease burden associated with term SGA births, as well as their distribution and characteristics nationally. A study that used data from the 2001 HCUP NIS dataset estimated that there were 58,600 delivery discharges with ICD-9-CM codes indicating slow fetal growth/malnutrition; these births had longer stays and significantly higher costs than for uncomplicated newborn hospitalizations (Russell et al. 2007). However, that study did not limit the analysis to term infants (Escobar et al. 2006, 2005).

Term births with SGA codes result in a disproportionate economic burden (6.5 % of all charges and 3.5 % of all costs for term births). In 2011, hospital charges for these births were, on average, more than double those of those without SGA codes. These charges are increasing over time, possibly reflecting the overall trend of hospital charges in the United States over the study period (Weiss et al. 2014). Estimated costs did not increase over that

period, although this dataset does not provide information on what hospitals were actually reimbursed for the services they provided. In addition to the increased charges, families and hospital systems must accommodate the increased time that SGA-coded term newborns spend in the hospital and increased odds of in-hospital mortality (5.1 % of total term newborn deaths).

We found that there are differences in the distribution of term births with SGA codes in the U.S. by income. These births were more frequent among the lowest socioeconomic (SES) stratum, as evidenced by both proxy measures of SES used: expected primary payer and zip code income quartile. On the contrary, there was no significant variation in the distribution of births with SGA codes by US geographic region or urban/rural location. This contrasts with the findings of a 2005 study that showed that rates of low birthweight varied regionally in the U.S. (Thompson et al. 2005); that analysis used smaller geographical units than those available in the HCUP NIS (Healthcare Cost and Utilization Project (HCUP) 2014).

SGA diagnosis was associated with several neonatal comorbidities among term newborns. These comorbidities may influence and/or be influenced by the processes that result in a term SGA birth. Of interest, there was a strong association of SGA diagnosis with NAS. Evidence suggests maternal drug use may be associated with both premature and SGA birth (Cleary et al. 2011). There have recently been increases in the number of prescription opioid overdoses (Centers for Disease Control and Prevention 2013) and newborns with NAS (Patrick et al. 2012). A study using the HCUP NIS found an 11.9 % increase in maternal opioid use among pregnancy hospitalizations over a period significantly overlapping the one studied in our analysis (2001–2009) (Salihu et al. 2015). SGA diagnosis was also associated with congenital anomalies in this study, a comorbidity that was increasingly coded over the study period. This increase may be due to enhanced detection via prenatal and neonatal screening (Siddique et al. 2009; Marek et al. 2011). The other categories of co-morbidities that exhibited associations of large magnitude with SGA diagnosis included seizures/CNS diseases/feeding disorders and metabolic disorders. The strength of these associations may be due in part to potential shared risk factors leading to their causation. These co-morbidities have been included to provide a comprehensive picture of the disease burden faced by term newborns with SGA codes. It is important to note that none of the comorbidities that were increasingly prevalent for SGA-coded term newborns increased more rapidly than for non-SGA-coded term newborns. Indeed, for metabolic disorders, which increased for the non-SGA group, there was no increase in the SGA group. This last may indicate improving management of pregnancies and deliveries of infants with SGA diagnosis, but may also be a result of more thorough coding practices over time.

In the most recent year we studied (2011), SGA-coded term newborns had a 200 % higher odds of in-hospital death than non-SGA-coded term newborns. A study that used a linked birth/infant death dataset from the CDC National Center for Health Statistics showed SGA infants born at term from 1995 to 1999 had a 50 % higher odds of overall infant mortality, and 20 % higher odds of neonatal death compared to term non-SGA infants (Kristensen et al. 2007). The smaller increased odds in that study, compared with our study, likely stems from its adjustment for a wide range of maternal factors. Another study showed term newborns born at <3rd percentile birthweight for their gestational age had a higher neonatal

mortality rate compared with non-SGA newborns (McIntire et al. 1999). Additionally, a recent systematic review showed higher odds of neonatal mortality for SGA (defined as <10th percentile birthweight for gestational age) infants, but did not analyze term births separately (Malin et al. 2014; Wennergren et al. 1988).

SGA newborns are a heterogeneous group. As noted by other researchers, definitions of SGA based on birthweight quantiles are a mix of constitutionally small and pathologically small newborns (Wilcox 2001; Malin et al. 2014; McIntire et al. 1999; Ananth and Vintzileos 2009). Results from this study are representative of newborns diagnosed and coded as SGA, but should not necessarily be applied to specific birthweight for gestational age quantiles. The comparison of term SGA newborns in the HCUP NIS with those in National Vital Records data used a <3rd birth-weight percentile cutpoint because term newborns under this cutpoint have been shown to have significantly worse outcomes compared to their normal birthweight peers (McIntire et al. 1999). The estimated number of term newborns with SGA diagnoses is considerably smaller than what would have been expected had birthweight for gestational age percentiles been used to define exposure. Term newborns with SGA codes increased over the study period without an accompanying increase in term SGA births identified using a 3rd percentile for gestational age cutoff. The increase in the NIS likely results from increased coding of the condition.

Newborns with SGA codes may represent neonates with more pronounced growth restriction, or with other comorbidities. This would tend to bias associations away from the null hypothesis, when compared to an exposure group based on a 3rd or 10th percentile birthweight per gestational age cutoff. Analyses correcting for differential misclassification due to lower (30 %) sensitivity of SGA coding among those without adverse outcomes weakened associations between coded SGA and the outcomes, but most ORs remained elevated compared to term newborns without SGA codes.

To our knowledge, this is the first study to produce national estimates of the number of SGA-coded term births in the U.S., as well as their distribution, demographic and clinical characteristics, and trends over time. Strengths include the large sample size, and ability to produce nationally-representative estimates of perinatal and newborn outcomes, including hospital charge data. However, this study has some limitations. The maternal record cannot be linked to the newborn birth record, so the effect of maternal preconception and pregnancy factors such as maternal age, weight, tobacco use, prescription drug use, diabetes, and other parameters that may influence SGA cannot be assessed. This may also result in coding only for the more serious perinatal complications in the infant record, thus biasing away from the null hypothesis. Information on maternal race was not reliably available for all states or years (HCUP 2014). Analyses using administrative datasets like the NIS depend on the accuracy and completeness of coding, which may be variable and may change over time. Indeed, the fact that some conditions increased over time in both SGA and non SGA-coded newborns may suggest improvements in thoroughness of coding practices in the U.S., as well as increases in the number of diagnoses per record reported to HCUP by states. Restricting this study to the birth hospitalization means post-transfer data are not available for those requiring transfer to a different facility after birth, and thus underestimates the true costs of hospitalizations for term SGA births, as well as the burden of co-morbidities that

may require care at referral centers (such as newborn intensive care, cardiopulmonary support or care for neurologic diseases, to name a few). This may disproportionately affect those with SGA diagnosis, as they generally have more co-morbidities, biasing observed measures of disease burden closer to the null. However, this restriction assured that each hospitalization represented an individual newborn. In this analysis the non-SGA group included all term births without SGA diagnosis, whether appropriate for gestational age (AGA) or large for gestational age (LGA). However, the associations observed would only be expected to be larger if only AGA newborns had been in the comparison group. LGA newborns are known to be at increased risk for certain morbidities (Weissmann-Brenner et al. 2012), thus their inclusion may bias the adjusted odds ratios for such complications (particularly birth trauma or metabolic disorders, such as hypoglycemia) towards the null.

The results of this study reinforce the need for interventions to address factors associated with SGA, especially among populations shown to have higher prevalence of the condition. These can include interventions addressing established factors like maternal tobacco use and chronic hypertension. The rapid increase in the prevalence of neonatal abstinence syndrome in the context of increasing maternal opioid use and opioid overdoses coupled with the association shown between neonatal abstinence and SGA gives another reason to address this growing public health threat. Considering the higher charges term newborns coded SGA incur, interventions of this nature also have the potential to reduce the financial burden on individuals and public health insurance programs.

In conclusion, more newborns are being diagnosed as SGA in the U.S., both in numbers and as a percentage of all term births since 2002, possibly due to increased awareness. SGA-coded term newborns are more likely than those without SGA codes to come from families with lower income, suffer an increased burden of morbidity, and experience longer, often more medically complex and costly birth hospitalizations. These findings call for further research to characterize and address the causes and associated morbidities of SGA among term newborns, as well as to identify ways to reduce SGA and its complications.

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Significance

What's known on this topic

Size for gestational age is an important measure of neonatal health. Small for gestational age at term (≥37 weeks of gestational age) newborns are less well characterized, compared with preterm neonates.

What this study adds

Characteristics, morbidity, mortality and trends are described for newborns coded as small for gestational age at term in a nationally representative sample from 2002 to 2011.

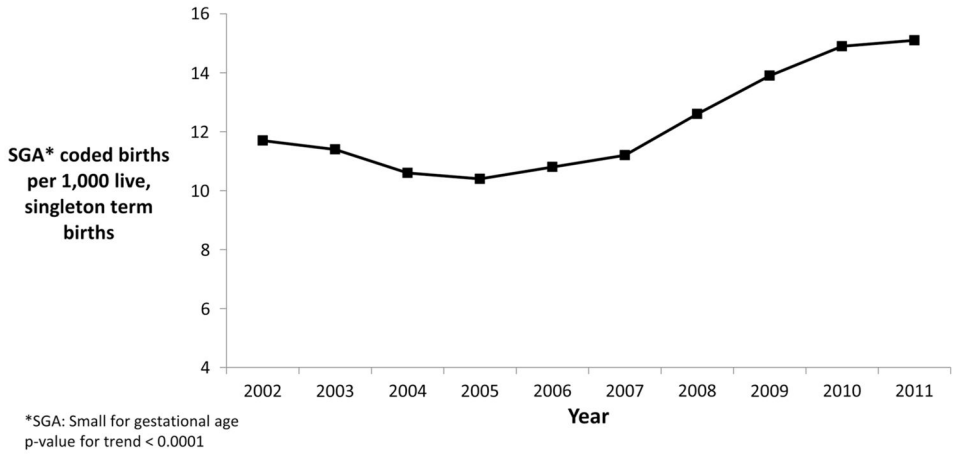

Fig. 1.

Births with codes for small for gestational age per 1000 live, singleton term births per year, 2002–2011

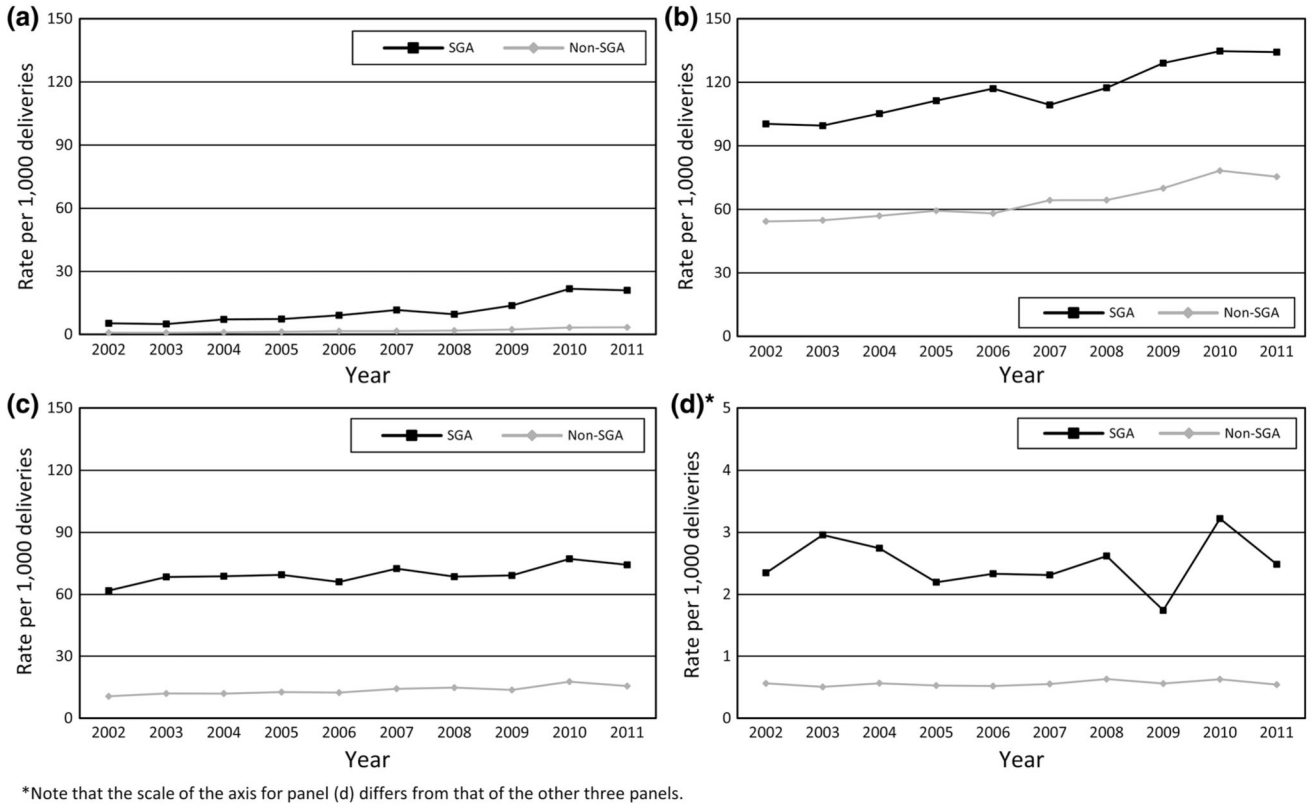

Fig. 2.

Annual rates (based on data from the Healthcare Cost and Utilization Project) of select outcomes per 1000 live, singleton term (≥ weeks of gestational age) births in the USA 2002–2011. **a** Neonatal abstinence syndrome. **b** Congenital anomalies. **c** Metabolic disorders. **d** In-hospital death

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Table 1

Demographic and hospital characteristics and select outcomes of newborn hospitalizations of live, singletons born at ≥37 weeks of gestational age in US hospitals in 2002 and 2011, by presence of small for gestation age (SGA) code

	2002			2011		
	SGA (n = 44,161) %	Non SGA (n = 3,727,962) %	*p*†	SGA (n = 51,956) %	Non SGA (n = 3,386,269) % %	*p*†
Sex			< 0.001			<0.001
Male	55.5	48.7		58.8	48.9	
Female	44.5	51.3		41.2	51.1	
Expected primary payer			< 0.001			<0.001
Public	45.3	36.5		53.3	44.8	
Private	47.0	55.7		40.5	48.8	
Self-pay/other	7.7	7.8		6.2	6.4	
Zip code income quartile[a]			< 0.001			0.005
1—lowest	29.7	25.5		28.6	26.3	
2	25.5	25.2		23.5	24.3	
3	24.7	25.4		27.6	27.1	
4—highest	20.1	24.0		20.3	22.3	
Location of hospital			0.71			0.13
Urban	86.5	86.2		89.5	88.1	
Rural	13.5	13.8		10.5	11.9	
Hospital region			0.77			0.23
Northeast	17.1	16.8		17.2	16.9	
Midwest	21.8	21.7		25.1	20.7	
South	34.4	35.9		33.2	36.7	
West	26.7	25.5		24.5	25.7	
Method of delivery			< 0.001			<0.001
Vaginal	69.4	75.4		64.2	68.8	
Cesarean	30.6	24.6		35.8	31.2	
Disposition of patient			< 0.001			<0.001
Routine	91.3	96.6		92.3	97.4	
Transfer/other[b]	8.5	3.4		7.4	2.5	

	2002			2011		
	SGA (n = 44,161) %	Non SGA (n = 3,727,962) %	$p^{\dagger}$	SGA (n = 51,956) %	Non SGA (n = 3,386,269) % %	$p^{\dagger}$
Died	0.23	0.06		0.25	0.05	
Length of stay (days)			< 0.001			<0.001
Mean	3.7	2.3		3.7	2.3	
Charges[c]			< 0.001			<0.001
Mean	$8351	$3048		$12,621	$5013	

[a] Data displayed for zipcode income quartiles are from 2003, instead of 2002

[b] Other category can include transfers to Home Health Care (HHC), those who left Against Medical Advice (AMA) and those who were “discharged alive, destination unknown.”

[c] All charges were converted to 2011 dollars using conversion factors provided by the Healthcare Cost and Utilization Project

† p value for $\chi 2$ test

Table 2

Comparisons of rates of select conditions and procedures among live, singleton newborns born at ≥37 weeks of gestational age in hospitals in the USA in 2002 and 2011, by presence of small for gestational age (SGA) code

	2002				2011			
	SGA (n = 44,161)	Non SGA (n = 3,727,962)			SGA (n = 51,956)	Non SGA (n = 3,386,269)		
	Rate[a]	Rate[a]	aOR[b]	(95 % CI)	Rate[a]	Rate[a]	aOR[b]	(95 % CI)
Birth trauma[c]	31.9	33.5	0.9	(0.8, 1.1)	32.0	30.7	1.0	(0.9, 1.2)
Seizures, CNS diseases and feeding disorders	61.8	10.6	5.5	(4.9, 6.2)	74.3	15.6	4.7	(4.1, 5.3)
Perinatal complications[d]	90.9	33.4	2.8	(2.4, 3.1)	102.4	42.1	2.5	(2.2, 2.8)
Congenital anomalies	100.4	54.3	1.9	(1.8, 2.1)	134.2	75.4	1.9	(1.7, 2.1)
Metabolic disorders	108.0	19.5	5.6	(5.0, 6.2)	114.1	24.1	4.9	(4.4, 5.5)
Neonatal abstinence syndrome	5.3	0.8	5.5	(4.0, 7.7)	20.9	3.4	5.5	(4.7, 6.5)
Respiratory distress and other respiratory conditions	115.8	49.4	2.3	(2.1, 2.5)	117.4	50.9	2.3	(2.1, 2.5)
Congenital/neonatal infection	35.2	12.1	2.6	(2.3, 3.0)	37.7	11.7	2.9	(2.5, 3.3)
Intubation and CPAP	37.4	12.9	2.5	(2.1, 3.0)	39.1	14.4	2.4	(2.0, 2.9)
In-hospital death	2.3	0.6	2.7	(1.7, 4.2)	2.5	0.5	3.0	(2.0, 4.4)

[a] Rates are per 1000 births

[b] Adjusted for sex, mode of delivery, expected payer and presence of congenital anomalies

[c] Birth trauma includes mechanical or anoxic trauma incurred by or to the infant during labor or delivery, and physical injuries (such as brain damage) received during birth, mostly in, but not limited to, breech births, instrument deliveries, neonatal anoxia

[d] Perinatal complications include maternal conditions and complications, complications of the placenta, cord and membranes and other complications of labor and delivery

CNS Central nervous system

CPAP Continuous positive airway pressure

Table 3

Trends in morbidities, in-hospital death, procedures, mean length of stay and mean hospital charges among live, singleton newborns born at ≥37 weeks of gestational age in hospitals in the USA, 2002–2011 by presence of small for gestational age (SGA) code

Total SGA	**2002**	**2005**		**2008**		**2011**		***p*[a]**
	44,161	**39,794**		**48,221**		**51,956**		**< 0.001[b]**
	aOR[c]	**aOR[c]**	**(95 % CI)**	**aOR[c]**	**(95 % CI)**	**aOR[c]**	**(95 % CI)**	
SGA								
Birth trauma[d]	1.0	1.1	(0.9, 1.3)	0.9	(0.7, 1.1)	1.0	(0.8, 1.2)	0.03
Seizures, CNS diseases and feeding disorders[*]	1.0	1.1	(0.9, 1.4)	1.1	(0.9, 1.4)	1.2	(1.0, 1.4)	0.09
Perinatal complications[e,*]	1.0	0.8	(0.7, 1.0)	1.1	(0.8, 1.4)	1.1	(0.9, 1.4)	0.28
Congenital anomalies[f]	1.0	1.1	(1.0, 1.3)	1.2	(1.0, 1.4)	1.4	(1.2, 1.6)	< 0.001
Metabolic disorders[g,h,*]	1.0	0.9	(0.8, 1.1)	0.9	(0.8, 1.1)	1.1	(0.9, 1.3)	0.14
Neonatal abstinence syndrome	1.0	1.3	(0.7, 2.1)	1.7	(1.0, 2.8)	3.6	(2.3, 5.6)	< 0.001
Respiratory distress and other respiratory conditions	1.0	0.9	(0.7, 1.0)	0.8	(0.7, 0.9)	1.0	(0.9, 1.1)	0.28
Congenital/neonatal infection	1.0	0.9	(0.7, 1.1)	0.9	(0.7, 1.2)	1.0	(0.8, 1.3)	0.84
Intubation and CPAP	1.0	0.8	(0.6, 1.0)	0.7	(0.6, 0.9)	1.0	(0.8, 1.2)	0.64
In-hospital death	1.0	0.9	(0.4, 1.7)	1.0	(0.5, 1.9)	0.8	(0.5, 1.5)	0.15
Mean charges	$8714	$7749		$9024		$12,242		<0.001
Mean length of stay (days)	3.7	3.4		3.4		3.7		<0.001
Non SGA								
Birth trauma[d]	1.0	0.9	(0.8, 1.0)	0.8	(0.7, 0.9)	0.9	(0.8, 1.0)	0.11
Seizures, CNS diseases and feeding disorders[*]	1.0	1.2	(1.0, 1.3)	1.4	(1.2, 1.6)	1.4	(1.2, 1.6)	< 0.001
Perinatal complications[e,*]	1.0	0.8	(0.6, 1.0)	1.2	(0.9, 1.5)	1.2	(1.0, 1.5)	< 0.001
Congenital anomalies[f]	1.0	1.1	(1.0, 1.2)	1.2	(1.1, 1.3)	1.4	(1.3, 1.6)	< 0.001
Metabolic disorders[g,h,*]	1.0	1.0	(0.9, 1.1)	1.1	(1.0, 1.3)	1.2	(1.1, 1.3)	< 0.001
Neonatal abstinence syndrome	1.0	1.4	(1.1, 1.9)	2.1	(1.6, 2.8)	3.7	(2.8, 4.8)	< 0.001
Respiratory distress and other respiratory conditions	1.0	1.0	(0.9, 1.1)	0.9	(0.9, 1.0)	1.0	(0.9, 1.1)	0.07
Congenital/neonatal infection	1.0	0.9	(0.8, 1.1)	0.9	(0.8, 1.1)	0.9	(0.8, 1.1)	0.47
Intubation and CPAP	1.0	0.9	(0.7, 1.1)	0.9	(0.7, 1.1)	1.1	(0.8, 1.4)	0.38

Total SGA	**2002**	**2005**		**2008**		**2011**		***p*[a]**
	44,161	**39,794**		**48,221**		**51,956**		**< 0.001[b]**
	aOR[c]	**aOR[c]**	**(95 % CI)**	**aOR[c]**	**(95 % CI)**	**aOR[c]**	**(95 % CI)**	
In-hospital death	1.0	0.9	(0.7, 1.1)	1.0	(0.8, 1.2)	0.8	(0.6, 1.0)	0.01
Mean charges	$3125	$3535		$4128		$4906		<0.001
Mean length of stay (days)	2.3	2.3		2.3		2.3		0.30

[a] *p*-value is for f test of overall effect of year, unless otherwise noted

[b] *p*-value is for $\chi 2$ test of difference in SGA birth proportion by year

[c] Adjusted for sex, expected primary payer and presence of congenital anomalies

[d] Birth trauma includes mechanical or anoxic trauma incurred by or to the infant during labor or delivery, and physical injuries (such as brain damage) received during birth, mostly in, but not limited to, breech births, instrument deliveries, neonatal anoxia

[e] Perinatal complications include maternal conditions and complications, complications of the placenta, cord and membranes and other complications of labor and delivery

[f] The ORs for congenital anomalies are not adjusted for congenital anomalies

[g] Metabolic disorders include syndrome of “infant of a diabetic mother,” neonatal diabetes mellitus, neonatal myasthenia gravis, neonatal thyrotoxicosis, hypocalcemia and hypomagnesemia of newborn, other transitory neonatal electrolyte disturbances, neonatal hypoglycemia, late metabolic acidosis and other acidosis of newborn, other and unspecified neonatal endocrine and metabolic disturbances

[h] Neonatal hypoglycemia is included in the metabolic disorders category

CNS Central nervous system

CPAP Continuous positive airway pressure

[*] Interaction of SGA and year is significant at $\alpha = 0.05$