Prenatal, Perinatal and Postnatal Mortality: Developing and Evaluating Spatial Indices Identifying Gaps in Health Care and Determining Risk Relationships

by

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2. Bachelor Thesis

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Science Pledge

By my signature below, I certify that my thesis is entirely the result of my own work. I have cited all sources I have used in my thesis and I have always indicated their origin.

Baton Rouge, 12.05.2011

Gabriele Wruss

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Zusammenfassung

Die Kindersterblichkeitsrate (Infant Mortality Rate - IMR) und die Sudden Infant Death Syndrome Rate (SIDSR) sind, verglichen mit den restlichen Regionen der U.S., im Süden höher. Louisiana gehört zu den Südstaaten mit höheren SIDS Raten. Während der Datenaufbereitung wurden die zur Verfügung gestellten statistischen Datensätze der IMR und der SIDSR der gesamten U.S. für die Jahre 2002, 2003, 2005, und 2006, in die geographische Datenbank eines U.S. shapefiles eingefügt.
Die Datensätze konnten somit visualisiert und analysiert werden. Die Einflussfaktoren wie Rasse und sozioökonomische Faktoren werden ausführlich diskutiert. Darüber hinaus wird die lokale räumliche Autokorrelation der Kindersterblichkeit und des SIDS berechnet und mit LISA cluster Karten und Box plots dargestellt. Räumliche Schwankungen der Kindersterblichkeit und des SIDS werden mit Hilfe der deskriptiven Statistik und des local Moran´s I berechnet. Die Anzahl der SIDS Sterbefälle und die SIDSR für einzelne Regionen in Louisiana wurden den geographischen Datensätzen eines Louisiana shapefiles hinzugefügt. Veränderungen in der Häufigkeit und in den Regionen, konnte für die Jahre 2004 bis 2008 für Louisiana gemacht werden. Die Rasse und sozioökonomische Faktoren werden untersucht und interpretiert. Die sozioökonomischen Faktoren, die zur Kindersterblichkeits- und SIDS-Analyse verwendet wurden, sind im Bildungsbereich die Anzahl der Abiturienten, der Bachelors oder Personen mit höheren akademischen Abschlüsse, sowie das mittlere Haushaltseinkommen und die Anzahl der Personen, die unter der Armutsgrenze leben. Die Ergebnisse der IMR und SIDSR -Forschung zeigen räumliche und jährliche Besonderheiten im Einzelnen und lokale räumliche Autokorrelationen sowohl in der U.S. und in den Regionen Louisianas.

Abstract

The infant mortality rate (IMR) and the sudden infant death syndrome rate (SIDSR) are higher in the U.S. south, than in any other region of the U.S. Louisiana is always among those states with higher values. During the data preparation stage, the collected statistical records of the IMR and the SIDSR for the entire U.S. for the years 2002, 2003, 2005 and 2006, were added into the geographic database of U.S. shapefiles. This allowed those records to be visualized and analyzed. The factors influencing the IMR and the SIDSR, such as race and socio-economic factors are discussed in detail. Furthermore, the local spatial autocorrelation of infant mortality and SIDS are calculated and displayed with LISA cluster maps and box plots. Spatial variations of infant mortality and SIDS are calculated using descriptive statistics and the local Moran's I. The number of SIDS death and the SIDSR for individual regions in Louisiana are added to the geographic records of the Louisiana shapefile. Changes in the frequency and across the regions are shown for Louisiana for the years 2004 to 2008. The racial and socio-economic factors are investigated and discussed. The socio-economic factors high school graduates, bachelor's degree or higher, median household income, and persons living below the poverty level are used as factors influencing the infant mortality and the SIDS for both the entire U.S. and for Louisiana. The results of the IMR and the SIDSR research show spatial and annual patterns for the local spatial autocorrelation for the U.S. and the regions of Louisiana.

Table of Content

List of Abbreviations

AAP	*American Academy of Pediatrics*
ABBR	*Abbreviation*
ALTEs	*Apparent Life-Threatening Events*
CDC	*Centers for Disease Control and Prevention*
DHH	*Louisiana Department of Health and Hospitals*
DOHMH	*Department Of Health and Mental Hygiene*
ELBW	*Extremely Low Birth Weight*
ESDA	*Exploratory Spatial Data Analysis*
ESPID	*European Society for Pediatric Infectious Diseases*
FMR	*Fetal Mortality Rate*
GIS	*Geographic Information System*
HRSA	*Health Resources and Services Administration*
ICD-10	*International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*
IMR	*Infant Mortality Rate*
IQR	*Interquartile Range*
LBW	*Low Birth Weight*
LGA	*Large for Gestation Age*
LISA	*Local Indicators of Spatial Association*
NCHS	*National Center for Health Statistics*
NCS	*National Co-morbidity Survey*
NICHHD	*National Institute of Child Health and Human Development*
NMR	*Neonatal Mortality Rate*
NSIDRC	*National SIDS/Infant Death Resource Center*
NVSR	*National Vital Statistics Report*
NYC	*New York City*
OECD	*Organization of Economic Co-operation and Development*
PID	*Pre-Implantation Diagnostic*
PMR	*Perinatal Mortality Rate*
SGA	*Small for Gestation Age*
SIDS	*Sudden Infant Death Syndrome*
SIDSR	*Sudden Infant Death Syndrome Rate*
SUDI	*Sudden and Unexpected Death in Infancy*
TOP	*Termination of Pregnancy*
TVS	*Trans-Vaginal Ultrasound*
VLBW	*Very Low Birth Weight*
WHO	*World Health Organization*
R95	*International classification for cause of death "SIDS" (ICD-10)*

1. Introduction

1.1. Motivation

The progress of demographic aging in Austria and the annual birth deficit in the Austrian Province of Carinthia have financial and economic impacts. According to the Austrian Financial Equalization Act 2008[1], budget appropriations and grants to communities and countries are calculated according to population sizes. Therefore, the objective should be to carry about prenatal and perinatal mortality in general, because this also affects the number of births.

The capital of the US State of Louisiana, Baton Rouge was chosen for this research, because the Department of Geography and Anthropology at Louisiana State University has a research focus on the spatial analysis of health outcomes and disease data (Curtis & Leitner, 2006). The question whether methods for analyzing poor prenatal and postnatal care can be transferred as to causes and risks of miscarriage, still births, and infant mortality have to be explored. The motivation for this research is not only based on analyzing existing vital records, like birth and death records, but also to identify problems and risks that may occur in the daily life of a pregnant woman. It is not only the physical or psychological properties of the mother, but also the domestic environment (inside or outside the "own four walls") or the workplace that can cause stress. In the worst-case scenario this can also result in a miscarriage, stillbirth, or infant death.

In the ranking of the causes of infant deaths, the sudden infant death syndrome (SIDS) is the third leading cause overall of infant mortality and the leading cause of death among infants aged 1-12 months in the United States (CDC, 2011). The SIDS is also the third leading cause overall of infant mortality in Austria (Statistik Austria, 2009). These rankings and my own private experience with SIDS put the research focus of this project on the SIDS. As far as my own experience is concerned, I had three newborns that were diagnosed with SIDS. With the help of annual observations of each newborn in the sleep laboratory at the clinic and with monitoring devices at home, and by using specific medication, these newborns fortunately did not die from SIDS.

1.2. Goals

Based on the work of Curtis and Leitner (2006), the aim of this research was to visualize mortality data in the form of choropleth maps for the entire U.S. and for the administrative regions of Louisiana. The attribute table of the shape files for the U.S. and for Louisiana had to be updated with the statistical data from Excel files and Access data, in order analyze the data and visualize the results, using a Geographical Information System (GIS). In order to identify relationship between the IMR and the SIDSR and some influencing factors throughout the U.S., racial and socio-economic variables are combined with the records of the IMR and the SIDSR.

[1] http://www.ris.bka.gv.at

The comparison of the SIDSR for the administrative regions of Louisiana with their racial and socio-economic factors was a further motivation to find regional variations. Using the concept of local spatial autocorrelation, positive and negative neighborhood relationships could be identified, for the IMR and the SIDSR. In addition, spatial outliers and spatial hot spots, and cold spots are found as well.

1.3. Background

Mortality and burden of disease are now among the first in the World Health Organization (WHO) indicators of global public health. The values and trends of child mortality are relevant for understanding the public health, since almost 20% of all deaths worldwide are children less than five years old. In the neonatal mortality, there are is a large percentage of deaths among children in many different countries, especially in low-income countries (WHO, 2010). In numbers, this results in an annual global child mortality rate of nine million children less than five years old. Approximately 40% (3.7 million) of children less than five years die in the neonatal period. In the developing countries, perinatal and neonatal mortality is more than ten times higher than in developed countries (Tanaka et al., 2010). In terms of prenatal care and the risks during pregnancy, the fetal mortality rate (FMR) and perinatal mortality rate (PMR) are considered as an indicator.

The different definitions of fetal death in relation to the gestation age make it difficult to compare the FMR records between countries around the world. There is a fetal death between the 20th and 27th gestation week and a fetal death at the 28th gestation week or more. In the United States the FMR decreased between 1995 and 2005 from 3.33 to 3.21 (20 to 27 gestation weeks) and from 3.64 to 3.03 (28 gestation weeks or more) (MacDorman & Kirmeyer, 2009). The perinatal mortality indicator also plays an important role in providing the information needed to improve the health status of pregnant woman, new mothers, and newborns (WHO, 2006). It is used as an indicator of the quality of obstetric and maternal care (Drife, 2006) and shows the pediatric care available. Possible problems in the health policy and health practice identify temporal and spatial differences, which also have influence on the success of a birth such as social factors (WHO, 2006). Table 1 shows a comparison of estimated worldwide records of the WHO for the years 2000 and 2004:

	Live births (in thousand)	No. of perinatal deaths (in thousand)/ perinatal mortality rate	No. of stillbirths (in thousand)/ stillbirths rate	No. of early neonatal deaths (in thousand)/ early neonatal mortality rate	No. of neonatal deaths (in thousand)/ neonatal mortality rate
World 00	132882	6337 / 47	3328 / 24	3008 / 23	4002 / 30
World 04	133136	5852 / 43	3027 / 22	2825 / 21	3729 / 28
Africa 00	30305	1929 / 62	1002 / 32	927 / 31	1240 / 41
Africa 04	33049	1896 / 56	946 / 28	950 / 29	1261 / 38
Northern America 00	4479	33 / 7	16 / 3	17 / 4	21 / 5
Northern America 04	4464	29 / 7	14 / 3	15 / 3	19 / 4
Europe 00	7185	91 / 13	61 / 8	30 / 4	38 / 5
Europe 04	7354	60 / 8	34 / 5	26 / 4	34 / 5
Austria 00	75	1 / 6	<1 / 4	<1 / 2	<1 / 3
Austria 04	75	<1 / 4	<1 / 2	<1 / 2	<1 / 3

Table 1: Differences in mortality rates and live births, worldwide, compared with Africa, North America, Europe and Austria, between 2000 and 2004. (WHO, 2006; WHO, 2007)

Europe has a higher mortality statistic (due to the high values in Eastern European countries) than Northern America both in 2000 and in 2004. Northern America includes Canada, the United States of America, as well as the United States Virgin Islands (WHO, 2007). It is quite clear that mortality rates have fallen, but Africa has, in comparison to Europe and Northern America a 3.5 to 9.7 times higher mortality rate (*Table 1*). Another distinction in the documentation of mortality is made in neonatal mortality and postneonatal mortality. The neonatal mortality means the death of a child born alive, but living for less than 28 days after birth. Another important term is the early neonatal mortality. It includes children who die within less than seven days after birth. A late neonatal mortality refers to death, within seven to less than 28 days after birth. Postneonatal mortality is defined as the death of a child born alive between 28 and 364 days of life (Rowley et al., 1993).

What are the reasons for this mortality? In a ranking of the five leading causes of infant death as defined by the ICD-10, the congenital malformation is in first place, the preterm birth / low birth weight (LBW) second and sudden infant death syndrome (SIDS) third. These three reasons are followed by maternal complications and cord complications. It is remarkable that if you split the five leading causes of death across race/ethnicity you can see that SIDS is twice as high in the African American and American Indian / Alaska Native population, as in the White population and almost four times higher compared to the Asian / Pacific Islander and Hispanic population. The causes of death preterm birth / LBW are significant; there is a four times higher value rate in the African American than in the White population (Mathews & MacDorman, 2010).

A mortality study carried out for the United States in 1989 with the ten leading causes of neonatal and postneonatal death, had SIDS ranking in eighth place in neonatal and first in postneonatal ranking. In this age, SIDS deaths account for 36.1% of all postneonatal mortality. The second-place death reason, "congenital anomalies", is with 15.3% less than half as frequent as a causale factor of SIDS (Rowley et al., 1993). Such imbalances can cause actions and changes to reduce disparities in pregnancy and infant care. In 1994 one of these measures was the "Back to Sleep Campaign" to highlight the importance of sleeping position for a newborn baby to reduce SIDS (O'Neil et al., 2008). The SIDS rate declined between 1995 - 2002 for all races and ethnicities from 87.2 % to 57.1% per 100000 live births in the United States (O'Neil et al., 2008).

1.4. Hypothesis

A relationship exists between racial and selected socio-economic variables and the SIDS and the IMR. In addition, the SIDS and the IMR are not randomly distributed across the US and Louisiana, but show distinctive spatial outliers and hot and cold spots.

1.5. Structure

The introduction to this project is described in Chapter 1. It includes the motivation for studying prenatal and postinatal mortality as well as the goals of this project, the background information and the hypothesis. Chapter 2 describes the theoretical background, which is divided into two subchapters. In subchapter 2.1., the terminologies of perinatal and prenatal mortality are explained in the literature review, as well as measures to reduce or prevent mortalities during pregnancy or until the first year of life after birth. Subchapter 2.2. describes the geospatial technologies that are applied to the spatial analysis and the visualization of the collected data. Chapter 3 deals with the problem definition, the study area, the methods, used to spatially analyze and to visualize statistical records. Furthermore, this chapter also describes how the data records were manipulated to make them ready to be analyzed in a GIS. Chapter 4 illustrates the results and their interpretation. This chapter starts with the visualization of the IMR and SIDSR across the U.S. and their spatial analysis, followed by the SIDSR visualization and their analysis of the data for Louisiana. Chapter 5 provides a discussion and a short summary of the entire research and Chapter 6 describes the outlook for this research. References, the list of Figures and Tables, and the Appendix are represented in Chapters 7, 8, 9 and 10.

2. Theoretical Background

The following sections include a literature review concerning perinatal, neonatal, and postneonatal mortality and the influencing risk factors in general and SIDS as postneonatal cause of death, in particular, followed by geospatial technologies.

2.1. Literature Review

The ability to have children is one of the most basic human values. It encompasses not only the desire to have children but also to have them at a time and in a manner, that their future health, both physical and mental, is best assured (Zmora, 2001). Different reasons and risks during pregnancy can lead to miscarriage, stillbirth, premature birth, or live births and later death within the first year of life. The international classification of diseases and related health problems (ICD-10) makes it possible that global data and statistics are documented in a standardized form. An effort of the WHO is to harmonize the definitions worldwide. The aim is to document the health of the world's population, to find out differences in health care, to identify possible nuisances, and to propose measures, if necessary (WHO, 2004).

2.1.1. Miscarriage

Miscarriage is the most common serious complication of pregnancy. In 30% of biochemical pregnancies and in 11-20% of clinical pregnancies, miscarriages are diagnosed. The diagnosis of a miscarriage is usually made with trans-vaginal ultrasound (TVS), (Bottomley & Bourne, 2009). A study conducted in Great Britain in 2001 on the causes of miscarriages has shown that it is an important way to reduce feelings of guilt and responsibility in the loss of a child and to create the acceptance that it was not possible to prevent it. In 50% of the cases the reasons for a miscarriage are unknown. The physical and personal experience of the miscarriage in the private, clinical, and social areas were documented by questionnaires to randomly selected women (60,000). Results found room for improvement, particularly with regard to treatment and care of women who have suffered a miscarriage (Simmons et al., 2006).

The exact incidence of a miscarriage is difficult to assess. Studies document a miscarriage rate between 17-46% and abortions between 6-11% (Bottomley & Bourne, 2009). The majority of miscarriages in the first trimester is due to chromosomal abnormalities. Other factors include the ingestion of drugs, diseases of the mother, and anatomical uterus abnormalities. In the mid-trimester, there are causes such as infections, cervical weakness, structural abnormalities, or uterine thrombophilia, whereas genetic anomalies account for about 15% of miscarriages (Bottomley & Bourne, 2009). Periodontal diseases increase the risk of miscarriage and increase more when the periodontal disease progresses during pregnancy (Iams et al., 2008). The age of the mother is one of the most important demographic variables to be able to predict the risk of miscarriage. The risk increases from the age of 35. About 20% of pregnancies among 35-year-old women result in fetal loss, 55% of 42 - year-old women. The increase has to do with the chromosome abnormalities of the age of the mother. In addition, pain and bleeding are usually an indicator of a miscarriage, because 55% of the women suffered a miscarriage with bleeding (Bottomley & Bourne, 2009). Psychological aspects such as anxiety (45%) and depression (15%) also increase the risk of a miscarriage. These aspects include mental illness, childlessness, lack of social support, bad marriage, previous abortions, and unwanted pregnancy (Bottomley & Bourne, 2009).

2.1.2. Low Birth Weight / Preterm Birth

The risk of mortality increases with LBW (AAP, 2001; Leach et al., 1999) and is a serious public health problem in the United States (Grady & Ramirez, 2008). More than 50% of premature births occur in pregnancies without obvious risk factors (Iams et al., 2008). The risk for pregnant women and an association between racial isolation and LBW of African-American women are explored in a New York study (Grady & Ramirez, 2008). In the United States, the U.S. Bureau of the Census[2] (2010) differs between White, African-American, American Indian, and Alaska Native, Asian, Native Hawaiian and other Pacific Islander and other races. Socio-economic disadvantages and racial segregation contribute to the positive relationship between social isolation and infant mortality for African-American children. In a Chicago study, the risk factors of LBW, preterm birth and small for gestation age (SGA) were confirmed as being almost equally high (Masi et al., 2007). This was also documented also in 176 U.S. cities, with IMRs being the dependent variable, and LBW, unwed birth rates, area-poverty, racial segregation, and geographic region as independent variables. Regardless of the median family income and poverty the racial segregation was an important predictor for African-American, White infant mortality and LBW. Factors of this segregation may be poverty, the nature of poor districts conditions such as inadequate housing, crime, noise and psychosocial stress, which can increase the risk of pregnant women for preterm births. These risk factors affect the general health status by causing stress, depression (Bottomley & Bourne, 2009), and violence and thus weaken the immune system, cause premature rupture of membranes by infection of the genital tract or premature labor (Grady & Ramirez, 2008; Iams et al., 2008). Although genital infections increase the risk of preterm delivery, antibiotic treatment does not reduce this risk reliably (Iams et al., 2008).

Another study found a higher birth weight of infants of Mexican-American women when living in predominantly Mexican immigrant neighborhoods (Masi et al., 2007). A combination of economic disadvantage and violence results in a risk for low birth weight. Among all racial and ethnic groups, the violent crime rate is most significant for a negative relationship between moderate economic handicaps and birth weight in a district. In Chicago, Masi and colleagues (2007) found that acts of

[2] http://2010.census.gov/2010census/data/

violence in connection with economic disadvantages influence birth weight, but more among Whites and Hispanics than among African Americans. Similar to social stressors, which are among the risk factors for LBW and infant mortality, nicotine and alcohol use also have a negative impact during pregnancy (Leach et al., 1999; Grady & Ramirez, 2008; Curtis & Leitner, 2006). In connection with poor housing quality and the location of apartments, physical hazards can increase the likelihood of LBW (Grady & Ramirez, 2008) or be a possible explanation for the high infant mortality among the African American population in highly segregated cities (Masi et al., 2007). In this context, dust, mold, inhalation of lead from paint chips or uptake of lead from contaminated water by old pipes are mentioned as risk factors. Apartments near polluted streets and abandoned areas increase the risk of asthma and infectious diseases. The risk of exposure to chemical pollutants increases due to the contact with rodents or chemical dumps. Moreover, in districts as described before there is a lack of community resources including social services and services related to health care and inadequate prenatal care (Grady & Ramirez, 2008). The report of the Health Resources and Services Administration (HSRA) 2006 shows, that African American women compared to other races and ethnic groups have the lowest preventive measures related to pregnancy and childbirth. This results in a higher rate of miscarriages, a higher risk of LBW, and in the highest infant mortality. In combination with smoking and alcohol consumption during pregnancy, American Indian / Alaska Natives have the highest risk in relation to SIDS (O'Neil et al., 2008).

In another study, it is noted that early access to prenatal care does not affect the rate of premature births. Due to this study the proportion of preterm births among African-American women despite of early prenatal care remains still high. This may be due to the scant attention in the United States preterm birth prevention. In contrast, the European prenatal care points out primary prevention of risks during pregnancy (Iams et al., 2008). Studies show that not only features of the mothers are of special relevance for the present pregnancy. There is an increasing focus on ecological factors such as being a minority and facing violent crimes that affect health and behavior of mothers, which can be identified as risk factors (Masi et al., 2007). Ecological studies show that in territories with a high proportion of minorities, people live in poorer buildings, get less urban services, and are impacted by crime. However, in areas of the same race or ethnicity, minorities offer a health benefit, possibly through greater social cohesion and protection against discrimination (Masi et al., 2007; Curtis & Leitner, 2006).

2.1.3. Stillbirth

The perinatal mortality rate, including stillbirths and neonatal deaths is often used as a measure of the quality of perinatal care (Galan-Roosen et al., 2002) and a measure of the global perinatal health (Tanaka et al., 2010). Infant mortality also is often used as an international indicator of health and well-being in a nation (O'Neil et al., 2008). Different classification systems of stillbirth and death, and no standardized definition of perinatal mortality and their registration within countries and continents, contribute to the fact that a cross-country comparison is only partly possible (Galan-Roosen et al., 2002; Tanaka et al., 2010; Galan-Roosen et al., 2002). For international statistics, the term "perinatal mortality" of the ICD-10 (WHO) is recommended, but many countries use different definitions of this recommendation (Galan-Roosen et al., 2002). For example, in Great Britain the perinatal period is defined with 24, in Japan with 22 gestation weeks. The perinatal mortality is defined in the OECD with at least 28 gestation weeks or a minimal fetal weight of 1000g, expressed per 1000 births (Tanaka et al., 2010).

The separation between miscarriage and stillbirth is also different from country to country (Drife, 2006). In 2004, the global perinatal mortality was 43/1000 live births (a total of 6.3 million cases), more than half of which were stillbirths. The highest stillbirth rate of 41/1000 live births was in Middle Africa in comparison to three to five stillbirths/1000 live births in developed countries (Tanaka et al., 2010). Causes of stillbirths in developed countries are hypertension and preeclampsia, autoimmune disease, infections, malformations or genetic abnormalities, placenta-abruption, other placenta problems, umbilical cord abnormalities, blood loss, smoking, obesity and diabetes (Tanaka et al., 2010). Mental disorders such as depression or anxiety are common in pregnancy and have a different risk assessment with preterm birth, LBW, and birth-related complications. The study of national data from the National Comorbidity Survey (NCS) of the United States determines that a pre-existing mental illness before pregnancy represents an increased risk of miscarriage and stillbirth. Other studies connect untreated depression with single or repeated miscarriages. In addition, schizophrenia and psychosis could be identified as risk factors for a stillbirth (Gold et al., 2007).

A study in the U.K. developed a possible classification scheme to distinguish between stillbirth, miscarriage, and related causes of death, where the created structure can be used in low- and high income countries. The basis is the ICD-10 (WHO) definition of stillbirth and its extension to concepts such as late miscarriage, early and late neonatal death, and postneonatal death. This classification scheme includes three areas. First, an extended Wigglesworth classification according to nine categories (such as birth defects, infection, or SIDS); second, the obstetric classification of Aberdeen with 22 categories, such as congenital anomalies and maternal diseases; third, the fetal and neonatal classification with 24 categories, which include, for example, congenital abnormalities, birth trauma, infections, or immaturity (Drife, 2006).

2.1.4. Sudden Infant Death Syndrome

The focus in the mortality of newborns and infants in the neonatal and postneonatal period is on SIDS. The term SIDS was introduced in 1969 and first published in 1970 (Beckwith, 1970). "The sudden death of any infant or young child, which is unexpected by history, and a thorough post mortem examination which fails to demonstrate the adequate cause of death." (Kerbl et al., 2003; Koiner, 2008). Statistics Austria registered 146 deaths from SIDS in 1988 and 22 deaths from SIDS in 2008. The annual number from 1999 to 2008 is between 16 and 39 (Statistik Austria, 2010). In comparison, from 1984 to 1994 in Austria, around 35% (1070 deaths in absolute numbers) of all deaths of the postneonatal period were SIDS related (Kytir & Paky, 1997). In the United States, SIDS ranked third among the cause of infant deaths in 1996, 2000 and 2006 among white and African American population. Between the first month and the first year (NSIDRC, 2005) and in the western world in the postneonatal period (Hanzer et al., 2010) SIDS is the leading cause of infant death (NSIDRC, 2005). The mortality rate among the African American population is twice as high in comparison to the white population.

Cause of death		White	Black	American Indian	Asian and Pacific Islander	Total Hispanic	Mexican	Puerto Rican	Central and South American	Non-Hispanic White
SIDS 1996	A B C	3 1.990 64.3	3 915 153.8	1 77 203.3	3 73 44.0	3 340 48.5				
SIDS 2000	A B C	3 1.653 51.8	3 760 122.1	2 50 120.0	3 59 29.4	3 280 34.3	3 185 31.8	3 37 63.7	3 30 26.5	3 1.364 57.7
SIDS 2006[1]	A B C		3 641 103.8	2 57 119.4	4 55 22.8	4 282 27.1	4 183 25.5	3 37 55.3	5 25 15.1	3 1.283 55.6

A SIDS 1996 - Rank (Based on the Ninth Revision, International Classification of Diseases, 1975)
SIDS 2000 - Rank (Based on the Tenth Revision, International Classification of Diseases, 1992)
SIDS 2006 - Rank (Based on the Tenth Revision, International Classification of Diseases, 1992)
B Number
C Rates per 100,000 live births in specified group

[1] Period 2006, Black redefines in Non-Hispanic black

Table 2: SIDS in the U.S. with differences between races and periods; Data sources: SIDS Period 1996 (MacDorman & Atkinson, 1998), SIDS Period 2000 (Mathews et al., 2002), SIDS Period 2006 (Mathews & MacDorman, 2010)

Congenital malformations and disorders related to a short gestation week and LBW are the two leading causes of death. For American Indian SIDS in 1996 and 2000 was the primary cause of death and in 2006 the secondary. In 1996, the SIDS rate (SIDSR) of the American Indian was more than three and a half times that of the white population, in 2000 and 2006 it was more than double (MacDorman & Atkinson, 1998; Mathews et al., 2002; Mathews & MacDorman, 2010; Hunt & Hauck, 2006).

Medical research into the causes of SIDS started about 50 years ago, especially the critical diagnosis, whether the death is SIDS related or a fatal child abuse. SIDS is the leading cause of death between the first and the sixth month after birth, and in about 90% of SIDS deaths, the SIDS occurs before children are six months old (AAP, 2001; NSIDRC, 2005; Hunt & Hauck, 2006). SIDS occurs very rarely with a small child and cannot be adequately explained in many cases by careful post-mortem examinations (Hanzer et al., 2010). A previously healthy child is usually found dead in bed (NSIDRC, 2005), usually in the same situation in which one has gone to bed. SIDS rates are two to three times higher for African American and some American Indian populations. Etiologic research has connected SIDS with the sleeping position (prone), sleeping on a soft surface, overheating (Saternus, 2004), smoking during and after pregnancy (Kerbl et al., 2003), "bed sharing" with other children or parents, and babies of brothers and sisters, who already had the SIDS (the recurrent infant death is six times higher in subsequent siblings) (Hunt & Hauck, 2006), late or no prenatal care, maternal age, premature birth, LBW and male gender (AAP, 2001; Leach et al., 1999), congenital anomalies, short gestation week (Leach et al., 1999), infections of the upper airways (NSIDRC, 2005; Saternus, 2004), intrauterine growth retardation and shorter intervals between pregnancies (Hunt & Hauck, 2006). Other findings, albeit rare, were documented, including vascular malformation of the cerebellum and fatty liver alteration (Kerbl et al., 2003), in a study on the classification of SIDS causes. Research results of Canadian autopsies identified pulmonary congestion in 89% of SIDS cases and pulmonary edema in 63% (Hunt & Hauck, 2006; Saternus, 2004), whereas pulmonary edema (hemorrhagic pulmonary edema) are found even after resuscitation (Saternus, 2004). Further studies revealed an increased risk for single mothers (Leach et al., 1999; Hunt & Hauck, 2006) and mothers with multiple births, previous stillbirth, or death of a young child. SIDS deaths are recorded in each population group and social class, however, a major part among socially disadvantaged families (Leach et al., 1999), low maternal education level, and single mothers (Hunt & Hauck, 2006). This is possibly an explanation, why of the 12 SIDS deaths in NYC, in 2008, two deaths are registered in the Bronx, six in Brooklyn, and four in Queens (New York City Department of Health and Mental Hygiene (NYC DOHMH), 2010. Socio-economic factors, such as unemployment of parents, occupation, housing conditions, overcrowding (more than one person / room), smoking and taking of illegal drugs during pregnancy, and alcohol consumption before pregnancy, are also taken into account in studies of SIDS (Leach et al., 1999). Not only smoking of the mother is a major SIDS risk factor (a three times higher risk), but also the smoking behavior of fathers, even if only to a small degree. Parental smoking or smoking of other household members living together with the infant also increases the risk of SIDS. Prenatal drug use especially opiates, increases the risk for SIDS between two to 15 times. No association between SIDS and alcohol consumption during pregnancy can be determined, but a six to eight times higher risk was found for "binge drinking" mothers (Hunt & Hauck, 2006). There is no definitive evidence on the question of causality between SIDS and recurrent cyanosis, apnea, ALTE, or immunizations during infancy (American Academy of Pediatrics (AAP), 2001; Saternus, 2004).

SIDS describes a diagnosis of exclusion (National SIDS/Infant Death Resource Center (NSIDRC), 2005) and requires an autopsy to accurately review, if diseases, alcohol, drugs or toxic exposure or trauma to the skeleton, as well as environmental or accidental causes of death can be ruled out (AAP, 2001). In about 15% of SIDS cases a disease or genetic disorder, as well as unintentional injury or unnatural death may be determined by an autopsy (NSIDRC, 2005). About 1% to 5% of SIDS cases are child killings (AAP, 2001).

Covert video surveillance in the U.K. uncovered deliberate suffocation of children by their parents in 30 of 39 cases. Among the 41 siblings of 39 children in the study, twelve died suddenly and unexpectedly. Although eleven of these dead children were classified with the SIDS, four parents later admitted to have stifled eight of these siblings (AAP, 2001). It is impossible to distinguish during an autopsy between SIDS and accidental or deliberate asphyxiation with a soft object. (AAP, 2001; Koiner, 2008). During an autopsy a deadly child abuse can be diagnosed, (AAP, 2001) which can be classified as the "Battered Child Syndrome", the "Shaken Baby Syndrome", or the "Munchausen Syndrome of proxy" (Koiner, 2008). These causes of death are head injuries, injuries in the abdomen, burns, drowning or exposure, (AAP, 2001) severe bone fractures, internal injuries and bleeding in the skull interior or massive shaking or hitting the child on a hard surface, as well as injuries and suffocation among persons with a "Munchausen Syndrome by proxy", thereby obtaining care and attention (Koiner, 2008; Saternus, 2004).

2.1.5. Measures to reduce or prevent peri-, pre- or postnatal mortalities

A uniform classification model for all kinds of mortalities (perinatal, prenatal and postnatal) and causes of death, especially SIDS causes, to be able to compare the differences and to find out causations worldwide, should be created (Koiner, 2008; Kerbl et al., 2003). The introduction of mandatory enhanced ultrasound (interval 7-14 days) to reduce possible miscarriages or advise women about this possibility (Bottomley & Bourne, 2009) is needed.

Campaigns, such as the "Back to Sleep" campaign, have reduced SIDS in the United States and other countries in terms of risk factors (AAP, 2001; Leach et al., 1999; NSIDRC, 2005) and therefore SIDS decreased by almost 50% between 1994 and 2002 (NSIDRC, 2005). SIDS cannot be prevented, but seven studies in different countries and continents between 1984 – 2000 show that using pacifier can reduce the risk of SIDS. This result has led to a general recommendation by the AAP to start the use of the pacifier later than the first month of life and continuing until the end of the first year of life (Kerbl & Zotter, 2006). Another study showed, that during the active sucking on a pacifier, neither the cardiac and respiration rate nor the oxygen saturation changed significantly and therefore the use of a pacifier is no evidence to reduce SIDS risk (Hanzer et al., 2010).

Possibilities of intentional suffocation should be investigated, if the infant is older than six months at recurrent cyanosis, apnea, or ALTE while the care is by the same person. Furthermore, previously unexpected or unexplained deaths of one or more siblings, simultaneously or nearly simultaneous death of twins, previous death of infants under the care of the same person (not parents), or discovery of blood in the nose or mouth in relation to ALTEs (AAP, 2001) should also be investigated in more detail. In addition, a thorough documentation is required at the scene. A thorough documentation means to document the position of the child and marks on the body, body temperature, type of bed height and position of the clothing, room temperature, type of ventilation or heating, and reactions of caregivers (AAP, 2001). In addition, protocols and guidelines in hospitals or medical facilities by perinatal audits should be created. That review by the perinatal audits, in particular maternal mortality, stillbirths and neonatal deaths, contains cause finding, gathering information, analyzing results and making recommendations. In addition, action should be taken to implement changes and the introduction of evaluation and refinement to achieve a continuous process of improvement in patient care (Drife, 2006).

Studies have shown that chromosome abnormalities of the embryos are a major cause of unexplained repeated miscarriages. Alternatively, the Pre-Implantation Diagnostic (PID) is proposed, which is banned in Germany and Austria (ORF ON Science, 2009). PID is an examination of the embryo prior to transfer into the uterus, aimed at identifying a specific genetic predisposition. After the PID, only those embryos get transferred in the uterus, which do not have a certain genetic predisposition for a severe illness or disability. Embryos with genetic defects are discarded (BKA, 2004).

Other studies document that the preventing use of progestin in the early to middle pregnancy cannot prevent a threatening miscarriage, but can reduce the risk of miscarriage. To minimize the threat of miscarriage or premature birth, for example, progestin is mostly taken in France and nearly a third of all women with threatening miscarriage in Italy take progestin (Thach, 2006).

2.2. Geospatial Technologies

The following sections describe the software products used in this research. It deals only with the GIS software and the software for spatial statistical data analysis, but not with the Microsoft Office 2010 products that are used to manipulate tables and excel spreadsheets.

2.2.1. ArcGIS 10

ArcGIS 10 is a GIS software product of ESRI (ESRI, 2011). The product is only available with a license agreement and is not an open source product. ArcGIS 10 consists of the modules ArcMap and ArcCatalog. The main purpose of ArcMap is to capture, edit, analyze, and display of spatial data. The geocoding tool describes how street addresses are converted into graphic features (i.e., points on maps). For example, address tables are geocoded with the associated street feature class. Newly created shapefiles (i.e., point distribution maps) can be used for analysis and visualization in GIS, or for specific spatial analysis in statistical software package. In general, in a GIS, it is possible to switch between two views, including the data view of a certain selected section or layer and the layout view, where cartographic elements can be embedded, such as, north arrow, legend, and scale. The ArcCatalog module is used for the administration of spatial data, databases, and metadata. In ArcCatalog, geo databases can be imported, exported, or produced, as well as coordinate systems can be modified or re-imported.

2.2.2. GeoDa™

GeoDa™ is a trademark of Luc Anselin and an open source software (include a reference of GeoDa™ and its version here). GeoDa™ is a collection of software tools designed to implement techniques for exploratory spatial data analysis (ESDA) on lattice data[3]. It has a user friendly and graphical interface and includes methods of descriptive spatial data analysis, autocorrelation statistics and indicators of spatial outliers (Anselin, 2003). The spatial data analysis is performed by a combination of ESRI shapefiles and statistical graphics. Analysis modules interact with a GIS database. The ESRI shapefiles can be point or polygon representations.

In this research, the generated polygon shapefiles output from ArcGIS 10 are used as input shapefiles for analysis in GeoDa™. The existing database of each shapefile can be combined with different tables or can be manually extended with statistical data. For example, the Louisiana shapefile showing Parishes will be expanded with additional data, including SIDS deaths and the SIDSR. These data were collected from the Louisiana Department of Health and Hospitals (DHH). The such generated new database is exported as a shapefile and stored and implemented as a new input shapefile for further statistical analysis. In ArcGIS 10, this newly created shapefile is used for analysis and visualization, as in GeoDa™, visualization of spatial data is restricted to choroplethic mapping only. The statistical analysis of the IMR and SIDSR in this research includes the standard deviation, the mean, the box plot and, local spatial autocorrelation, based on the local Moran´s I. Local Indicators of Spatial Association (LISA) statistics are also displayed as cluster maps.

The standard deviation and the mean are calculated, and values are classified according to their deviation from the mean (z-transform). The box plot is a variant of a quartile classification, designed to highlight outliers, which may exist within the lower and upper quartiles. These outliers are defined as being data values that are more than 1.5 (or 3.0) times the inter-quartile range (IQR) away from the upper or lower end of the box indicating the interquartile range (Longley et al., 2005).

Spatial autocorrelation measures spatial dependence. "All things are related but nearby things are more related than distant things”, define spatial dependence and Tobler's first law of geography (Miller, 2004). Positive spatial dependence means, nearby things are more alike than distant things. Negative spatial

[3] Lattice data are discrete spatial units that are not a sample from an underlying continuous surface (geostatistical data) or locations of events (point patterns) (Anselin, 2003)

dependence means, nearby things are less alike than things. The Moran´s I statistic calculates the product of values in neighboring objects (Longley et al., 2005).
To analyze spatial autocorrelation in GeoDa^{TM}, the first step is to create a spatial weight file (.gal), which includes information about spatial contiguity. In this research rook contiguity will be used. The rook contiguity uses only common boundaries to define neighbors (Anselin, 2003).

3. Methodology

The following sections define, first the research problem, followed by the definition of the study area, and the data to be used in this research. After that, the methodology describes how the data, which are available in different formats will be implemented. A summary of these sections will be provided at the end.

3.1. Defining the Problem

This research based on a study by both Charreire & Combier (2009) and Curtis & Leitner (2006). The first study analyzes the poor prenatal care in a French urban district. The second comparative study shows the poor infant health, high infant mortality, and high risks that exist during pregnancy in East Baton Rouge Parish. The question, whether methods for analyzing infant mortality and poor prenatal care can be transferred as to causes and risks of miscarriages, stillbirths, and infant deaths will be explored in this research.

3.2. Method of Solution

Visualizing the original textual records of the IMR and the SIDSR will reveal spatial characteristics within the entire United States and the state of Louisiana. Furthermore, race, education, and income will be added and the relationship with the IMR and SIDSR statistically analyzed in GeoDa™, and visualized in ArcGIS 10. The detail of analysis is the Baton Rouge Zip-Code. Detailed records of every single pregnant women include social and non-social risk factors. These variables provide information about possible effects on stillbirths, miscarriages, and the SIDS as a cause of death. In detail, these variables describe, for example, the mother's age, previous pregnancies and complications, the number of prenatal cares, the housing situation, alcohol, nicotine and drug use, violence in the family as well race, education and income.

3.3. Study Area

This research starts with an overview of the IMR and the SIDSR in the entire U.S. and its states. In Louisiana, the visualization of the IMR and the SIDSR is based on both administrative regions and address-based data by Zip Codes in East Baton Rouge Parish.

The U.S. provides an excellent starting point for this study. The entire area of the U.S. spreads over approximately 9.8 million square kilometer, is divided into 50 states and the District of Columbia, with an estimated population of 313 million (July 2011 estimates). Puerto Rico is a dependent area, usually shown on U. S. Census Bureau shape files. The ethnic groups are white 79.96%, African American 12.85%, Asian 4.43%, American Indian and Alaska native 0.97%, native Hawaiian, and other Pacific Islander 0.18% and two or more races 1.61% (July 2007 estimates). The birth rate is 13.83 births per 1,000 population (2011 estimates). This ranks the U.S. at the 149th position of the world. In contrast, Austria is ranked at the 215th position, with a birth rate of 8.67 births per 1,000 population (2011 estimates). The birth rate is usually the dominant factor in determining the rate of population growth. The IMR in the U.S. is 6.06 deaths per 1,000 live births and compared to the world it is ranked at the 176th position. Austria with 4.32 deaths per 1,000 live births is ranked at the 195th position. The unemployment rate, estimated for 2010, is 9.7%, which is ranked at the 106th position worldwide. Austria, with an unemployment rate of about 4.5% (2010 estimates) is ranked 42nd worldwide. The percentage of the U.S. population living below the poverty line is 12% (2004 estimates) (Central Intelligence Agency, 2011).

Louisiana is located in the South of the U.S. and borders Arkansas in the North, the Mississippi in the East and Texas in the West. Louisiana is divided into 64 parishes, which are equivalent to counties in other U.S. states. There are numerous different population groups, which consist of the original Indian inhabitants and settlers from France, Spain, England, and Germany as well Acadian, African, Irish, and Italian (State of Louisiana, 2011). The 2010 census results in a state population of 4,533,372, which includes 62.6% white, 32.0% African American, 1.5% Asian, 0.7% American Indian and Alaska Native, 1.5% other races, and 1.6% two or more races. Compared to other states, Louisiana is with 32.0% of African American in 2nd place, behind Mississippi with 37.0%, and just before Georgia with 30.5%. Louisiana´s population is 4.2% of Hispanic Origin or Latino Origin (U.S. Census Bureau, 2011). Louisiana is a major U.S. producer of oil and natural gas and a center of petroleum refining and petrochemicals manufacturing. The principal (agricultural) products are seafood, especially crawfish, cotton, sugar cane, poultry, dairy products, and rice (State of Louisiana, 2011). 17.6% of the people of Louisiana live the below poverty level. This is second highest after Mississippi with 20.8%. West Virginia is third with 17.4%, and Arkansans and Kentucky tied for fourth with 17.3% (U.S. Census Bureau, 2011).

East Baton Rouge Parish is located in Louisiana. Its major city is Baton Rouge, which is the capital of Louisiana. Baton Rouge is 74.74 square miles in size with some 230,000 people. It is situated on the Mississippi River. Baton Rouge is a thriving city that is home to both Louisiana State University and Southern University, and numerous business and industrial facilities (Baton Rouge Government Website, 2011). The population consists of 45.7% white and 50% African American. About 24.0% of persons live below the poverty level (U.S. Census Bureau, 2011). The East Baton Rouge Parish population is approximately 412,500, (Baton Rouge Government Website, 2011) of which 51.9% are white and 44.4% are African American. 17.2% of the people live below the poverty level (U.S. Census Bureau, 2011). East Baton Rouge Parish is 472.1 square miles in size (Baton Rouge Government Website, 2011).

3.4. Data

This part of the thesis describes the data that have been used in this research. The data set is divided into three types of data. Mortality related data discuss both the infant mortality and the sudden infant death syndrome for the entire United States, and the sudden infant death syndrome for different regions in Louisiana. The second dataset specifies the race and socio economic factors for both the United States and Louisiana. The third data set contains spatial data. Additional information such as format, content, and completeness of the records are also cited.

3.4.1. Mortality data

The child mortality data are available online for each state in the United States (The National Resource Center for Child Death Review, 2011). The availability of these data is limited to the years 2002, 2003, 2005, and 2006. The records include the number of child deaths and the child mortality rate, the number of infant deaths and the IMR. Selected causes of death include the appropriate number and the mortality rate of the individual causes of death. In this thesis, the number of infant deaths, the IMR, and one particular cause of death, namely the SIDS, as well as the number of deaths and the mortality rate, are used for each state. The completeness of the data was checked by the Center for Disease Control and Prevention National Center for Health Statistics (CDC, 2011) and declared to be complete. The SIDS data for Louisiana are provided in detail by the Louisiana Office of Public Health in tabular format. The records include the years 2004 until 2008 and are annually subdivided in the number of SIDS deaths and the corresponding SIDSR. To protect the privacy, Louisiana is divided into nine administrative regions (*Figure 1, Table 3*). The Louisiana Department of Health and Hospitals (DHH, 2011) is responsible for this subdivision.

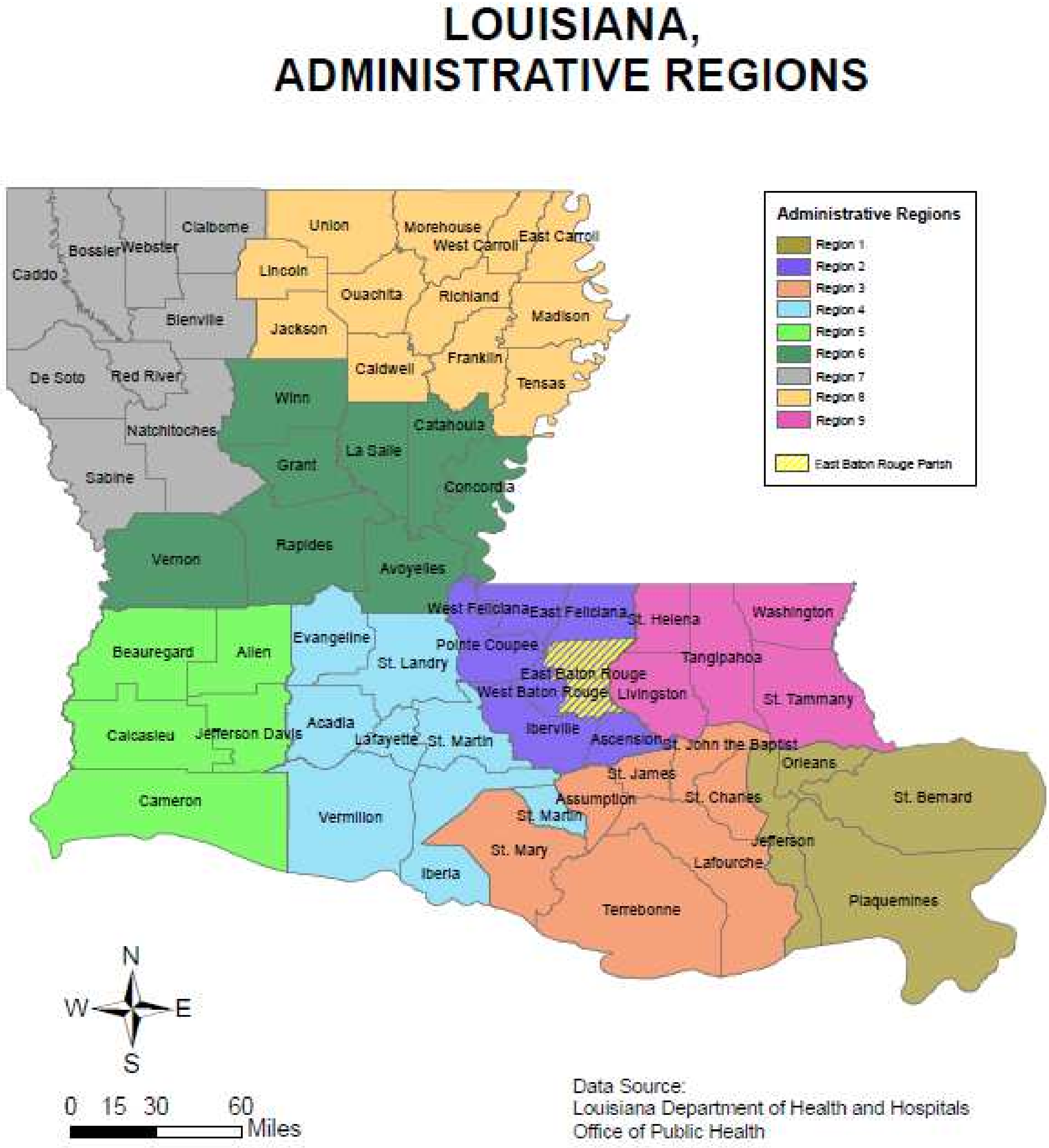

Figure 1: Louisiana and its nine administrative regions

Administrative Regions Louisiana	Parish	Administrative Regions Louisiana	Parish
Region 1	Jefferson	**Region 7**	Bienville
	Orleans		Bossier
	Plaquemines		Caddo
	St. Bernard		Claiborne
Region 2	Ascension		De Soto
	East Baton Rouge		Natchitoches
	Iberville		Red River
	Pointe Coupee		Sabine
	West Baton Rouge		Webster
	West Feliciana	**Region 8**	Caldwell
Region 3	Assumption		East Carroll
	Lafourche		Franklin
	St. Charles		Jackson
	St. James		Lincoln
	St. John the Baptist		Madison
	St. Mary		Morehouse
Region 4	Acadia		Ouachita
	Evangeline		Richland
	Iberia		Tensas
	Lafayette		Union
	St. Landry		West Carroll
	St. Martin	**Region 9**	Livingston
	Vermilion		St. Helena
Region 5	Allen		St. Tammany
	Beauregard		Tangipahoa
	Calcasieu		Washington
	Cameron		
	Jefferson Davis		
Region 6	Avoyelles		
	Catahoula		
	Concordia		
	Grant		
	La Salle		
	Rapides		
	Vernon		
	Winn		

Table 3: Louisiana, its administrative regions and parishes

The data, provided by DHH are not complete, as SIDS deaths in any regions with less than five deaths are not shown because of the protection of privacy.

Another data set was made available by the organization "Family Road of Greater Baton Rouge[4]", located in East Baton Rouge Parish. These address-based data sets are provided in form of access and excel spreadsheets, and include the period 2002 to 2010. The data include records beginning with the mother´s pregnancy until the end of the second year of the child. Other information to be documented is, for example, the address of the mother, their age, the family situation, their education, as well prenatal examinations, the consumption of alcohol, drugs, and nicotine. After birth, post neonatal records show the development of the child, as well as physical and psychological changes of the mother during the post neonatal period. The data set is not complete, because not all zip codes of the East Baton Rouge Parish are included. The East Baton Rouge Parish includes 47 different zip codes (*U.S. Census Bureau, 2010*) and all women who were analyzed in 2010 are located in eleven different zip codes. To protect the privacy of women, these zip codes are not mentioned by their zip code numbers in this research. The study on miscarriage, stillbirth, and post-neonatal death of a child is limited to the year 2010.

3.4.2. Race and socio-economic factors

The U.S. Census Bureau provides online information about people, businesses, and the geography of the entire United States, in the form of text files or excel spreadsheets (U.S. Census Bureau; State, and County Quick Facts, 2011). For this research, two types of data are used, including first, the white and African American population and, second socio-economic factors, including education and household. The education variable includes the percentage of high school graduates and bachelor's degree or higher. The household variable represents the median household income and persons living below the poverty level. These data are used in the IMR and SIDSR analysis, in order to make a comparison among the states, the individual parishes, and the administrative regions of Louisiana. As far as completeness is concerned, the available data sets include all states and counties, and cities and towns with more than 25,000 people. Based on an estimated total population for the year 2009, states and parishes represent the white and the African American population by percentage for the year 2009. Both groups include persons reporting only one race. High school graduates and persons with a bachelor degree or higher, are expressed in percent of person's age 25 years or higher, for the year 2000. The median household income and persons living below the poverty level in percent are provided for the year 2008.

[4] http://www.familyroadgbr.org

3.4.3. Spatial data

The street and boundary data are derived from the U.S. Census Bureau. The Census makes such data available to the public as TIGER / Line® shapefiles as well as TIGER / Line® Files (U.S. Census Bureau, 2011). Both registered trademarks of the U.S. Census Bureau. TIGER® stands for **T**opologically **I**ntegrated **G**eographic **E**ncoding and **R**eferencing system. The shapefiles include the geographical areas, and roads, railroads and rivers, but no demographic data. The online linefiles are digital files and contain geographic features, such as roads, railroads, rivers, as well as legal and statistical geographic areas. The shapefiles can be downloaded as (.zip) file and can be opened in ArcGIS 10 as well as in GeoDa™. Additional formats besides the shape file are, for example, the (.dbf) format, which includes the attribute data, and the (.prj) format that accommodates the projection. For visualizing the IMR and the SIDSR by states for the entire U.S., the TIGER / Line® shapefiles of 2010 were used. The shapefile and the related database files include the geographic boundary information of the U.S. The shape file represents not only the 50 States, but also the District of Columbia, Puerto Rico, and all islands. The metadata-update originates from 2005, the metadata-contact is the U.S. Department of Commerce and Census Bureau, and the metadata-standard is named FGDC Content Standards for Digital Geospatial Metadata in the version FGCD-STD-001-1998. The shape file for the parishes of Louisiana comes from the Louisiana Department of Transportation and Development and was created in 2007. It can be downloaded as a (.zip) file (LAGIC, 2011). The vector data set represents the boundaries for Louisiana and for all 64 parishes. The metadata author is the Louisiana Department of Transportation and Development, which modified the metadata in the year 2007. The metadata standard is FGDC Content Standards for Digital Geospatial Metadata in the version, FGDC-STD-001-1998. Both, the TIGER / Line® shapefile and the shapefile for the Louisiana Parishes use the North American Datum of 1983 and the Geodetic Reference System 80.

3.5. Implementation

The following section describes the manipulation of the data in GeoDa™ in order to prepare them to be used in ArcGIS 10 for spatial analysis or for statistical analysis in GeoDa™. Following is the discussion of the geocoding process, which is performed in ArcGIS 10 for the address related data.

3.5.1. Data manipulation in GeoDa™ and ArcGIS 10

The software GeoDa™ allows shapefiles to be manipulated. In this thesis, the TIGER / Line® shapefile 2010 of the entire U.S. was manipulated to include the IMR and the SIDSR data. Additional columns for the IMR analysis included the white and African American population, the percentage of people below the poverty line, the IMR for the years 2002, 2003, 2005, and 2006 and the annual number of infant deaths. This newly created table is stored as a new shapefile together with the predefined coordinate system (NAD83) of the original shapefiles. This newly created shapefile of the entire U.S. was manipulated one more time in ArcGIS 10. The states Hawaii, Puerto Rico, and Alaska were removed and stored as a separate shapefile for the statistical analysis in GeoDa™. The import of the coordinate system (NAD83) in ArcCatalog was also required. For the spatial analysis of the SIDSR in ArcGIS 10, the TIGER / Line® shapefile 2010 of the entire U.S. was manipulated again in GeoDa™. The additional columns included were the white and African American population, people living below the poverty line as a percentage, as well the annual SIDSR and the annual number of SIDS deaths, separately for each state and the years 2002, 2003, 2005 and 2006. The import of the coordinate system (NAD83) in ArcCatalog was again necessary, by removing the States Hawaii, Puerto Rico, and Alaska and storing them in a separate shapefile with the imported coordinate system.

The spatial analysis of Louisiana is not possible for each parish individually. To protect a person´s privacy, Louisiana subdivided by the Department of Health and Hospitals into nine administrative regions. Each of the regions contains a different number of parishes (*Table 3*). Combining the individual parishes was accomplished in ArcGIS10, using the editing tools. The newly created shapefiles of the nine regions made it possible that further columns could be added into the database. The percentages of white and African American population, and of persons living below the poverty line were determined by calculating the average of the values of all parishes that are located in each region. The SIDSR in each region was taken from the table, provided by Louisiana Office of Public Health. The newly created shapefile with the coordinate system (NAD83) could subsequently be used for spatial SIDS analysis in ArcGIS 10.

The geocoding tool in ArcGIS 10 matches the address data of each mother, which are available in excel spreadsheets, with the geographic coordinates in the TIGER / Line® linefile 2010. Thereafter, the geocoded addresses are represented as point data in ArcGIS 10 and are ready to be analyzed. The geocoding process matched 68% of the addresses and the remaining 32% were manually matched.

3.6. Summary

Chapter 3 starts with the question, whether methods for analyzing infant mortality and poor prenatal care can be transferred as to causes and risks of miscarriages, stillbirths, and infant deaths. The input of statistical records in existing databases is described in detail. Additionally, the differences in the availability of data and the existence of different formats, describe the limitations in the visualization and analysis of miscarriage, stillbirth, the IMR, as well the SIDSR.

4. Results and Interpretation

The following chapter discusses the results of the spatial and temporal distribution and spatial autocorrelation of the IMR and the SIDSR analysis for the entire United States (*Figure 2, Table 4*) for the years 2002, 2003, 2005, and 2006. Similarly, the spatial distribution of the SIDSR in Louisiana in the years 2004, 2005, 2006, 2007, and 2008 will also be discussed. In the following maps, the IMR and the SIDSR are shown in the form of choropleth maps. For each of the two study areas, blue and light blue indicate a low IMR and SIDSR. In contrast, Red and light red depict high IMR and SIDSR values. Medium values are shown in light yellow. The classification was carried out by natural breaks in ArcGIS 10. The spatial autocorrelation statistic is accomplished in GeoDa™. The results of the descriptive statistics are depicted in the form of box plots. The results of the local spatial autocorrelation of the IMR and the SIDSR are displayed with LISA cluster and significance maps. The results of the Moran's I, the standard deviation, and the mean of the IMR and SIDSR are represented in tabular form as well. The results of the address-based data are documented as numbers only, as they cannot be visualized in form of maps, due to concerns regarding the protection of personal privacy.

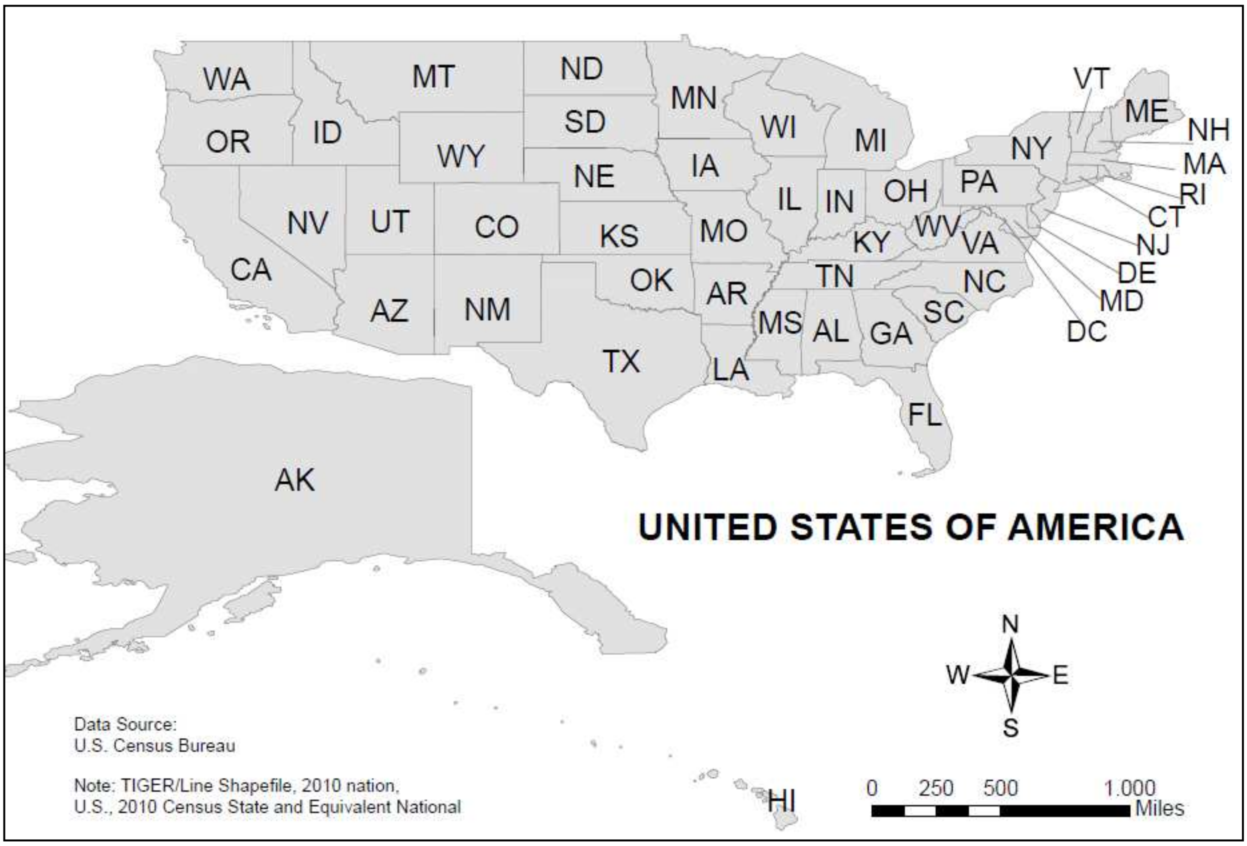

Figure 2: The 50 states of the U.S.

Abbr.	State	Abbr.	State	Abbr.	State	Abbr.	State	Abbr.	State
AL	**Alabama**	HI	**Hawaii**	MI	**Michigan**	NC	**North Carolina**	UT	**Utah**
AK	**Alaska**	ID	**Idaho**	MN	**Minnesota**	ND	**North Dakota**	VT	**Vermont**
AZ	**Arizona**	IL	**Illinois**	MS	**Mississippi**	OH	**Ohio**	VA	**Virginia**
AR	**Arkansas**	IN	**Indiana**	MO	**Missouri**	OK	**Oklahoma**	WA	**Washington**
CA	**California**	IA	**Iowa**	MT	**Montana**	OR	**Oregon**	WV	**West Virginia**
CO	**Colorado**	KS	**Kansas**	NE	**Nebraska**	PA	**Pennsylvania**	WI	**Wisconsin**
CT	**Connecticut**	KY	**Kentucky**	NV	**Nevada**	RI	**Rhode Island**	WY	**Wyoming**
DE	**Delaware**	LA	**Louisiana**	NH	**New Hampshire**	SC	**South Carolina**		
DC	**District of Columbia**	ME	**Maine**	NJ	**New Jersey**	SD	**South Dakota**		
FL	**Florida**	MD	**Maryland**	NM	**New Mexico**	TN	**Tennessee**		
GA	**Georgia**	MA	**Massachusetts**	NY	**New York**	TX	**Texas**		

Table 4: List of abbreviations and full names for the 50 states of the U.S.

4.1. Infant Mortality Rate, United States

The infant mortality relates to the death of newborns ages 0 - 1. Looking at the spatial representation of the IMR in 2002, 2003, 2005, and 2006 across (*Figures 3 - 6*), it can be seen that a low IMR always occurs in the east and the west of the U.S. (blue and light blue areas). A high IMR, shown in red and light red, is found in the south and in the southeast of the U.S., but also in 2003 and 2004 in the northern U.S. With the exception of the year 2003, Louisiana and Mississippi are those two states with the highest percentage of the IMR.

In 2002, the IMR, calculated as per 1,000 live births, ranges between 4.4 and 11.3 (*Figure 3*). The five states with the lowest values are Vermont and Maine, each 4.4, followed by Massachusetts with 4.9, New Hampshire with 5.0, and Iowa with 5.3. In contrast, the five states with the highest IMR are South Carolina with 9.3, Tennessee with 9.4, as well as Louisiana and Mississippi with 10.3. The District of Columbia with 11.3 as the highest rate. Compared to the lowest IMR in Vermont and Maine, Louisiana and Mississippi have an IMR that is more than twice as high. In absolute values, Vermont had 28 infant death, Maine 59, Maryland, and Massachusetts 395, and New Hampshire 72. Off the five leading IMR states, these are in South Carolina had 507 infant deaths, Tennessee 727, Louisiana 665, Mississippi 428, and the District of Columbia 85.

The IMR shows a similar picture for the year 2003 (*Figure 4*). The IMR ranges between 4.0 and 10.7, and compared with 2002 the range is lower. Those five states with the lowest IMR are New Hampshire with 4.0, Minnesota with 4.6, followed by Massachusetts with 4.8, and Maine and Utah with 4.9 and 5.0, respectively. The IMR among the leading states are Louisiana and Tennessee with 9.3, Delaware with 9.4, and the District of Columbia with 10.5. Mississippi has the highest IMR with 10.7. In absolute numbers of deaths, New Hampshire had 57 deaths, Minnesota 324, Massachusetts 388, Maine 68, and Utah 249. Those states with the highest IMR, Mississippi had 455, Delaware 107, Tennessee 730, and Louisiana 606. The District of Columbia had 80 infant deaths in 2003.

In 2005 (*Figure 5*) the IMR ranges between 4.5 and 14.6. This is the highest range among the four selected years (2002-2003, 2005-2006). The five states with the lowest IMR are similar to the years 2002 and 2003 with Utah having an IMR with 4.5, Washington, Massachusetts, and Minnesota with 5.1, and New Hampshire with 5.2. In terms of absolute numbers those five states had 230 infant deaths (Utah), 421 (Washington), 386 (Massachusetts), 362 (Minnesota), and 76 (New Hampshire). The highest IMR values are found in the District of Columbia with 14.6 (112 infant deaths), followed by Mississippi with 11.3 (481 infant deaths), Alabama and South Carolina with 9.6 (568 and 543 infant deaths), respectively Louisiana with 9.5 (613 infant deaths).

In 2006, the IMR ranges (*Figure 6*) between 4.7 and 12.1, and was lower than the previous year but higher than in the years 2003 and 2004. A ranking of the five states with the lowest IMR value shows that there are few differences from the previous years. Washington has the lowest IMR with 4.7 (407 infant deaths), followed by Massachusetts with 4.9 (370 infant deaths) and Utah, California and Iowa, with 5.2 (273, 2835, and 208 infant deaths). The District of Columbia leads all states with respect to the IMR ranking with 12.1 (96 infant deaths), followed by Louisiana with 11.8 (629 infant deaths), Mississippi with 10.9 (488 infant deaths), Alabama with 9.3 (571 infant deaths), and Tennessee with 8.9 (733 infant deaths).

Comparing the IMRs of Louisiana with the lowest IMR in each year, then it can be seen that Louisiana´s IMR is, on average, more than two times higher. In the year 2006, the IMR in Louisiana was even 2.5 times higher than the IMR in Washington.

Comparing the estimated population structure in 2009 (U.S. Census Bureau: State and County QuickFacts, 2011) of those states with a low IMR and those with a high IMR, clear differences in the percentage between the white and the African American population can be seen. For the states with the lowest IMR (Vermont, Maine, Massachusetts, New Hampshire, Iowa, Minnesota, Utah, Washington and California) the proportion of the African American population is between 1.0% and 7.1%. Vermont has the lowest and Massachusetts the highest proportion. For the states with the highest IMR (South Carolina, Tennessee, Louisiana, Mississippi, Alabama and Delaware and the District of Columbia), the proportion of the African

American population is between 16.8% and 54.0%. Tennessee has the lowest and the District of Columbia the highest percentage of the African American population. Striking differences between high and low IMR states are also found for people who live below the poverty line (U.S. Census Bureau: State and County QuickFacts). In those states with a low IMR, the percentage of people living below the poverty level lies between 7.8% and 13.3%. New Hampshire has the lowest percentage value and California the highest value. Among those states with a higher IMR, this percentage ranges between 10.3% and 20.8%. Mississippi has the highest and Delaware the lowest percentage value. The comparison between the IMR and the two socio-economic variables (i.e., ethnicity status and people living below the poverty line), does not necessarily indicate that the IMR is always higher (or lower) in those states, but the strength of this relationship is consistent with previous research findings, where these two socio-economic variables are referred to as IMR risk factors (WHO, 2010; Tanaka et al., 2010; Mathews & MacDorman, 2010, O'Neil et al., 2008).

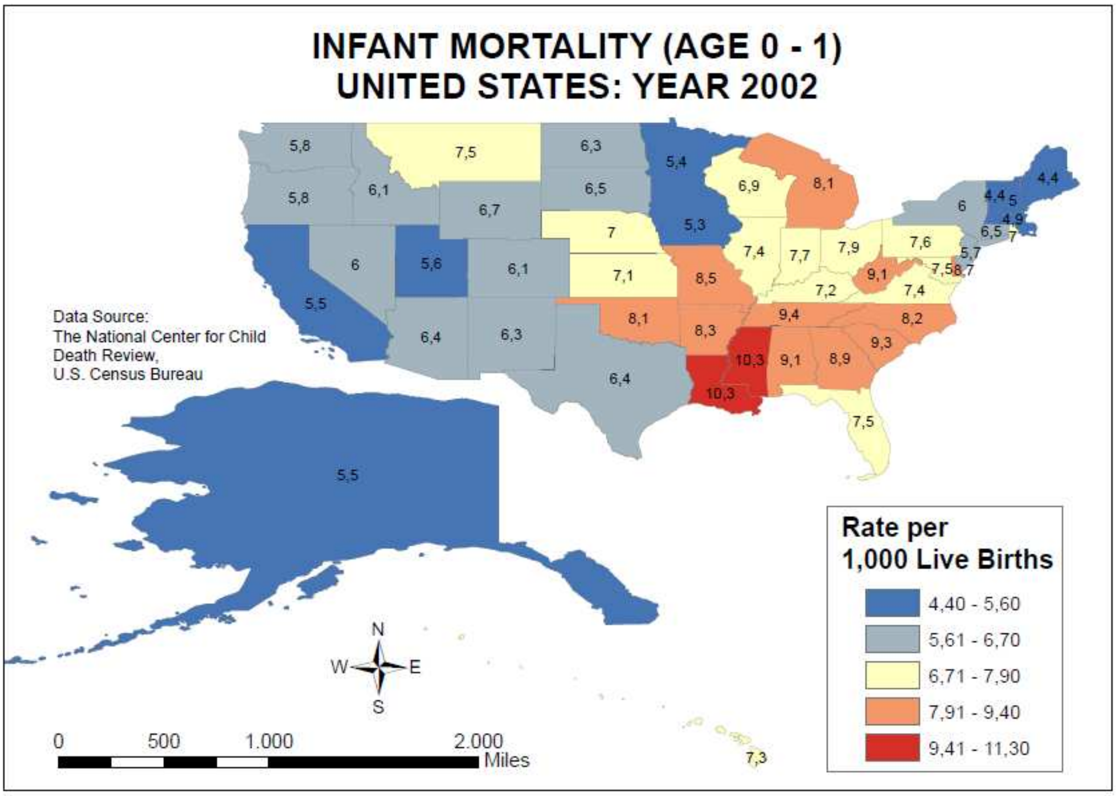

Figure 3: Infant Mortality Rate for the U.S. in 2002

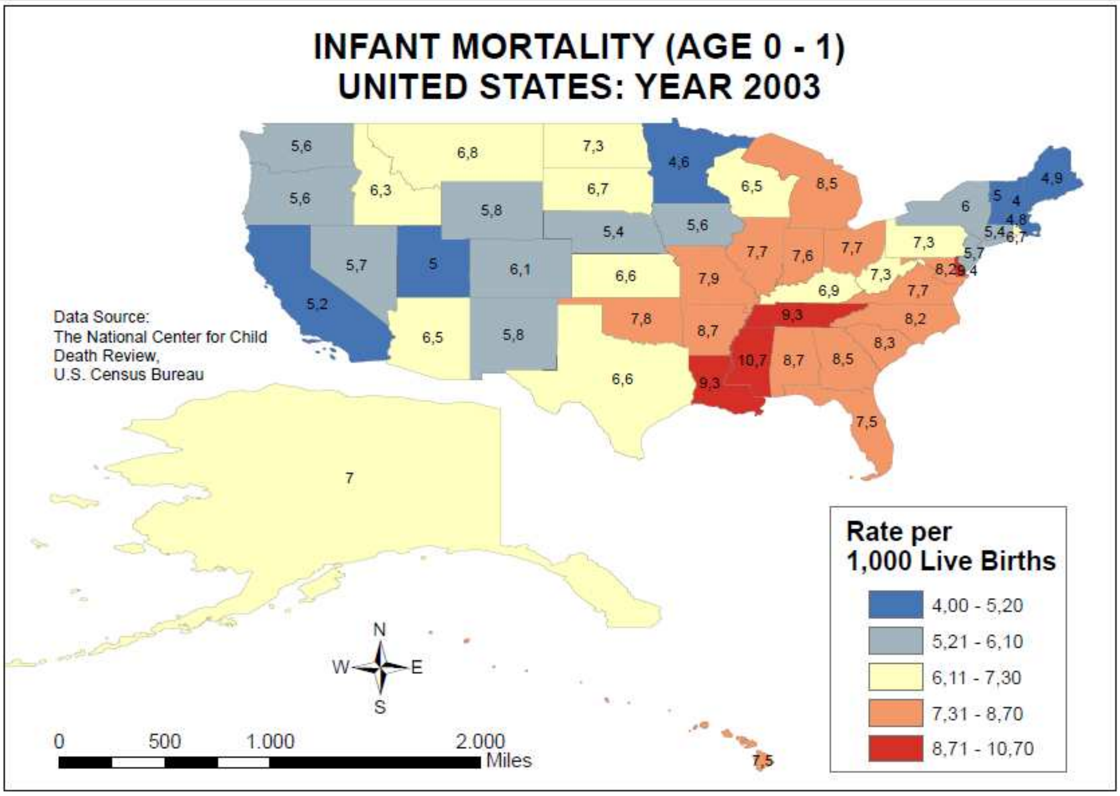

Figure 4: Infant Mortality Rate for the U.S. in 2003

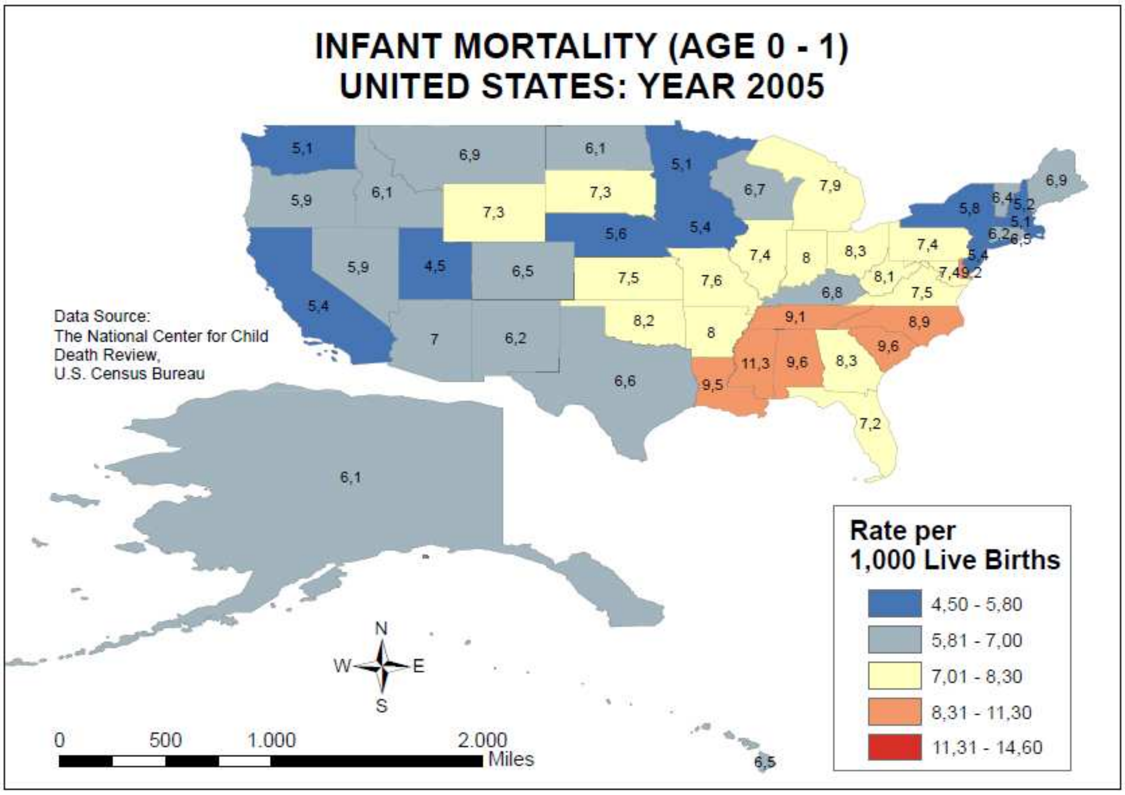

Figure 5: Infant Mortality Rate for the U.S. in 2005

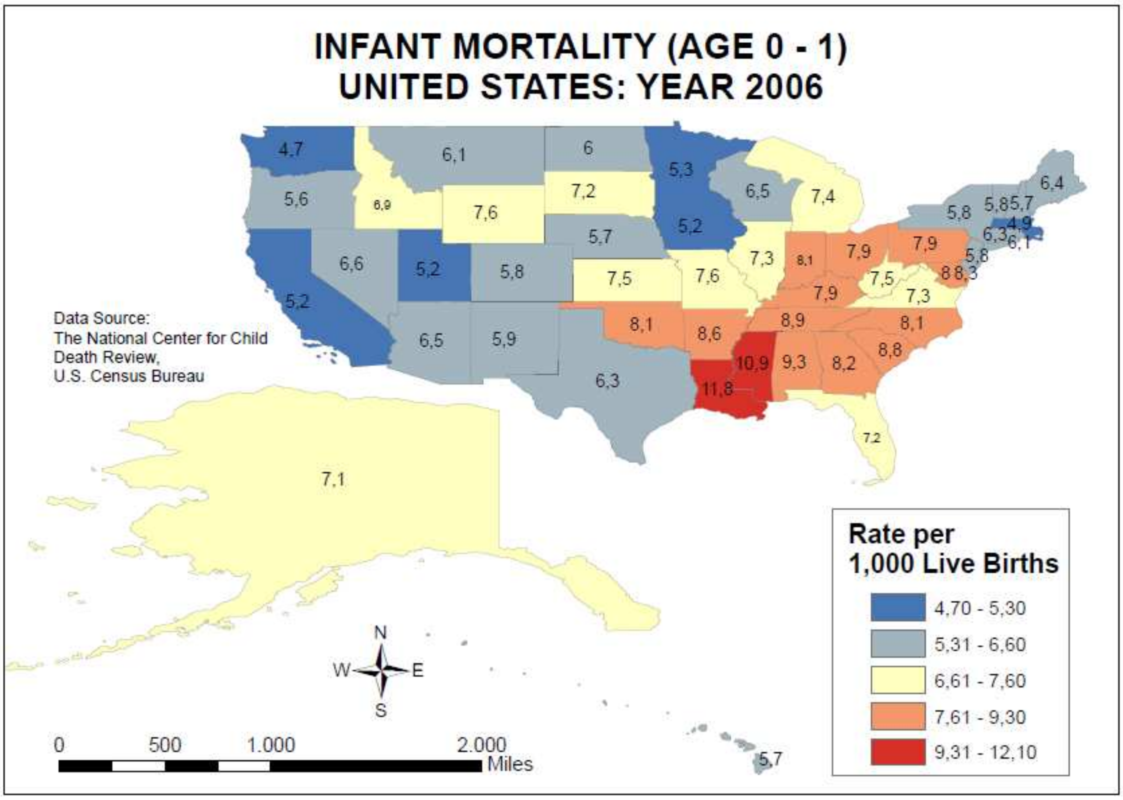

Figure 6: Infant Mortality Rate for the U.S. in 2006

The Moran´s I measures the global spatial autocorrelation in a spatial data distribution (Anselin, 2003). Moran's I values in the table show the linear relationship between the IMR value on the x-axis and the spatially lagged transformation of the IMR of the neighboring states on the y-axis. The slope of the regression line is equal to the Moran's I. A Moran's I equaling 1.0 means that all points lie exactly on a straight line with no scatter and that with the knowledge of x y can be exactly predicted (Anselin, 2003; Longley et al., 2005). For each year, a positive spatial autocorrelation can be detected. The lowest linear relationship between x and y is in the year 2006 (0.3371), the highest linear relationship between x and y is in the year 2003 (0.6127) (*Table 5*). The values of the mean and of the standard deviation are displayed in the same table, as well. The highest values for the standard deviation and the mean, namely 1.79 and 7.24, respectively are shown for 2005 (*Figure 9*, *Table 5*) and the lowest, namely 1.56 and 6.94, respectively for the year 2003 (*Figure 8*, *Table 5*). 68% of all IMR values fall in the interval between ± 1 standard deviation of the mean (Longley et al., 2005). Approximately, 95.4% of all IMR values fall within ± 2 standard deviations of the mean, and around 99.7% within ± 3 standard deviations of the mean (*Figure 7-10*). Values that fall between two to three standard deviations above and below the mean and beyond three standard deviations above and below can be classified as an outlier (Anselin, 2003).

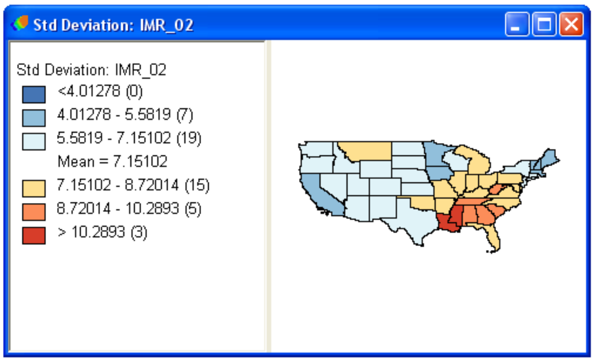

Figure 7: IMR standard deviation and mean of the 48 contiguous states in 2002

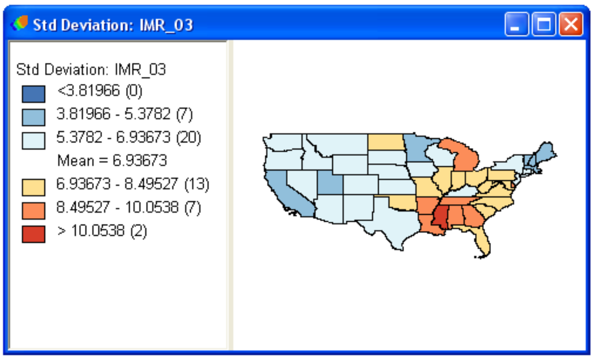

Figure 8: IMR standard deviation and mean of the 48 contiguous states in 2003

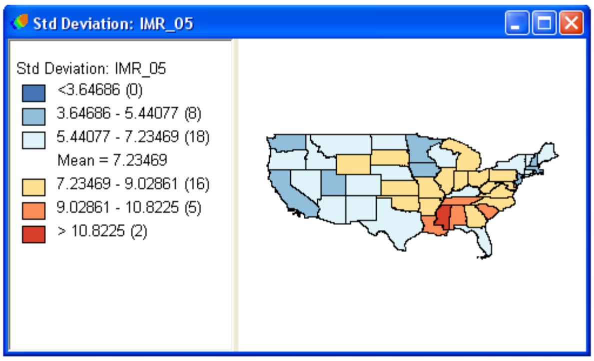

Figure 9: IMR standard deviation and mean of the 48 contiguous states in 2005

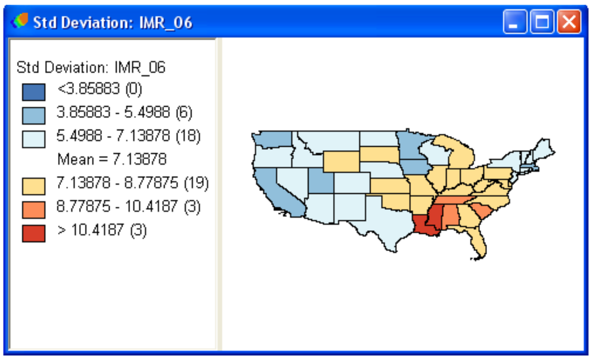

Figure 10: IMR standard deviation and mean of the 48 contiguous states in 2006

	Moran's I **(Contiguity Weight, Rook)**	**Standard Deviation**	**Mean**
United States IMR 2002	0.5507	1.57	7.15
United States IMR 2003	0.6127	1.56	6.94
United States IMR 2005	0.3529	1.79	7.24
United States IMR 2006	0.3371	1.64	7.14

Table 5: Moran´s I, standard deviation, und mean of the IMR 2002, 2003, 2005, and 2006, for the 48 contiguous states of the U.S.

The boxplot will identify non-spatial outliers and can be calculated in GeoDa^{TM}. It is a non-parametric model, without assuming normality (Anselin, 2003) and provides an overview of the spread of a distribution. The boxplot indicates the median (50% of the cumulative distribution) of the distribution, shown as a blue line in the purple box. The purple box itself includes the lower (second) quartile (25%) and the upper (third) quartile, 75% of the cumulative distribution. The difference between the 75% and 25% observation is the interquartile range (IQR), which is multiplied with the hinge of either 1.5 or 3.0. Values that are higher or lower than 1.5 x IQR or 3.0 x IQR from the upper or lower edge of the purple box are known as outliers (Anselin, 2003). Values falling between (1.5 x IQR) and (3.0 x IQR) from the upper or lower edge of the purple box are referred to as "mild outliers", and those values that exceeded the (3.0 x IQR) from the upper or lower edge are referred to as “extreme outliers”. Mild or extreme outliers for the IMR in 2002 are Vermont, New Hampshire, Maine, and Mississippi (*Figure 11, Figure 12*), and for the IMR in 2003, New Hampshire and Mississippi (*Figure 13, Figure 14*). For the IMR for 2005, there is only one extreme outlier, namely Mississippi (*Figure 16*), and for the IMR in 2006, Louisiana and Mississippi are the outliers (*Figure 17, Figure 18*).

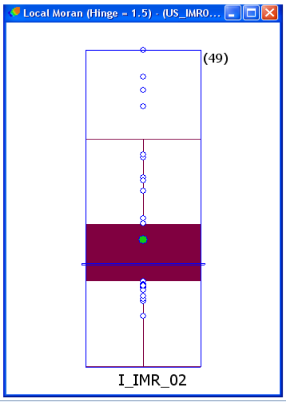

Figure 11: IMR boxplot for 2002 (hinge = 1.5)

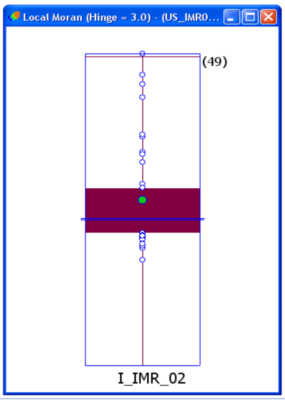

Figure 12: IMR boxplot for 2002 (hinge = 3.0)

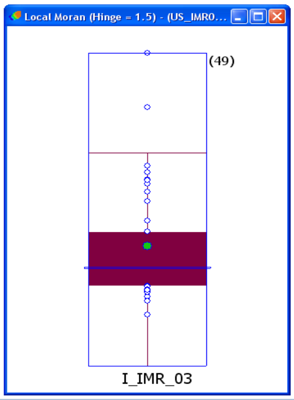

Figure 13: IMR boxplot for 2003 (hinge = 1.5)

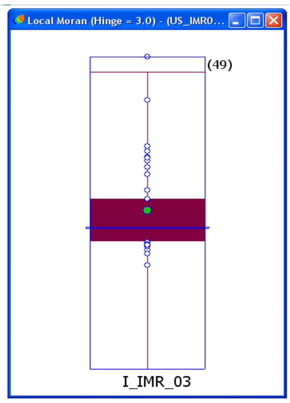

Figure 14: IMR boxplot for 2003 (hinge = 3.0)

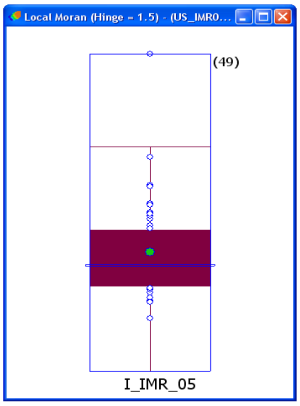

Figure 15: IMR boxplot for 2005 (hinge = 1.5)

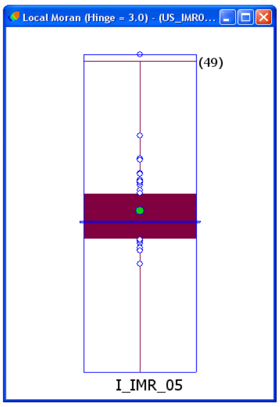

Figure 16: IMR boxplot for 2005 (hinge = 3.0)

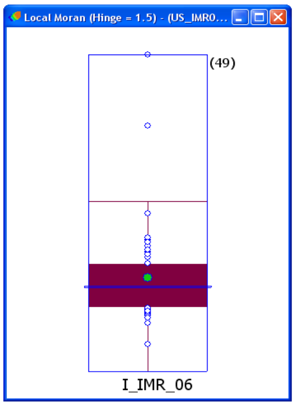

Figure 17: IMR boxplot for 2006 (hinge = 1.5)

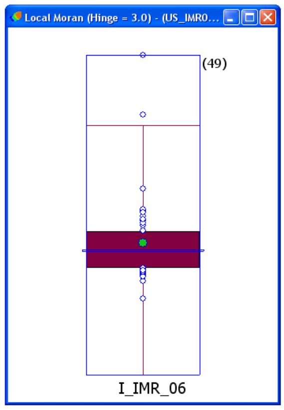

Figure 18: IMR boxplot for 2006 (hinge = 3.0)

The spatial autocorrelation for the IMR was performed with the software GeoDa™ (Geoda Center, 2011). Only spatially contiguous states can be analyzed, and LISA maps are incompatible with islands (Anselin, 2003). Therefore the states Hawaii, Alaska and Puerto Rico were excluded from this analyses. In the following, the univariate local Moran´s I spatial autocorrelations (LISA) are calculated. Both, cluster maps, showing hot and cold spots as well as significance maps are shown. In addition, box plots and the global Moran's I are calculated. In addition the standard deviation and the mean of the IMR from the selected years are shown.

The LISA hot and cold spots include the relationship of the IMR between neighboring states. The calculation is based on the IMR and not on the absolute numbers on infant deaths. Absolute clusters can be buffaloing, therefore relative and standardized clusters should be calculated (Curtis & Leitner, 2006). LISA proceeds by comparing, each state´s IMR with the IMR values of the adjacent states to determine similarities or differences. In this research, adjacency is defined with rook neighbors, that means that adjacent neighbors shared a common borders (Anselin, 2003). The resulting contiguity matrix can be saved as a file with the extension ".gal". The hot spots, cold spots, and spatial outliers calculated in this research are based on a significance level of $p<0.05$. The LISA cluster maps in Figure 19, 20, 21, and 22 show hot spots in the south of the U.S. Hot spots displayed in red mean that states with a high IMR value are surrounded by states with the similarly high IMR. Cold spots show those states with a low IMR, which in turn are surrounded by states with a similarly low IMR (*Figure 19*).

In 2003 (*Figure 20*), a spatial outlier no. 1 describes an area in light blue. This means that areas with a high IMR are surrounded by areas with a low IMR. In this case, the spatial outlier no. 1 is the state of Kentucky. The spatial outlier no. 2 (*Figure 21*) in light red shows that areas with a low IMR (Wyoming and South Dakota) are surrounded by areas with a high IMR. In the year 2006 (*Figure 22*) both spatial outliers no. 1 and 2 are found. The spatial outlier no. 1 is Texas, and spatial outlier no. 2 South Dakota. Spatial outliers can be values that are more extreme than those of the distribution, as well as point to the possible existence of a structural break in the data (Anselin, 2003).

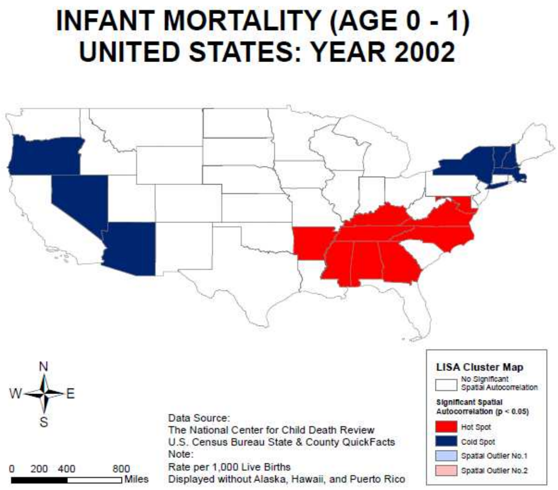

Figure 19: IMR Cluster Map of the 48 contiguous states in 2002

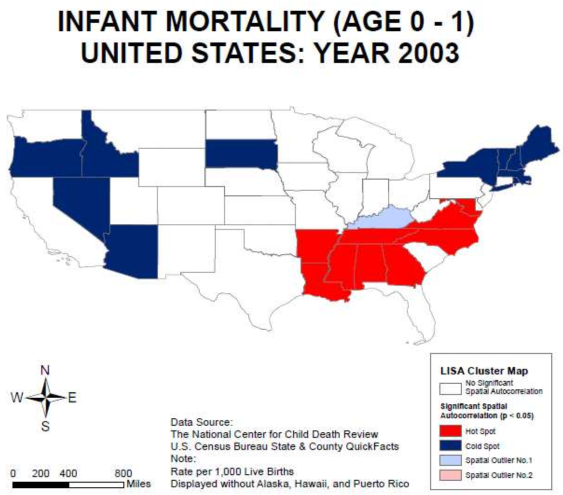

Figure 20: IMR Cluster Map of the 48 contiguous states in 2003

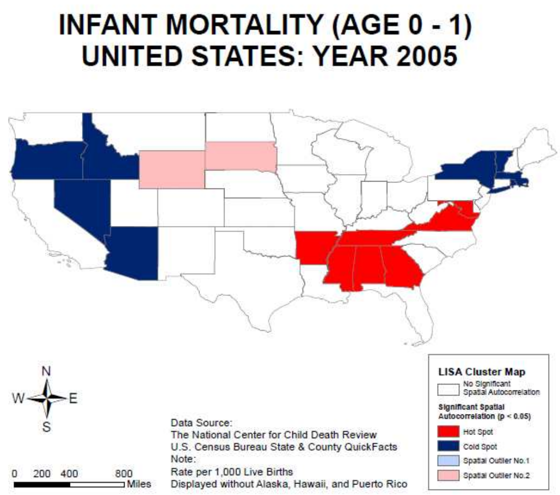

Figure 21: IMR Cluster Map of the 48 contiguous states in 2005

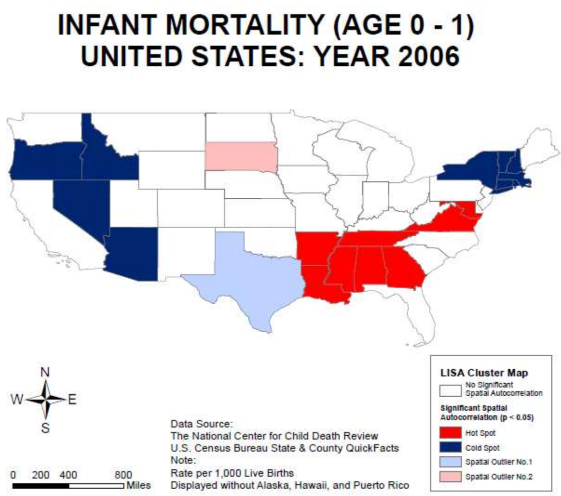

Figure 22: IMR Cluster Map of the 48 contiguous states in 2006

4.2. Sudden infant deaths syndrome rate, United States

In the United States, the SIDS was ranked on third place among infant deaths in 1996, 2000, and 2006 in the white and the African American population. For infants between the first month and the first year (NSIDRC, 2005) and in the western world in the neonatal period (Hanzer et al., 2010), SIDS is the leading cause of all deaths (NSIDRC, 2005). The research presented in this thesis should show whether there is a relationship in the results between the IMR and the SIDSR. The SIDSR is displayed for the same periods, as the IMR (*Figure 23, Figure 24, Figure 25, and Figure 26*). A quick overview shows that Mississippi has a high SIDSR whereas the eastern and western part of the U.S. has a low SIDSR.

In 2002 (*Figure 23*) the SIDSR is between 0.5 and 6.6, and has the lowest value, compared to the subsequent years. High SIDSR values run almost as a straight line from north to south through central U.S. Similar to the IMR in 2002, the eastern and western parts of the U.S. display low values. Among the five states with the lowest SIDS rates and the corresponding number of SIDS deaths are Delaware with the lowest rate of 0.5 (one death), followed by New York with 0.8 (43 deaths), and on the ranking three and four, Rhode Iceland with 1.1 (three deaths) and Massachusetts with 1.1 (18 deaths), followed by Maine with 1.2 (four deaths). The District of Columbia with a SIDSR of 6.6 (eight deaths) represents the highest value, followed by the states South Dakota with 6.3 (14 deaths), Mississippi with 6.2 (53 deaths) followed by Montana and North Dakota with 6.0 (15 deaths) and 5.9 (10 deaths). Louisiana is ranked 12th with a SIDSR of 4.7 (63 deaths).

In 2003 (*Figure 24*), the SIDSR range is clearly higher with the state of Mississippi having the highest value with 11.3. The remaining states are in the range between 0.5 to 6.9 and thus similar to the previous year. Among the states with the lowest SIDSR, is Vermont with 0.6 (one death), New York with 0.7 (34 deaths), followed by New Hampshire with 0.9 (three deaths) and Wyoming with 1.5 (four deaths) and Rhode Iceland with 1.5 (four deaths). Besides Mississippi with the highest SIDSR of 11.3 (95 deaths) are West Virginia and South Dakota with 6.9 (30 deaths) and 6.4 (14 deaths), followed by Alaska with 5.7 (12 deaths) and Delaware with 5.5 (12 deaths). Louisiana is in sixth place with 5.3 (70 deaths). It is clearly seen that the majority of the states with a low SIDSR are mainly in the east and northeast of the United States and after 2002 in the west and southwest of the U.S. also.

A similar picture as in 2003 can also be found in 2005 (*Figure 25*). The range of the SIDSR is between 0.4 and 10.7 and again Mississippi has the highest rate with 10.7. The remaining states range from 0.4 to 6.0. New York has the lowest rate with 0.4 (19 deaths), followed by Delaware and Hawaii with 0.9 (two deaths) and 0.9 (three deaths) as well Alaska with 1.0 (two deaths) and Vermont with 1.3 (two deaths). As mentioned before Mississippi has the highest value with 10.7 (91 deaths), followed by Nebraska and Louisiana with both 6.0 (30 and 78 deaths, respectively). Kansas ranks fourth with 5.7 (44 deaths) followed by Arkansas with 5.5 (42 deaths). Again, it can be seen that the SIDSR in the eastern and western U.S. is much lower.

In 2006 (*Figure 26*) the SIDSR ranges between 0.0 and 9.2. For the first time Vermont has a SIDSR of 0.0. Rhode Island follow with 0.7 (two deaths) and Hawaii with 0.9 (three deaths). Next are New York and California both with 1.3 (66 and 137 deaths, respectively). West Virginia has the highest SIDSR with 9.2 (40 deaths), followed by Mississippi and Kansas with 8.0 (68 deaths) and 6.8 (53 deaths), the District of Columbia with 6.7 (9 deaths), and finally Kentucky with 6.2 (69 deaths). Louisiana is located with a rate of 4.8 at 57 deaths at 14^{th} place.

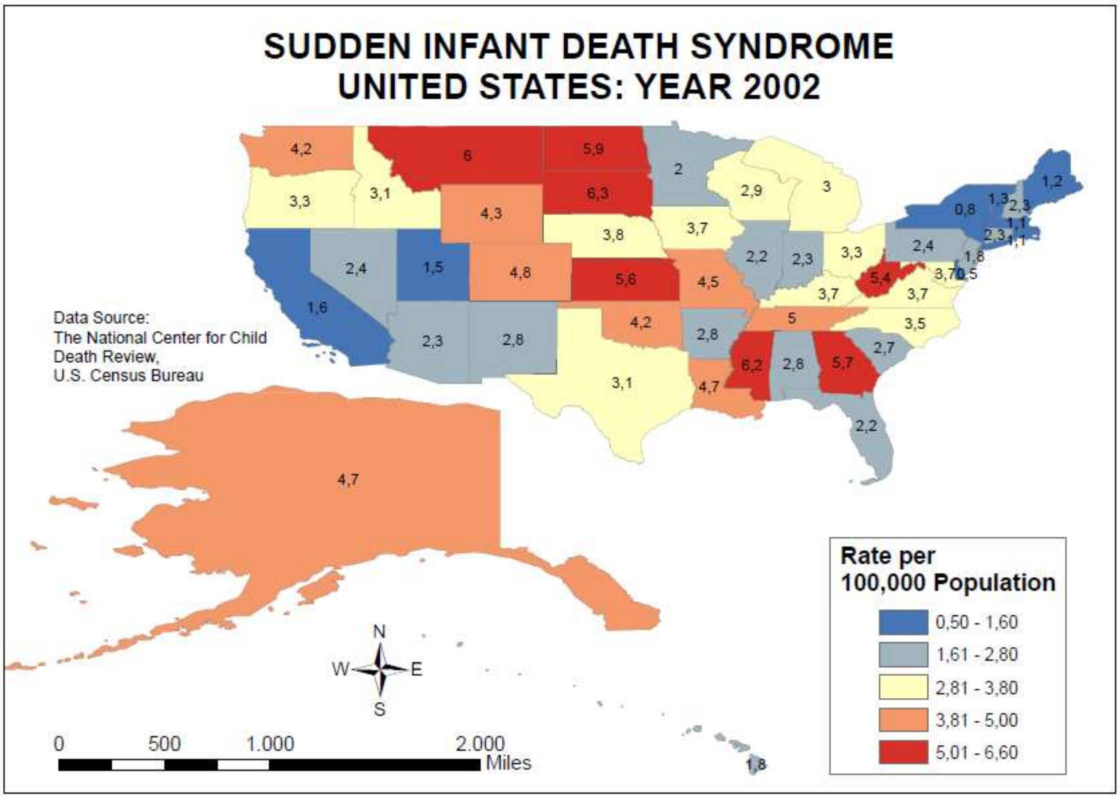

Figure 23: Sudden Infant Death Syndrome Rate for the U.S. in 2002

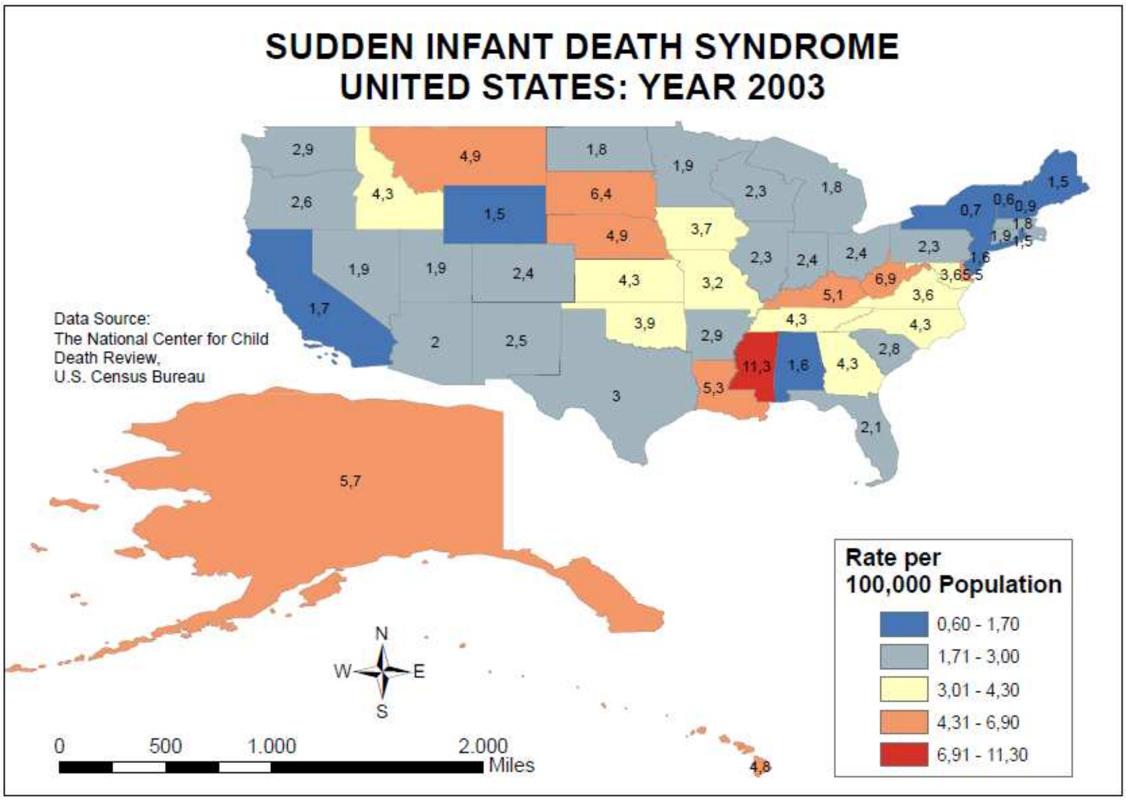

Figure 24: Sudden Infant Death Syndrome Rate for the U.S. in 2003

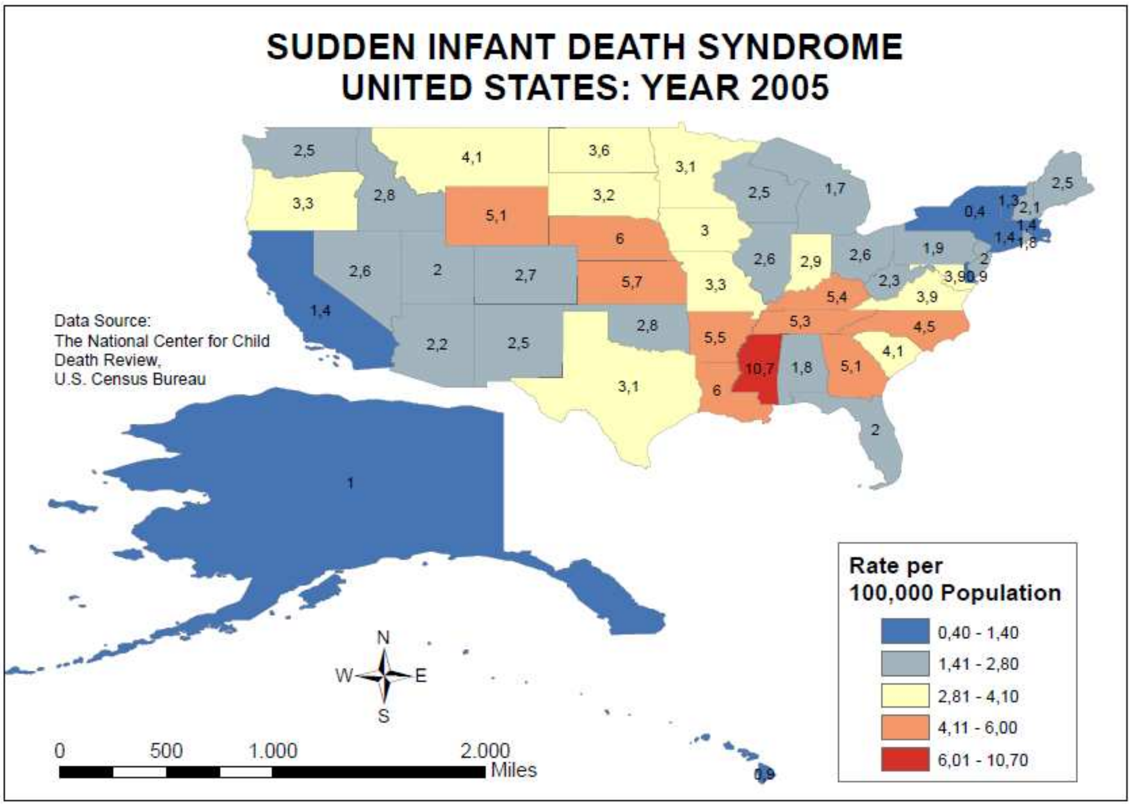

Figure 25: Sudden Infant Death Syndrome Rate for the U.S. in 2005

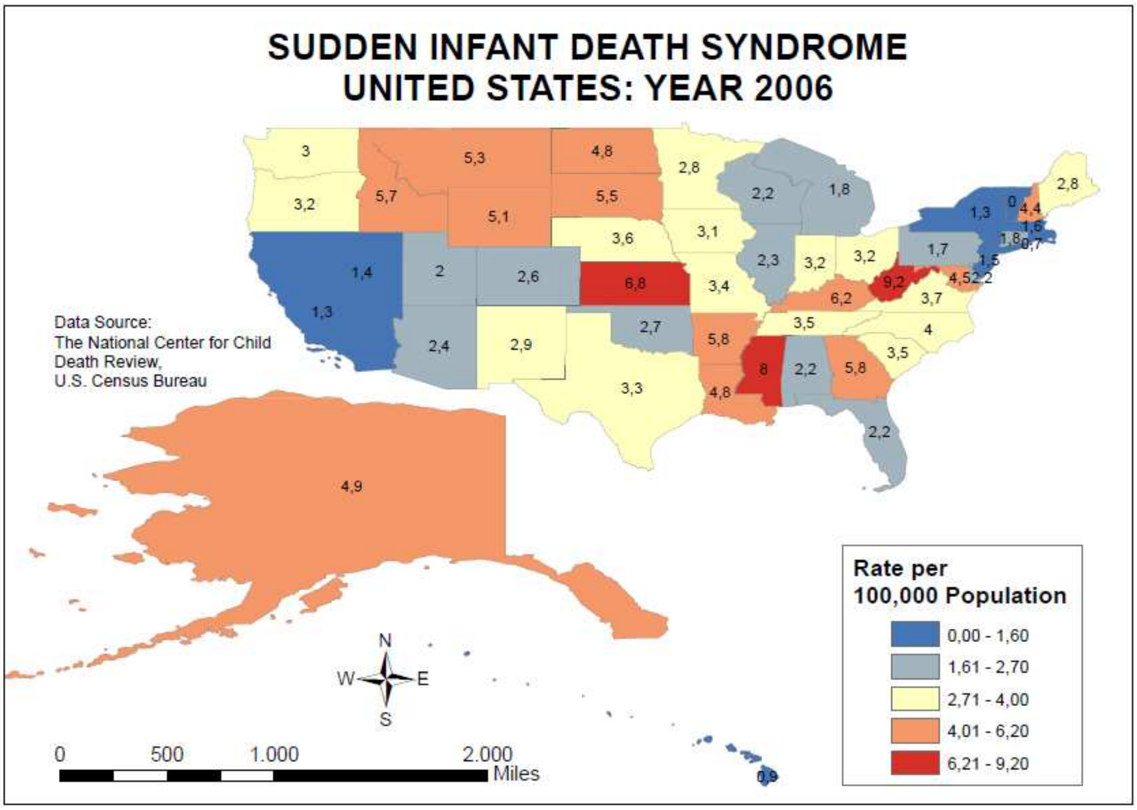

Figure 26: Sudden Infant Death Syndrome Rate for the U.S. in 2006

The Moran's I, the standard deviation, and the mean have already been described in Chapter 4.1. The Moran's I values of spatial autocorrelation show the lowest linear relationship in the year 2003, namely 0.2171 and the highest linear relationship with 0.4150 in 2005. The highest value of the standard deviation and mean (1.93 and 3.50, respectively) is shown for 2006 (*Figure 30, Table 6*) and the lowest (1.59 and 3.32, respectively) for the year 2002 (Figure 27, *Table 6*). The values for the standard deviation and the mean, namely 1.89 and 3.11, respectively are shown for 2003 (*Figure 28*, *Table 6*) and the values, namely 1.77 and 3.21, respectively for the year 2005 (*Figure 29*, *Table 6*).

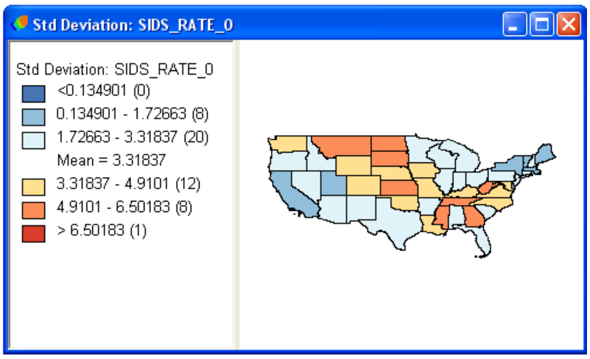

Figure 27: SIDSR standard deviation and mean of the 48 contiguous states in 2002

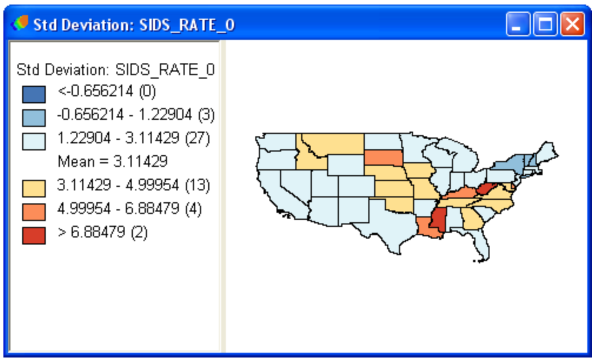

Figure 28: SIDSR standard deviation and mean of the 48 contiguous states in 2003

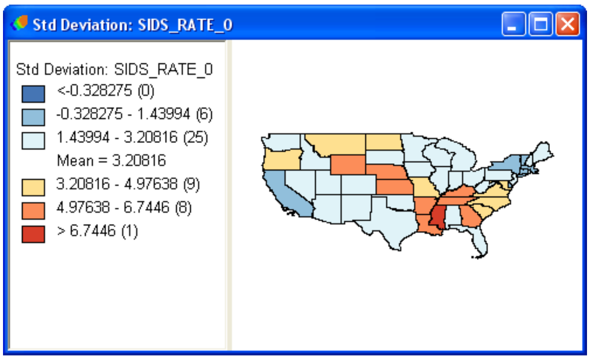

Figure 29: SIDSR standard deviation and mean of the 48 contiguous states in 2005

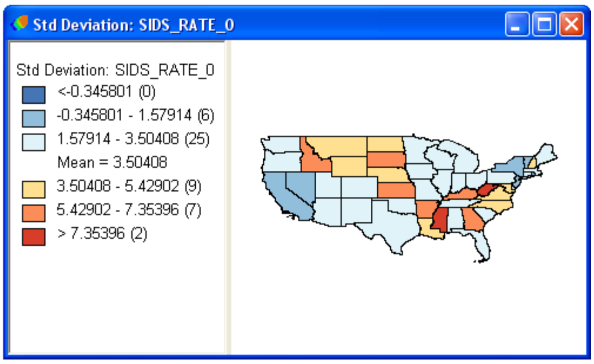

Figure 30: SIDSR standard deviation and mean of the 48 contiguous states in 2006

	Moran's I (Contiguity Weight, Rook)	Standard Deviation	Mean
United States SIDS Rate 2002	0.4124	1.59	3.32
United States SIDS Rate 2003	0.2171	1.89	3.11
United States SIDS Rate 2005	0.4150	1.77	3.21
United States SIDS Rate 2006	0.2670	1.93	3.50

Table 6: Moran´s I, standard deviation, und mean of the SIDS 2002, 2003, 2005, 2006, for the 48 contiguous states of the U.S.

The boxplot for the SIDSR for the year 2002 did not find an outlier, neither with a hinge of 1.5 nor with a hinge of 3.0 (*Figure 31, Figure 32*). However, mild and extreme outliers for the SIDSR in 2003 are identified as Mississippi, Maine, New York, New Hampshire, Louisiana and Vermont (*Figure 33, Figure 34*). In 2005 New York, Arkansas, Louisiana and Mississippi are the outliers for the SIDSR (*Figure 35, Figure 36*). The box plot for the SIDSR in 2006 identified mild outliers with New York and Rhode Island (*Figure 37*). There were no extreme outliers for the SIDSR in 2006 (*Figure 38*).

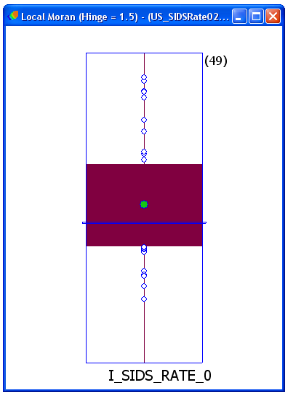

Figure 31: SIDSR boxplot for 2002 (hinge = 1.5)

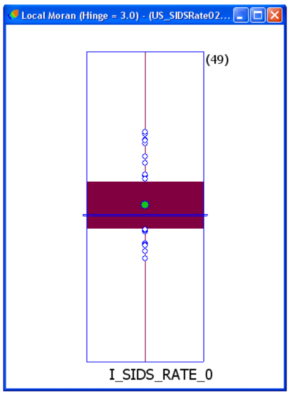

Figure 32: SIDSR boxplot for 2002 (hinge = 3.0)

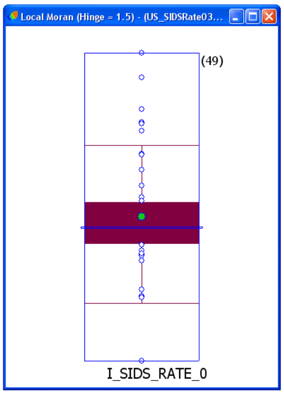

Figure 33: SIDSR boxplot for 2003 (hinge = 1.5)

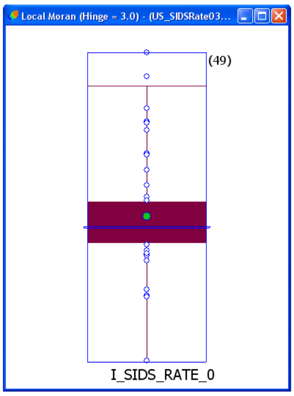

Figure 34: SIDSR boxplot for 2003 (hinge = 3.0)

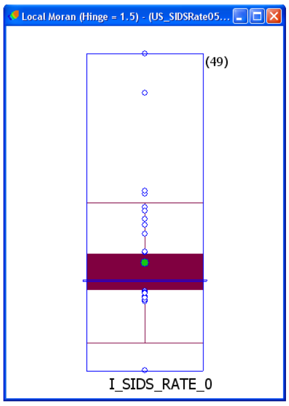

Figure 35: SIDSR boxplot for 2005 (hinge = 1.5)

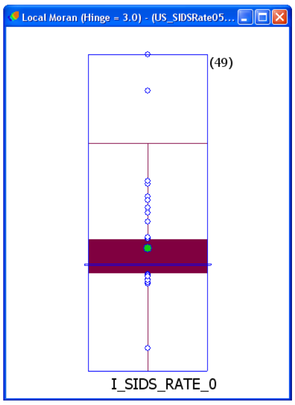

Figure 36: SIDSR boxplot for 2005 (hinge = 3.0)

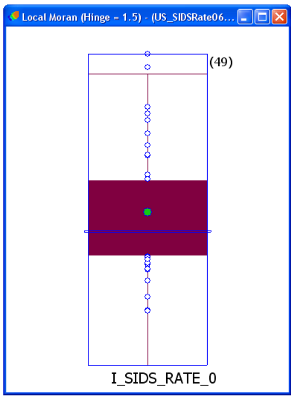

Figure 37: SIDSR boxplot for 2006 (hinge = 1.5)

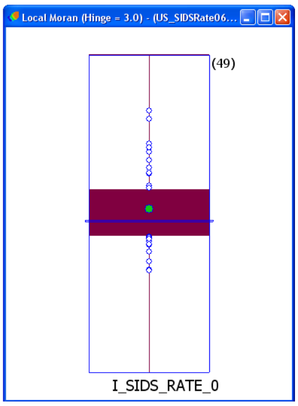

Figure 38: SIDSR boxplot for 2006 (hinge = 3.0)

To calculate the spatial autocorrelation for the SIDSR in the United States with the software GeoDa^{TM}, Hawaii, Alaska, and Puerto Rico were removed from the analysis. The description of the univariate LISA method can be found in Section 4.1. In contrast to the IMR, the following LISA cluster maps of the SIDSR show a different picture every year. Cold spots include those states with a low SIDSR, surrounded by states with a low SIDSR. Cold spots can be found for each year in the eastern part of the U.S. and in Arizona in 2002 and 2006. Hot spots, defined as high SIDSR values, are found in the southern U.S. in 2003, 2005, and 2006 (*Figure 40, Figure 41, and Figure 42*). Louisiana is the only southern state that appears as a hot spot in all three years. An exception is the year 2002 (*Figure 39*), where hot spots can be found in the north (Montana and Nebraska), and in Virginia in the eastern U.S. Spatial outliers from type no. 1 (light blue) can be detected each year in the southern U.S. Alabama is represented as a no. 1 outlier three times, Arkansas twice and Tennessee once. Interestingly, a spatial outlier of the no. 2 type (light red) appears in Massachusetts in 2006 (*Figure 42*). Structural breaks in the data could not be found, and therefore the question "why do spatial outliers of the no. 1 type occur annually in the south of the U.S." should be investigated.

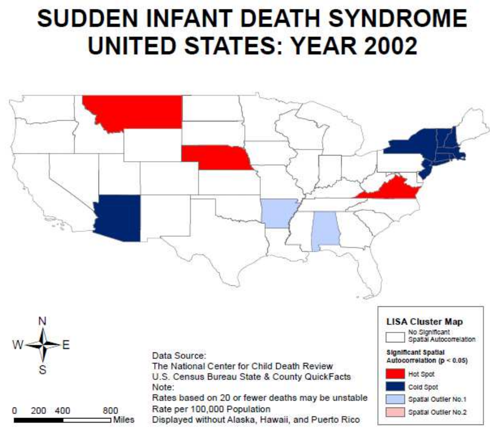

Figure 39: SIDSR Cluster Map of the 48 contiguous states in 2002

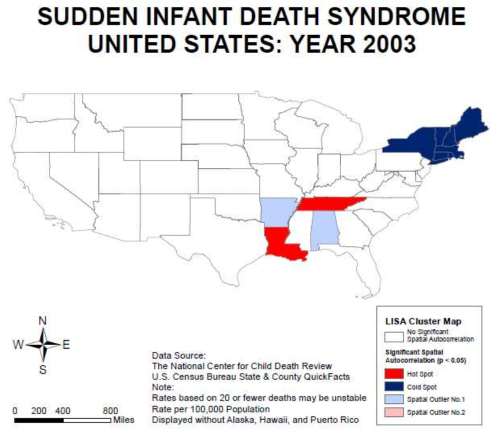

Figure 40: SIDSR Cluster Map of the 48 contiguous states in 2003

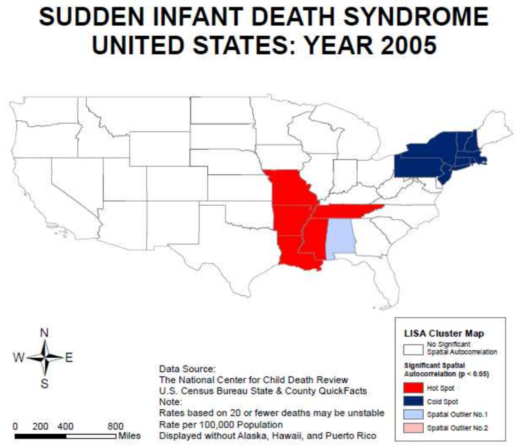

Figure 41: SIDSR Cluster Map of the 48 contiguous states in 2005

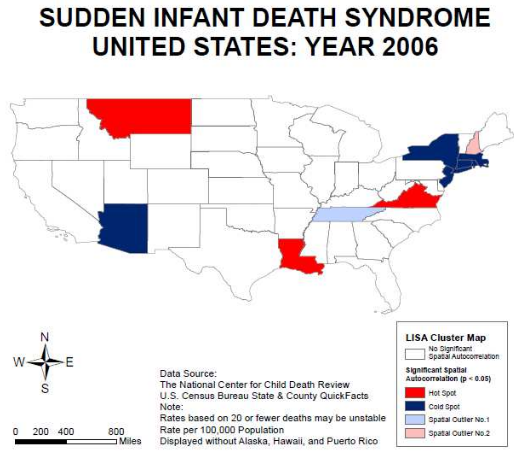

Figure 42: SIDSR Cluster Map of the 48 contiguous states in 2006

4.3. Sudden infant death syndrome rate for the administrative regions of Louisiana

The five leading causes of death in Louisiana, between 2004 and 2008 for all races and both sexes in the age group <1 are short gestation, congenital anomalies, SIDS, unintentional injury, and maternal pregnancy complications (CDC, 2011). The SIDS is always in the ranking in third place. The following maps show the SIDSR in Louisiana from 2004 to 2008. To protect individual privacy, the SIDS deaths are not made available at the parish level. The Louisiana Department of Health and Hospitals divides Louisiana into nine administrative regions (*Figure 1, pg. 25*). The capital Baton Rouge is located in Region 2 (*Table 3*).

Regions with a black and white pattern in each of the maps indicate that the number of deaths is less than five. The Louisiana Department of Health and Hospitals do this in order to protect the individual privacy.

In 2004 (*Figure 43*), the SIDSR was the highest in Region 9 (North Shore) with 1.45, and in 2005 the highest SIDSR was found in Region 6 (Alexandria) (*Figure 44*) with 2.22. The highest SIDSR was located in Region 3 (Houma) in 2006 (*Figure 45*) with 1.51 and in 2007 (*Figure 46*) Region 6 (Alexandria) had the highest SIDS with a rate of 2.55. In 2008 (*Figure 47*), Region 9 (North Shore) possessed the highest rate with 2.66.

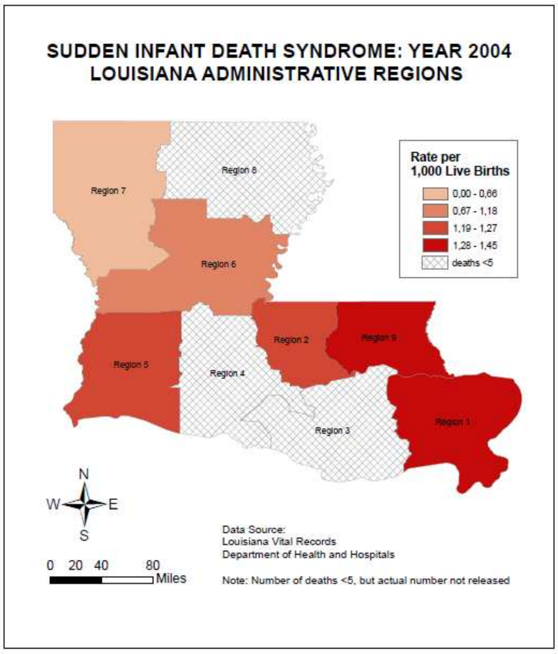

Figure 43: The SIDSR for Louisiana in 2004

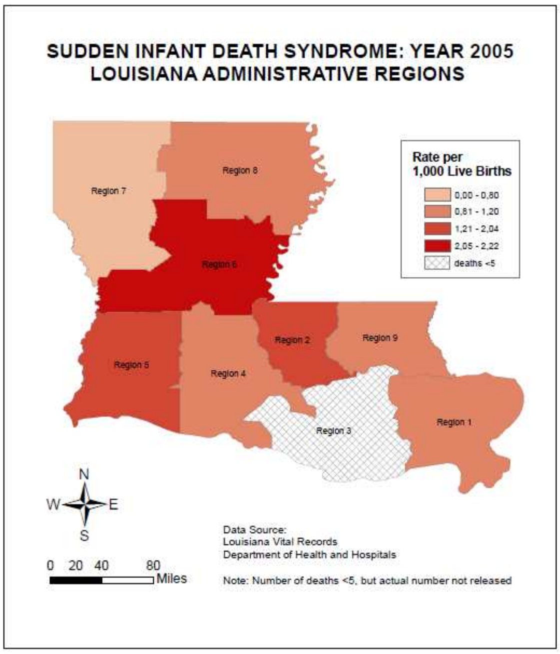

Figure 44: The SIDSR for Louisiana in 2005

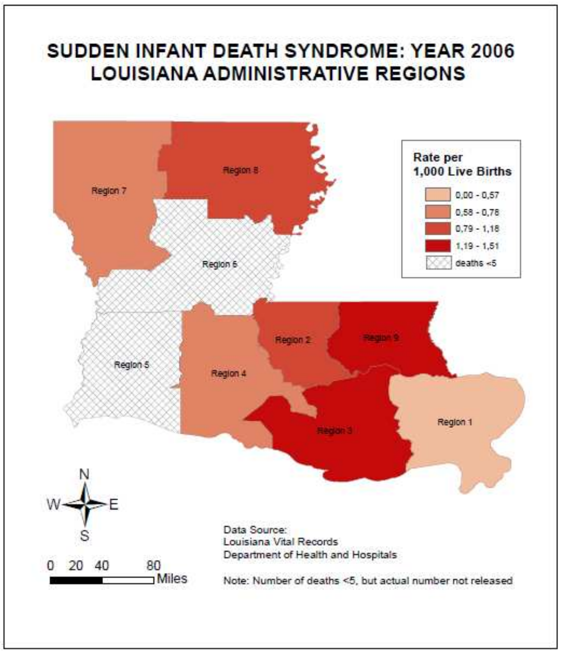

Figure 45: The SIDSR for Louisiana in 2006

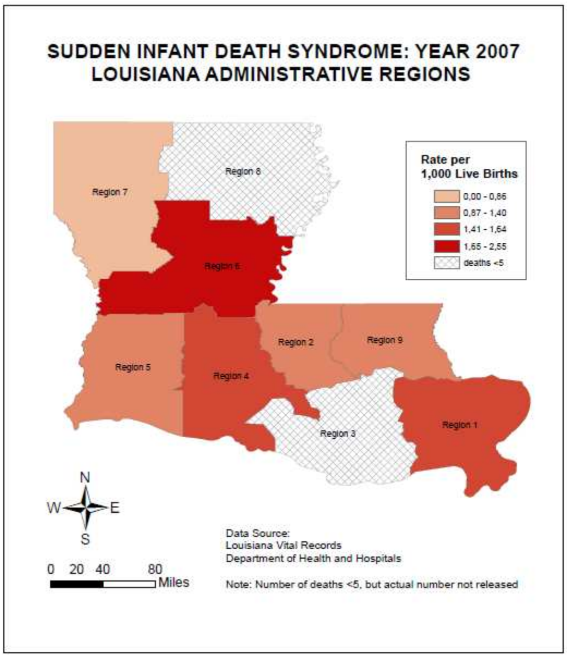

Figure 46: The SIDSR for Louisiana in 2007

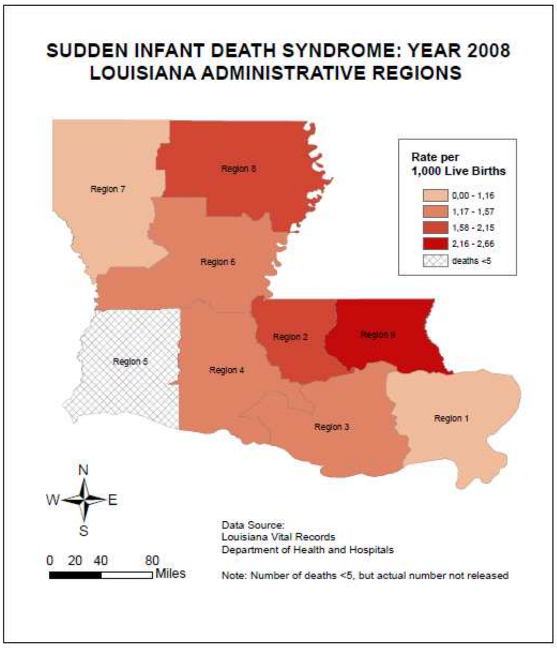

Figure 47: The SIDSR for Louisiana in 2008

If you compare the records of SIDS deaths from 2004 to 2008 from DHH with the records from the CDC (2011) (*Table 7*), the missing numbers of SIDS deaths are evident (except for 2008 because records are not available for that year). While we know the total number of SIDS cases for Louisiana, for individual privacy reasons, a total of 10 SIDS deaths are not associated with any of the nine regions in 2004, a total of four SIDS deaths with any of the nine regions in 2005, three SIDS deaths in 2006, and five SIDS deaths in 2007 (*Table 7, Figures 43-47*).

SIDS Rate	2004		2005		2006		2007		2008	
	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate
Region 1 (Orleans)	20	1.38	11	1.02	5	0.57	17	1.53	13	1.16
Region 2 (Baton Rouge)	11	1.27	16	1.87	11	1.18	12	1.28	17	1.79
Region 3 (Houma)	---	---	---	---	9	1.51	---	---	8	1.36
Region 4 (Lafayette)	---	---	10	1.20	7	0.78	15	1.64	14	1.57
Region 5 (Lake Charles)	5	1.23	8	2.04	---	---	6	1.40	---	---
Region 6 (Alexandria)	5	1.18	10	2.22	---	---	12	2.55	7	1.52
Region 7 (Shreveport)	5	0.66	6	0.80	6	0.75	7	0.86	9	1.11
Region 8 (Monroe)	---	---	6	1.20	5	0.96	---	---	11	2.15
Region 9 (North Shore)	10	1.45	7	1.06	11	1.42	10	1.27	20	2.66
Complete by DHH	**56**		**74**		**54**		**79**		**99**	
Complete by CDC	**66**		**78**		**57**		**84**		**n/a**	

Table 7: SIDS (absolute and rate) for Louisianan from 2004 to 2008, comparing date from DHH with CDC

The nine administrative regions include the 64 parishes of Louisiana and the average percentage of the racial and the four selected socioeconomic variables of each parish located in the respective region is shown in Table 8. In the years 2004 to 2008, the regions with the highest SIDSR were region 1, region 3, region 6, and region 9. Among those, region 6 and region 9 had twice the highest SIDSR. Looking at Table 8, either race or any of the four socio-economic variables vary significantly across the nine regions. In order to see a much stronger variation, it would be important to collect the number of SIDS deaths and the SIDSR for each parish, because parishes inside any region can have drastically different number of SIDS deaths, SIDS rates, and percentages of individual races and level of socio-economic variables.

For example, the percentage of the African American population in all parishes of region 9 is between 6.1% in Livingston Parish and 51.3% in St. Helena Parish, and the percentage of high school graduates is between 67.5% in St. Helena

Parish and 83.9% in St. Tammany Parish. The same is true for the median household income, which is between $ 30,725 in Washington Parish and $ 57,129 in St. Tammany Parish. The percentage of persons, living below poverty level is 24.1% in Washington Parish and 10.0% in the St. Tammany Parish, which is the lowest number of all parishes in Louisiana (U.S. Census Bureau: State and County QuickFacts). Therefore, calculating spatial autocorrelation only makes sense at the parish level and is not useful for the nine administrative regions, as significant spatial differences do not exist at the regional level.

Race and Socio-economic factors	R 1 (New Orleans)	R 2 (Baton Rouge)	R 3 (Houma)	R 4 (Lafayette)	R 5 (Lake Charles)	R 6 (Alexandria)	R 7 (Shreveport)	R 8 (Monroe)	R 9 (North Shore)
White (2009)	63.0%	58.3%	65.0%	70.1%	80.6%	72.5%	60.6%	60.1%	72.5%
Black (2009)	32.0%	40.1%	31.6%	27.5%	16.7%	24.7%	36.4%	38.5%	25.8%
High school graduates (2000)	74.0%	70.8%	69.9%	65.3%	70.5%	68.4%	72.4%	67.0%	73.7%
Bachelor´s degree or higher (2000)	16.8%	14.4%	11.7%	12.2%	11.6%	11.0%	13.7%	14.0%	15.6%
Median household income (2008)	$ 43,542	$ 45,782	$ 47,408	$ 38,270	$ 43,383	$ 35,650	$ 35,492	$ 31,858	$ 42,754
Persons below poverty level (2008)	17.8%	18.4%	15.9%	19.8%	15.7%	20.0%	21.7%	26.1%	17.5%

Table 8: Comparing race and socio-economic factors of the nine administrative regions of Louisiana

4.4. Prenatal and postnatal mortality, East Baton Rouge Parish

Prenatal and postnatal mortality data for East Baton Rouge Parish from 2010 includes a total of 196 Excel spreadsheets. These spreadsheets show, for example, demographic data, housing and living conditions, number of screening, clinical test results and medications, risk factors such as alcohol, drugs and smoking consumption of the mother, domestic violence and the mortality during pregnancy or after birth, within the first year of live after birth. For the analysis, all available records of each mother and her child or children were combined and merged into one record. The data are limited to the mortality before and after birth within the first year of life in relationship to selected risk factors. The data from 2010 represent only an overview and are not complete. For example, prenatal records from 2009 are missing, if the mother had a birth at the beginning of 2010. Similarly, if the births were documented at the end of 2010, records from 2011 are not included, even if the child died in 2011. When differentiating the births in 2010 by race, then there are 0.9% Asian, 0.9% White or Caucasian, 94.5% Black or African American with 3.7% of births not having a classification. Prenatal mortality distinguishes between miscarriage and spontaneous abortion before the 20th gestation week and miscarriage, spontaneous abortion, or stillbirth before the 28th gestation week. Infant deaths within the first year of life are assigned to either the neonatal or postneonatal period. There are no other classifications of the mortality records available and therefore, only the date, but not the cause of death is immediately obvious. For 2010, 1.8% of births were recorded as miscarriage before the 20th gestation week and 1.8% of births were defined as a miscarriage before the 28th gestation week. 0.9% of all live birth infants died in the postneonatal period. Selected risk factors, contributing to the death of a child during pregnancy or after birth, are low birth weight (LBW), alcohol, nicotine, or drug use, and violence in the family. 15.6% of the newborns had a birth weight less than 2,500 g and were born between the 31st and 39th gestation week. During pregnancy, 1.8% of the mothers smoked and 4.6% used drugs. Domestic and/or sexual violence were affirmed by 5.5% of the mothers. Risk factors combined with the different mortality causes indicate, that neither the miscarriages and stillbirths or the postneonatal deaths are commonly documented with the selected risk factors. The risk factors alcohol, nicotine or drug use, as well as domestic and/or sexual violence, in conjunction with the LBW show that 11.8% of mothers experienced domestic and/or sexual violence and 5.9% had drug use during pregnancy. Alcohol or nicotine consumption was not specified. The investigation cannot show that the selected risk factors have an influence on different causes of infant mortality or miscarriages and stillbirths.

5. Summary

The following subchapter concludes and discusses the summary of this research. Future research that could be implemented in this study is mentioned in the second subchapter.

5.1. Conclusion and Discussion

The data collected about prenatal, perinatal and postnatal mortality provided important information about the spatial distribution of the IMR and the SIDSR across in the United States and the SIDSR across Louisiana. The results of this research show how the IMR and the SIDSR are distributed across the United States. The local spatial autocorrelation statistic detects local spatial characteristics of the infant mortality and the SIDS such as hot- and cold spots and spatial outliers. Results in the SIDSR across Louisiana show the spatial distribution within the nine administrative regions of Louisiana.

The spatial distribution showed high percentage of the IMR in the south of the United States. Louisiana and Mississippi include those states with the highest IMR in each examined year. The results also document an annual low IMR in the east and west of the United States. The LISA maps displayed hot spots for IMR in the south, and cold spots in the east and west of the United States. The spatial distribution of the SIDS in the United States compared to the IMR showed a different picture. As compared to the IMR, a smaller number of states with a low SIDSR are in the east and west. A higher percentage of SIDSR as compared to the IMR can be found from the north of the U.S. to the south of the U.S. almost along a swath. During the analyzed years, the LISA maps showed cold spots for the SIDSR in the east and a few in the west and hot spots in the south and north of the U.S. The higher percentage of African Americans, poor education, and low income were detected as important factors positively influencing the IMR and the SIDSR.

For Louisiana, the Louisiana Department of Health and Hospitals makes SIDS data available in detail for the years 2004 to 2008. To protect individual privacy, the 64 parishes of Louisiana were grouped into nine administrative regions. Those regions with less than five SIDS deaths were not visualized numerically in order to protect the individual privacy. The results show that the SIDSR was twice the highest in Region 9 (North Shore) and was twice the highest in Region 3 (Houma).

Unfortunately, the address-based data of eleven different zip codes in East Baton Rouge Parish are incomplete for 2010. Data from the year 2009, which document the history of mothers, and infant data from the year 2011 to determine the child's development are not included in the records analyzed. The selected risk factors that may have an impact on mortality were LBW, alcohol, nicotine and drug consumption, and domestic and/or sexual violence. No conclusions could be made on the infant mortality rate as related to the selected risk factors.

However, these collected data do not provide a complete picture because of the limitation of the data records and because some address-based data are still missing. In both spatial and tabular form the current results of my research show that the IMR and the SIDSR related to race and selected socio-economic factors, which, in general, confirms existing infant mortality research results.

5.2. Further Perspectives

I would be very interested to continuing to research the SIDS in my master thesis. It should be possible to collect SIDS records, at least at the parish or even at the census tract level. Additional data on race and socio-economic variables could be included in this analysis, as for example personal data of the mother, such as the use of prenatal care, alcohol, nicotine, and abuse of illegal drugs, abuse and family violence or crime-related data. In relation to housing, the availability of public health facilities, traffic and pollution-related data would be additional important factors to find out possible causes for SIDS. A comparison of the results between the United States and Austria may unveil similarities or differences in the causes and risks of SIDS and precautions against it. Such findings could have an influence on policy and public health, like the "Back to Sleep" campaign, which is considered a SIDS risk reduction measure on the basis of SIDS research.

Furthermore, the analysis of an existing point data set representing the mother, the father, and the child, located in a selected number of zip codes in East Baton Rouge Parish, may provide information about possible causes and risks, in relation to miscarriages, stillbirth, and SIDS. Apart from age, race, education, income, and prenatal care, these personal data include, both, personal data, such as alcohol, nicotine, and abuse of illegal drugs and abuse and family violence.

6. References

6.1. Literature

American Academy of Pediatrics (AAP), Committee on Child Abuse and Neglect, 2001, "Distinguishing Sudden Infant Death Syndrome From Child Abuse Fatalities", *Pediatrics*, Vol. 107, No.2, pp. 437-441.

Anselin, L., "*GeoDa^{TM} 0.9 User´s Guide*", Spatial Analysis Laboratory, Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champain, Urbana, IL, 2003.

Beckwith, J.B., 1970, "Discussion of terminology and definition of the sudden infant death syndrome", In Bergman, A.B., Beckwith, J.B., Ray, C.G., (Eds.), Sudden Infant Death Syndrome Proceedings of the Second International Conference on the Causes of Sudden Death in Infants, pp. 14-22. Seattle, WA: University of Washington Press.

Bundeskanzleramt (BKA), "*Präimplantationsdiagnostik (PID) Bericht der Bioethikkommission beim Bundeskanzleramt*", Wien, 2004.

Bottomley, C. & T. Bourne, 2009, "Diagnosing miscarriage", *Best Practice & Research Clinical Obstetrics & Gynaecology,* Vol. 23, No. 4, pp. 463-477.

Charreire, H. & E. Combier, 2009, "Poor prenatal care in an urban area: A geographic analysis", *Health & Place*, Vol. 15, No. 2, pp. 412-419.

Curtis, A. & M. Leitner, "*Geographic Information Systems and Public Health: Eliminating Perinatal Disparity*", IRM Press, Hershey, 2006.

Drife, J.O., 2006, "Perinatal audit in low- and high-income countries", *Seminars in Fetal and Neonatal Medicine*, Vol. 11, No. 1, pp. 29-36.

Galan-Roosen, A.E.M. de, Kuijpers, J.C., Straaten, P.J.C. van der, Merkus, J.M.W.M., 2002, "Evaluation of 239 cases of perinatal death using a fundamental classification system", *European Journal of Obstetrics & Gynecology and Reproductive Biology*, Vol. 103, No. 1, pp. 37-42.

Galan-Roosen, A.E.M. de, Kuijpers, J.C., Straaten, P.J.C. van der, Merkus, J.M.W.M., 2002, "Fundamental classification of perinatal death: Validation of a new classification system of perinatal death", *European Journal of Obstetrics & Gynecology and Reproductive Biology*, Vol. 103, No. 1, pp. 30-36.

Gold, K.J., Dalton, V.K., Schwenk, T.L., Hayward, R.A., 2007, "What causes pregnancy loss? Preexisting mental illness as an independent risk factor", *General Hospital Psychiatry,* Vol. 29, No. 3, pp. 207-213.

Grady, S.C. & I.J. Ramirez, 2008, "Mediating medical risk factors in the residential segregation and low birthweight relationship by race in New York City", *Health & Place*, Vol. 14, No. 4, pp. 661-677.

Hanzer, M., Zotter, H., Sauseng, W., Pichler, G., Müller, W., Kerbl, R., 2010, "Non-nutritives Saugen am Beruhigungsschnuller Vorteile, Nachteile und die Assoziation mit dem Plötzlichen Säuglingstod", *Pädiatrie & Pädologie,* Vol. 45, No. 1, pp. 12-15.

Hunt, C.E. & F.R. Hauck, 2006, "Sudden infant death syndrome", *Can. Med. Assoc. J.,* Vol. 174, No. 13, pp. 1861-1869.

Iams, J.D., Romero, R., Culhane, J.F., Goldenberg, R.L., 2008, "Primary, secondary, and tertiary interventions to reduce the morbidity and mortality of preterm birth", *The Lancet*, Vol. 371, No. 9607, pp. 164-175.

Kerbl, R., Zotter, H., Einspieler, C., Roll. P., Ratschek. M., Köstl, G., Strenger, V., Hoffmann, E., Perrogon, A., Zötsch, W., Schober, P., Gränz, A., Sauseng, W., Bachler, I., Kenner, T., Ipsiroglu, O., Kurz, R., 2003, "Classification of sudden infant death (SID) cases in a multidisciplinary setting. Ten years experience in Styria (Austria)", *Wiener Klinische Wochenschrift,* Vol. 115, No. 24, pp. 887-893.

Kerbl, R. & H. Zotter, 2006, "Plötzlicher Säuglingstod (SIDS) Protektiver Effekt des Beruhigungsschnullers", *Monatsschrift Kinderheilkunde,* Vol. 154, No. 2, p. 179.

Koiner, K.A., 2008, "*SIDS Der plötzliche Kindstod Aktuelle Daten und Trends*", Graz, Dissertation.

Kytir, J. & F. Paky, 1997,"Sudden infant death syndrome (SIDS) in Austria. Socioeconomic risk factors for postneonatal SIDS- and non-SIDS-mortality", *Monatsschrift Kinderheilkunde,* Vol. 145, No. 6, pp. 613-618.

Leach, C.E.A., Blair, P.S., Fleming, P.J., Smith, I.J., Platt, M.W., Berry, P.J., BCD, FRCP, Golding, J., and the CESDI SUDI Research Group, 1999, "Epidemiology of SIDS and Explained Sudden Infant Deaths", *Pediatrics*, Vol. 104, No. 4, p. e43.

Longley, P.A., Goodchild, M.F., Maguire, D.J., Rhind, D.W., "*Geographical Information Systems and Science*", John Wiley & Sons Ltd, England, 2005.

MacDorman, M.F. & J.O. Atkinson, 1998, "Infant mortality statistics from the 1996 period linked birth/infant death data set", *Monthly vital statistics report*, Vol. 46, No. 12, supp. Hyattsville, Maryland: National Center for Health Statistics.

MacDorman, M.F. & S. Kirmeyer, 2009, "Fetal and perinatal mortality, United States, 2005", *National vital statistics reports*, Vol. 57, No. 8.

Masi, C.M., Hawkley, L.C., Piotrowski, Z.H., Pickett, K.E., 2007, "Neighborhood economic disadvantage, violent crime, group density, and pregnancy outcomes in a diverse, urban population", *Social Science & Medicine*, Vol. 65, No. 12, pp. 2440-2457.

Mathews, T.J. & M.F. MacDorman, 2008, "Infant mortality statistics from the 2005 period linked birth/infant death data set", *National vital statistics report*, Vol. 57, No. 2. Hayattsville, MD: National Center for Health Statistics.

Mathews, T.J. & M.F. MacDorman, 2010, "Infant mortality statistics from the 2006 period linked birth/infant death data set", *National vital statistics report*, Vol. 58, No. 17. Hayattsville, MD: National Center for Health Statistics.

Mathews, T.J., Menacker, F., MacDorman, M.F., 2002, "Infant mortality statistics from the 2000 period linked birth/infant death data set", *National vital statistics reports*, Vol. 50, No. 12. Hyattsville, Maryland: National Center for Health Statistics.

Miller, H.J., 2004, "Tobler´s First Law and Spatial Analysis", *Annals of the Association of American Geographers*, Vol. 94, No. 2, pp. 284-289.

O´Neil, S.S., Besculides, M., Rosenbach, M., 2008, "Evidence of Trends, Risk Factors, and Intervention Strategies", *Healthy Start National Evaluation 2006: Racial and Ethnic Disparities in Infant Mortality*

New York City Department of Health and Mental Hygiene (NYC DOHMH), "*Summary of Vital Statistics 2008 The City of New York*", NYC, 2010.

Roos, R., Genzel-Boroviczény, O., Proquitté, H., "*Checkliste Neonatologie*", Thieme Verlagsgruppe, Stuttgart, 2010.

Rowley, D.L., Iyasu, S., MacDorman, M.F., Atrash, H.K., 1993, "Neonatal and postneonatal mortality", In: Wilcox LS, Marks JS, eds. *Data to Action: CDC's Public Health Surveillance for Women, Infants, and Children.* CDC Monograph. Centers for Disease Control and Prevention, Public Health Service, US Department of Health and Human Services; Hyattsville, MD: US Department of Health and Human Services; 251–262.

Saternus, K. –S., 2004, "Sudden infant death-focus subject of medico-legal research", *Forensic Science International,* Vol. 144, No. 2-3, pp. 247-253.

Simmons, R.K., Singh, G., Maconochie, N., Doyle, P., Green, J., 2006, "Experience of miscarriage in the UK: Qualitative findings from the National Women´s Health Study", *Social Science & Medicine,* Vol. 63, No. 7, pp. 1934-1946.

Statistik Austria, "*Demographisches Jahrbuch*", Verlag Österreich GmbH, Wien, 2009.

Statistik Austria, "*Todesursachenstatistik*", Verlag Österreich GmbH, Wien, 2010.

Tanaka, S., Stock, S.J., Yamamoto, Y., Kondejewski, J., Olson, D.M., 2010, "Understanding perinatal mortality", *Obstetrics, Gynaecology & Reproductive Medicine,* Vol. 20, No. 22, pp. 317-322.

Thach, T.S., 2006, "Progestogen for preventing miscarriage: RHL commentary", *The WHO Reproductive Health Library,* Geneva, World Health Organization

Willinger, M., James, L.S., Ceatz, C., 1991, "Defining the Sudden Infant Death Syndrome (SIDS): Deliberations of an Expert Panel Convened by the National Institute of Child Health and Human Development", *Pediatric Pathology*, Vol. 11, No. 5, pp. 677-684.

World Health Organization, "*ICD-10: International Statistical Classification of Diseases and Related Health Problems: Tenth Revision – 2nd Ed.*", WHO Press, Geneva, 2004.

World Health Organization, "*Neonatal and Perinatal Mortality: Country, Regional and Global Estimates*", WHO Press, Geneva, 2006.

World Health Organization, "*Neonatal and Perinatal Mortality: Country, Regional and Global Estimates 2004*", WHO Press, Geneva, 2007.

World Health Organization, "*World Health Statistics 2010*", WHO Press, Geneva, 2010.

Zmora, E., 2001, "From Cells to Selves Strategic Plan 2000", *National Institute of Child Health and Human Development (NICHD).*

6.2. Online Literature

Baton Rouge Government Website, "*City of Baton Rouge/Parish of East Baton Rouge*", April 18, 2011. http://ci.baton-rouge.la.us/

Central Intelligence Agency, "*The World Factbook*", April 18, 2011. https://www.cia.gov/library/publications/the-world-factbook/geos/us.html

Centers for Diseases Control and Prevention (CDC), "*WONDER Online Databases*", April 18, 2011. http://wonder.cdc.gov/

Enzyklopädie, "Epidemiology", April 18, 2011. http://www.enzyklo.de/lokal/42134&page=201

ESRI, 2011, "*ArcGIS 10*", April 18, 2011. http://help.arcgis.com/EN/ArcGISDesktop/10.0/help/index.html#//00qp0000000p000000.htm

GeoDa Center, "*Download GeoDa*", March 02, 2011. http://geodacenter.asu.edu/software/downloads

Louisiana Department of Health and Hospitals (DHH), "*DHH Administrative Regions Map*", April 18, 2011. http://www.dhh.state.la.us/medialibrary.asp?ID=1&Detail=38

Louisiana Geographic Information Center (LAGIC), "*Louisiana Parish Boundaries*", April 18, 2011. http://lagic.lsu.edu/data/losco/parishes_ldotd_2007.html

MedicineNet, "*Aetiology*", April 18, 2011. http://www.medterms.com/script/main/art.asp?articlekey=2166

National Center for Health Statistics (NCHS), "*Mortality Technical Appendix*", April 18, 2011. http://www.cdc.gov/nchs/datawh/statab/pubd/ta.htm

National Resource Center for Child Death Review, "*Child Mortality Data*", April 18, 2011. http://www.childdeathreview.org/home.htm

National SIDS/Infant Death Resource Center (NSIDRC), "*What is SIDS*", http://www.sidscenter.org/whatisSIDS.html#1, Virginia, 2005

ORF ON Science, 2009, "*Präimplantationsdiagnostik statt Fehlgeburten*", März, 2011. http://sciencev1.orf.at/science/news/54405

State of Louisiana, "*About Louisiana*", April 18, 2011. http://louisiana.gov/Explore/About_Louisiana/

U.S. Census Bureau, "*2010 Census Data*", April 18, 2011. http://2010.census.gov/2010census/data/

U.S. Census Bureau, "*Poverty*", April 18, 2011. http://www.census.gov/hhes/www/poverty/methods/definitions.html

U.S. Census Bureau, "*TIGER®*", April 18, 2011. http://www.census.gov/geo/www/tiger/

U.S. Census Bureau: State and County QuickFacts, "*People QuickFacts*", April 18, 2011. http://quickfacts.census.gov/qfd/index.html

U.S. Department of Health & Human Services, "*Infantile Apnea and Home Monitoring*", April 18, 2011. http://consensus.nih.gov/1986/1986InfantApneaMonitoring058html.htm

U.S. National Library of Medicine, "*Health Topics*", April 18, 2011. http://www.nlm.nih.gov/medlineplus/ency/article/003215.htm

7. List of Figures

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9. Appendix

TERM	DEFINITION
Abortion	Occurs if there is the complete expulsion or extraction of a fetus or embryo of less than 500g, regardless of gestation age, as far as there are no signs of life (according to live birth), regardless of whether the abortion was initiated or spontaneously (Roos et al., 2010). Is the termination of pregnancy before the completion of the 24th week of gestation, and when the fetus has 500g or less (Bottomley & Bourne, 2009, Drife, 2006).
Aetiology	The study of the causes (MedicineNet, 2011)
Apparent Life-Threatening Event (ALTE)	An episode that is frightening to the observer and that is characterized by some combination of apnea (central or occasionally obstructive), color change (usually cyanotic or pallid but occasionally erythematous or plethoric), marked change in muscle tone (usually marked limpness), choking, or gagging (U.S. Department of Health & Human Services, 2011).
Birth	It is the complete expulsion or extraction of a 500g or more vast fetus, regardless of gestation age and regardless of whether the umbilical cord is disconnected or the placenta is expulsed, too (Roos et al., 2010). If there are no measured values, the WHO defines birth weight according to body length. Thus, a length of 25 cm means 500g, if neither weight nor length are known, 22 gestation weeks mean a weight of 500g (WHO, 2004).
Birth Weight	This is the weight of the fetus or newborn within the first hour after birth, even before the start of postnatal weight loss (Roos et al., 2010, Statistik Austria, 2009, WHO, 2004).
Cyanosis	Is a bluish color to the skin or mucus membranes due to a lack of oxygen in the blood (U.S. National Library of Medicine, 2011).
Deadborn Fetus	See Fetal Death.
Early Neonatal Death	The death of a live-born child within the first seven days (168 hours of life) (Roos et al., 2010, WHO, 2004).
Early Neonatal Mortality Rate	Number of early neonatal deaths per 1000 live births (Roos et al., 2010). $$\frac{\text{Early neonatal deaths}}{\text{Live births}} \; x \; 1{,}000$$
Embryo	Is used when the pregnancy is less than ten weeks of gestation (Bottomley & Bourne, 2009, Drife, 2006).
Epidemiology	Science of arise and spread of diseases (Enzyklopädie, 2011)
Extremely Low Birth Weight (ELBW)	Birth weight less than 1000 g (Roos et al., 2010, WHO, 2004).

TERM	DEFINITION
Fetal Death	Fetal death is death prior to the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy. The death is indicated by the fact that after such separation the fetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or evident movement of voluntary muscles (WHO, 2004).
Fetal Death Rate	Number of fetal deaths per 1000 total births (live births plus fetal deaths) (WHO, 2004). $\frac{\text{Fetal death}}{\text{Total births}}\ x\ 1{,}000$
Fetus	If the pregnancy exceeds ten weeks (Bottomley & Bourne, 2009, Drife, 2006).
Gestation Period	Is calculated from the first day of last normal menstrual period and expressed in completed weeks and completed days (Roos et al., 2010, WHO, 2004).
Infant Death	Deaths in the first year (excluding fetal deaths) (Statistik Austria, 2009).
Infant Mortality Rate	Deaths in the first year deaths related to 1000 live births in the same calendar year (Statistik Austria, 2009). $\frac{\text{Deaths under one year of age}}{\text{Live births}}\ x\ 1{,}000$
Large For Gestation Age (LGA)	Birth weight lies above the 90th percentile for that gestational age (Roos et al., 2010).
Late Neonatal Death	Death of a child born alive after seven but before the completion of 28 days of life (Roos et al., 2010, WHO, 2004).
Late Neonatal Mortality Rate	Number of late neonatal deaths per 1000 live births (Roos et al., 2010). $\frac{\text{Late neonatal deaths}}{\text{Live births}}\ x\ 1{,}000$
Live Birth	Existing signs of life of the child after full expulsion. This is the case, if either there was a beginning of the heartbeat, the pulsation of the umbilical cord or the natural breathing of the lungs (Roos et al., 2010, WHO, 2004). The live birth is entered in the register of births. If the child died immediately after birth, birth and death must be reported in the registry office (Statistik Austria, 2009).
Low Birth Weight (LBW)	A birth weight less than 2500 g (Statistik Austria, 2009, WHO, 2004).

TERM	DEFINITION
Median income	Median income is the amount which divides the income distribution into two equal groups, half having incomes above the median, half having incomes below the median. The medians for households, families, and unrelated individuals are based on all households, families, and unrelated individuals, respectively. The medians for people are based on people 15 years old and over with income (U.S. Census Bureau, 2011).
Miscarriage	Occurs if there is the complete expulsion or extraction of a fetus or embryo of less than 500g, regardless of gestation age, as far as there are no signs of life (according to live birth), regardless of whether the abortion was initiated or spontaneously (Roos et al., 2010). Is usually classified as the first trimester (12^{th} week of gestation) or later (12 to 24 weeks). However, if a baby is born before 24 weeks of gestation, this is a live birth, if the newborn does not survive, then it is a neonatal death (Bottomley & Bourne, 2009, Drife, 2006). In Austria, miscarriages are considered stillborn, if their birth weight is less than 500g, and are not registered (Statistik Austria, 2009).
Neonatal Mortality Rate	Number of early and late neonatal deaths per 1000 live births (Roos et al., 2010, Statistik Austria, 2009). $$\frac{\text{Neonatal deaths}}{\text{Live births}} \; x \; 1{,}000$$
Neonatal Period	Means the first 27 days of life after birth (Mathews & MacDormann, 2008) or 28 completed days after birth (WHO, 2004)
Perinatal Mortality Rate	Number of stillborn children and early neonatal death of deceased children per 1000 births (stillbirths and live births), (Roos et al., 2010, Statistik Austria, 2009). $$\frac{\text{Fetal deaths and early neonatal deaths}}{\text{Total births}} \; x \; 1{,}000$$
Perinatal Period	Means the first seven days or 168 hours after birth (Statistik Austria, 2009). Commences at 22 completed weeks (154 days) of gestation (the time when birth weight is normally 500 g), and ends seven completed days after birth (WHO, 2004). Begins at 22 weeks gestational age - Japan (Tanaka et al., 2010). Minimum gestation period 28 weeks or minimum fetal weight of 1000g - OECD (Tanaka et al., 2010). Extends from 24 weeks gestational age - United Kingdom (Tanaka et al., 2010).

TERM	DEFINITION
Postneonatal Death	Death of a live-born child from the 29th day of life until the completion of the first year of age (Roos et al., 2010).
Postneonatal Mortality Rate	Is the number of resident newborns dying between 28 and 364 days of age in a specified geographic area (country, state, county, etc.) divided by the number of resident live births for the same geographic area (for a specified time period, usually a calendar year) and multiplied by 1,000 (NCHS, 2011). $$\frac{\text{Postneonatal deaths}}{\text{Live births}}\ x\ 1{,}000$$
Postneonatal Period	Is the period from the 28th day of life till below the first year of age completed (Mathews & MacDormann, 2008).
Post-Term	Is equivalent to a gestation period of 42 completed weeks or more or 294 days or more (Roos et al., 2010, WHO, 2004).
Poverty	Following the Office of Management and Budget's (OMB) Statistical Policy Directive 14, the Census Bureau uses a set of money income thresholds that vary by family size and composition to determine who is in poverty. If a family's total income is less than the family's threshold, then that family and every individual in it is considered in poverty. The official poverty thresholds do not vary geographically, but they are updated for inflation using Consumer Price Index (CPI-U). The official poverty definition uses money income before taxes and does not include capital gains or noncash benefits (such as public housing, Medicaid, and food stamps) (U.S. Census Bureau, 2011).
Premature / Prematurity Birth	See Low Birth Weight.
Preterm	Means a gestation period of less than 37 completed weeks or less than 259 days (Roos et al., 2010, WHO, 2004).
Sleep Apnea	Is a common disorder that can be serious. In sleep apnea, your breathing stops or gets very shallow. Each pause in breathing typically lasts 10 to 20 seconds or more. These pauses can occur from 20 to 30 times or more an hour (U.S. National Library of Medicine, 2011).
Small For Gestation Age (SGA)	If the birth weight lies below the 10th percentile for that gestational age (Roos et al., 2010).

TERM	DEFINITION
Stillbirth	Is available if there are no signs of life (according to live birth) of a child weighing more than 500g after a complete expulsion or extraction. The stillbirth is registered (Roos et al., 2010). In Austria stillbirths, which have less than 500g are named as abortion and are not certified. *Since 01.01.1995* there is a new definition (in Austria) according to the WHO guidelines: deadborn fetus or died at birth, if there are no signs mentioned under "born alive" and has a birth weight of at least 500g. *Between 01/01/1977 and 31/12/1994* a child was considered stillborn or died during childbirth, if it was at least 35 cm long, and there was neither a natural pulmonary respiration nor heartbeat nor pulsation of the umbilical cord. Stillbirth that are less than 35 cm long, were considered abortions, and have not been authenticated (Statistik Austria, 2009).
Sudden Infant Death Syndrome (SIDS)	SIDS is the sudden death of an infant under one year of age, remains unexplained after a thorough case investigation, including performance of a complete autopsy, examination of the death scene, and review of the clinical history (Willinger et al., 1991). SIDS's most common characteristics are: SIDS is unexpected and usually appears at obviously healthy children under one year of age. A SIDS death occurs quickly and usually during sleep. SIDS is rare during the first month of life, the majority of deaths occurs between the second and the fourth month. SIDS is a diagnosis of exclusion (NSIDRC, 2005).
Term	Corresponds to a gestation period of 37 to less than 42 completed weeks or 259 to 293 days (Roos et al., 2010, WHO, 2004).
Very Low Birth Weight (VLBW)	Birth weight 1500 g or less (Roos et al., 2010, WHO, 2004).