

Prevalence of Selected Bacterial Infections Associated with the Use of Animal Waste in Louisiana

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Abstract: Human health is a major concern when considering the disposal of large quantities of animal waste. Health concerns could arise from exposure to pathogens and excess nitrogen associated with this form of pollution. The objective was to collect and analyze health data related to selected bacterial infections associated with the use of animal waste in Louisiana. An analysis of adverse health effects has been conducted based on the incidence/prevalence rates of campylobacteriosis, *E. coli* O157:H7 infection, salmonellosis and shigellosis. The number of reported cases increased during the summer months. Analysis of health data showed that reported disease cases of *E. coli* O157:H7 were highest among Caucasian infants in the 0–4 year old age category and in Caucasian children in the 5–9 year old age category. Fatalities resulting from salmonellosis are low and increases sharply with age. The number of reported cases of shigellosis was found to be higher in African American males and females than in Caucasians. The high rate of identification in the younger population may result from the prompt seeking of medical care, as well as the frequent ordering of stool examination when symptoms become evident among this group of the population. The association with increasing age and fatality due to salmonellosis could be attributed to declining health and weaker immune systems often found in the older population. It is concluded that both animal waste and non-point source pollution may have a significant impact on human health.

Keywords: Non-point source pollution, campylobacteriosis, *E. coli* O157:H7, salmonellosis, shigellosis, runoff water, land application

Introduction

Animal waste from dairy and poultry operations is an economical and commonly used fertilizer in the state of Louisiana. The application of animal waste to pasture lands not only is a source of fertilizer, but also allows for a convenient method of waste disposal. One type of animal waste product that is commonly used is dairy lagoon sediment or effluent. Most dairies in Louisiana have a one or two stage lagoon that collects liquid and semi-liquid manure from loafing barns and milking parlor areas. The solid waste settles in the lagoon where it is reduced by the process of anaerobic digestion. The liquid effluent is often pumped onto fields or is recycled for other uses. Periodically, the lagoon must be emptied of the sediment build up. The sediment is typically agitated in order to suspend it into a semi-liquid state and is pumped onto the fields. The disposal of animal

wastes on land is a potential non point source of water degradation. Runoff and percolation could possibly transport organic matter and nutrients to surface and ground water. Animal wastes applied to the land come from wastes that have been removed from feeding facilities, runoff from feeding areas, and waste from animals on pasture and rangeland. Proper application of animal wastes provides nutrients for crop production and also reduces surface runoff.

The health of humans is of concern when considering large quantities of animal waste. Some of the main concerns include the exposure to pathogens and excess nitrogen associated with this form of pollution. Animal waste can contain pathogens, such as fecal coliform bacteria and viruses that can contaminate drinking water and cause gastrointestinal illnesses. High levels of nitrogen leaching into drinking water supplies can increase the risk of methemoglobinemia [1]. In 1996,

the Centers for Disease Control linked the high nitrate levels in Indiana well water near feedlots to spontaneous abortions in humans [2].

Nitrites are relatively short-lived because they're quickly converted to nitrates by bacteria. Nitrites produce a serious illness (brown blood disease) in fish, even though they don't exist for very long in the environment. Nitrites also react directly with hemoglobin in human blood to produce methemoglobin, which destroys the ability of blood cells to transport oxygen. This condition is especially serious in babies under three months of age as it causes a condition known as methemoglobinemia or "blue baby" disease. Water with nitrite levels exceeding 1.0mg/L should not be given to babies. Nitrite concentrations in drinking water seldom exceed 0.1mg/L [3].

Nitrate is a major ingredient of farm fertilizer and is necessary for crop production. When it rains, varying nitrate amounts wash from farmland into nearby waterways. Nitrates also get into waterways from lawn fertilizer run-off, leaking septic tanks and cesspools, manure from farm livestock, animal wastes, and discharges from car exhaust. Nitrates can be reduced to toxic nitrites in the human intestine. The U.S. Public Health Service has established 10mg/L of nitrate-nitrogen as the maximum contamination level allowed in public drinking water [3]. Nitrate-nitrogen levels below 90mg/L and nitrite levels below 0.5 mg/L seem to have no effect on warm-water fish, but many cold water fish are more sensitive. The recommended nitrite minimum for salmon is 0.06mg/L [4].

Ammonia is a toxic form of nitrogen. Open air lagoons emit ammonia into the air [5]. One survey of residents living in the vicinity of a 2,500-sow facility found much higher reports of respiratory problems than were recorded from the neighbourhoods of farms where no livestock was raised [6].

Many regulations for water are found in the Clean Water Act. The H.R. 961, a bill to reauthorize the Clean Water Act, was approved by the House of Representatives. The bill would reverse a 1994 Federal circuit court ruling that land application of livestock manure from a concentrated animal feeding operation is a point source which is subject to permit and enforcement provisions of the CWA (*Concerned Area Residents for the Environment v. Southview Farm*, No. 93-9229 ((2 Cir. Sept. 2, 1994))). The Supreme Court recently declined review of the *Southview Farm* case [7].

Drinking water quality has been improving over time. According to the Centers for Disease Control and Prevention (CDC), the proportion of reported disease outbreaks that can be attributed to problems at public water treatment systems has steadily declined, from 73% in 1989 – 1990 to 30% in 1995 – 1996. It is possible that this decrease reflects the improvements in water treatment and in operation of plants [8].

Between the years of 1997 and 1998, 13 states reported a total of 17 significant illness outbreaks associated with drinking water [9]. These caused an estimated 2,038 persons to become ill. CDC keeps records on occurrences and causes of outbreaks of illness related drinking water and recreational water. Many of

the outbreaks that occur are often missed by the public health officials because some of the illnesses that are associated with the outbreaks are not perceived to be water related [9].

In 1999, *E. coli* contaminated water at the Washington County fairgrounds in New York State caused the death of two people and illness in over 1000 others. The source of contamination was probably cattle fecal material from a nearby barn, which was swept into the soil by storm runoff, and then leached into the aquifer [10].

Drinking water health effects are not limited to gastrointestinal illness associated with microbes. Drinking water can transmit bacteria, micro organisms, and chemicals that are capable of causing disease. The symptoms can be acute, such as diarrhoea and dehydration, or they can be long term effects that include infertility and reproductive health effects, or chronic illnesses such as cancer [11].

Materials and Methods

Method

An analysis of the adverse health effects that are associated with the types of animal waste studied in this project was conducted by the usage of materials received from Louisiana Health and Hospital Systems, Infectious Disease Epidemiology Section, New Orleans, LA. Other relevant information was collected from Louisiana Department of Environmental Quality (Shreveport, LA). Illnesses having a bacterial origin were checked in regards to the number of cases in the state of Louisiana and the incidence rates as well. Patterns in regards to race, age and gender were recorded. The parishes with high incidence rates of these illnesses were identified. Data from the 2000 census were also utilized in order to identify populations at risk so that comparisons of disease incidence rates by county, area, or other characteristics could be made. An analysis of the total amounts of animal waste, cattle waste, poultry waste, amounts of nitrogen in waste and the amount of phosphorus in waste was carried out in reference to the top four parishes with high incidence rates of diseases with bacterial origins possibly associated with animal waste. Relative information found was mapped to illustrate the distribution of diseases by areas.

Statistical Analysis

Demographic data and data on the numbers of cases of campylobacteriosis, shigellosis, salmonellosis, and *E. coli* infections in Louisiana were collected. Cases of diseases were divided by the population at risk to determine the incidence/prevalence rates. These disease rates were used as the basis or end-point for comparing the health risks by parishes, gender, race, etc. Additional information was collected on the amounts of animal wastes generated by parish, and a linear regression analysis was performed to determine if there is a correlation between the level of waste and the incidence of diseases by parish.

Results

An analysis of information received from the Louisiana Department of Health and Hospitals Infectious Disease Epidemiology Section for the years 1988 – 2001 was conducted for diseases caused by campylobacter, *E.coli* O157:H7, salmonella and shigella.

As shown in figure 1, the majority of cases of campylobacteriosis reported occurred during the summer months of May, June, July and August. The fewest number of cases were seen during the months of December and January. This seasonal trend was noted for the years of 1988 – 2001. Between the years of 1988 and 2001, the highest number of cases of campylobacter reported occurred in 1992 with approximately 280 cases being reported. There has been a gradual decrease of the number of cases since 1992. There were 150 cases reported in 1998 and 130 cases reported during the year 2001. This shows a 50% reduction. In 1999, it was noted that the number of campylobacter cases reported was twice as high for Caucasians than that of African Americans. Caucasians had a rate of 2.6 per 100,000 people and African Americans had a lower rate of 1.3 per 100,000 people. It was found that the majority of the cases reported during this same year were in children within the 0-4 year's age group. The lowest number of cases was seen in the 15-19 year age group. The parishes that had the highest rates of campylobacteriosis per 100, 000 people in 1999 were Red River, Jackson, and Terrebonne Parishes. The reported rates per 100,000 people for these parishes were 22, 13, and 12 per 100,000 people, respectively. In the year 2001, the highest rate was seen in Washington Parish with 1.62 per 100,000 people followed by Red River Parish with 1.08 per 100,000 people [12].

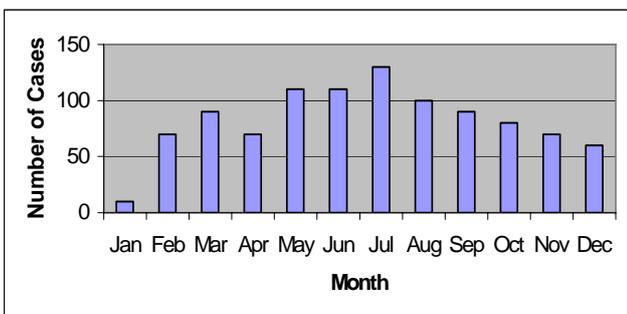


Figure 1: State of Louisiana campylobacter average annual cases by seasonal distribution for years 1988-2001(LDHH 2001).

An analysis of *E. coli* O157:H7 cases for the state of Louisiana showed that for the years 1996-2001, the highest reported cases were in 1997 followed by the year 2000.

Figure 2 shows that of the years 1996-2001, the majority of the cases were reported for young Caucasian infants and children between the ages of 0 and 9 years of age. The highest number of cases reported during the years of 1996–2001 was found in St. Tammany Parish with a total of 11 cases. Figure 3 shows that the *E. coli* O157:H7 number of cases reported increased during the months of June, July, August and November. These

months reported 12, 13, and 9 cases, respectively. During 1999, sixty-four percent of the cases reported occurred between the months of June and September. For the years of 1996-2001, 1 case was reported during the month of February [12].

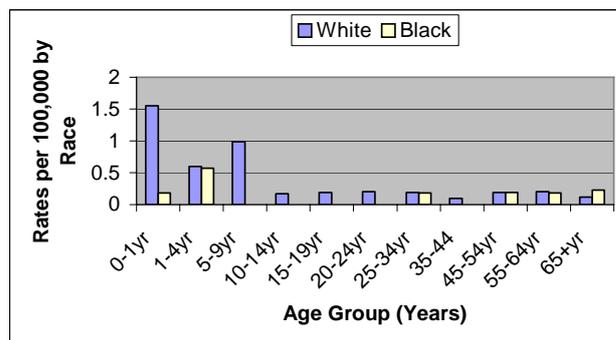


Figure 2: *E.coli* O157:H7 average incidence rates by race and age for the years 1996 - 2001 in Louisiana (LDHH 2001).

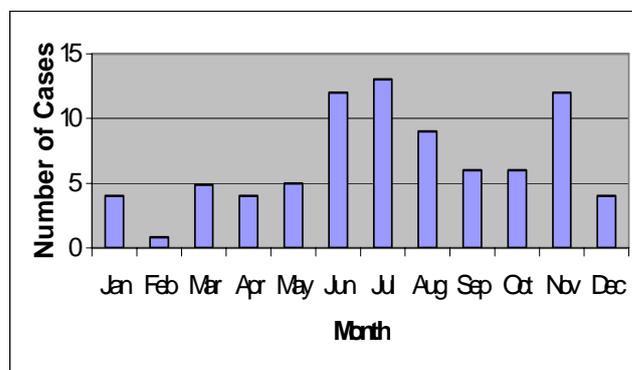


Figure 3: Average annual cases of *E.coli* O157:H7 by seasonal distribution for the years 1996 - 2001 in Louisiana (LDHH 2001).

An analysis of salmonellosis for the state of Louisiana revealed that during the year 1999, there were a total of 718 reported cases of salmonellosis. This showed a 17% decrease in the number of cases that were reported in 1998. When looking at the years of reporting ranging from 1965-2001, the majority of the cases occurred during the late 1980s and among Caucasian infants, adolescents and the older population. The numbers of cases of salmonellosis in infants that were reported between the years of 1997-2001 were highest in the 0-1 year of age group and children in the 1-5 year of age group. According to the Louisiana Department of Health and Hospitals, the case fatality for salmonella is extremely low (0.2%). As shown in Figure 4, the case fatality increases with increasing age. Two parishes were noted as having the highest number of reported salmonellosis cases. St. Tammany Parish reported a total of 47 cases followed by Washington Parish with a total of 46 reported cases [13]. St. Tammany Parish, with a rate of 5.26 per 100,000, was found to be among the top three parishes reporting salmonellosis for the year 2000. Also among the top three during the year 2000 were Caldwell and Terrebonne Parishes with rates

of 7.14 and 4.54 per 100,000, respectively. Terrebonne Parish was noted again in the year 2001 with a high rate of 4.13 per 100,000 [12].

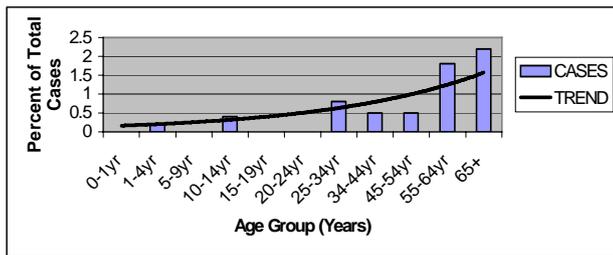


Figure 4: Annual percentages of total deaths by age caused by salmonella in Louisiana during the years of 1987-2001(LDHH 2001).

In 1999, the number of shigellosis cases that were reported was 227. This was at a rate of 5.3 per 100,000 people. The reported cases showed that shigellosis occurred most often in African American males and African American females when compared to the number of cases reported for Caucasian males and females. The sex-race specific rates were 8.3 per 100,000 for African American males and 5.9 per 100,000 for African American females. The lower occurrence rates for Caucasian males and Caucasian females were 1.5 and 2.4 per 100,000 respectively. In 1999 the parishes having the highest rate of cases of shigellosis that were reported were West Baton Rouge, Livingston, St. John and Assumption. The rates reported for these parishes were 21, 14, 13 and 13 per 100,000, respectively [13]. In the year 2000, Desoto Parish at a rate of 1.58 per 100,000 and St. Tammany Parish at a rate of 1.45 per 100,000 had the highest reported rates of shigellosis. St. Tammany Parish appeared as having one of the highest rates again in the year 2001 at 1.67 per 100,000 followed by Washington Parish with a rate of 1.16 per 100,000. The parish having the highest reported rate of shigellosis during the year 2001 was Vermillion (4.2 per 100,000).

An analysis of the parishes that were reported as having the highest incidence rates of campylobacteriosis, salmonellosis, and shigellosis for the years of 1999, 2000, and 2001 are found in Table 1.

Table 1: Highest infection rates per number of cases for campylobacteriosis, salmonellosis, and shigellosis in Louisiana parishes (LDHH 2001).

Year	Campylobacteriosis Parish Name	Salmonellosis Parish Name	Shigellosis Parish Name
2000	Catahoula (2.73) St. Helena (2.04)	Caldwell (7.14)	Desoto (1.58)
		St. Tammany (5.26)	St. Tammany (1.45)
		Terrebonne (4.54)	
			Vermillion (4.2)
2001	Washington (1.62) Red River (1.08)	Morehouse (5.64)	St. Tammany (1.67)
		Terrebonne (4.13)	Washington (1.16)

Parishes having the highest number of reported cases for these same illnesses in 1999 are shown in Table 2. A comparison of the data regarding the parishes reporting the highest number of cases by rates for campylobacteriosis, salmonellosis, and shigellosis within the years of 1999-2001 showed that four parishes on three or more occasions were noted as being among those parishes with the highest rates for the studied illnesses. These four parishes are Red River, St Tammany, Terrebonne, and Washington. Washington Parish had the highest amount of cattle waste generated in the year 1997 among these parishes [14].

Table 2: Highest number of reported cases of campylobacteriosis, salmonellosis, and shigellosis in Louisiana parishes in 1999 (LDHH 1999).

Campylobacteriosis Parish Name	Salmonellosis Parish Name	Shigellosis Parish Name
Red River (22)	St. Tammany (47)	W. Baton Rouge (21)
Jackson (13)	Washington (46)	Livingston (14)
Terrebonne (12)		St. John (13)
		Assumption (13)

As seen in Table 3, Washington Parish ranked second in the state among the sixty-four parishes with 490,000 tons of cattle waste and ranked thirteenth with regards to poultry waste generated with only 64 tons. The amounts of reported cattle waste generated in Red River, St. Tammany, and Terrebonne Parishes were 200,000, 65,000, and 33,000 tons, respectively. In regards to the amount of poultry waste generated by these parishes, lower amounts were reported with Red River having less than one ton. St. Tammany and Terrebonne Parishes reported 39 and 2 tons of poultry waste generated respectively. The state of Louisiana showed an increase in the number of heads of cattle between the years of 1987 and 1997. The number of cattle in 1987 was reported as being 813,181 and in 1997 it was 905,193 cattle. This clearly indicates a 7% increase. This increase is also reflected in the 6,600,000 tons of cattle waste generated in 1987 compared to the 7,100,000 tons that were generated in 1997. Poultry numbers showed a 14% increase between the years of 1987 and 1997. In 1987, it was reported that the state's poultry numbers were 17,068,652 and increased to 20,335,050 in 1997. The amounts of poultry waste generated for 1987 and 1997 were reported as being 540,000 and 610,000 tons, respectively. While St. Tammany, Terrebonne, and Washington reported decreases in the amount of waste generated for cattle and poultry between the years of 1987 and 1997, Red River showed a 101 % increase in cattle waste generated [14]. Educational, socioeconomic and racial makeup of Red River, St. Tammany, Terrebonne, and Washington Parishes were analyzed from the 2000 census. Based upon the census, of these four parishes Terrebonne had the largest percentage of residents having less than a ninth grade education as well as the lowest percentage of residents having a high school education or higher. In regards to the poverty level, 22.23% of the residents of

Table 3: Amount of cattle and poultry waste for Louisiana parishes (Environmental Defense and GetActive Software 2003).

Parish	Cattle Waste		Poultry Waste	
	Amount (ton)	Rank	Amount (ton)	Rank
Tangipahoa	680,000	1	96	12
Washington	490,000	2	64	13
Desoto	360,000	3	2	38
Bossier	250,000	4	20	25
Calcasieu	250,000	5	27	22
Vermilion	240,000	6	37	21
Natchitoches	240,000	7	24,000	6
Beauregard	200,000	8	45	16
Red River	200,000	9	0	54
St. Landry	190,000	10	52	14
Cameron	190,000	11	0	61
Rapides	170,000	12	42	17
St. Helena	170,000	13	0	51
E. Feliciana	160,000	14	0	58
LaFourche	160,000	15	41	18
Avoyelles	140,000	16	38	20
Pointe Coupe	140,000	17	0	55
Caddo	130,000	18	1	44
E. Batton Rouge	130,000	19	120	11
Jeff. Davis	130,000	20	11	31
Franklin	130,000	21	10	33
Union	130,000	22	250,000	1
W. Carroll	110,000	23	13	30
Sabine	110,000	24	120,000	2
Iberville	110,000	25	0	46
Vernon	110,000	26	13,000	7
Evangeline	100,000	27	14	28
Claiborne	96,000	28	47,000	5
Richland	86,000	29	2	41
Catahoula	85,000	30	0	62
Lafayette	83,000	31	45	16
Linclon	78,000	32	77,000	3
Ouachita	78,000	33	12,000	8
Grant	74,000	34	18	26
Webster	74,000	35	0	49
Allen	71,000	36	1	43
W. Feliciana	70,000	37	0	48
Acadia	65,000	38	21	23
St. Tammany	65,000	39	39	19
Ascension	62,000	40	13	29
Livingston	59,000	41	7,800	9
Winn	59,000	42	0	47
Bienville	58,000	43	5,300	10
Morehouse	56,000	44	2	42
LaSalle	56,000	45	0	56
Plaquemines	47,000	46	7	34
Caldwell	44,000	47	21	24
Terrebonne	33,000	48	2	39
Iberia	32,000	49	15	27
Concordia	32,000	50	0	60
E. Carroll	29,000	51	0	59
St. Charles	28,000	52	0	52
Jackson	26,000	53	52,000	4
St. Martin	25,000	54	54	32
Madison	22,000	55	55	40
Jeff. Davis	14,000	56	56	31
St. Mary	12,000	57	57	36
W. Batton Rouge	11,000	58	58	35
Tensa	7,200	59	59	37
St. Bernard	6,600	60	60	53
St. J. Baptist	4,100	61	61	50
Assumption	3,200	62	62	45

Red River parish lived below this level. The percentage of residents living below the poverty level for St. Tammany, Terrebonne, and Washington Parishes were 8.86, 17.2, and 21.68 %, respectively.

Table 4 shows that although Red River Parish has the smallest total population (9,622 residents) in comparison to the other three parishes, it has the largest percentage of African Americans (40.9 %) compared to 57.9 % Caucasian residents. Eighty-seven percent of the residents of St. Tammany are Caucasian, and only a small percentage (9.9%) of the residents are African Americans. The parish having the largest total population of the three compared parishes is St. Tammany Parish with a total of 191,268 residents. The largest percentage (29.9%) of St. Tammany residents is in the 25-44 year old category. Terrebonne Parish also recognizes its 25-44 year old category as being the majority of its residents at 29.8 %. Terrebonne Parish is also known for having the largest amount of water area and land area among the four discussed parishes. Terrebonne has 824.97 square miles of water area and 1254.93 square miles of land area [15].

Table 4: Education, socioeconomic status and demographics for Red River, St. Tammany, Terrebonne and Washington parishes in Louisiana for the year 2000.

Parameter	Red River	St. Tammany	Terrebonne	Washington
% <9 th grade education	6.93	6.54	20.5	10.08
% H.S. Graduate or Higher	71.93	80.66	61.07	70.50
% in Selected Industry-Agriculture, Forestry, Fishing and Hunting	2.77	1.26	4.53	2.1
% Families Income in 1999 Below Poverty Level	22.23	8.86	17.2	21.68
Total Population	9,622	191,268	104,503	43,926
% Under 18	30.1	28.4	29.2	26.8
% 18-24	9.3	7.3	10.1	9.5
% 25-44	24.8	29.9	29.8	26.7
% 45-64	1.5	24.3	21.1	22.6
% 65-Older	4.4	10.0	9.7	14.3
White (%)	57.9	87.0	74.1	67.4
Black (%)	40.9	9.9	17.8	31.5
Water Area in sq. miles	12.79	269.93	824.97	6.40
Land Area in sq. miles	389.29	854.15	1254.93	669.57
Population Density per sq. mile of Land Area	24.7	223.9	83.3	65.6

Table 5: Distribution of campylobacter in various parishes for the year 2000.

<i>Group</i>	<i>Rate*</i>	<i>No. of Parishes</i>	<i>Parish Names</i>
A	0.00	31	Allen, Assumption, Avoyelles, Beauregard, Bienville, Claiborne, Concordia, DeSoto, E. Carroll, E. Feliciana, Evangeline, Franklin, Iberville, Jeff. Davis, LaSalle, Lincoln, Madison, Morehouse, Plaquemines, Red River, Richland, Sabine, St. James, St. John Baptist, St. Mary, Tensas, Union, Vernon, W. Baton Rouge, W. Feliciana, Winn
B	0.01-1.00	28	Acadia, Ascension, Bossier, Caddo, Calcasieu, E. Baton Rouge, Grant, Jackson, Jefferson, Lafayette, Lafourche, Livingston, Natchitoches, Orleans, Ouachita, Pointe Coupee, Rapides, St. Bernard, St. Charles, St. Landry, St. Martin, St. Tammany, Tangipahoa, Terrebonne, Vermilion, W. Carroll, Washington, Webster
C	1.01-2.00	3	Caldwell, Cameron, Iberia
D	2.01-3.00	2	Catahoula, St. Helena

*Number of cases per 100,000 people

Table 6: Distribution of campylobacter in various parishes for the year 2001.

<i>Group</i>	<i>Rate*</i>	<i>No. of Parishes</i>	<i>Parish Names</i>
A	0.00	36	Acadia, Allen, Assumption, Beauregard, Bienville, Caldwell, Cameron, Catahoula, Claiborne, Concordia, DeSoto, E. Carroll, E. Feliciana, Franklin, Grant, Iberville, Jackson, Jeff. Davis, LaSalle, Madison, Natchitoches, Pointe Coupee, Richland, Sabine, St. Charles, St. Helena, St. James, St. John Baptist, St. Landry, St. Martin, St. Mary, Tensas, Vernon, W. Carroll, W. Feliciana, Winn
B	0.01-1.00	26	Ascension, Avoyelles, Bossier, Caddo, Calcasieu, E. Baton Rouge, Evangeline, Iberia, Jefferson, Lafayette, Lafourche, Lincoln, Livingston, Morehouse, Orleans, Ouachita, Plaquemines, Rapides, St. Bernard, St. Tammany, Tangipahoa, Terrebonne, Union, Vermilion, W. Baton Rouge, Webster
C	1.01-2.00	2	Red River, Washington

*Number of cases per 100,000 people

Table 7: Distribution of salmonella in various parishes for the year 2000.

<i>Group</i>	<i>Rate*</i>	<i>No. of Parishes</i>	<i>Parish Names</i>
A	0.00	13	Assumption, E. Carroll, Franklin, Jackson, LaSalle, Madison, Pointe Coupee, Red River, Richland, St. Helena, St. Mary, W. Feliciana, Winn
B	0.01-1.00	21	Avoyelles, Beauregard, Bienville, Concordia, DeSoto, E. Feliciana, Evangeline, Iberville, Jeff. Davis, Jefferson, Lincoln, Morehouse, Orleans, Plaquemines, Rapides, Sabine, St. James, Union, Vernon, W. Baton Rouge, W. Carroll
C	1.01-2.00	16	Acadia, Allen, Caddo, Calcasieu, Cameron, Claiborne, E. Baton Rouge, Grant, Iberia, Lafourche, Livingston, Ouachita, St. Charles, St. John Baptist, St. Landry, St. Martin
D	2.01-3.00	8	Ascension, Bossier, Catahoula, Natchitoches, St. Bernard, Tangipahoa, Tensas, Vermilion
E	3.01-4.00	2	Lafayette, Washington
F	>4.00	3	Terrebonne, St. Tammany, Caldwell

*Number of cases per 100,000 people

Table 8: Distribution of salmonella in various parishes for the year 2001.

<i>Group</i>	<i>Rate*</i>	<i>No. of Parishes</i>	<i>Parish Names</i>
A	0.00	4	Iberville, Richland, St. Mary, Tensas
B	0.01-1.00	9	Avoyles, Beauregard, Bienville, DeSoto, Jeff. Davis, Lincoln, Orleans, Webster, Winn
C	1.01-2.0	34	Acadia, Allen, Ascension, Assumption, Bossier, Caddo, Calcasieu, Caldwell, Cameron, Catahoula, Claiborne, E. Baton Rouge, E. Carroll, E. Feliciana, Franklin, Grant, Jackson, Jefferson, LaSalle, Livingston, Madison, Natchitoches, Ouachita, Plaquemines, Pointe Coupee, Rapides, Red River, Sabine, St. James, St. John Baptist, St. Martin, Vernon, W. Baton Rouge, W. Carroll
D	2.01-3.00	13	Concordia, Evangeline, Iberia, Lafayette, LaFourche, St. Charles, St. Helena, St. Landry, Tangipahoa, Union, Vermilion, W. Feliciana, Washington
E	>3.00	4	St. Tammany, St. Bernard, Terrebonne, Morehouse

*Number of cases per 100,000 people

Table 9: Distribution of shigella in various parishes for the year 2000.

<i>Group</i>	<i>Rate*</i>	<i>No. of Parishes</i>	<i>Parish Names</i>
A	0.00	30	Acadia, Allen, Assumption, Avoyelles, Beauregard, Caldwell, Cameron, Catahoula, Concordia, E.Carroll, E.Feliciana, Evangeline, Grant, Jackson, Jeff.Davis, Pointe Coupee, Red River, Sabine, St. Bernard, St. Helena, St. John Baptist, St. Martin, St. Mary, Tensas, Union, Vermilion, W. Carroll, W. Feliciana, Washington, Winn
B	0.01-1.00	25	Bienville, Bossier, Caddo, Calcasieu, E. Baton Rouge, Franklin, Iberville, Jefferson, LaSalle, Lafayette, Lafourche, Lincoln, Livingston, Madison, Morehouse, Natchitoches, Plaquemines, Rapides, Richland, St. Charles, St. James, St. Landry, Vernon, W. Baton Rouge, Webster
C	1.01-2.00	9	Ascension, Claiborne, DeSoto, Iberia, Orleans, Ouachita, St.Tammany, Tangipahoa, Terrebonne

*Number of cases per 100,000 people

Table 10: Distribution of shigella in various parishes for the year 2001.

<i>Group</i>	<i>Rate*</i>	<i>No. of Parishes</i>	<i>Parish Name</i>
A	0.00	36	Allen, Assumption, Avoyelles, Beauregard, Bienville, Caldwell, Cameron, Catahoula, Claiborne, Concordia, E. Carroll, E. Feliciana, Evangeline, Franklin, Grant, Jeff.Davis, LaSalle, Lafayette, Lincoln, Morehouse, Plaquemines, Pointe Coupee, Red River, Richland, Sabine, St. Helena, St. James, St. Landry, St. Martin, St. Mary, Tensas, Union, Vernon, W. Baton Rouge, W. Feliciana, Winn
B	0.01-1.00	24	Acadia, Bossier, Caddo, Calcasieu, DeSoto, E. Baton Rouge, Iberia, Iberville, Jackson, Jefferson, LaFourche, Livingston, Madison, Natchitoches, Orleans, Ouachita, Rapides, St. Bernard, St. Charles, St. John Baptist, Tangipahoa, Terrebonne, W. Carroll, Webster
C	1.01-2.00	3	Ascension, St. Tammany, Washington

*Number of cases per 100,000 people

Tables 5, 6, 7, 8, 9 and 10 show the distribution of campylobacter, salmonella, and shigella in the various parishes for the years 2000 and 2001. The distribution of campylobacter for parishes having a rate of 0 per 100,000 for the year 2000 totalled 31 parishes and was 36 for the year 2001. The numbers of parishes reporting rates of 0.01 to 1.00 for campylobacter for these same years were 28 and 26 parishes respectively. In 2000, three parishes had rates between 1.01 and 2.00 and only two parishes reported rates above 2.00. During 2001, only two parishes had rates above 1.01.

The distribution of salmonella for parishes having a rate of 0 per 100,000 for the years 2000 and 2001 were 13 and 4, respectively. For these same years, the number of parishes with rates ranging between 0.01 and 1.00 were 21 and 9 per 100,000, respectively. In the year 2000, 16 parishes reported rates ranging between 1.01 and 2.00, 8 parishes reported rates ranging between 2.01 and 3.00, and 5 parishes had rates greater than 3.01 per 100,000 people. In the year 2001, 34 parishes had rates ranging between 1.01 and 2.0, 13 parishes reported rates ranging between 2.01 and 3.00 and 4 parishes reported rates higher than 3.01.

There were a total of 30 parishes that reported rates per 100,000 of zero for shigella during the years of 2000. In the year 2001, a total of 36 parishes also reported a rate of zero for Shigella. The number of parishes that reported rates ranging from 0.01 to 1.00 for the years 2000 and 2001 were 25 and 24 respectively. Only 9 parishes reported rates higher than 1.01 in 2000 while in 2001, 3 parishes reported this same rate. In 2001 only one parish had a rate that was greater than 2.00 per 100,000.

Using the described statistical methods, no apparent significant correlation ($p > 0.05$) between the amount of animal waste and the studied disease incidence rates among the parishes in the state of Louisiana was observed.

Discussion

The state of Louisiana is reported as having a total of 7,876,528 acres of farmland. Of this amount, the parishes of Red River, Washington, Terrebonne and St. Tammany have been reported as having 113,176 acres, 100,006 acres, 52,873 acres and 41,863 acres respectively [15].

Campylobacteriosis is a Class C disease and must be reported to the state within five business days. Campylobacteriosis is estimated to affect about one percent of the population in the United States. Many of the cases are undiagnosed and unreported. Approximately six cases for each 100,000 persons in the U.S. population are reported to the Centers for Disease Control and Prevention (CDC), while in Louisiana the reported incidence is about five per 100,000. Most cases of campylobacteriosis are associated with the handling of raw poultry or eating raw or under cooked poultry meat. Water may be a source for sporadic cases or outbreaks [12]. An increased prevalence of campylobacteriosis is possible in humans inhabiting areas of intensive cattle production [16]. It is believed that the high rate of occurrence in infants is likely to be the result of cross contamination from parent to child. There is a reported increase of cases during the summer months [12]. The

distribution of campylobacter during the years 2000 and 2001 remained relatively the same. The majority of the parishes had rates less than 1.01 per 100,000. There were only two parishes that had rates greater than 2 per 100,000 in the year 2000 and none having this rate in the year 2001.

E. coli O157:H7 is found in both dairy and beef herds in the majority of cattle farms across the United States [12]. Infection from this organism is considered as a Class B disease and must be reported to the state within one business day. It became reportable in Louisiana in 1996, with the number of cases ranging between five to twenty cases per year. The detection is higher among infants than among children and adults because infants with diarrhea are more likely to be brought to a medical facility to have stool examination. A higher number of cases are reported for Caucasian than for African Americans. A possible explanation for the low number of African Americans reporting the disease is possibly the result of a lack of access to medical care for this community. Because of this, more screening is done for Caucasian than for African Americans. Another possible explanation to the differences in the amount of cases reported between the Caucasian and African American community could be that the parishes reporting the highest rates of this illness also had a much lower minority population as compared to the majority population [12]. The Surveillance Summaries of the Morbidity and Mortality Weekly Reports noted that between the years of 1997 and 1998, there were four outbreaks caused by bacteria; three were attributed to *E. coli* O157:H7 and one to *Shigella sonnei*. One of these outbreaks occurred in the state of Illinois and involved three persons who drank from an untreated well located near a cattle pasture. Another outbreak involving 26 people was noted to have occurred in the state of Georgia at a water park. It is believed that a fecal accident in the children's wading pool was the source [9].

Salmonellosis is a Class B disease and must be reported to the state within one business day. The rates observed in Louisiana are the same as in the rest of the United States. The increase in the reported incidence rates after 1980 is possibly the result of improved reporting by all facilities. The seasonal pattern favoring the summer months is thought to be because salmonella experiences better growth at higher temperatures. The high rate of identification in the younger population may result from the prompt seeking of medical care when symptoms become evident among infants and young children. The high rate of identification may also be the result of more frequent ordering of stool examination from children when healthcare workers investigate diarrhea symptoms. These practices result in the over-sampling of the child population. Access to medical care and more screening among the Caucasian community may explain the differences in the reported rates by race. Although case fatality for salmonellosis is known to be extremely low at 0.2%, it appears to increase sharply with age. This may be due to the declining health and weaker immune systems often found among the older population [12]. The Infectious Disease Epidemiology Annual Report states that the rates of Salmonella infection in Terrebonne Parish are consistently high.

Terrebonne Parish was among the parishes having the highest rate of salmonellosis for the years 2000 and 2001 [12]. It is suggested that the medical facilities are good at culturing Salmonella, but the amount of water and land availability could also be a factor. The distribution of salmonella during the year 2000 and the year 2001 showed an increase during the year 2001 in the number of parishes in Louisiana that had rates greater than 1.01 per 100,000. The number of parishes having rates of 1.01 to 2 per 100,000 more than doubled from 16 in the year 2000 to 34 in the year 2001. The number of parishes having rates greater than 3 remained the same during both years, while those parishes with rates of 0 per 100,000 decreased from 13 parishes to four parishes.

Shigellosis is a Class B disease and must be reported to the state within one business day. Although reported infrequently in the United States, outbreaks of shigellosis have been associated with food, drinking water and recreational activities in water. Only 0.3% of the cases are reported as occurring in outbreaks. Some shigella infections in the U.S. occur among young adult males as a result of sexual transmission among homosexual men. There is no peak among adult males in the state of Louisiana. The race distribution shows a high rate among Caucasian infants as compared to African American infants. This could be the result of Caucasian infants having better access to medical care. Shigella seems to occur throughout the year without any seasonal peaks [12]. The distribution of shigellosis during the years of 2000 and 2001 remained relatively the same. The majority of the parishes had rates less than 1.01 per 100,000. The year 2000 did not have any parishes with rates greater than 2.00. There was only one parish in the year 2001 that had a rate greater than 2.01 per 100,000.

The highest rate among many of the studied diseases was not only among Caucasian, but in infants in the 0-4 year old age category and in children in the 5-9 year old age category. The largest segment of the population in Red River and Washington Parishes was found to be in the under 18 year old age group. This probably accounts for such large numbers of young residents being reported [12]. As mentioned earlier, a factor as to the possibility of why this segment of the population is represented in such high numbers is the possibility that this community also had more access to health care and more screening by health officials in which the disease would have been required to be reported. This would be expected in a parish like St. Tammany in which 80.66 % of the residents were high school graduates or higher. All four studied parishes showed that greater than 50 % of its residents have a high school diploma or above. The parish having the lowest percent of high school graduates was Terrebonne Parish with 61.07 %. There is no correlation seen among the parishes when comparing the educational status of the residents to the percent of families living below the poverty level in 1999 [15]. In regards to the high number of infants and children being infected with the studied diseases, the risk from direct contact with fecal material at farms and petting zoos is also recognized as an important factor [17]. According to the Surveillance Summaries of the Morbidity and Mortality Weekly Reports between the years of 1997 and 1998, nine persons became ill from *Shigella sonnei* in

Massachusetts. This outbreak was associated with a wading pool that included a sprinkler fountain and was used by many diaper-aged children.

According to the 2000 census, Terrebonne Parish reported that 4.53 % of its business industry is considered as being a selected industry such as agriculture, forestry, fishing and hunting. The selected industry percent was highest for Terrebonne Parish than the other three studied parishes of Red River, St. Tammany and Washington. Washington Parish had the third highest percent of 2.1 when compared to the other three parishes of Red River, St. Tammany and Terrebonne. In terms of the water area per square mile, Washington Parish had the smallest number of 6.40 square miles as compared to the other three studied parishes. Terrebonne Parish is also noted as having the largest water area and land area in square miles [15]. Many of the water areas of these parishes include estuaries. Estuaries can become contaminated with fecal coliform bacterial pollution as a result of rainfall runoff from urbanized areas [18]. Water plays an important role in the transmission of campylobacteriosis [19].

In 1997, the amounts per year of nitrogen and phosphorous in animal waste for Terrebonne Parish were found to be 390,000 and 100,000 pounds, respectively. Of the reported amount, 210,000 pounds of nitrogen per year were reported as being lost to the atmosphere [14]. Washington Parish ranked second in the state among the sixty-four parishes with 490,000 tons of cattle waste and ranked thirteenth with regards to poultry waste generated, with only 64 tons. Between the years of 1999 and 2001, Washington Parish had one of the highest reported rates for at least one of the bacterial diseases such as campylobacteriosis, *E.coli*, salmonellosis and shigellosis [12]. In 1997, a total of 5,300,000 pounds per year of nitrogen in animal waste and a lower amount of 1,200,000 pounds per year of phosphorous in animal waste were reported for Washington Parish. Compared to the other parishes in the state, Washington Parish ranked fourth in the amount of phosphorus reported in animal waste and third in the amount of nitrogen reported in animal waste. Of the reported amount of nitrogen, 1,600,000 pounds per year was lost to the atmosphere [14]. There was no correlation found to exist between the amount of animal waste stored within the parishes and the incidence rates of the studied diseases. It must also be noted that the amounts of animal waste totals reported from the Environmental Defence and Get Active Software seem relatively high based upon the number of animals used in the calculation.

Conclusions

Survey of literature information regarding diseases such as campylobacteriosis, *E. coli* O157:H7 infections, salmonellosis and shigellosis within the state of Louisiana indicated that these diseases have animal origins. It is possible that some of the cases were related to animal waste, but there is no clear indication that all cases have this origin. Although the four parishes surveyed had large amount of animal waste generated each year, statistics does not show a correlation between this and the studied diseases.

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