

Reptile-Associated Salmonellosis in Preschool-Aged Children in Michigan, January 2001–June 2003

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Objectives. Determine the incidence of reptile-associated salmonellosis in preschool-aged children in Michigan.

Methods. Cases of reptile-associated salmonellosis in children ≤ 5 years of age occurring in Michigan January 2001–June 2003 were identified through review of individual patient case-history forms provided by local health departments to the Michigan Department of Community Health and by identification of Michigan Department of Community Health laboratory-confirmed cultures of reptile-associated serotypes, determined by evaluation of the Public Health Laboratory Information System's Clinical Nonhuman *Salmonella* data for 1990–2001.

Results. The incidence of reptile-associated salmonellosis was 11.8% of all *Salmonella* cases reported in Michigan children aged ≤ 5 years for the period January 2001 through June 2003.

Conclusions. Despite the recommendations of the Centers for Disease Control and Prevention to avoid the exposure of children < 5 years old to reptiles, reptile-associated salmonellosis in preschool-aged children continues to be a public health problem in Michigan.

The problem of reptile-associated salmonellosis in children is not new. Reptiles are cold-blooded, scaled vertebrates, such as turtles, lizards, and snakes, and have long been kept as household pets. Reptiles are known to carry *Salmonella*, which can be transmitted directly or indirectly to humans through ingestion of the bacteria, which causes subsequent infection. Direct transmission occurs through handling of a reptile, and indirect transmission occurs by contact with an object contaminated by a reptile or its feces. Infants and young children are more likely than the general population to become infected with *Salmonella* [1–3] and are at greater risk for progression of salmonellosis to complications, such as septicemia, meningitis, and death [3–5]. Infants and young children also appear to be at increased risk for reptile-associated salmonellosis [5]. Studies indicate that these increased risks may be caused by diet (e.g., bottle-feeding) [6], infectious dose, host susceptibility, and environmental factors [4, 5, 7]. Pet turtles were a major

source of reptile-associated salmonellosis until the 1975 legislation that banned the sale of small turtles. This led to an 18% reduction in observed salmonellosis in children aged 1–9 years [8]. In 1999 and 2003, the Centers for Disease Control and Prevention (CDC) recommended that children < 5 years old and immunocompromised persons should avoid contact with reptiles; further, reptiles should not be kept in homes where immunocompromised people or children < 5 years old reside [1, 2]. However, it is estimated that up to 7% of the 1.4 million annual salmonellosis cases in the United States continue to be caused by contact with reptiles [1]. Reptile ownership is common; according to the American Veterinary Medical Association, as many as 2.8 million reptiles were owned as pets in 2001 in the United States [9]; ~ 1.5 – 2.5 million US households (1.6%) have a pet reptile [9, 10], translating into an estimated 60,570 Michigan households with reptiles [11].

Public health surveillance for salmonellosis in Michigan is uniquely comprehensive. Bacterial cultures of samples obtained from patients with suspected cases are collected from local laboratories and are then confirmed and serotyped at the Michigan Department of Community Health (MDCH) laboratory (MDCH-L) for $\sim 88\%$ of all cases that are electronically reported to the MDCH (unpublished data). Local health depart-

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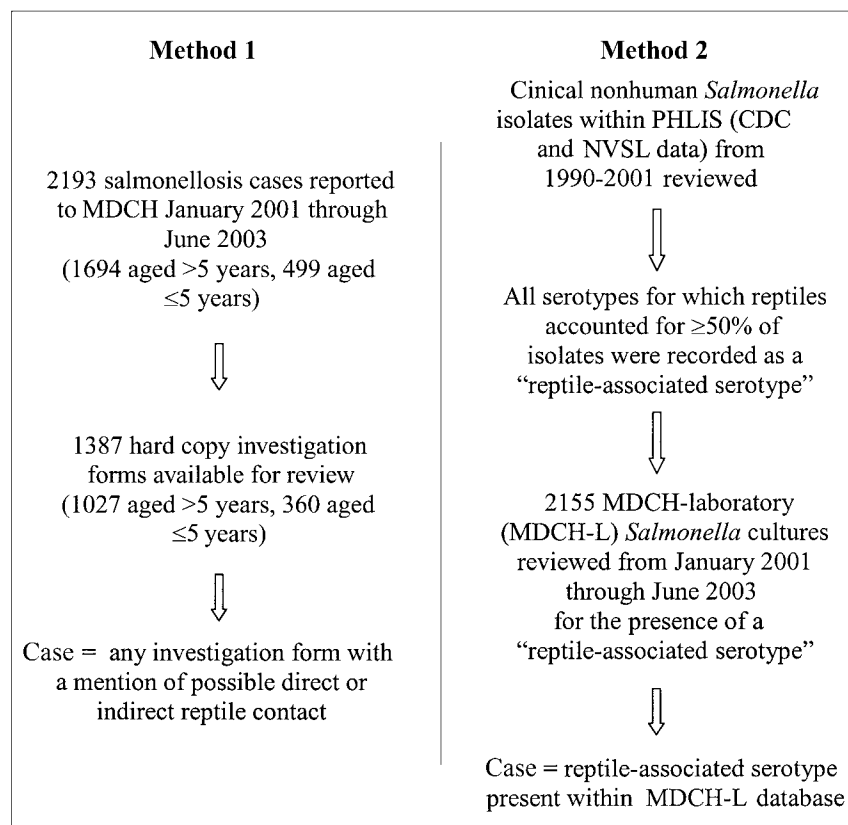


Figure 1. Two methods used in the case definition of reptile-associated salmonellosis. CDC, Centers for Disease Control and Prevention; MDCH, Michigan Department of Community Health; NVSL, National Veterinary Laboratories; PHLIS, Public Health Laboratory Information System.

ments (LHDs) routinely contact all patients, if possible, and collect epidemiologic information; 90% of all cultures positive for *Salmonella* in Michigan from January 2001 through June 2003 can be linked to an LHD report in the electronic surveillance database (unpublished data).

This study is intended to assess the incidence of reptile-associated salmonellosis in preschool-aged Michigan children from January 2001 through June 2003.

METHODS

Salmonellosis is required to be reported by physicians and laboratories to public health authorities under the Communicable Disease Rules of the Michigan Public Health Code [12]. LHDs routinely attempt follow-up on cases of salmonellosis, which often includes contact with the patient or their physician. LHDs complete a case investigation form, which includes questions about animal contacts. A total of 2193 *Salmonella* cases were reported to MDCH during January 2001–June 2003, and 1387 investigation forms (63.5%) were available for review, representing both adult and pediatric cases. Of 499 reported cases occurring in patients ≤ 5 years, a total of 360 (72%) had forms that were available. Incidence, age group distributions, and de-

mographic characteristics of reptile-associated salmonellosis in Michigan were determined for the period of interest using EpiInfo software, version 6.0 (Centers for Disease Control and Prevention).

In addition, information for 2155 cultures obtained during the period January 2001–June 2003 that were positive for *Salmonella* species was available for review in the MDCH-L database. Identification of serotypes predominantly associated with reptiles was performed by means of a previously established methodology [1, 3, 4, 13]. These serotypes were determined to be reptilian if $\geq 50\%$ of all nonhuman isolates were from reptile sources. Nonhuman isolate data were drawn from the Clinical *Salmonella* Isolations from Nonhuman Sources [13] tables within the CDC's Public Health Laboratory Information System and National Veterinary Services Laboratories reports for the years 1990–2001.

A reptile-associated salmonellosis case was defined (figure 1) as salmonellosis with a report of a reptile and/or a reptile in the household, as identified on the case investigation form; or any *Salmonella* culture within the MDCH-L database associated with a reptile-associated serotype.

For purposes of this study, a preschool-aged patient with a

reptile-associated case was defined as a child aged ≤ 5 years with reptile-associated salmonellosis identified during the period January 2001–June 2003.

RESULTS

A total of 106 (7.6%) of the 1387 salmonellosis case investigation forms for all cases reported during January 2001–June 2003 indicated exposure to a reptile; 50 of these documented reptile exposures were in children ≤ 5 years of age. These 50 preschool-aged children represented 13.9% of the 360 case investigation forms available for this age group. In contrast, of the remaining 1027 case investigation forms available for salmonellosis cases in patients ≥ 6 years, only 56 (5.5%) mentioned an exposure to reptiles. The serotypes representing these 50 pediatric cases are listed in table 1. χ^2 analysis of the data from the salmonellosis case investigation forms was significant for an increased association of reptile contacts in children ≤ 5 years old, compared with reptile association in cases occurring in patients aged > 5 years ($\chi^2 = 26.86$; $P < .0000002$; $RR = 2.55$; 95% CI, 1.77–3.66).

The age distribution analysis of these case investigation forms revealed that 35 (70%) of these 50 patients were ≤ 1 year of

age; of these infants, 14 (28%) were ≤ 2 months of age at the time of illness.

Reptile-associated salmonellosis was also identified by looking for reptilian serotypes within the MDCH-L database. Twenty-four *Salmonella* cultures reported during the period January 2001–June 2003 by the MDCH-L were identified as reptilian serotypes; 11 of these were for patients who were ≤ 5 years of age (table 1). Three (27%) of these 11 cases were associated with *S. Monschuai*, and 1 case each was associated with 8 other serotypes. One *S. Monschuai* case and the *S. Chameleon* case had reptiles noted on the case investigation form and had been identified by case definition 1; of the other 9 cases, 4 did not mention reptile exposure on their forms, and 5 did not have investigation forms on file at MDCH.

We were also able to link each case in a preschool-aged child that was identified by the investigation form as reptile-associated to a culture at the MDCH-L. These 50 cases had cultures that grew both reptilian and nonreptilian serotypes. The most common serotypes were *S. Typhimurium* (7 cases [14%]), *S. Poona* (6 cases [12%]), *S. Enteritidis* (5 cases [10%]), and *S. Typhimurium* (var 5-) (3 cases [6%]).

Identification of cultures in the MDCH-L database that grew

Table 1. *Salmonella* serotypes in 59 cases found in patients ≤ 5 years old and identified as reptile-associated by examination of case investigation forms (case definition 1) or by determination that $\geq 50\%$ of all nonhuman isolates were from reptilian sources (case definition 2).

Case definition, no. of cases identified per serotype	Serotype(s)	No. (%) of cases ($n = 59$)
Case definition 1		
7	<i>S. Typhimurium</i>	7 (11.9)
6	<i>S. Poona</i>	6 (10.1)
5	<i>S. Enteritidis</i>	5 (8.5)
2	<i>S. Group B</i> [4-], <i>S. Java</i> , <i>S. Marina</i> , <i>S. Montevideo</i> , <i>S. Muenchen</i> , <i>S. Newport</i> , <i>S. Oakland</i> , <i>S. Typhimurium</i> [var 5-]	16 (27.1)
1	<i>S. Abaetuba</i> , <i>S. Adelaide</i> , <i>S. Ajiobo</i> , <i>S. Berta</i> , <i>S. Butantan</i> , <i>S. Cubana</i> , <i>S. Ealing</i> , <i>S. Heidelberg</i> , <i>S. Madelia</i> , <i>S. Oranienburg</i> , <i>S. Paratyphi b</i> , <i>S. Sandiego</i> , <i>S. Thompson</i> , <i>S. Waral</i> , <i>S. Chameleon</i> (IV) ^a , <i>S. Monschuai</i> ^a	16 (27.1)
Subtotal		50 (84.7)
Case definition 2		
2	<i>S. Monschuai</i>	2 (3.4)
1	<i>S. Aguevee</i> , <i>S. Group V</i> [44-], <i>S. Jangwani</i> , <i>S. Kingabwa</i> , <i>S. Poano</i> , <i>S. Subgroup III B</i> , <i>S. Wandsworth</i>	7 (11.9)
Subtotal		9 (15.3)
Total		59 (100)

^a Case associated with a reptile serotype that was initially identified with use of a case investigation form.

a reptile-associated serotype provided an additional 9 cases for the preschool-aged group. Thus, 59 preschool-aged salmonellosis cases suggestive of reptile sources were identified. In Michigan, 499 salmonellosis cases occurring in patients ≤ 5 years old were reported electronically by the LHDs to MDCH during the study period. Given that only 360 case investigation forms were available for review for the 499 cases electronically reported, these 59 reptile-associated cases represent $\geq 11.8\%$ of all cases occurring in patients ≤ 5 years old that were reported to MDCH during the period January 2001–June 2003.

DISCUSSION

A substantial proportion (11.8%) of reported cases of salmonellosis in Michigan children ≤ 5 years old can be linked to a reptile contact or reptilian serotype. Like previous studies, we identified a modest number of the reptile-associated cases occurring in patients ≤ 5 years of age as being caused by *S. Poona* (6 [10.2%] of 59 cases), and we noted other serotypes that are often reported in the literature as being associated with reptiles [1, 3, 4, 14]. However, some serotypes that are commonly reported in the literature as being reptile-associated (e.g., *S. Poona*, *S. Java*, and *S. Marina*) did not meet our case definition for a reptile-associated serotype. This may be because serotypes previously known to be cultured primarily from reptiles are increasingly being cultured from other animal sources, including humans [1, 4, 12].

The finding that 13.9% of the 360 case investigation forms for patients ≤ 5 years old were reptile-associated, compared with 5.4% of the case investigation forms for the 1027 patients aged > 5 years, is consistent with past findings that reptile-associated salmonellosis occurs more frequently in infants and small children [1–2, 4–5]. Thirty-five of these reptile-associated cases occurred in infants ≤ 1 year old, who are more susceptible to invasive disease than are older children [1, 3]; 14 of these patients were ≤ 2 months old.

This observed frequency of reptile-associated salmonellosis in Michigan during the study period may be an underestimation. Only 1387 (63.2%) of the 2193 reported cases had investigation forms that could be reviewed for reptilian exposure. In many cases, possible reptile contact was not evaluated because of lack of patient access for follow-up. Furthermore, we did not include serotypes that are commonly cited as reptilian in the literature (e.g., *S. Poona* and *S. Marina*) because they did not fulfill the second case definition; inclusion of these serotypes would increase our estimates for reptile-associated illness.

A limitation of this study is that the case definitions are proxy criteria for true reptile-associated salmonellosis. Misclassification can occur if reptile contact noted on a case investigation form did not cause the illness, resulting in overestimation, or a case may have been caused by a reptile but not have been reported as such on the investigation form. Identification of

reptile-associated cases solely on the basis of reptilian serotypes is an insensitive method. Many of the cases (81.4%) are associated with nonreptilian serotypes, so applying the second case definition alone would underestimate the true incidence of reptile-associated salmonellosis. However, these methodologies are widely used [1–4] and yield consistent data across different studies. It would be expected that misclassification would occur similarly between the preschool-aged group and older age groups, so that observed differences in the frequency of reptile-associated disease between groups are actual.

A total of 59 cases occurring in infants and preschool-aged children were identified as reptile-associated during the period January 2001–June 2003, 50 of which were identified by case investigation form review and 9 of which were identified through linkage to a reptile-associated *Salmonella* serotype, giving an average of 23.6 cases per year. It is estimated that the total number of salmonellosis cases from any source is 38 times [15] that of the number reported to health authorities. This estimate may be smaller for cases occurring in preschool-aged children, because selection bias may occur as a result of the greater likelihood of obtaining stool or blood cultures from ill children; if the total number of cases occurring in preschool-aged children in Michigan is only 10 times the number of cases reported, an estimated 236 cases annually may be due to reptile contact.

CONCLUSION

Numerous articles and recommendations have been published regarding the ownership and care of reptiles and the potential risks of *Salmonella* exposure to children. Despite these recommendations, pediatric reptile-associated salmonellosis continues to be a public health problem within the state of Michigan. Given the current popularity of reptile pet ownership and the relatively high incidence of reptile-associated salmonellosis, there is a need for continued public health messages regarding the risk of disease caused by these pets. However, notifying pet store owners and their potential customers of the risk of salmonellosis transmission from snakes, iguanas, and other reptiles may be insufficient to reduce incidence rates in infants and young children, who constitute the most susceptible age group. Legislation does exist in several states requiring pet store owners to communicate the increased risks of salmonellosis to customers purchasing reptiles; currently, Michigan requires consumer education for the sale of turtles only [1]. In 1999, the Council of State and Territorial Epidemiologists and the National Association of State Public Health Veterinarians recommended local and state legislation for the provision of consumer education about salmonellosis risks when and where reptiles are sold [1, 2, 16]. Increased dissemination of educational posters, such as those developed by the Pet Industry Joint Advisory Council and CDC, to pet stores, pet supply retailers, and reptile trade shows, would help to increase reptile

owner awareness of this issue. Given the relatively high incidence of reptile-associated salmonellosis in Michigan infants and children found in this study, it is necessary to have ongoing development and evaluation of public health programs to reduce risks for reptile-associated salmonellosis.

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