

Background Population Exposure Estimates Using *Salmonella* Case Interviews

INTRODUCTION/INTENDED USE

The following data comprise exposure frequencies for sporadic culture-confirmed *Salmonella* cases that occurred in Minnesota from 2011 through 2018. Cases were interviewed with a detailed questionnaire about exposures that occurred in the 7 days prior to their illness onset.

Epidemiologist can use these frequencies to estimate the background exposure rate in the population for a particular food item or other exposure and then use this estimate in a binomial model comparison which is available in Epi Info 7 under StatCalc or as an excel spreadsheet [here](#)

This can be useful to quickly evaluate potential hypotheses during the hypothesis generation phase of an investigation prior to conducting a more resource-intensive study method like a case-control study. Cases who were not interviewed, cases who reported international travel within the week prior to illness onset, and outbreak-associated cases, regardless of the transmission route, were not included in these data.

Epidemiologists should carefully consider any potential biases arising from the use of *Salmonella* case exposure information to estimate background population exposure rates. Using *Salmonella* cases to estimate the background exposure rate in the population will likely introduce bias towards the null hypothesis when evaluating exposures that are risk factors for *Salmonella*. For example, the percentage of sporadic *Salmonella* cases that were exposed to a known *Salmonella* risk factor such as eggs is potentially higher than the true background rate of exposure to eggs in the population. Epidemiologists should also consider if the food item under evaluation has seasonal consumption patterns, or if consumption of the food varies by gender or age.

Another potential source for background exposure data is the [FoodNet Population Survey 2018-2019](#)

For more specific exposure frequencies to match the demographics of your current investigation or to discuss how to compile background exposure estimates for your own jurisdiction, please contact Joshua.rounds@state.mn.us

DAIRY

Food Item	Denominator	% Overall	% Overall (including maybe)	Female	Male	Age: <18	Age: 18 – 65	Age: >65	Spring	Summer	Fall	Winter	Pop Survey MN	Pop Survey National
Eggs	3412	68%	71%	68%	68%	61%	70%	74%	69%	68%	67%	69%	77%	75%
Shredded cheese	3298	49%	55%	51%	47%	45%	56%	29%	48%	48%	51%	52%	N/A	N/A
Processed cheese slices	3472	35%	39%	32%	38%	29%	38%	33%	32%	36%	39%	29%	57%	51%
Block cheese	3575	19%	22%	19%	18%	14%	19%	25%	18%	19%	19%	19%	62%	61%
String cheese	3571	15%	19%	17%	13%	23%	14%	8%	14%	16%	16%	16%	21%	16%
Cheese curds	3673	3%	5%	3%	3%	3%	4%	2%	2%	4%	4%	2%	N/A	N/A
Queso fresco or other Mexican style cheese	3652	4%	6%	4%	4%	5%	4%	2%	3%	5%	4%	5%	4%	6%
Gourmet cheese (gouda, blue, other cow, goat or sheep cheeses)	3577	7%	9%	7%	6%	3%	9%	6%	6%	7%	7%	7%	N/A‡	N/A‡
Ice cream	3405	35%	41%	35%	35%	43%	30%	42%	30%	41%	32%	32%	63%	59%
Frozen dessert treats	3098	14%	17%	15%	14%	21%	11%	13%	10%	19%	12%	11%	N/A	NA
Yogurt	3513	40%	43%	44%	35%	49%	37%	35%	39%	39%	41%	40%	45%	43%
Milk	3737	68%	69%	65%	71%	77%	63%	71%	67%	69%	67%	70%	85%	79%
Unpasteurized milk	3733	0.5%	0.6%	0.3%	0.8%	0.7%	0.4%	0.4%	0.7%	0.3%	0.8%	0.4%	2%	3%
Milk alternatives (soy, almond, rice milk)	3612	10%	12%	12%	8%	10%	11%	6%	10%	11%	9%	11%	N/A	N/A
Other dairy (cottage cheese, cream cheese, sour cream)	3389	31%	36%	33%	27%	22%	34%	34%	27%	31%	30%	36%	N/A‡	N/A‡

‡ Please refer to pages 13-15 of the FoodNet Population Survey Atlas of Exposures, 2006-2007. Question asked by population survey may not have been compatible to MN hypothesis generating form or population survey may include additional details.

MEAT / POULTRY / SEAFOOD

Food Item	Denominator	Overall %	Overall % (including maybe)	Female	Male	Age: <18	Age: 18 – 65	Age: >65	Spring	Summer	Fall	Winter	Pop Survey MN	Pop Survey National
Ground beef	3276	58%	63%	56%	60%	53%	60%	58%	56%	59%	59%	56%	52%‡	40%‡
Other beef (steak)	3429	30%	36%	28%	34%	23%	34%	32%	28%	31%	30%	33%	50%	46%
Meat from Hunting, private kill, live animal market, butcher shop	3756	22%	22%	19%	25%	23%	21%	19%	22%	22%	21%	22%	N/A‡	N/A‡
Chicken (including ground)	3394	74%	76%	75%	73%	73%	76%	66%	72%	75%	73%	75%	63%‡	65%‡
Stuffed chicken product	3706	2%	3%	2%	2%	2%	2%	2%	3%	2%	1%	2%	N/A	N/A
Turkey (including ground)	3545	23%	27%	22%	23%	20%	25%	18%	21%	23%	22%	25%	20%‡	22%‡
Pork (ham, bacon)	3337	51%	56%	46%	56%	45%	51%	61%	47%	54%	50%	47%	49%‡	43%‡
Lamb	3713	2%	2%	2%	2%	2%	2%	1%	3%	2%	2%	2%	3%	6%
Sausage	3497	27%	32%	26%	28%	27%	28%	24%	24%	28%	27%	28%	29%‡	27%‡
Other meat/poultry	3635	9%	11%	9%	10%	10%	10%	6%	7%	10%	10%	9%	N/A‡	N/A‡
Fish	3514	23%	27%	24%	22%	16%	26%	28%	23%	25%	22%	20%	14%	23%
Shrimp	3546	12%	16%	13%	11%	8%	14%	13%	13%	12%	11%	16%	24%	28%
Other seafood	3633	6%	6%	6%	5%	3%	7%	4%	7%	5%	5%	6%	N/A‡	N/A‡

‡ Please refer to pages 16-19 of the FoodNet Population Survey Atlas of Exposures, 2006-2007. Question asked by population survey may not have been compatible to MN hypothesis generating form or population survey may include additional details.

FROZEN FOODS

Food Item	Denominator	Overall %	Overall % (including maybe)	Female	Male	Age: <18	Age: 18 – 65	Age: >65	Spring	Summer	Fall	Winter	Pop Survey MN	Pop Survey National
Frozen dinners/entrees	3523	12%	15%	14%	9%	8%	13%	14%	11%	11%	13%	13%	27%	28%
Frozen pizza	3360	25%	32%	24%	27%	27%	27%	15%	25%	23%	27%	28%	41%	25%
Other frozen microwaveable foods	3547	9%	12%	10%	9%	13%	8%	7%	8%	10%	9%	11%	N/A‡	N/A‡

‡ Please refer to page 25 of the FoodNet Population Survey Atlas of Exposures, 2006-2007. Question asked by population survey may not have been compatible to MN hypothesis generating form or population survey may include additional details.

FRUITS

Food Item	Denominator	Overall %	Overall % (including maybe)	Female	Male	Age: <18	Age: 18 – 65	Age: >65	Spring	Summer	Fall	Winter	Pop Survey MN	Pop Survey National
Oranges	3565	21%	24%	22%	20%	27%	17%	25%	27%	16%	18%	32%	49%	45%
Other citrus (grapefruit, lemon, lime, tangerine)	3583	15%	18%	17%	13%	14%	16%	14%	18%	14%	12%	19%	N/A‡	N/A‡
Pears	3629	9%	11%	9%	8%	11%	6%	12%	10%	7%	8%	11%	21%	20%
Apples	3454	42%	46%	44%	40%	55%	37%	37%	40%	38%	49%	44%	65%	62%
Other tree fruit (apricot, plum, nectarine, peach)	3603	13%	16%	16%	11%	12%	12%	21%	7%	20%	11%	7%	N/A‡	N/A‡
Strawberries	3487	33%	37%	38%	27%	41%	30%	30%	32%	44%	23%	21%	46%	45%
Other berries (blue, black, raspberries)	3545	25%	28%	29%	20%	25%	25%	25%	21%	31%	20%	20%	N/A‡	N/A‡
Grapes	3471	34%	38%	36%	31%	42%	29%	38%	27%	38%	37%	28%	N/A‡	N/A‡
Bananas	3478	57%	60%	58%	57%	63%	53%	63%	60%	58%	55%	57%	76%	70%
Watermelon	3551	20%	23%	21%	18%	23%	18%	21%	11%	34%	12%	4%	27%	28%
Cantaloupe	3565	13%	17%	15%	11%	12%	12%	18%	11%	18%	11%	6%	32%	32%
Honeydew or other melon	3430	5%	6%	5%	4%	4%	5%	6%	4%	6%	4%	4%	14%	16%
Other fruit (pomegranate, kiwi, mango, pineapple)	3567	19%	22%	22%	15%	21%	18%	18%	19%	22%	17%	15%	N/A‡	N/A‡
Unpasteurized apple cider	3629	0.2%	0.7%	0.3%	0.1%	0%	0.3%	0.2%	0.1%	0.2%	0.3%	0.2%	3%	4%
Other unpasteurized juice	3624	1%	2%	1%	1%	1%	1%	1%	1%	1%	1%	2%	N/A‡	N/A‡
Other juice	3464	43%	46%	42%	45%	54%	38%	43%	43%	43%	43%	46%	N/A‡	N/A‡

‡ Please refer to pages 11-12 of the FoodNet Population Survey Atlas of Exposures, 2006-2007. Question asked by population survey may not have been compatible to MN hypothesis generating form or population survey may include additional details.

VEGETABLES

Food Item	Denominator	Overall %	Overall % (including maybe)	Female	Male	Age: <18	Age: 18 – 65	Age: >65	Spring	Summer	Fall	Winter	Pop Survey MN	Pop Survey National
Prepackaged salad	3478	23%	27%	25%	20%	16%	27%	20%	21%	24%	22%	24%	37%	39%
Iceberg	3410	28%	34%	30%	25%	17%	32%	37%	26%	29%	28%	28%	44%	46%
Romaine	3397	22%	28%	25%	19%	13%	27%	23%	22%	25%	20%	19%	39%	47%
Other lettuce/leafy greens (red leaf, radicchio, mesclun, endive)	3555	10%	13%	12%	8%	6%	13%	8%	9%	12%	9%	9%	N/A‡	N/A‡
Spinach	3535	18%	22%	20%	16%	13%	22%	12%	20%	18%	18%	17%	20%	24%
Cabbage	3572	11%	14%	13%	9%	8%	12%	17%	10%	13%	12%	9%	23%	28%
Tomatoes	3421	46%	50%	49%	43%	28%	53%	56%	39%	49%	50%	41%	49%	60%
Cucumbers	3506	25%	29%	29%	20%	20%	26%	31%	20%	29%	26%	18%	39%	47%
Peppers (green, yellow, red, jalapeno, serrano)	3493	30%	33%	30%	30%	16%	36%	31%	28%	31%	32%	25%	N/A‡	N/A‡
Asparagus	3599	9%	11%	9%	9%	4%	10%	12%	10%	10%	7%	6%	18%	21%
Celery	3524	14%	18%	18%	10%	8%	14%	29%	15%	13%	15%	17%	43%	42%
Carrots	3416	43%	48%	47%	38%	42%	42%	49%	41%	43%	42%	48%	N/A‡	N/A‡
Radishes	3639	5%	6%	5%	5%	2%	5%	12%	4%	6%	4%	4%	N/A	N/A
Pea pods/snap peas	3598	11%	13%	13%	9%	11%	11%	11%	11%	13%	10%	9%	N/A	N/A
Onions (red, white, yellow)	3413	49%	52%	49%	48%	33%	55%	56%	47%	50%	51%	43%	67%	71%
Green onions/scallions	3602	9%	11%	10%	8%	7%	9%	13%	7%	11%	8%	9%	23%	30%
Broccoli	3449	27%	31%	29%	24%	28%	26%	28%	28%	26%	27%	29%	45%	53%
Cauliflower	3524	12%	15%	14%	11%	9%	13%	20%	12%	12%	14%	12%	25%	23%
Sprouts (alfalfa, bean, radish, clover)	3610	3%	3%	3%	2%	2%	3%	1%	2%	3%	2%	2%	N/A‡	N/A‡
Micro greens	3100	0.3%	0.6%	0.3%	0.4%	0.3%	0.4%	0%	0.3%	0.4%	0.3%	0.2%	N/A	N/A
Cilantro/parsley	3504	16%	19%	16%	15%	16%	17%	8%	11%	18%	16%	12%	N/A‡	N/A‡
Other fresh herbs (basil, thyme, mint, sage)	3576	7%	9%	8%	6%	6%	8%	5%	5%	8%	7%	5%	N/A‡	N/A‡
Other vegetables	3432	24%	27%	26%	22%	23%	24%	28%	21%	25%	25%	23%	N/A‡	N/A‡

‡ Please refer to pages 7-10 of the FoodNet Population Survey Atlas of Exposures, 2006-2007. Question asked by population survey may not have been compatible to MN hypothesis generating form or population survey may include additional details.

OTHER

Food Item	Denominator	Overall %	Overall % (including maybe)	Female	Male	Age: <18	Age: 18 – 65	Age: >65	Spring	Summer	Fall	Winter	Pop Survey MN	Pop Survey National
Mushrooms	3494	17%	21%	17%	17%	8%	21%	20%	16%	15%	18%	19%	30%	34%
Tofu	3640	2%	3%	2%	2%	2%	2%	1%	2%	1%	2%	2%	4%	7%
Hummus or tahini	3617	7%	8%	8%	5%	5%	8%	3%	7%	7%	7%	5%	N/A	N/A
Nuts (almonds, pecans, walnuts, peanuts, cashews)	3403	32%	37%	33%	31%	19%	37%	40%	33%	33%	31%	30%	N/A‡	N/A‡
Sesame seeds	3562	3%	5%	3%	3%	2%	3%	2%	4%	3%	2%	4%	N/A	N/A
Other seeds (flax, sunflower, alfalfa)	3533	10%	13%	11%	9%	7%	13%	6%	10%	11%	11%	7%	N/A‡	N/A‡
Salsa	3468	21%	26%	21%	22%	13%	27%	15%	18%	23%	22%	20%	29%	28%
Avocado	3500	18%	20%	20%	15%	14%	21%	10%	17%	20%	16%	15%	16%	27%
Recently purchased spices (black pepper, white pepper, paprika, oregano, cumin)	3502	10%	13%	11%	9%	9%	11%	8%	11%	8%	9%	15%	N/A	N/A
Spice rubs or blends	3529	8%	11%	8%	9%	8%	10%	4%	7%	10%	7%	10%	N/A	N/A
Peanut butter	3435	46%	49%	45%	46%	48%	44%	47%	48%	45%	46%	43%	65%	58%
Chocolate	3238	42%	49%	46%	37%	45%	41%	41%	42%	38%	45%	48%	N/A	N/A
Trail mix	3512	11%	13%	11%	11%	10%	13%	5%	12%	11%	11%	9%	N/A	N/A
Snack foods, chips, crackers	3307	65%	68%	67%	63%	71%	64%	58%	63%	65%	68%	65%	N/A‡	N/A‡
Nutritional supplements	3563	26%	27%	29%	22%	21%	27%	32%	28%	25%	25%	26%	N/A	N/A

‡ Please refer to pages 7-10 of the FoodNet Population Survey Atlas of Exposures, 2006-2007. Question asked by population survey may not have been compatible to MN hypothesis generating form or population survey may include additional details.

RESTAURANTS‡

(Note: Cases were not asked specifically about these restaurants by name. Cases were asked if they ate at a restaurant in the 7 days prior to illness onset. If the case reported eating at a restaurant, the case was asked to name the restaurant.)

Restaurant Name	Denominator	Overall %	Female	Male	Age: <18	Age: 18 – 65	Age: >65	Spring	Summer	Fall	Winter
Applebee's	3698	1%	1%	1%	1%	1%	2%	2%	1%	1%	1%
Arby's	3698	2%	2%	1%	1%	2%	2%	3%	1%	2%	2%
Burger King	3698	3%	3%	4%	3%	4%	3%	3%	3%	3%	4%
Buffalo Wild Wings	3698	1%	1%	1%	1%	1%	0%	1%	1%	1%	0.2%
Chili's	3698	0.3%	0.3%	0.4%	0.3%	0.4%	0%	0.5%	0.3%	0.3%	0%
Chipotle	3698	3%	3%	3%	1%	4%	0.2%	3%	3%	3%	2%
Culver's	3698	2%	2%	2%	2%	1%	4%	3%	2%	1%	1%
Dairy Queen	3698	2%	2%	3%	3%	2%	2%	2%	4%	2%	1%
Denny's	3698	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.3%	0.1%	0.2%
Domino's Pizza	3698	1%	1%	1%	1%	1%	0.2%	1%	1%	1%	1%
IHOP	3698	0.2%	0.3%	0.1%	0.4%	0.2%	0%	0.1%	0.2%	0.3%	0.2%
Jimmy John's	3698	1%	1%	1%	1%	2%	0.2%	1%	2%	1%	0.4%
KFC	3698	1%	1%	1%	0.5%	1%	2%	1%	2%	2%	0.4%
McDonalds	3698	12%	12%	13%	15%	12%	8%	11%	14%	12%	11%
Noodles and Company	3698	0.3%	0.3%	0.4%	0.4%	0.3%	0.2%	0.1%	0.3%	0.4%	0.4%
Olive Garden	3698	0.5%	0.8%	0.5%	0.6%	0.8%	0.6%	0.8%	0.9%	0.7%	0%
Outback Steakhouse	3698	0.3%	0.2%	0.4%	0.1%	0.3%	0.6%	0.1%	0.4%	0%	0.6%
Papa John's Pizza	3698	0.2%	0.3%	0.2%	0.1%	0.3%	0.2%	0.4%	0.1%	0.3%	0.2%
Panera	3698	0.8%	1%	0.4%	0.4%	1%	0.6%	1%	0.7%	0.4%	1%
Perkins	3698	2%	2%	1%	1%	1%	5%	1%	2%	2%	1%
Pizza Hut	3698	1%	1%	1%	1%	1%	0.2%	1%	0.5%	1%	0.4%
Popeye's	3698	0.3%	0.2%	0.4%	0.1%	0.4%	0%	0.1%	0.3%	0.4%	0.2%
Subway	3698	7%	6%	7%	5%	8%	3%	7%	7%	7%	5%
Taco Bell	3698	2%	2%	2%	2%	3%	1%	1%	3%	2%	3%
Taco John's	3698	1%	1%	1%	0.4%	1%	0.2%	0.8%	0.9%	1.2%	0.4%
Red Lobster	3698	0.4%	0.4%	0.5%	0.2%	0.5%	0.8%	0.1%	0.3%	0.7%	0.8%
Wendy's	3698	1.4%	1.4%	1.3%	1.2%	1.5%	1.2%	1.3%	1.6%	1.1%	1.4%

‡ Please refer to page 26 of the FoodNet Population Survey Atlas of Exposures, 2006-2007. The population survey did not include restaurant names but does have data on types of foods consumed at commercial establishments.

OTHER NON-FOOD TRANSMISSION ROUTES‡

Exposure	Denominator	Overall %	Female	Male	Age: <18	Age: 18 – 65	Age: >65	Spring	Summer	Fall	Winter
International Travel	5189	18%	18%	17%	10%	23%	7%	28%	9%	13%	29%
Ill contact before onset	3812	8%	8%	7%	13%	6%	5%	8%	7%	7%	11%
Well water	3860	23%	22%	25%	22%	23%	28%	19%	25%	24%	21%
Other water (such as from a stream while camping)	3799	2%	2%	2%	3%	2%	0.2%	0.5%	3%	1%	1%
Recreational water (swim in ocean, lake, river, or pool)	3871	14%	15%	14%	24%	12%	4%	8%	24%	8%	7%
Live on Farm	3858	8%	6%	9%	8%	8%	9%	7%	8%	9%	6%
Work on Farm	3844	2%	1%	3%	1%	3%	0.4%	1%	2%	2%	1%
Visit Farm	3850	5%	4%	6%	8%	4%	3%	5%	5%	5%	3%
Visit petting zoo, educational exhibit, fair or other venue with animals	3859	4%	4%	4%	8%	3%	1%	2%	5%	6%	2%
Cow (present)	3872	7%	6%	7%	8%	6%	5%	6%	7%	8%	3%
Cow (contact)	3872	3%	2%	4%	4%	3%	2%	3%	4%	3%	2%
Goat (present)	3872	3%	3%	3%	5%	2%	1%	2%	3%	4%	2%
Goat (contact)	3872	2%	1%	2%	3%	1%	0.2%	1%	2%	2%	1%
Sheep (present)	3872	2%	2%	2%	3%	2%	2%	1%	2%	3%	1%
Sheep (contact)	3872	1%	1%	1%	1%	1%	0.4%	0.3%	1%	1%	1%
Pig (present)	3872	4%	3%	5%	5%	4%	2%	3%	4%	5%	2%
Pig (contact)	3872	2%	1%	2%	2%	2%	1%	1%	2%	3%	0.4%
Chicken (present)	3872	6%	6%	7%	10%	5%	4%	6%	6%	8%	4%
Chicken (contact)	3872	3%	3%	4%	5%	3%	3%	3%	4%	4%	2%
Turkey (present)	3872	1%	1%	2%	1%	2%	1%	1%	1%	2%	1%
Turkey (contact)	3872	1%	1%	1%	1%	1%	0.2%	1%	1%	1%	1%

‡ Please refer to pages 27-28 of the FoodNet Population Survey Atlas of Exposures, 2006-2007. Question asked by population survey may not have been compatible to MN hypothesis generating form or population survey may include additional details.

Technical Details

Exposure frequencies were calculated from *Salmonella* case interviews from 2011-2018. Six thousand seven hundred and seventy-seven laboratory confirmed *Salmonella* cases were identified during that time period. Seven hundred twenty-six (10.7%) cases were excluded because they could not be interviewed. Eight hundred sixty-two (12.2%) cases that were determined to be part of a recognized outbreak were also excluded. Finally, nine hundred and nine (13.4%) cases who reported international travel within the week prior to their illness onset were excluded.

This left 4280 cases that were included the exposure analyses. However, for each specific exposure if the case did not answer the question, they were not included in the denominator for that exposure. Additionally, cases who reported “may have eaten” were only included in the column, “Overall % (including maybe).”