

# 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 2009 through 2015. Cases were interviewed with a detailed questionnaire about exposures that occurred in the 7 days prior to their illness onset (<http://mnfoodsafetycoe.umn.edu/wp-content/uploads/2014/02/Salmonella-and-STEC-Interview-Form.pdf>).

Epidemiologists 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 at (<https://public.health.oregon.gov/DiseasesConditions/CommunicableDisease/Outbreaks/Gastroenteritis/Pages/Outbreak-Investigation-Tools.aspx#binomial>). 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 away from 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 Atlas of Exposures, 2006-2007 ([http://www.cdc.gov/foodnet/surveys/FoodNetExposureAtlas0607\\_508.pdf](http://www.cdc.gov/foodnet/surveys/FoodNetExposureAtlas0607_508.pdf)).

For more specific exposure frequencies to match the demographics of your current investigation, please contact [Joshua.rounds@state.mn.us](mailto: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	3059	67%	71%	67%	66%	61%	69%	73%	66%	67%	64%	71%	77%	75%
Shredded cheese	3021	47%	54%	49%	45%	45%	53%	27%	44%	45%	50%	52%	N/A	N/A
Processed cheese slices	3015	35%	40%	33%	38%	31%	37%	33%	32%	35%	38%	34%	57%	51%
Block cheese	3016	21%	24%	21%	21%	16%	22%	25%	20%	20%	21%	23%	62%	61%
String cheese	3014	15%	19%	16%	13%	22%	13%	8%	13%	15%	15%	17%	21%	16%
Cheese curds	3010	3%	4%	4%	3%	3%	4%	2%	3%	4%	3%	2%	N/A	N/A
Queso fresco or other Mexican style cheese	2991	3%	5%	3%	3%	4%	3%	2%	2%	4%	4%	4%	4%	6%
Gourmet cheese (gouda, blue, other cow, goat or sheep cheeses)*	2206	6%	9%	7%	5%	3%	8%	5%	5%	6%	7%	5%	N/A‡	N/A‡
Ice cream	3011	36%	42%	36%	35%	45%	30%	42%	31%	42%	33%	30%	63%	59%
Frozen dessert treats	2989	14%	17%	14%	13%	20%	11%	13%	10%	18%	11%	11%	N/A	NA
Yogurt	3013	40%	44%	44%	34%	47%	37%	36%	39%	38%	42%	41%	45%	43%
Milk	3061	72%	73%	69%	75%	79%	68%	72%	70%	71%	72%	75%	85%	79%
Unpasteurized milk	3073	0.6%	0.6%	0.5%	0.7%	0.6%	0.5%	0.8%	0.8%	0.5%	0.7%	0.2%	2%	3%
Milk alternatives (soy, almond, rice milk)*	2200	9%	10%	11%	7%	9%	10%	5%	8%	10%	8%	11%	N/A	N/A
Other dairy (cottage cheese, cream cheese, sour cream)*	2211	29%	35%	32%	27%	21%	32%	35%	24%	29%	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	3027	58%	64%	57%	59%	53%	61%	56%	54%	61%	57%	59%	52%‡	40%‡
Other beef (steak)	3014	30%	36%	26%	34%	23%	32%	34%	26%	30%	29%	36%	50%	46%
Meat from Hunting, private kill, live animal market, butcher shop	3077	22%	22%	20%	24%	22%	21%	20%	24%	21%	21%	22%	N/A‡	N/A‡
Chicken (including ground)	3051	74%	77%	74%	74%	74%	76%	62%	72%	75%	72%	78%	63%‡	65%‡
Stuffed chicken product	3014	2%	3%	2%	1%	1%	2%	3%	3%	2%	1%	2%	N/A	N/A
Turkey (including ground)	3032	24%	29%	24%	25%	21%	27%	18%	21%	25%	24%	27%	20%‡	22%‡
Pork (ham, bacon)	3040	49%	55%	46%	53%	44%	50%	60%	45%	51%	50%	50%	49%‡	43%‡
Lamb	3014	2%	2%	2%	2%	2%	2%	1%	3%	2%	2%	1%	3%	6%
Sausage	3029	27%	32%	26%	28%	27%	27%	26%	25%	28%	26%	30%	29%‡	27%‡
Other meat/poultry	2980	11%	13%	10%	13%	12%	12%	6%	10%	12%	11%	11%	N/A‡	N/A‡
Fish	3015	23%	27%	23%	22%	16%	25%	26%	23%	24%	22%	19%	14%	23%
Shrimp*	2223	11%	14%	12%	10%	8%	13%	13%	12%	9%	11%	16%	24%	28%
Other seafood*	2206	5%	5%	5%	4%	3%	6%	4%	6%	5%	4%	5%	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*	2207	12%	16%	15%	10%	9%	14%	16%	12%	11%	14%	14%	27%	28%
Frozen pizza*	2206	26%	33%	26%	26%	30%	26%	16%	27%	24%	26%	28%	41%	25%
Other frozen microwaveable foods*	2188	9%	12%	9%	9%	12%	8%	5%	7%	9%	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	3000	21%	25%	22%	20%	28%	17%	25%	29%	15%	18%	33%	49%	45%
Other citrus (grapefruit, lemon, lime, tangerine)	2997	13%	16%	15%	11%	11%	15%	10%	17%	11%	12%	16%	N/A‡	N/A‡
Pears	2999	9%	12%	10%	9%	12%	7%	12%	12%	7%	9%	12%	21%	20%
Apples	3008	42%	46%	44%	39%	54%	37%	37%	41%	35%	50%	46%	65%	62%
Other tree fruit (apricot, plum, nectarine, peach)	2995	14%	16%	15%	12%	12%	12%	23%	6%	21%	12%	7%	N/A‡	N/A‡
Strawberries	2996	31%	36%	37%	25%	37%	28%	32%	32%	42%	22%	19%	46%	45%
Other berries (blue, black, raspberries)	2993	21%	25%	24%	17%	20%	22%	22%	17%	29%	17%	15%	N/A‡	N/A‡
Grapes	2992	36%	40%	39%	32%	42%	31%	40%	29%	39%	39%	31%	N/A‡	N/A‡
Bananas	3004	59%	62%	60%	57%	62%	55%	66%	60%	58%	57%	61%	76%	70%
Watermelon	2993	19%	22%	20%	18%	22%	17%	20%	10%	32%	13%	4%	27%	28%
Cantaloupe	2993	15%	19%	17%	12%	14%	14%	19%	12%	20%	12%	8%	32%	32%
Honeydew or other melon*	2205	5%	7%	6%	4%	4%	6%	4%	4%	6%	4%	4%	14%	16%
Other fruit (pomegranate, kiwi, mango, pineapple)*	2999	19%	22%	23%	14%	21%	19%	14%	19%	22%	16%	15%	N/A‡	N/A‡
Unpasteurized apple cider*	2187	0.2%	0.6%	0.3%	0.1%	0%	0.3%	0.4%	0.2%	0.1%	0.4%	0.3%	3%	4%
Other unpasteurized juice*	2182	0.9%	1.1%	0.8%	1%	1%	1%	0.4%	1%	1%	0.5%	1%	N/A‡	N/A‡
Other juice*	2203	45%	48%	44%	47%	58%	39%	44%	45%	45%	44%	49%	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	3001	23%	28%	25%	21%	17%	27%	20%	23%	25%	22%	23%	37%	39%
Iceberg	2978	29%	35%	31%	26%	18%	33%	38%	27%	30%	30%	28%	44%	46%
Romaine*	2209	20%	26%	22%	18%	14%	24%	20%	20%	23%	18%	17%	39%	47%
Other lettuce/leafy greens (red leaf, radicchio, mesclun, endive)*	2201	8%	10%	10%	6%	5%	10%	7%	7%	9%	8%	8%	N/A‡	N/A‡
Spinach	2991	15%	19%	18%	12%	13%	18%	11%	18%	16%	14%	13%	20%	24%
Cabbage	2992	10%	14%	11%	9%	7%	11%	16%	10%	10%	13%	7%	23%	28%
Tomatoes	3000	46%	50%	49%	42%	27%	53%	56%	38%	48%	52%	39%	49%	60%
Cucumbers	2994	23%	27%	27%	18%	18%	25%	28%	17%	27%	26%	15%	39%	47%
Peppers (green, yellow, red, jalapeno, serrano)	2986	27%	31%	26%	28%	15%	34%	26%	22%	29%	29%	24%	N/A‡	N/A‡
Asparagus	2985	8%	10%	8%	8%	4%	10%	12%	10%	9%	7%	6%	18%	21%
Celery	2987	14%	18%	17%	10%	8%	14%	31%	14%	13%	15%	17%	43%	42%
Carrots	3000	43%	47%	46%	38%	42%	42%	48%	40%	42%	43%	48%	N/A‡	N/A‡
Radishes	2980	5%	6%	5%	5%	1%	5%	11%	3%	6%	4%	3%	N/A	N/A
Pea pods/snap peas	2985	10%	12%	12%	8%	10%	10%	9%	9%	12%	9%	7%	N/A	N/A
Onions (red, white, yellow)	2979	47%	51%	47%	47%	32%	53%	57%	44%	48%	49%	46%	67%	71%
Green onions/scallions	2959	9%	11%	9%	8%	7%	9%	12%	7%	10%	8%	9%	23%	30%
Broccoli	2981	25%	31%	27%	23%	26%	25%	27%	25%	24%	27%	28%	45%	53%
Cauliflower	2192	11%	14%	12%	10%	8%	11%	18%	12%	10%	12%	11%	25%	23%
Sprouts (alfalfa, bean, radish, clover)	2196	2%	3%	2%	2%	2%	3%	1%	2%	3%	3%	1%	N/A‡	N/A‡
Micro greens*	2018	0.4%	0.75%	0.3%	0.6%	0.5%	0.4%	0%	0.5%	0.4%	0.4%	0.4%	N/A	N/A
Cilantro/parsley*	2198	15%	18%	16%	14%	15%	16%	7%	9%	17%	18%	11%	N/A‡	N/A‡
Other fresh herbs (basil, thyme, mint, sage)	2974	7%	10%	8%	7%	6%	9%	4%	7%	8%	8%	6%	N/A‡	N/A‡
Other vegetables*	2137	21%	25%	23%	18%	21%	20%	27%	16%	23%	22%	21%	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	2983	16%	21%	15%	16%	8%	20%	16%	16%	14%	17%	17%	30%	34%
Tofu	2971	2%	2%	2%	1%	2%	2%	1%	2%	1%	2%	1%	4%	7%
Hummus or tahini	2967	6%	7%	7%	4%	5%	7%	2%	6%	6%	7%	4%	N/A	N/A
Nuts (almonds, pecans, walnuts, peanuts, cashews)	2978	31%	36%	33%	29%	20%	36%	37%	30%	31%	30%	33%	N/A‡	N/A‡
Sesame seeds*	2181	3%	5%	3%	3%	2%	3%	3%	4%	3%	1%	4%	N/A	N/A
Other seeds (flax, sunflower, alfalfa)	2186	10%	12%	11%	9%	7%	13%	6%	10%	11%	10%	8%	N/A‡	N/A‡
Salsa	2972	23%	27%	23%	23%	16%	28%	15%	16%	25%	26%	22%	29%	28%
Avocado*	2183	16%	20%	19%	13%	12%	20%	9%	15%	18%	16%	15%	16%	27%
Recently purchased spices (black pepper, white pepper, paprika, oregano, cumin)*	2161	15%	18%	15%	14%	14%	15%	12%	17%	12%	12%	22%	N/A	N/A
Spice rubs or blends*	2173	10%	13%	10%	11%	10%	12%	4%	8%	12%	8%	14%	N/A	N/A
Peanut butter	2981	46%	50%	46%	46%	50%	44%	47%	47%	46%	47%	44%	65%	58%
Chocolate	2962	45%	52%	49%	40%	49%	43%	41%	43%	41%	50%	50%	N/A	N/A
Trail mix*	2170	7%	10%	7%	7%	6%	8%	4%	8%	6%	7%	7%	N/A	N/A
Snack foods, chips, crackers*	2183	66%	69%	67%	65%	74%	63%	59%	66%	65%	68%	64%	N/A‡	N/A‡
Nutritional supplements*	2169	30%	31%	34%	26%	24%	31%	41%	33%	29%	31%	27%	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	3058	2%	2%	1%	1%	2%	2%	2%	1%	2%	1%
Arby's	3058	2%	2%	2%	1%	2%	2%	2%	2%	1%	2%
Burger King	3058	5%	5%	5%	4%	5%	3%	3%	6%	4%	5%
Buffalo Wild Wings	3058	1%	0.3%	1%	1%	0.5%	0%	0.1%	1%	1%	1%
Chili's	3058	0.3%	0.3%	0.3%	0.2%	0.4%	0%	0.6%	0.2%	0.3%	0%
Chipotle	3058	3%	3%	3%	1%	4%	1%	2%	3%	3%	2%
Culver's	3058	2%	2%	2%	2%	1%	4%	2%	2%	1%	2%
Dairy Queen	3058	3%	3%	4%	3%	3%	3%	2%	5%	3%	1%
Denny's	3058	0.4%	0.4%	0.4%	0.3%	0.4%	0.5%	0.5%	0.6%	0.1%	0.2%
Domino's Pizza	3058	1%	1%	1%	1%	1%	0%	1%	1%	1%	0.2%
IHOP	3058	0.1%	0.2%	0%	0.1%	0.2%	0%	0%	0.1%	0.1%	0.5%
Jimmy John's	3058	2%	1%	2%	1%	2%	0.3%	1%	2%	2%	0.2%
KFC	3058	2%	2%	1%	1%	2%	2%	1%	2%	2%	1%
McDonalds	3058	15%	14%	15%	20%	13%	10%	14%	16%	14%	13%
Noodles and Company	3058	0.3%	0.4%	0.3%	0.4%	0.3%	0.3%	0.2%	0.4%	0.5%	0%
Old Country Buffet	3058	1%	1%	1%	1%	1%	2%	1%	1%	1%	0.5%
Olive Garden	3058	1%	1%	0.5%	1%	1%	1%	1%	1%	1%	1%
Outback Steakhouse	3058	0.3%	0.4%	0.3%	0.3%	0.4%	0.3%	0.5%	0.3%	0.1%	0.5%
Papa John's Pizza	3058	0.4%	0.5%	0.3%	0.3%	0.5%	0%	0.3%	0.2%	1%	0.5%
Panera	3058	1%	1%	0.4%	0.1%	1%	1%	1%	1%	1%	1%
Perkins	3058	2%	3%	2%	2%	2%	7%	2%	2%	3%	3%
Pizza Hut	3058	1%	1%	1%	1%	1%	0.3%	2%	1%	1%	1%
Popeye's	3058	0.2%	0.2%	0.2%	0.1%	0.3%	0%	0.2%	0.1%	0.3%	0.5%
Subway	3058	8%	8%	8%	6%	9%	4%	8%	9%	7%	6%
Taco Bell	3058	3%	3%	2%	2%	3%	1%	2%	3%	2%	3%
Taco John's	3058	1%	1%	1%	1%	1%	0%	0.5%	1%	2%	0.2%
Red Lobster	3058	0.6%	0.4%	0.7%	0.2%	0.7%	0.8%	0.2%	0.6%	0.8%	0.5%
Wendy's	3058	2%	3%	2%	2%	3%	2%	2%	3%	2%	3%

‡ 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	4041	16%	16%	16%	11%	20%	5%	24%	8%	12%	27%
Ill contact before onset	3083	9%	8%	9%	13%	6%	7%	8%	9%	8%	10%
Well water*	2352	24%	22%	27%	23%	23%	29%	20%	26%	25%	22%
Other water (such as from a stream while camping)*	2295	2%	2%	2%	3%	2%	0%	0.2%	4%	1%	1%
Recreational water (swim in ocean, lake, river, or pool)	3159	14%	13%	15%	24%	12%	3%	9%	24%	8%	6%
Live on Farm*	2359	8%	6%	10%	8%	7%	9%	8%	8%	9%	5%
Work on Farm*	2359	2%	1%	3%	1%	3%	1%	2%	2%	2%	2%
Visit Farm*	2359	4%	4%	5%	6%	4%	1%	5%	4%	5%	2%
Visit petting zoo, educational exhibit, fair or other venue with animals*	2356	4%	4%	4%	8%	3%	1%	2%	5%	6%	2%
Cow (present)*	2359	4%	4%	4%	6%	4%	1%	3%	5%	5%	1%
Cow (contact)*	2359	2%	2%	3%	2%	2%	0.3%	1%	2%	2%	0.3%
Goat (present)*	2359	3%	2%	3%	5%	2%	0.3%	2%	3%	4%	1%
Goat (contact)*	2359	1%	1%	2%	3%	1%	0%	1%	1%	3%	0%
Sheep (present)*	2359	1%	2%	1%	3%	1%	1%	1%	1%	2%	1%
Sheep (contact)*	2359	1%	1%	1%	1%	0.5%	0%	0.2%	1%	1%	0.3%
Pig (present)*	2359	3%	2%	3%	4%	2%	0.3%	2%	3%	4%	1%
Pig (contact)*	2359	1%	1%	1%	1%	1%	0%	1%	1%	2%	0%
Chicken (present)*	2359	3%	3%	3%	5%	3%	0.3%	3%	3%	4%	1%
Chicken (contact)*	2359	1%	1%	1%	2%	1%	0%	1%	1%	2%	1%
Turkey (present)*	2359	1%	1%	1%	1%	1%	0%	1%	1%	1%	1%
Turkey (contact)*	2359	1%	1%	1%	1%	0.4%	0%	1%	1%	0.3%	0%

‡ 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.

\* Question added in 2011 (data only available for 2011-2015)



## **Technical Details**

Exposure frequencies were calculated from *Salmonella* case interviews from 2009-2015. Five thousand two hundred and sixty-one laboratory confirmed *Salmonella* cases were identified during that time period. Five hundred and ninety-five (11.3%) cases were excluded because they could not be interviewed. Five hundred eighty-six (12.6%) cases that were determined to be part of a recognized outbreak were also excluded. Finally, six hundred thirty-nine (15.8%) cases who reported international travel within the week prior to their illness onset were also excluded.

This left 3402 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).”