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Looking for food safety data in all the right places: using big data and other sources for decision making

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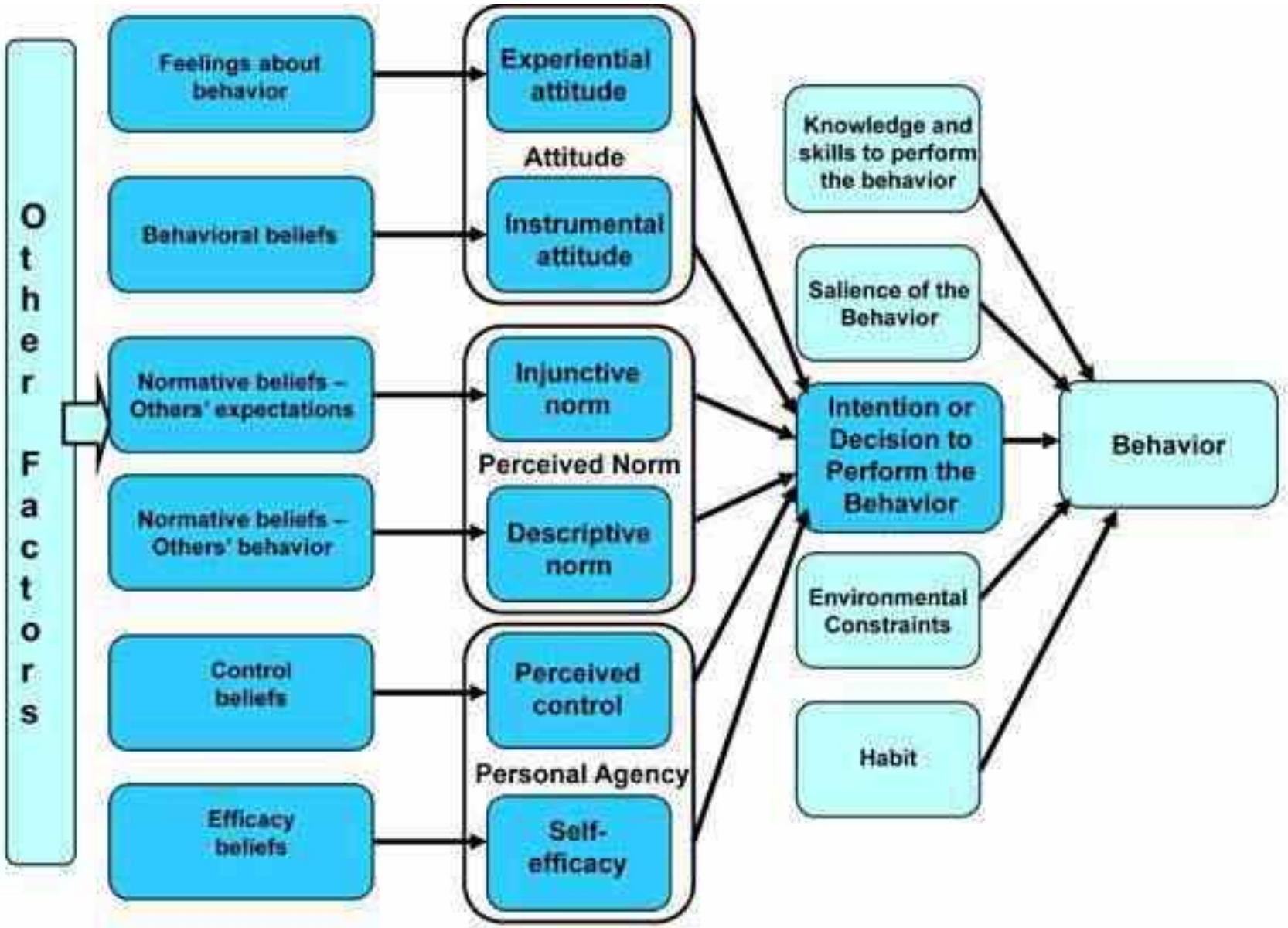
Other Factors
Feelings about behavior
Behavioral beliefs
Normative beliefs – Others' expectations
Normative beliefs – Others' behavior
Control beliefs
Efficacy beliefs
Experiential attitude
Attitude
Instrumental attitude
Injunctive norm
Perceived Norm
Descriptive norm
Perceived control
Personal Agency
Self-efficacy
Knowledge and skills to perform the behavior
Salience of the Behavior
Intention or Decision to Perform the Behavior
Environmental Constraints
Habit
Behavior

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Consumer Test Kitchen

Initiatives include:

- Hands-on **training** for field faculty on food preparation and food preservation
- **Video** streaming for field faculty and consumers on time sensitive foods and nutrition issues
- Research in the area of consumer food behaviors including **consumer observation**
- Research in the area of **recipe development** for consumers including food preservation


Need to know the science
What data do we have?

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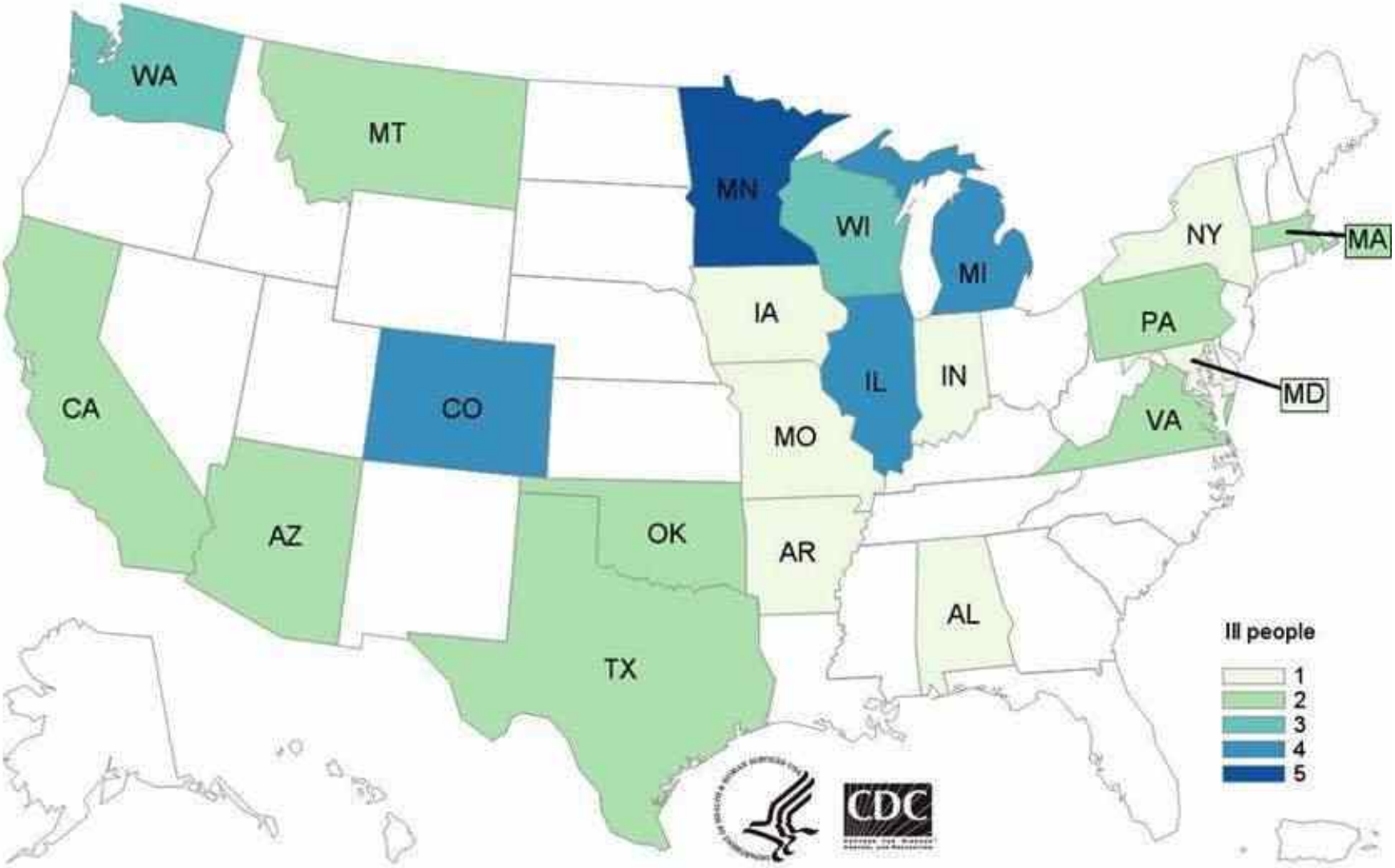
What data do we have?

- Outbreak data (limited)
- Consumption/ handling data
- Industry data (limited, restricted access)
- Literature
  - Generic *E. coli* species have been found in flour (multiple studies)
  - A survey conducted on wheat and flour milling in Australia showed no detectable *Salmonella*, 3.0 MPN/g of generic *E. coli* and 0.3 MPN/g of B. cereus recovered on average from 650 samples (from two mills)
  - 1 US study found generic *E. coli* in 12.8% of commercial wheat flour samples examined. (Sperber et al., 2007)


WA
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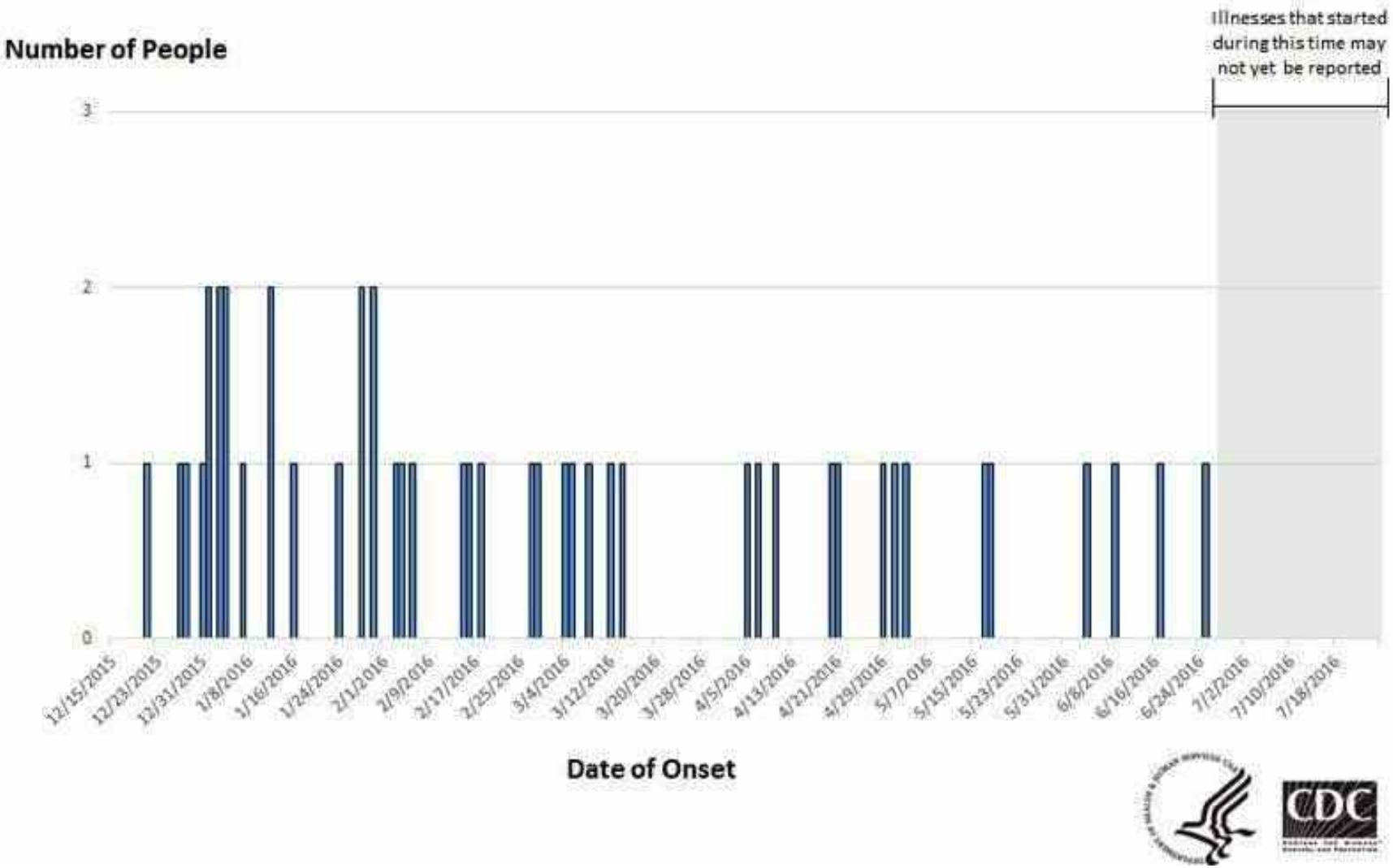
CDC



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Change in Handling/ Consumption

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Third-Party Audit Data

- Eight grocery store companies
- Continental United States and Canada
- Data spans 2009-2015
- 72,278 unique store visits
- 11,148,295 data points/observations

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Handwashing violations by department

Dept	Bakery	Deli	General	Meat	Produce	Seafood	Other
Pass	55908	58824	55567	77696	96830	41839	19456
Violation	1997	3693	177	2545	3984	1435	457
Prop. of violation	0.034	0.059	0.003	0.032	0.040	0.033	0.023

$p = 0$

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Handwashing violations by geographic location

Division	E. N. Cent.	W. N. Cent.	Mid-Atlan.	N. Eng	E. S. Cent.	S. Atlan.	W. S. Cent.	Mtn.	Pacif.
Pass	47750	9841	7486	10132	27739	115337	19216	48014	63793
Violation	2973	377	78	282	1079	2596	765	1653	2056
Prop.	0.062	0.038	0.010	0.028	0.039	0.023	0.040	0.034	0.032

$p = 1e^{-16}$

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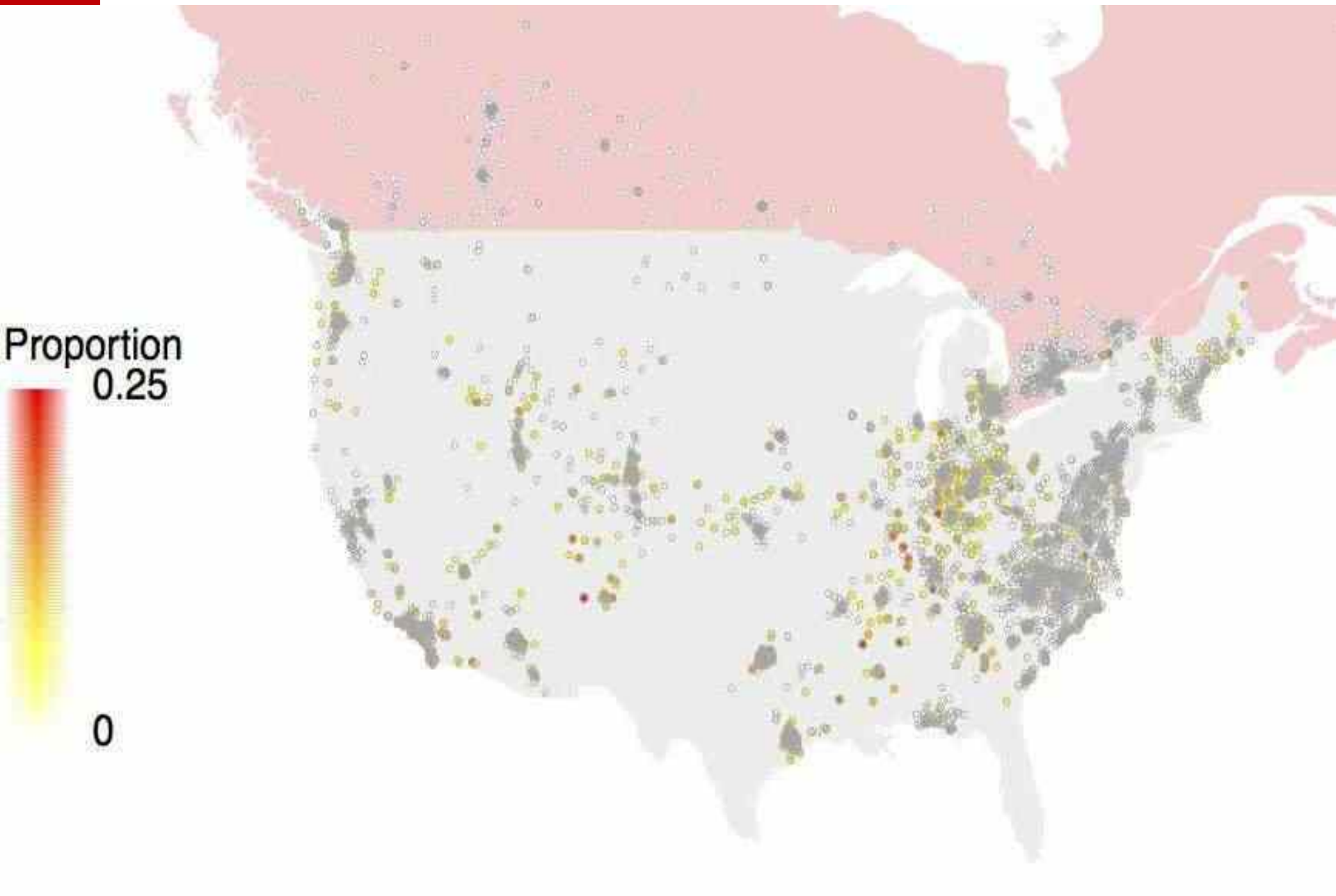

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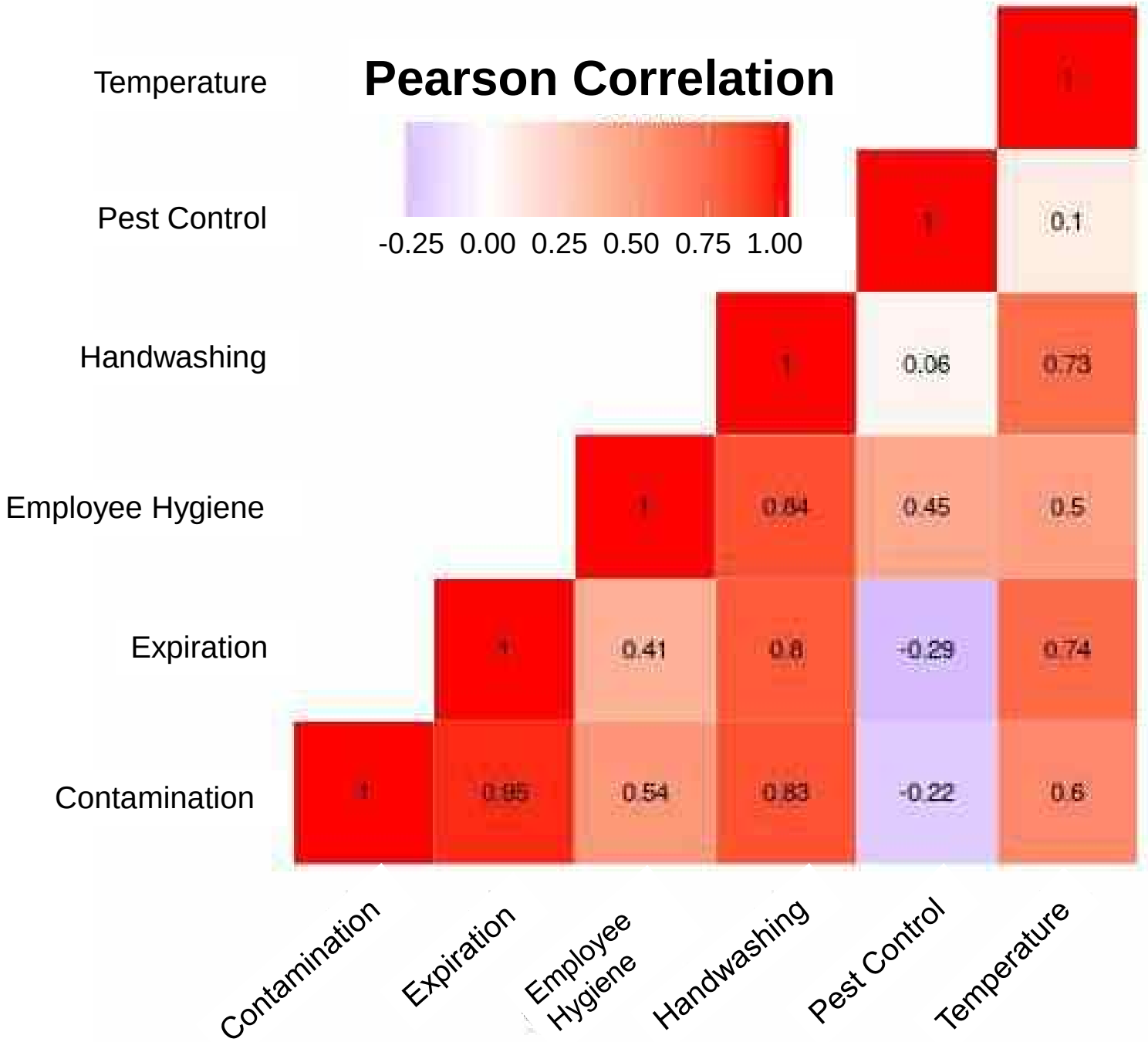
Temperature violations by department

Dept	Bakery	Deli	General	Meat	Produce	Seafood	Other
Pass	17627	152831	68418	62665	133830	56095	18320
Violation	47	9473	1482	1255	5613	1018	463
Prop. of violation	0.003	0.058	0.021	0.020	0.040	0.023	0.025

$p = 0$


Pearson Correlation
-0.25 0.00 0.25 0.50 0.75 1.00
Temperature
Pest Control
Handwashing
Employee Hygiene
Expiration
Contamination
1
0.1
0.06
0.73
0.64
0.45
0.5
0.41
0.8
-0.29
0.74
0.85
0.54
0.83
-0.22
0.6
Contamination
Expiration
Employee Hygiene
Handwashing
Pest Control
Temperature

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Ranking the Disease Burden of 14 Pathogens in Food Sources in the United States Using Attribution Data from Outbreak Investigations and Expert Elicitation†

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ABSTRACT

Understanding the relative public health impact of major microbiological hazards across the food supply is critical for a risk-based national food safety system. This study was conducted to estimate the U.S. health burden of 14 major pathogens in 12 broad categories of food and to then rank the resulting 168 pathogen-food combinations. These pathogens examined were *Campylobacter*, *Clostridium perfringens*, *Escherichia coli* O157:H7, *Listeria monocytogenes*, norovirus, *Salmonella enterica*, *Toxoplasma gondii*, and all other FoodNet pathogens. The health burden associated with each pathogen was measured using new estimates of the cost of illness and loss of quality-adjusted life years (QALYs) from acute and chronic illness and mortality. A new method for attributing illness to foods was developed that relies on both outbreak data and expert elicitation. This method assumes that empirical data are generally preferable to expert judgment; thus, outbreak data were used for attribution except where evidence suggests that these data are considered not representative of food attribution. Based on evaluation of outbreak data, expert elicitation, and published scientific literature, outbreak-based attribution estimates for *Campylobacter*, *Toxoplasma*, *Cryptosporidium*, and *Yersinia* were determined not representative; therefore, expert-based attribution were included for these four pathogens. Sensitivity analyses were conducted to assess the effect of attribution data assumptions on rankings. Disease burden was concentrated among a relatively small number of pathogen-food combinations. The top 10 pairs were responsible for losses of over $8 billion and 36,000 QALYs, or more than 50% of the total across all pairs. Across all 14 pathogens, poultry, pork, produce, and complex foods were responsible for nearly 60% of the total cost of illness and loss of QALYs.

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TABLE 6. *Estimated annual disease burden for top 50 pathogen-food combinations, by combined QALY and cost of illness ranking*[a]

Rank	Pathogen-food combination	Cost of illness ($million)	QALY loss	No. of illnesses	No. of hospitalizations	No. of deaths
1	*Campylobacter*-poultry	1,257 (606–2,988)	9,541 (5,753–18,730)	608,231 (242,588–1,159,624)	6,091 (3,095–10,960)	55 (0–239)
2	*T. gondii*–pork	1,219 (723–1,819)	4,495 (2,471–6,875)	35,537 (26,590–45,879)	1,815 (1,080–2,736)	134 (82–198)
3	*L. monocytogenes*–deli meats	902 (71–2,433)	3,281 (536–8,234)	357 (195–1,106)	509 (182–1,056)	89 (0–257)
4	*S. enterica*–poultry	693 (33–1,797)	3,513 (64–9,290)	215,109 (134,979–351,621)	4,048 (1,789–7,848)	79 (0–212)
5	*L. monocytogenes*–dairy	773 (61–2,086)	2,812 (459–7,058)	477 (167–948)	437 (156–905)	77 (0–220)
5	Norovirus–complex foods	911 (519–1,432)	2,288 (1,319–3,565)	2,485,694 (1,468,679–3,781,737)	6,673 (3,685–10,615)	68 (38–108)
7	*S. enterica*–complex foods	618 (30–1,604)	3,135 (57–8,290)	191,944 (120,443–313,754)	3,612 (1,596–7,003)	71 (0–189)
8	*S. enterica*–produce	581 (28–1,507)	2,946 (53–7,790)	180,361 (113,175–294,821)	3,394 (1,500–6,580)	66 (0–177)
8	*T. gondii*–beef	689 (409–1,028)	2,541 (1,396–3,888)	20,086 (15,029–25,931)	1,026 (610–1,546)	76 (46–112)
10	*S. enterica*–eggs	389 (19–1,009)	1,973 (36–5,217)	120,792 (75,796–197,449)	2,273 (1,004–4,407)	44 (0–119)
11	*L. monocytogenes*–complex foods	387 (31–1,043)	1,406 (230–3,529)	239 (84–474)	218 (78–453)	38 (0–110)
12	*S. enterica*–beef	229 (11–595)	1,162 (21–3,073)	71,152 (44,647–116,305)	1,339 (592–2,596)	26 (0–70)
13	*S. enterica*–pork	218 (11–567)	1,108 (20–2,930)	67,842 (42,570–110,896)	1,277 (564–2,475)	25 (0–67)
14	Norovirus–produce	313 (178–492)	786 (453–1,225)	854,457 (504,858–1,299,972)	2,294 (1,267–3,649)	23 (13–37)
15	*S. enterica*–dairy	187 (9–484)	946 (17–2,501)	57,914 (36,341–98,667)	1,090 (482–2,113)	21 (0–57)
16	*Y. enterocolitica*–pork	180 (3–1,010)	1,013 (9–5,880)	69,889 (21,748–123,620)	381 (0–839)	21 (0–124)
17	*T. gondii*–produce	209 (124–312)	772 (424–1,181)	6,104 (4,567–7,880)	312 (185–470)	23 (14–34)
18	*V. vulnificus*–seafood	291 (154–460)	557 (294–882)	96 (60–139)	93 (53–139)	36 (19–57)
19	*Campylobacter*-dairy	136 (66–324)	1,034 (623–2,029)	65,886 (26,278–125,615)	660 (335–1,187)	6 (0–26)
19	*S. enterica*–seafood	176 (8–456)	892 (16–2,358)	54,605 (34,264–89,358)	1,028 (454–1,992)	20 (0–54)

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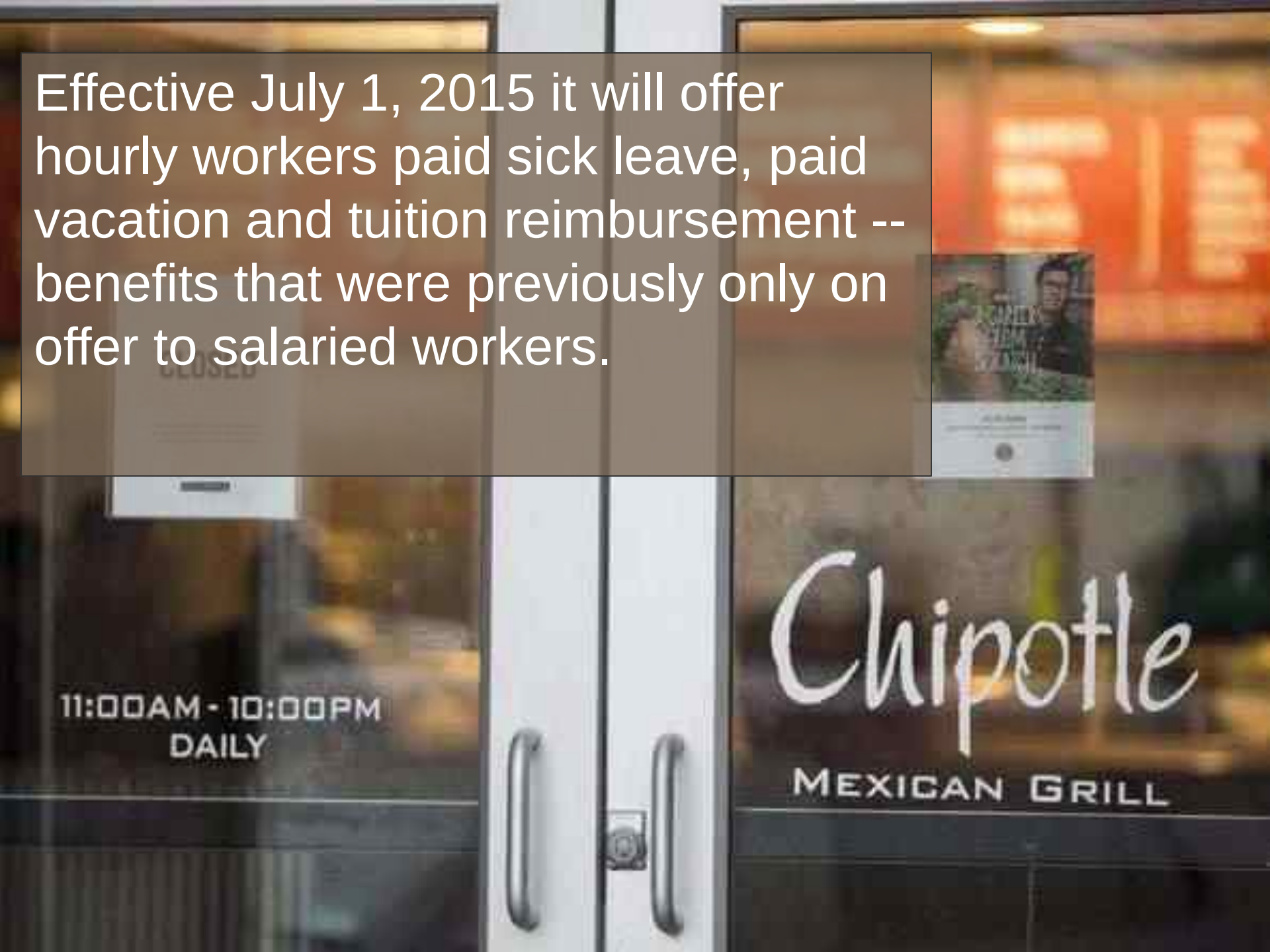
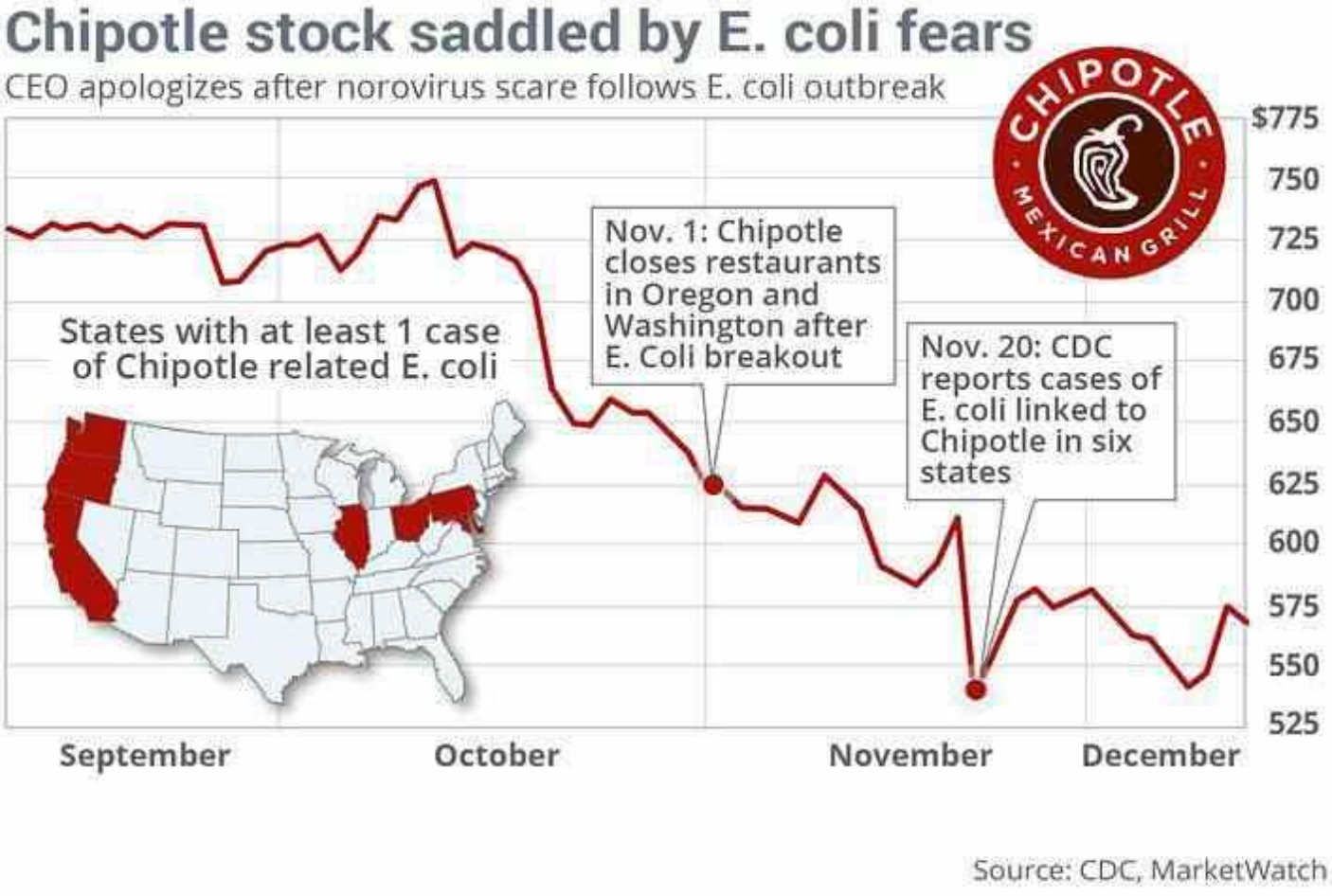
What About Costs?

- Pew studied costs of foodborne illnesses in the United States to be $152 billion per year.
- This study based the estimate on the costs of acute foodborne illnesses and a few long-term health-related costs
- Average cost of a foodborne outbreak to an establishment is about $75,000 (Fraser, 2006)



Effective July 1, 2015 it will offer hourly workers paid sick leave, paid vacation and tuition reimbursement -- benefits that were previously only on offer to salaried workers.


Chipotle stock saddled by E. coli fears
CEO apologizes after norovirus scare follows E. coli outbreak
CHIPOTLE
MEXICAN GRILL
States with at least 1 case of Chipotle related E. coli
Nov. 1: Chipotle closes restaurants in Oregon and Washington after E. Coli breakout
Nov. 20: CDC reports cases of E. coli linked to Chipotle in six states
$775
750
725
700
675
650
625
600
575
550
525
September
October
November
December
Source: CDC, MarketWatch

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Cost of Illnesses in North Carolina

Pathogen	Number of Cases in NC (avg. 2008-2011)	Cost per Case*	Cost per Year Sub-Total	Additional Cost per Death	Sub-Total Cost for Death Cases**	Total Cost in NC per Year
Hepatitis A virus	187	$5,187	$969,969	$32,814	$65,628	$1,035,597
***Shigella* spp.**	307	$9,548	2,931,236	$558	$1,674	$2,932,910
Shiga-toxin producing Escerichia coli (STEC) 0157:H7	145	$2,349	$340,605	$8,097	$8,097	$348,702
***Salmonella* Typhi**	2286	12,421	$28,394,406	$2,697	$62,031	$28,456,437
Norovirus	19,000***	$595	$11,305,000	$200	$38,000	$11,343,000
Total						**$44,116,646**

* Cost per case includes cost of medical care, loss of productivity of the ill person and caregiver, and quality of life loss

** Cost per death assumes 1% of cases in NC result in death

*** The Division of Public health estimates 1,900,000 cases of norovirus per year. If 1% is attributed to food service establishment transmission, then the total number of cases in NC is 19,000.

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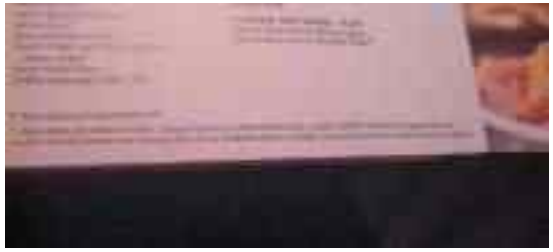
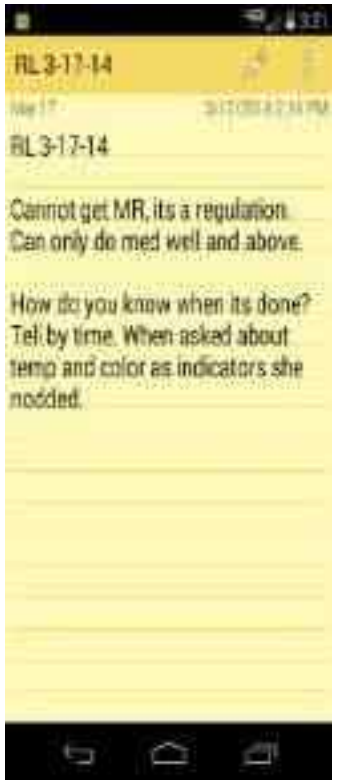
Table 1. Summary of Costs and Benefits from the Proposed Rule Changes

Costs	Year 1	Year 2	Year 3	Year 4
Industry	$5,517,400			$855,600
State Government	$400			
Local Government	$1,299,300			$74,400
Unquantifiable Costs	Yes	Yes	Yes	Yes
Total Costs	**$6,817,100**	**$0**	**$0**	**$930,000**
4-year NPV of Costs	**$7,080,614**			
Benefits				
Industry	$182,200	$182,200	$182,200	$182,200
State Government	-	-	-	-
Local Government	$15,800	$15,800	$15,800	$15,800
Public	$1,578,900	$1,578,900	$1,578,900	$1,578,900
Unquantifiable Benefits	Yes	Yes	Yes	Yes
Total Benefits	**$1,776,900**	**$1,776,900**	**$1,776,900**	**$1,776,900**
4-year NPV of Benefits	**$6,018,736**			

Data Collection: Secret Shopper Project

- 260 restaurants randomly selected in 7 states
- 2 types of restaurants: chain and independently owned
- Ordered 2 burgers to go (medium rare and well done)





Examples of Server Responses

"Eating medium rare burgers is perfe and not a pro Told us a st sister eating browned beef (middle) while she was pregnant and she is just fine.

Assurance of safety, even for at-risk groups

"Medium rare safe. It will cooked to 135."

Temperature mentioned, but not safe

"The ingredie good quality and so not risky…as long as the outside of the burger is cooked it is safe because that is where most of the bad bacteria is."

Incorrect information about meat

was actuall ou about th remind you t is a risk when you order undercooked food. You can still get medium rare, just need to let you know about that."

Good risk communication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FARMS
CANTALOUPE
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Is a consumer advisory for handling cantaloupes prudent?

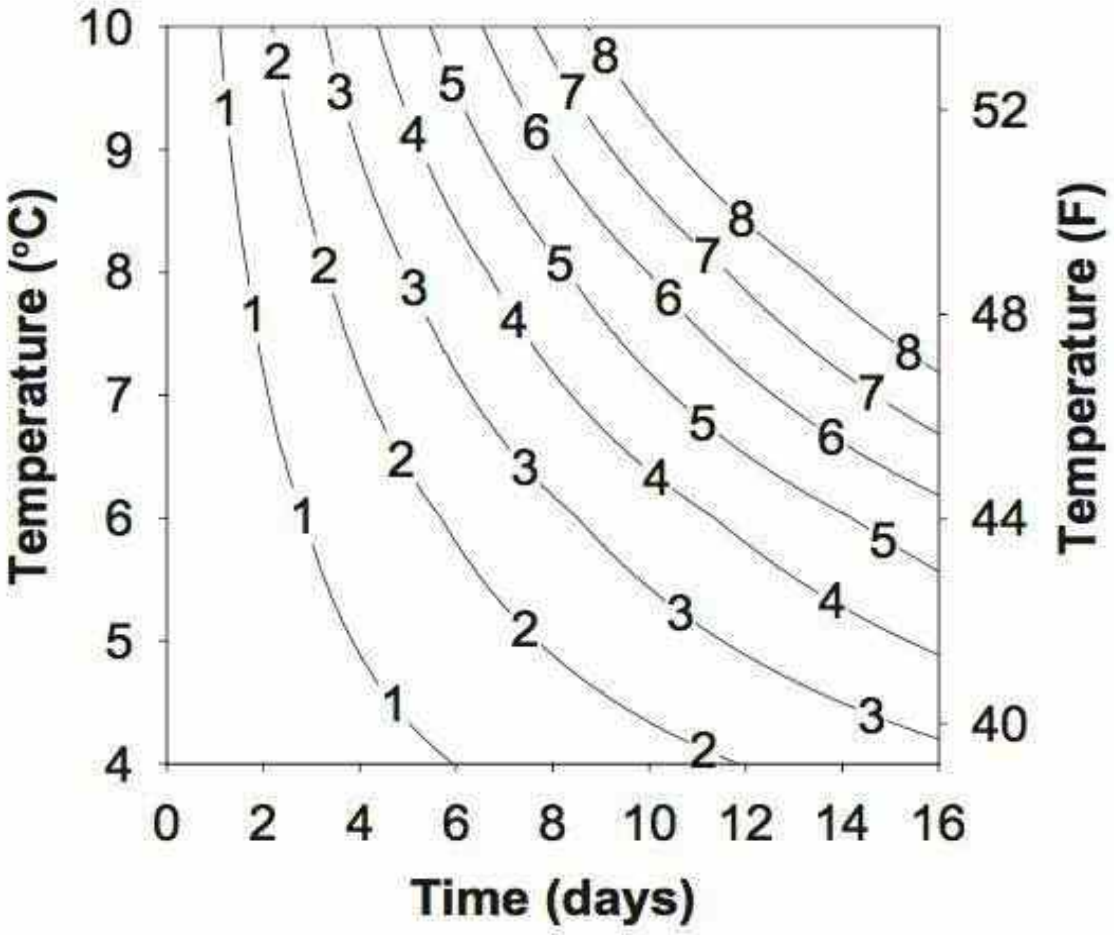

Fig. 3. Effect of storage time (*x*-axis) and temperature (*y*-axis) on the predicted log CFU/g increase of *L. monocytogenes* populations (contour lines) on cut melons.

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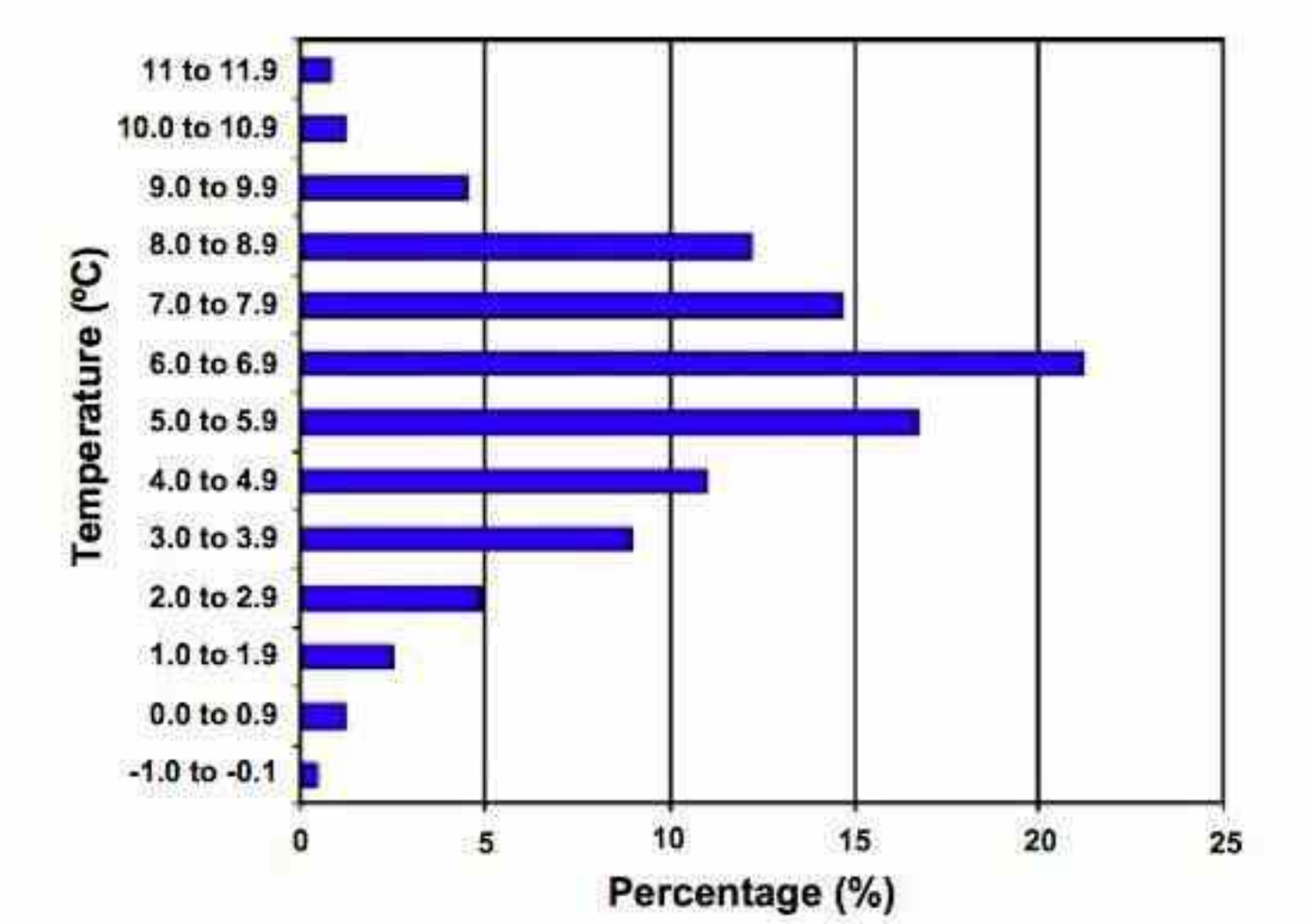
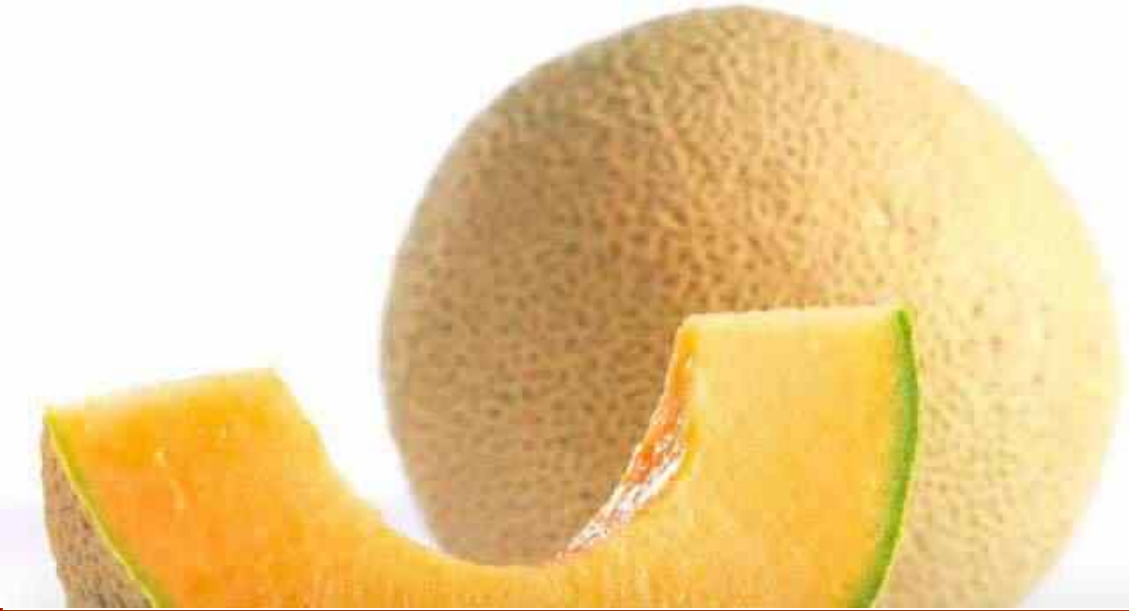
Kosa, 2007: 11% of all respondents had a thermometer



California cantaloupes:

http://www.californiacantaloupes.com/our-fruit/storing-and-preparing

University scientists recommend that melons should be washed under running tap water before cutting. If desired, a scrub brush can be used on the melon rind. Melons, like all fresh produce, must be strictly separated from all potential contact with food items such as raw chicken, meat, seafood and eggs. Food preparers should thoroughly wash their hands, utensils, countertops and cutting boards. Do not store cut cantaloupe at room temperature for any length of time. Sliced melon should be stored in the refrigerator until it is ready to be eaten.



Store cantaloupes in the refrigerator but do not freeze.

Cut cantaloupes only when you are ready to eat

Cut cantaloupes should be wrapped tightly in plastic wrap and put back in the refrigerator immediately

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What's Next?

- Explore under utilized data sets and sources
  - Census and socioeconomic data
  - Social media and trends in consumption
  - Geographic trends
- Move to a holistic approach to addressing food safety problems

We have the data…we just need to fit it together

Illnesses are preventable

People have control

Show them how

Explain the why

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Thank You

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