

Food contamination incidents: what do consumers seek online? Who cares?

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- *Consumers can play an active role in managing their health during food contamination incidents. With the popularity of the internet, consumers may seek online information to minimize health risks associated with the incidents. This study examines information demand and supply for consumers' online-information seeking by investigating the search queries commonly used by consumers during the incidents and returned first page search results. We use a stage of change model to frame our hypotheses about information demand and stakeholder and agenda setting theories to frame our hypotheses about information supply. Results show that consumers' information seeking may progress through stages of precontemplation (seeking no special information), contemplation (seeking information related to the facts of the incidents), preparation and action (seeking information related to safety precautions and practices), and maintenance and termination (seeking no special information). Mainstream news media play the most important role in providing online information related to the facts of the incidents during the contemplation stage of consumers' information seeking. Online citizen journalism is the major online source for information related to safety precautions and practices during the preparation and action stage of information seeking. A diversity of other stakeholders also provide online information related to the incidents but are not primary information sources for consumers. We suggest that stakeholders, especially those who are responsible for providing accurate and timely information to consumers such as government agencies, establish online marketing strategies to make their information more accessible by consumers. Copyright © 2016 John Wiley & Sons, Ltd.*

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Introduction

In the USA, foodborne diseases have been estimated to cause 6 million to 81 million illnesses and up to

9000 deaths each year (Todd, 1989; Foegeding *et al.*, 1994). Because of the prevalence and severity of foodborne diseases, to minimize health risk associated with food contamination incidents, it is important for consumers to be aware of and take adequate self-protective actions, including seeking information.

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Online information seeking has attracted growing attention from researchers in recent years. Extant research in this emerging field has followed two lines: (1) information demand and (2) information supply. Research on information demand has focused on search query formulation strategies and the correlation of search volume patterns and public behavior (Jansen, Spink, Bateman, & Saracevic, 1998; Lucas & Topi, 2002). For instance, researchers in medical informatics have found a high correlation of the occurrence of certain search queries and the incidence of certain diseases (Eysenbach, 2006, 2009). Research on information supply has focused on click-through rates of pages in search results and their effects on the popularity of information sources (Jansen *et al.*, 1998; Pan *et al.*, 2004; Law, Mintzes & Morgan, 2011). Research has found that people are most likely to click through to webpages at high ranking positions in search results (Spink *et al.*, 2001), and thus, webpage ranking can be used to judge the popularity of information sources.

This study contributes to the literature by providing theoretical insights and empirical evidence for consumer information seeking on food contamination incidents over time. Specifically, this study answers the following questions on information demand and information supply during a food contamination incident.

Information demand:

- (1) What information do consumers search for about an incident?
- (2) When do consumers start searching for information about an incident?
- (3) When do consumers stop searching for information about an incident?

Information supply:

- (4) Which online information sources influence consumers the most by taking high ranking positions in search results during an incident?

Information demand: consumer information search related to food contamination incidents

The transtheoretical model of behavior change proposed by DiClemente and Prochaska (1982) characterizes health behaviors as moving through six stages of change, including precontemplation, contemplation, preparation, actions, maintenance, and termination. A large volume of research has shown that consumers prefer stage-matched health information rather than generic information for facilitating positive health behaviors (Prochaska *et al.*, 2001; Johnson *et al.*, 2006).

We propose that consumers seek stage-matched information in response to food contamination incidents (Figure 1). Before any food contamination incidents occur, consumers are in the stage of precontemplation (pre-events) in which they are unaware of any problems with their food supply, and thus may only pay incidental attention to general information about food issues. We consider search volumes without the influence of any incidents as the baseline search volumes. Therefore, our first hypothesis is:

H1: The search volume for queries relevant to a specific food contamination incident will be at

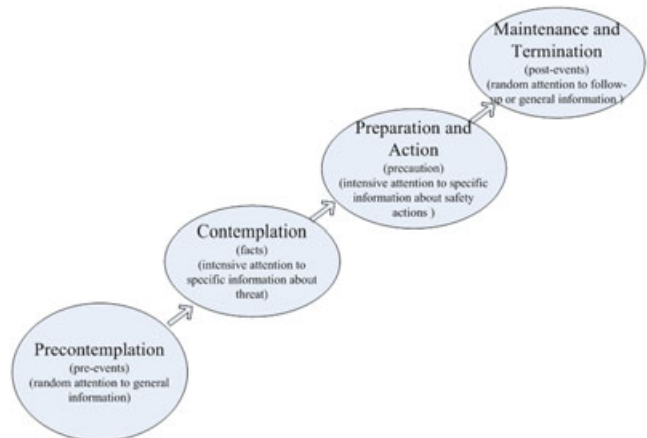


Figure 1. A flow chart of consumers seeking stage-matched information.

a low level (baseline level) prior to the announcement of the incident.

However, once a particular food contamination incident occurs, consumers progress into the stage of contemplation in which they begin to realize that their food may be contaminated, and thus could cause some health problems. In this stage, consumers may pay attention to information about the facts of the incidents such as the source of the contamination and the symptoms of infection. Then, consumers may progress into the preparation and action stages in which they intend to take actions to protect themselves from the contamination, and thus pay attention to information about safety precautions and practices such as thoroughly cooking food. Therefore, our second hypothesis is:

H2: The search volume for queries about the facts and safety precautions and practices relevant to a specific food contamination incident will rise to a high level during the first few weeks after the announcement of the incident with queries about the facts (contemplation) increasing first, followed by queries about safety precautions and practices (preparation and action).

As consumers learn more about the current incident, their need for information about the facts of the incident and food safety practices will decline. The facts of a specific food contamination incident include both the facts about the incident itself (e.g., the time the incident occurred) and the facts about the pathogen (e.g., A Salmonella). Because consumers may have a harder time understanding scientific facts than the details about specific incidents (e.g., time and location), they may spend more time searching for the facts about the pathogen than the facts about the incident itself.

As the action stage involves “the most overt behavioral changes and requires considerable commitment of time and energy” (Prochaska & Norcross, 2001), we argue that consumers will pay attention

to the information they need in the preparation and action stage for a longer time than the information they need in the contemplation stage. Thus, our third hypothesis is:

H3: The search volume for search queries will decline at different rates: First, search queries about the facts of the incident itself will decline most quickly; second, the facts of the pathogen will decline more slowly; and third, the information about safety precautions and practices will decline the most slowly.

Finally, in the maintenance and termination stage (post-events), consumers will no longer feel a need for information about the current food safety issue, but may still keep alert to it for a while, and finally resume their normal life. At this stage, consumers may only encounter information about past incidents by chance. Thus, our fourth hypothesis is:

H4: The search volume for search queries relevant to a specific food contamination incident will decrease to the lowest level after a few weeks, following the announcement of the incident.

Agenda setting theory proposes that the news media have an important influence on what issues the public considers to be important. The issues that are covered by the news media are likely to become the issues that the public cares about and considers as important (McCombs, 2004). Thus, mainstream news media are likely to play a leading role in shaping the public agenda of food contamination issues. In general, mainstream news media consider negative events as more newsworthy than positive events (Dunwoody & Griffin, 2002). Because the facts of a food contamination incident relate to what was performed wrong, whereas the safety precautions and practices relate to what can be performed right, we consider the former more negative and thus more newsworthy, and the latter more positive and thus less newsworthy. This suggests that mainstream news

media will pay more attention to the facts of the incident. As a result, more consumers will care about the facts of the incident and neglect information about the safety practices. Thus, our fifth hypothesis is:

H5: The total search volume for search queries about the facts of food contamination incidents will be much greater than that of search queries about food safety practices.

Information supply: stakeholder information provision during food contamination incidents

From a stakeholder point of view, we consider consumers as the focal group, and those organizations, groups, or individuals that may be involved in specific food contamination incidents as stakeholders. According to the Centers for Disease Control and Prevention (CDC, CDC) (2011a, CDC), *Salmonella* and *Escherichia coli* bacteria can be transmitted through the three stages of the food chain: food production and processing, distribution, and consumption. We present a set of stakeholders involved in every stage in Figure 2.

As noted in the introduction section, webpage ranking is one important marker of the popularity of an information source, and thus stakeholder influence. Stakeholders can become salient by providing information that matches search queries used by consumers during food contamination incidents. Each stakeholder group may have different interests in connection with consumers, and thus provide information to consumers relevant to different search queries.

Mainstream news media send the earliest and most “official” information concerning a specific food contamination incident with a focus on the facts of the incident. Thus, mainstream news media are most likely to obtain higher-ranking positions in search results for relevant search queries at an early stage of the incident. Our sixth hypothesis is:

H6: Mainstream news media will take the most positions on the first page of search results for

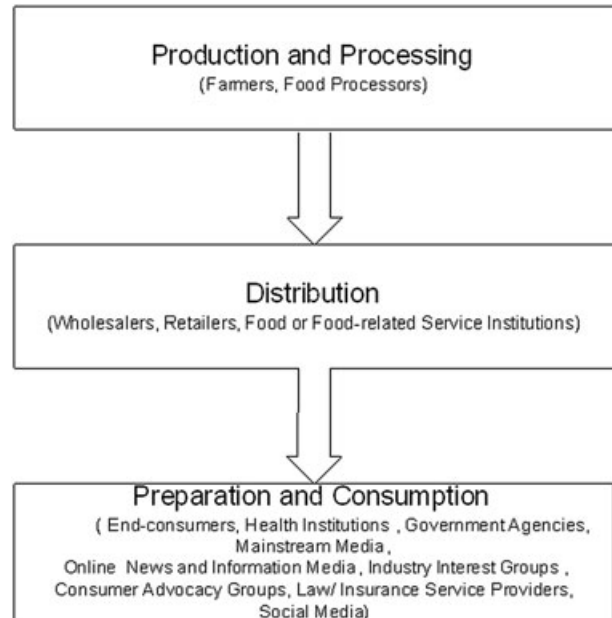


Figure 2. A flow chart of *Salmonella/Escherichia coli* transmission and potential stakeholders.

search queries about the facts of a specific food contamination incident during the first few weeks following the announcement of the incident.

As the food contamination incident progresses, mainstream news media will shift their attention to other newsworthy events, and thus reduce the number of reports on the incident. When mainstream news media are no longer the dominant source for information about the incident, a diverse set of stakeholders may share the high-ranked positions in the search results. Social media and online news and information media are two major online forms of citizen journalism. Food contamination incidents threaten consumers’ health and even life. Citizen journalism is responsive to this consumer perspective. Thus, following mainstream news media, social media, and online news and information media will become the major online source of information about the facts of the incident.

A similar logic describes the pre-incident stage. Before any food contamination incidents occur, mainstream news media will not pay special attention to, and thus provide little information about food contamination issues. As a result, a diverse set of stakeholders, especially social media and online news and information media, which are the media most sensitive to consumers' interests, will provide online information for consumers. Thus, our seventh hypothesis is:

H7: A diverse set of stakeholders will share positions with social media and online news and information media generally taking the most positions on the first page of search results for search queries about the facts of a specific food contamination incident before the incident occurs and during the last few weeks following the announcement of the incident.

As we noted, safety precautions and practices may be less newsworthy, and thus may not be the foci of mainstream news media. However, as they are the most important actions that consumers can take to protect themselves from unsafe food, safety precautions and practices will be the foci of citizen journalism. We predict that social media and online news and information media will be the major sources of information about safety precautions and practices. Our eighth hypothesis is:

H8: Through the whole cycle of a specific food contamination incident (before, during, and after the incident), social media and online news and information media will take the most positions on the first page of search results for search queries about the safety precautions and practices relevant to the incident.

With regard to stages of behavior change, consumers will primarily be influenced by mainstream news media when they seek information about the facts of the incident—the stage of contemplation; consumers will primarily be influenced by social media and online news and information media

(online citizen journalism) when they seek information about safety precautions and practices—the stage of preparation and action; at the other two stages (stages of precontemplation and maintenance and termination), consumers will be influenced by a diversity of stakeholders, especially social media and online news and information media.

Methodology

We conducted a multiple case study of national outbreaks of foodborne infection in the USA between 2006 and 2010. In this section, we present data collection methods, identification of search queries, and selection of case objects.

Data collection

Google is the most dominant search engine, serving the largest percentage of queries—65% (comScore, 2011). This indicates that data from Google can reflect the major consumer search trends. In addition, Google provides some free tools useful for search data analysis. Thus, we selected Google as our major data source. For each case, we collected two sets of data from Google: (1) search volume for specific search queries and (2) returned search-ranking results for these queries.

Search query data

Following methods used in previous studies, in this study, we use Google Insights for Search (GIFS) to identify the changing patterns of search queries used by aggregate consumers related to food contamination incidents. GIFS provides two types of search volume data: single-entry volume data and multiple-entry volume data. The single-entry volume data are generated by entering one query at a time. GIFS generates a single-line graph in which the weekly or monthly search volume numbers for this query are displayed. The search volume data in this graph are normalized on a scale from 0 to 100 and represents search volume numbers relative to the

total number of searches carried out for this query on Google over the relevant time range. We used this type of data to test the hypotheses about search volume of single search queries (H1–H4).

The multiple-entry volume data are generated by entering multiple search queries at one time using the “add terms” function. GIFS generates a multiple-line graph in which each line represents the search volume for each query, and the weekly or monthly search volume numbers for each query are displayed on each line. The search volume data in this graph are normalized on a scale from 0 to 100 and represent search volume numbers of one search query relative to search volume numbers of other search queries on Google over a time period. We used this type of data to test the hypothesis about the comparison of the total search volumes for multiple search queries (H5).¹

Using the graphs generated by GIFS, we observed the search volume trends for selected search queries. We also conducted qualitative analysis using the same data in downloadable comma-separated values files.

Search result data

We propose that different stakeholders uniquely provide information relevant to specific search queries in a timely manner during a food contamination incident. The relevance of different types of information to various stages of change in consumer behavior leads to temporal changes in search ranking results. Google search engine provides a filter tool called “custom range” on the left side of search result pages that helps narrow down the search results by specifying a time range during which webpages are indexed by Google. Using this tool, we downloaded the first-page search result items (10 items on one page) within specific time intervals. To maintain consistency, we set up the time intervals for search result data to be the same as that used for search volume data provided by GIFS.

¹For both types of data, when Google does not have enough data, zero is shown.

Based on the analysis of stakeholders involved in food contamination incidents, we coded the sources of search result information into nine categories: (1) government, (2) industry, (3) mainstream media, (4) social media, (5) online news and information media, (6) health care, (7) consumer advocacy, (8) research and academia, and (9) law/insurance service (Table 1).

Identification of search queries from an exemplar foodborne outbreak

A multistate outbreak of Salmonella infection associated with shell eggs occurred from August to November of 2010, leading to approximately 1939 illnesses (Centers for Disease Control and Prevention, CDC, CDC, 2011a, CDC). We conducted a brief preliminary study of this food contamination incident to identify the search queries that match the stages of behavior change.

Research has shown that internet users usually include one or two terms in one search query (Jansen, Spink, Bateman & Saracevic, 1998). Based on the stages of behavior change theory, we selected two-term search queries that would be relevant to consumers’ information needs at different stages during the egg contamination incident. We considered information about “egg recall” as facts about the incident itself and “egg salmonella” as the pathogen information, both of which would be useful during the contemplation stage. We considered “egg safe” as information about the safety precautions that would be useful during the preparation and action stage. GIFS provides several types of matching functions; we selected the matching function that shows results for searches containing both terms.

Using GIFS, we obtained graphs for the weekly search volume trends for the three search queries. We found that the patterns of the search volume trends for the three queries were consistent with our predictions (H1–H5). Based on these counts, we determined to use three search queries to test our hypotheses in the main study, including “food

Table 1. Coding scheme for stakeholder sources of information

Category	Description	Example
Government	Websites sponsored by government agencies	www.cdc.gov
Industry	Websites owned by businesses or industry interest groups	www.wholefoodsmarket.com/
Mainstream media	Websites owned by organizations that disseminate news or information via large distribution channels	www.cnn.com
Social media	Websites that focus on social interaction	www.springfieldnewssun.com
Online news and information media	Websites owned by organizations that disseminate news or information only or primarily via the internet	answers.yahoo.com
Health care	Websites owned by organizations that provide health care services	www.mayoclinic.org
Consumer advocacy	Websites sponsored by consumer advocacy organizations	http://www.makeourfoodsafesafe.org
Research and academia	Websites sponsored by research or academic institutions	http://www.foodpolicyinstitute.org
Legal/Insurance service	Websites owned by organizations that provide law or insurance consulting service	http://foodpoisoning.pritzkerlaw.com

name' 'recall', "'food name' 'pathogenic cause'", and "'food name' 'safe'".²

Selection of case objects

We selected study objects from the list of "multistate foodborne outbreaks" occurring from 2006 to 2011 provided by Centers for Disease Control and Prevention (CDC, CDC) (2011a, CDC). Because the search volumes for the three search queries used in the egg infection incident changed weekly, we considered the availability of weekly search volume data for the three queries from Google Insights for Search as the criterion of case object selection. After checking the search volume graphs for the three search queries for each outbreak, we selected four foodborne outbreaks as the objects of this study, including 2010 egg Salmonella infection, 2009 peanut butter Salmonella infection, 2008 tomato Salmonella

infection, and 2006 spinach *E. coli* infection. Next, we present the egg Salmonella incident, describing both the search volumes and the presence of information from different sources. We then briefly describe the peanut butter incident. The complete analysis for the other two incidents, spinach and tomato, is included in the appendix.

Egg incident of 2010

In the 2010 egg contamination incident, the FDA issued the first voluntary recall of contaminated egg products by farmers on August 13, 2010 through their official website. However, mainstream media did not report this incident until August 15, 2010 when the recall was expanded to more brands. Based on our observation, the search volumes for the three selected queries started to rise on August 15, 2010. Thus, we define August 15, 2010 as the starting time of the entire search cycle of this incident.

Demand for information. As Figure 3 demonstrates, throughout the entire search cycle (6 weeks:

²Because the term "recall" has multiple meanings such as bringing back to mind, in our data set, we deleted search items with meanings other than requests to return defective products to manufacturers.

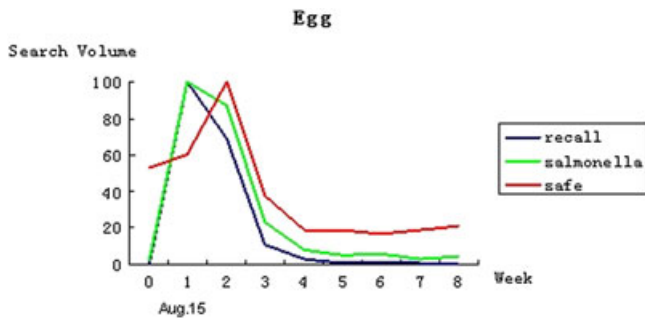


Figure 3. Weekly search volumes for multiple-entry search queries: egg.

from August 15 to September 25, 2010), the total search volume for “egg recall” was much greater than for “egg salmonella” and for “egg safe”. Figure 4 presents the search volume trends for each query. In week 1, the search volumes for “egg recall” and “egg salmonella” started to rise from the base-line value and reached their peak values. One week later, the search volume for “egg safe” started to rise and peak. In the following weeks, the search volumes for all three queries gradually fell, with “egg recall” falling at the fastest rate and “egg safe” falling at the slowest rate.

Supply of information. The search results for this incident are presented in Figures 5, 6, and 7. For the search query “egg recall”, 1 week before the incident was announced, a diversity of stakeholders took positions in the first page search results, with

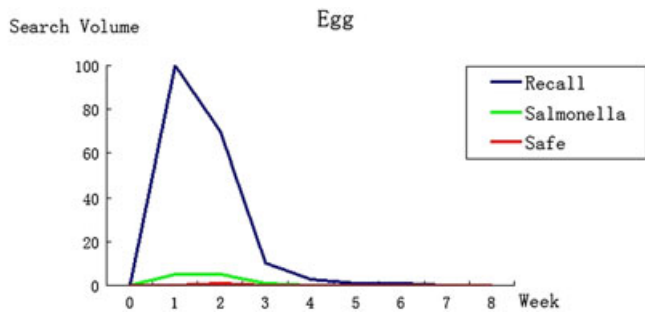


Figure 4. Weekly search volumes for single-entry search queries: egg.

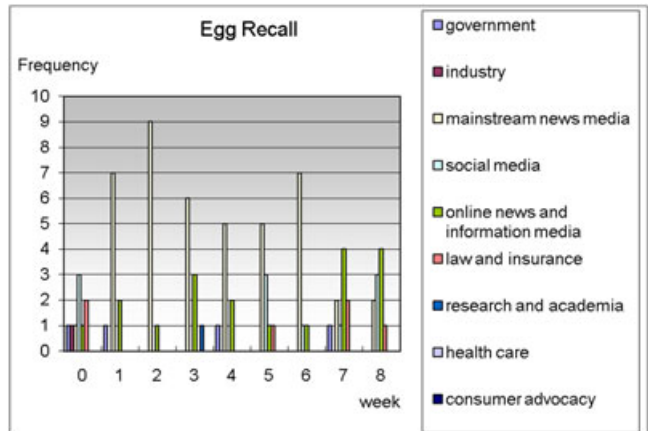


Figure 5. Search results for “Egg Recall”.

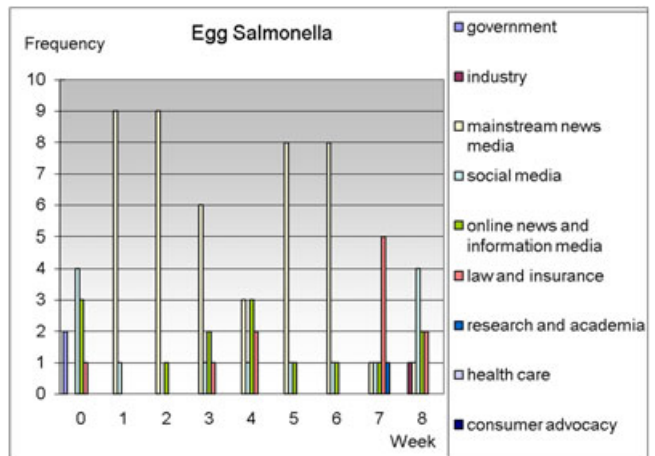


Figure 6. Search results for “Egg Salmonella”.

social media taking slightly more positions than others (Figure 5). The number of positions taken by mainstream media started to increase in week 1, following the announcement of the incident, and rose to a peak value in week 2, then decreased gradually. During week 6, mainstream media conducted intensive coverage of the events about the egg-recall congressional hearing and occupied seven positions in the first page search results. In week 7, more positions in the search results were occupied by other stakeholders, with on-line news and information media taking the most positions. In week 8, five stakeholders including industry

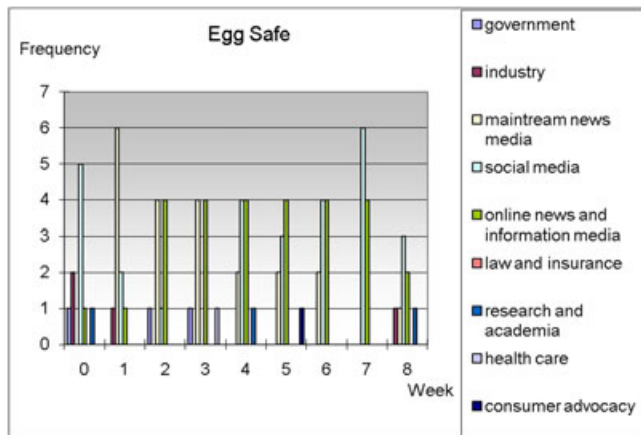


Figure 7. Search results for “Egg Safe”.

groups, mainstream news media, social media, online news and information media, and legal and insurance groups shared positions in the search results.

A similar trend was seen for the search results for “egg salmonella” (Figure 6). One week before the incident was announced, a diversity of stakeholders occupied positions, with social media taking the most positions among the first 10. Mainstream media rose to dominance by taking nine positions in weeks 1 and 2. Then, other stakeholders started to take more positions, and as a result, in week 4, mainstream media lost their dominance in search results. However, as new emerging issues related to Salmonella occurred during week 5 and week 6 such as egg farmers’ apologies for Salmonella outbreak, mainstream media again took dominance in the search results in weeks 5 and 6. In weeks 7 and 8, more positions in the search results were occupied by other stakeholders, with legal and insurance groups and social media taking the most positions respectively in weeks 7 and 8.

The search results for “egg safe” show a different trend compared with the search results for “egg recall” and “egg salmonella” (Figure 7). One week before the incident was announced, social media took dominance in the search results. When the egg recall occurred in week 1, mainstream media took dominance over social media. In weeks 2 and 3,

online news and information media were tied with mainstream media in terms of the number of positions in the first page search results. In the following weeks, social media and online news and information media took dominance in the search results.

Peanut butter incident of 2009

Based on our observation, the search volumes for the three selected queries started to rise on January 10, 2009 when mainstream media started to report this peanut butter incident. Thus, we define January 10, 2009 as the starting time of the entire search cycle of this incident.

Demand for information. The search query patterns for the peanut butter incident were similar to that for the egg incident. As Figure 8 shows, throughout the entire cycle of the incident (16 weeks, January 10 to May 9, 2009), the search volume for “peanut butter recall” was much greater than for the other two queries. Figure 9 presents the search volume trend for each query. The search volumes for “peanut butter recall” and “peanut butter salmonella” started to rise 1 week earlier than did the search volume for “peanut butter safe”. In week 2, the search volumes for all three queries reached their peak values. In the following weeks, the search volumes for the three queries

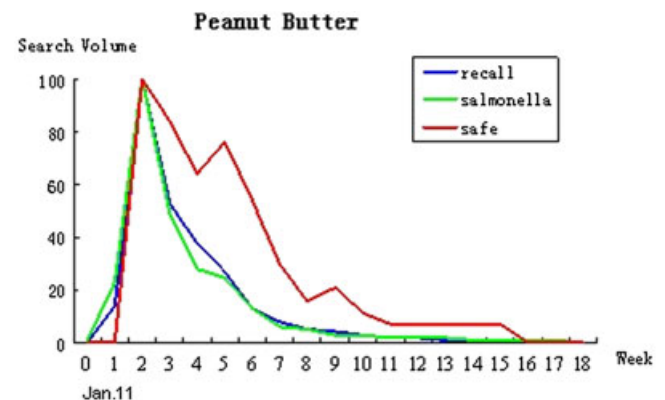


Figure 8. Weekly search volume for multiple-entry search queries: peanut butter.

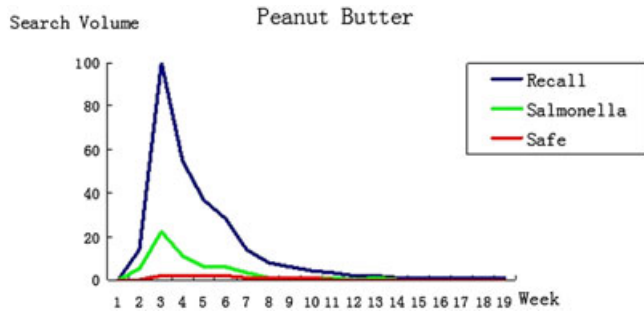


Figure 9. Weekly search volumes for single-entry search queries: peanut butter.

started to fall, with “peanut butter safe” decreasing at a slower rate than the other two queries.

Supply of information. We present the search results for this incident in Figures 10, 11, and 12. The two queries “peanut butter recall” and “peanut butter salmonella” shared a similar trend in search results (Figures 10 and 11). One week before the incident occurred, a diversity of stakeholders occupied the positions in the search results. The number of positions taken by mainstream media increased to its peak value in week 1. In the following weeks, a diversity of stakeholders, especially social media and online news and information media, gradually took more positions than others.

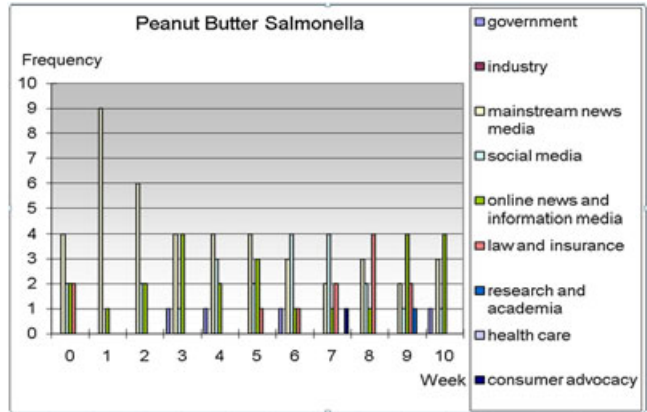


Figure 11. Search results for “Peanut Butter Salmonella”.

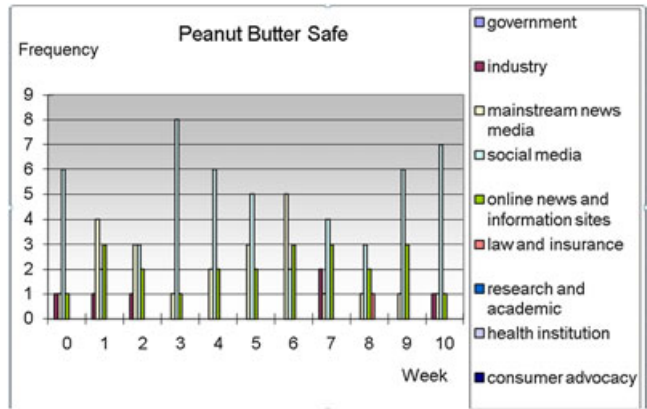


Figure 12. Search results for “Peanut Butter Safe”.

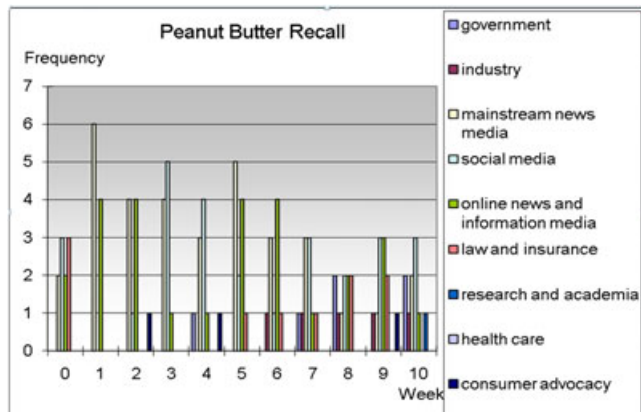


Figure 10. Search results for “Peanut Butter Recall”.

The search results for “peanut butter safe” show a different trend compared with the search results for the other two queries (Figure 12). One week before the incident occurred, social media was dominant in the first page search results. In week 1, mainstream media took the most positions among stakeholders; however, the total of positions taken by social media and online news and information media was more than the total of positions taken by mainstream media, showing the combined dominance of online citizen journalism. The similar situation was true for search results in weeks 2, 6, 7, and 8 that the total number

of positions taken by social media and online news and information media was more than the number of positions taken by any other stakeholder. In other weeks, social media took dominance over other stakeholders.

Results and findings

Demand for information: search term volume patterns

The patterns for search volume data across all four cases were remarkably similar and provide evidence to support our five hypotheses about the search volume trends for the three search queries. In this section, we present an overview of these patterns and note those cases in which individual search trends differed from the common patterns.

The search volumes for the three search queries were at their lowest levels (baseline levels) prior to the announcement of the incidents (H1). The search volumes for “recall” and “pathogenic cause” increased in the first 1 or 2 weeks, following the announcement of the incidents, and the search volume for “safe” increased a few days later (H2). In the following weeks, the search volumes for the three queries declined at different rates: “recall” declined most quickly, followed by “pathogenic cause”, then by “safe” (H3). The search volumes for the three search queries fell to the baseline values several weeks after the announcement of the incidents (H4). In total, the search volume for “recall” and for “pathogenic cause” was much greater than the search volume for “safe” (H5). The search results reveal some findings related to consumers’ progress through stages of information search behavior during food contamination incidents. In the following, we present a detailed description of our results.

Precontemplation stage

Before the incidents were announced, the search volumes for the three queries were at their lowest levels (baseline levels) (H1). This period corresponds with

the precontemplation stage of behavior change in which consumers only incidentally encounter information related to specific food contamination incidents.

Contemplation, preparation, and action stages

When information about the incidents was issued publicly, the search volumes for “recall” and “pathogenic cause” had almost the same upward change trends (H2). In all four cases, the search volumes for the two queries increased rapidly from the baseline values during the first week after the announcement of the incidents. The search volumes for the two queries then reached their peak values a few days later, in the same week in the case of egg, and in the following week in the other three cases. The period during which the search volumes for “recall” and “pathogenic cause” rose and peaked corresponds with the contemplation stage of behavior change in which consumers seek information about the facts of the incidents.

Across all four cases, the search volume for “safe” was different from the search volumes for the other two queries in the upward trend (H2). The search volume for “safe” started to rise a few days after the search volumes for the other two queries rose. The rise of the search volume for “safe” indicates that consumers start to progress from the contemplation stage to the preparation and action stages. Interestingly, the search volume for all these queries reached their peak values during the second week, following public announcement of the incidents in three of the four cases (egg case is an exception). Food contamination incidents threaten consumers’ health and even life. Thus, once consumers have acquired information about the facts of the incidents during the contemplation stage, they progress to preparation and action stages fairly quickly, with their information search shifting to other terms that will meet their evolving needs, that is, to self-protective actions.

After reaching their peak values, the search volumes for the three queries rapidly declined with “recall” showing the fastest decline rate and “safe”

showing the slowest decline rate pathogenic (H3). These trends demonstrate that (1) learning about the facts of the incident itself progressed at a faster rate than did learning about the pathogen, and (2) learning about both the facts and pathogen of the incident progressed at a faster rate than learning about self-protective actions about the incident.

The total search volume for “safe” was extremely low compared with the total search volume for the other two queries over the entire cycle of the incidents we studied. This suggests that the facts of the incidents, not the self-protective actions that consumers could take, were first to become the public agenda of the food contamination issues (H5).

Maintenance and termination stages

The search volumes for the three search queries fell to the baseline values several weeks after the announcement of the incidents (H4). The period in which all three search queries fell to their baseline values and leveled out corresponds with the maintenance and termination stages of behavior change in which consumers no longer seek information about the incidents and shift their attention to other events.

Cycle length of behavioral changes

With regard to the length of time that the search volumes for the three queries took to complete their upward and downward movements, the different foods show different results. In the cases involving eggs, tomatoes, and spinach, the search volumes for the three queries took 3 to 7 weeks to complete the upward and downward cycles. However, for the case involving peanut butter, the search volumes for the three queries took a longer time—around 16 weeks—to complete the upward and downward movements. A review of the content of the search results for the three queries in the four cases revealed that the peanut butter incident involved expansive recall of thousands of individual products containing peanut butter as an ingredient (e.g., cookies and cakes) by hundreds of brands (e.g.,

Kellogg and Kroger) (U.S. Food and Drug Administration (FDA), 2009) across a long period of time—nearly 6 weeks, whereas the other three incidents involved recall of only a small number of individual products (mostly the raw products) by a limited number of brands across a short period of time—around 2 weeks. These differences in search volume cycles likely relate to the fact that peanut butter is frequently consumed as an ingredient in processed products, while eggs, tomatoes, and spinach are commonly purchased and consumed as fresh, unprocessed foods. Thus, consumers may seek information relevant to incidents involving processed foods for a longer time than information relevant to non-processed foods.

Supply of information: patterns across stakeholders

Our next set of hypotheses relates to the prominence of various stakeholders during a food incident. The results from the four cases are consistent with our three hypotheses about patterns for the sources of information on the three search queries (H6–H8). In this section, we provide an overview of the results across all four incidents.

For the search queries “recall” and “pathogenic cause,” mainstream media took the most positions in returned search results during the first few weeks, following the announcement of the incidents (H6). A more diverse set of stakeholders shared positions, with online citizen journalism (including social media and online information and news media) generally taking the most positions in the search results before the announcement of the incidents and during the last few weeks following the announcement of the incident (H7).

For the search query “safe”, citizen journalism, including social media and online news and information media, took the most positions in the search results throughout the whole cycle of the incidents (H8). The one exception was that in the first week of the announcement of the egg incident, mainstream media took dominance in the search results. A possible

reason for this exception is that the massive marketing campaigns with a theme “thoroughly cooked eggs are safe” by the American Egg Board (AEB) caught mainstream media’s eye on the issue of egg safety. This indicates the power of marketing efforts by a stakeholder and the influence stakeholders can have on what information consumers will receive.

These patterns indicate that mainstream news media are the major information sources for consumers at the contemplation stage during which consumers seek information about the facts of the incidents; social media and online news and information media are the major information sources for consumers at the preparation and action stage during which consumers seek information about safety precautions and practices; at the other stages, a diversity of stakeholders, especially social media and online news and information media, are major information sources for consumers.

Discussion

Our multiple-case study examines public information demand and information supply during a food contamination incident. For information demand, in the cases we studied, consumers first sought information about the food involved in the incident, then about the cause of the incident, and last about ways they could be safe in the face of the threat. In terms of timing of information search, consumers began searching for information within the first week after incidents were publically announced and typically continued to search for around 6–8 weeks. An exception creating interest among consumers over a much longer period was the incident involving peanut butter, a common ingredient in processed foods and involving a large number of brands and product types. These trends suggest that consumers lose interest and likely move on to focus on other issues fairly quickly after an incident is announced. Thus, in order to ensure that the public is adequately informed about the threat of foodborne illnesses, it is important to get information out quickly and to provide suggestions for self-

protective behavior soon after the incident has been reported.

For information supply, our study shows that two types of mass media, including mainstream media and online citizen journalism, play a leading role in sending online information during an incident. However, the impact of the two types of mass media differs across the phases of an incident. In the cases we studied, during the first few weeks following the announcement of a food incident, mainstream news media took the most positions in the first page search results. During the later weeks, citizen journalism overtook mainstream news media by occupying more positions in the first page search results. This finding supports the proposition that mass media have two functions in disasters, including an information function and a social function (Dominick, 1996). During a food incident, the prominence of mainstream news media immediately following the announcement of the incidents suggests that they play primarily an information function, ensuring that a large population of consumers get timely and accurate information about the incidents. Their role is thus very important during the contemplation stage of behavior change. Citizen journalism exerts primarily a social function during the later weeks following the incidents by providing consumers with needed help in responding to the incidents. Citizen journalism plays an important role in information spread during the preparation and action stage of behavior change.

Implications

Our study has implications for protection of the public from foodborne illnesses. Consumers are selective in how they allocate their internet search time, spending time focusing on topics that are relevant to them. The common name for the food involved in an incident appears to be the first term that consumers use to search for information. Because certain pathogens have been the identified cause of several illness outbreaks, consumers may be somewhat familiar with those terms and use them

in information searches. Our observation that the term “safe” was the last term that consumers used suggests that consumer education about the importance of taking action to protect themselves in the face of a foodborne incident is critical. Public health professionals can partner with mainstream news media in putting less emphasis on the sensationalism surrounding an incident and more emphasis on ways in which consumers can protect themselves from risks. Additionally, public health professionals should be aware of the importance of organic search ranking results in influencing consumers’ response to the incidents and increase visibility of their online information by adopting search engine optimization strategies.

Future study

Our study focused on only three types of search term. More research into the terminology used by consumers would be welcomed as it could shed light on what is most “top of mind” for consumers. Stakeholders at national and local levels such as government and mainstream news media may demonstrate different functions at different levels. Our data show that national mainstream news media and federal government agencies often appeared in the first page search results during the early stages of the incidents, whereas local mainstream news media and local government agencies appeared in the search results during the late stages of incidents. More research is needed to investigate the content of the search results to identify the different roles played by mainstream news media and government agencies at these two levels.

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Appendix Case descriptions: tomato and spinach incidents.

Spinach incident of 2006

Based on our observation, the search volumes for the three selected queries started to rise on September 14, 2006 when CDC, in conjunction with FDA, issued a warning message about the contaminated spinach to the public through major media. Thus, we define September 14, 2006 as the starting time of the entire search cycle of this incident. Throughout the entire cycle of the incident, the search volume for "spinach E.coli" and for "spinach recall" was much greater than for "spinach safe". The search volumes for "spinach recall" and "spinach E.coli" started to rise 1 week earlier than did the search volume for "spinach safe". In week 2, the search volumes for all three queries reached their peak values. In the following weeks, the search volumes for the three queries started to fall, with "spinach safe" at a decreasing at a slower rate than the other two queries.

For the search result patterns for "spinach recall" and "spinach E. Coli", 1 week before the incident, a diversity of stakeholders occupied the positions in

the first page search results. Mainstream media took the most positions in the first page search results in the first 1 or 2 weeks. In the following weeks, more positions in the search results were occupied by a diversity of stakeholders, especially online news and information media. The search results for "spinach safe" show a different trend compared with the other two queries. Throughout the entire period of the incident, social media and online news and information media took a dominant number of positions in search results.

Tomato incident of 2008

Based on our observation, the search volumes for the three selected queries started to rise on June 4, 2008 when mainstream media started to report this incident. Thus, we define June 4, 2008 as the starting time of the entire search cycle of this incident. Throughout the entire cycle of the incident (6 weeks: June 1 to July 12, 2008), the search volume for "tomato recall" and for "tomato salmonella" is much greater than that for "tomato safe". The search volumes for "tomato recall" and "tomato salmonella" started to rise 1 week earlier than did the search volume for "tomato safe". In week 2, the search volumes for all three queries reached their peak values. In the following weeks, the search volumes for the three queries started to fall, with "tomato safe" at a decreasing at a slower rate than the other two queries.

The search results for "tomato recall" and "tomato safe" show a similar trend to the search results for the other incidents with regard to the influence of online citizen journalism on the first page search results. However, this incident demonstrated a different pattern for the search query "pathogenic cause". One week before the incident was announced, a diversity of stakeholders occupied the first page positions in the search results for "tomato salmonila". In the following weeks, online news and information news media and social media in turn took the most positions, and mainstream media took only a small number of positions within the first page results.

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