



The Missing Ingredient: Food Safety Messages on Popular Recipe Blogs

ABSTRACT

Recipe bloggers are social media influencers who have the potential to spread food safety messages to large audiences. Recipes from 50 popular recipe blogs were evaluated, using a structured, pre-tested coding form to determine whether food safety messages on blogs aligned with current government recommendations. Of the 784 recipes that met the selection criteria, 479 included as ingredients meats for which specific endpoint temperatures are suggested by national health authorities. The use of a thermometer to ensure adequate cooking was suggested in 16.9% ($n = 81$) of recipes, a recommendation that was more likely for certain types of meat than others ($P < 0.001$). Where endpoint temperatures were provided ($n = 79$), 60.8% were correct ($n = 48$). Endpoint temperatures were often paired with incorrect subjective doneness indicators. Among recipes containing fresh produce ($n = 304$), 3.3% ($n = 10$) suggested washing produce to be consumed raw. Instructions on storing leftovers were provided for 4.0% of recipes ($n = 31$), 55% of which ($n = 17$) correctly

corresponded to government guidelines. The lack of food safety messages on popular recipe blogs shows that efforts are needed to encourage bloggers to promote safe food handling to consumers.

INTRODUCTION

Educating consumers on safe food handling is important in reducing foodborne illness. Although largely preventable, the burden of foodborne illness is high, with an estimated 4 million episodes per year in Canada (59) and 47.8 million episodes per year in the United States (U.S.) (53, 54). Public health surveillance data implicate private homes as the most frequently suspected exposure settings (47) and improper consumer food handling behavior has been cited as an important cause of illness (5). Food safety experts recommend key safe food handling behaviors to prevent illness, including the use of a thermometer to ensure that foods are adequately cooked, avoidance of cross-contamination, and handwashing (29). Yet, previous research indicates that consumers often do not practice these behaviors (1, 11, 48). Studies reveal a persistent belief that

*Author for correspondence: Phone: +1 226.203.4585; Email: emily.morrison@ryerson.ca

foods prepared outside the home pose the greatest risk (26, 45). Influencing consumer behavior change surrounding such food safety practices remains an important challenge for food safety educators.

When searching for food safety information, consumers often turn to the Internet (45), where a wealth of food and cooking information abounds. Indeed, the online world often spills into real-world kitchens, where nearly two thirds of 25- to 34-year olds use their smartphones or tablets while cooking (15). Recipe blogs have become a major online attraction; blog authors are social media influencers, drawing as many as 5 million unique visitors to their sites each month (2). Given their clout, recipe bloggers have the power to spread food safety messages to large audiences.

Studies that have evaluated food handling behaviors of celebrity television chefs (14, 42, 69) and food safety messages in print recipes and cookbooks (27, 38) reveal that celebrity chefs are poor models of safe food handling behavior and that print recipes and cookbooks often lack food safety messaging. The one study that was identified that examined food safety messages on recipe blogs, among various other online and print sources, evaluated doneness recommendations for egg dish recipes (20). Only two of 226 evaluated recipes, neither of which were from blogs, gave final endpoint temperatures (20). Further consideration of the role of recipe blogs in food safety messaging is warranted.

The purpose of this study was to evaluate food safety messages on popular recipe blogs to determine their alignment with current government recommendations concerning specific food handling behaviors. These include the use of a thermometer to ensure adequate cooking, safe endpoint cooking temperatures, practices to reduce cross-contamination, washing raw produce, and storage of leftovers. The results of this study will identify areas where future outreach may be needed with food bloggers to more effectively communicate risk messaging to consumers concerning safe food handling.

MATERIALS AND METHODS

Selection of recipe blogs

A ranked list of the 355 most popular cooking weblogs was obtained from Alexa Internet (Table 1) (2). Popularity rankings are based on a combination of unique visitors and page views, determined through sampling of Alexa users (3). A sample of the most popular blogs that met specified inclusion criteria was selected for analysis in this study. For the purposes of this study, a recipe blog was defined as a website that regularly posts recipes, including an ingredient list and instructions for preparing food. Because of observed differences between blogs ranked higher and those ranked lower in popularity, such as number of blog posts, update frequency and web traffic, the sample was limited to the top 50 blogs. Exclusion criteria focused on blogs that aggregated recipes from other websites, blogs

that shared equipment and restaurant reviews but did not post recipes, and those that posted only recipes for baked goods. Because food safety messages were evaluated on the basis of Canadian and U.S. government recommendations, blogs whose authors resided outside North America were excluded. Also excluded were four blogs that could not be accessed because the website domain had expired or the website was not functioning or accessible.

Based on pre-testing of methods conducted by two researchers, it was determined that recipes containing meat, poultry or fish ingredients were far more commonly posted than recipes containing fresh produce. Therefore, for each of the 50 sampled blogs, the 10 most recently posted recipes containing meat, poultry or fish ingredients and the five most recently posted recipes containing fresh produce were selected for analysis. If fewer recipes were posted, all recipes that met the inclusion criteria were selected. If a recipe contained ingredients from multiple food categories, it was evaluated under each category (e.g., a recipe containing a meat ingredient requiring a cooking step and a fresh produce ingredient to be consumed raw).

Selection criteria for recipes were developed based on Canadian and U.S. government food safety recommendations for handling meat, poultry or fish ingredients and raw produce (21, 25, 62, 63). Recipes containing raw meat, poultry, fish or shellfish, were sampled if they included a cooking or a reheating step. Produce recipes were selected if they contained fruits, vegetables or herbs prepared without a cooking step (i.e., the food was intended to be consumed raw).

Coding of recipes for food safety messages

A coding form to assess food safety messages in sampled recipes was developed based on the system used by Levine et al. (38). The form was pre-tested to verify agreement between two independent researchers. For the pre-test, a total of 12 recipes were coded from four blogs. Based on results of pre-testing, changes were made to the coding form to reduce disagreement and ambiguity in coding. For instance, a partially correct option was added for recipes where washing raw produce was recommended for some ingredients but not others, and additional subjective doneness indicators were added to existing categories.

A researcher reviewed blog post introductions, narratives, and recipes to evaluate food safety messages in each of seven categories: thermometer use, endpoint temperature, subjective doneness indicators, handwashing, sanitizing surfaces and equipment, washing fresh produce, and storage time. Recipes were coded as “not provided,” “correct,” or “incorrect.” A fourth category, “partially correct,” was used for certain categories, as described below.

For blogs whose author resided in Canada ($n = 6$), food safety messages were evaluated on the basis of the Government of Canada’s food safety recommendations obtained from the “General Food Safety Tips” (21) and the “Safe

TABLE 1. Sample population of recipe blogs obtained from Alexa Internet, September 2017

Blog	Blogger Professional Status	Country	Number of Recipes Evaluated (Meat, poultry or fish, N = 479) ^a	Number of Recipes Evaluated (Fresh Produce, N = 304) ^b	30 Days Unique Visitors ^c
TheKitchen.com	Professional	USA	10	5	5,393,935
Food52.com	Professional	USA	10	5	2,097,010
Simplyrecipes.com	Amateur	USA	10	7	1,590,111
inspiredtaste.net	Amateur	USA	10	6	663,124
foodrepublic.com	Professional	USA	10	5	562,508
Foodwishes.blogspot.com	Professional	USA	10	5	549,316
Jocooks.com	Amateur	USA	10	5	491,250
Twopeasandtheirpod.com	Amateur	USA	10	6	543,032
Norecipes.com	Professional	USA	10	5	277,133
Kalynskitchen.com	Amateur	USA	10	5	359,849
101cookbooks.com	Professional	USA	0	5	248,235
Closetcooking.com	Amateur	Canada	10	7	338,726
Inspiralized.com	Amateur	USA	10	9	203,802
Kitchenstewardship.com	Amateur	USA	10	5	221,030
Whiteonricecouple.com	Amateur	USA	10	9	164,494
Cookingforengineers.com	Amateur	USA	10	4	76,334
Macheesmo.com	Amateur	USA	10	5	145,683
Simplebites.net	Professional	Canada	10	6	127,029
Acozykitchen.com	Amateur	USA	10	6	99,290
Heatherchristo.com	Professional	USA	10	6	103,689
Simple-nourished-living.com	Amateur	USA	10	5	98,635
Dashingdish.com	Amateur	USA	10	6	114,907
Blogchef.net	Amateur	USA	10	6	Not available
Bakingoutsidethebox.com	Amateur	USA	10	6	Not available
umamigirl.com	Amateur	USA	10	7	Not available
dinnerwithjulie.com	Professional	Canada	10	6	Not available
deliciouseveryday.com	Amateur	USA	0	5	Not available
foodnouveau.com	Professional	Canada	10	13	Not available
kellythekitchenkop.com	Amateur	USA	10	6	Not available
kitchenkonfidence.com	Amateur	USA	10	8	Not available
livinglou.com	Amateur	Canada	10	5	Not available
thecitycook.com	Professional	USA	10	7	Not available
amateurgourmet.com	Amateur	USA	10	7	Not available
fromaway.com	Amateur	USA	10	5	Not available
sarahscucinabella.com	Professional	USA	9	5	Not available
alidaskitchen.com	Amateur	USA	10	6	Not available
flourishingfoodie.com	Professional	USA	10	6	Not available

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TABLE 1. Sample population of recipe blogs obtained from Alexa Internet, September 2017 (cont.)

Blog	Blogger Professional Status	Country	Number of Recipes Evaluated (Meat, poultry or fish, N = 479) ^a	Number of Recipes Evaluated (Fresh Produce, N = 304) ^b	30 Days Unique Visitors ^c
thebrewerandthebaker.com	Amateur	USA	10	5	Not available
seductionmeals.com	Amateur	USA	10	7	Not available
olives-n-okra.com	Amateur	USA	10	5	Not available
3boysunprocessed.com	Professional	USA	10	6	Not available
cookinginstiletto.com	Amateur	USA	10	6	Not available
thefrugalcchef.com	Amateur	USA	10	5	Not available
chezus.com	Amateur	USA	10	5	Not available
phamfatale.com	Amateur	USA	10	5	Not available
chezpim.com	Professional	USA	10	5	Not available
crumbblog.com	Amateur	Canada	10	8	Not available
marxfoods.com	Professional	USA	10	6	Not available
delightfulrepast.com	Professional	USA	10	5	Not available
andreasrecipes.com	Amateur	USA	10	8	Not available

^aFor meat, poultry or fish recipes, the 10 most recent recipes that called for one of these ingredients and required a cooking or reheating step were included. Where fewer than 10 recipes on a blog included such ingredients, all relevant recipes were included.

^bFor fresh produce recipes, the five most recent recipes that contained produce meant to be consumed raw were included. In addition, where a recipe included both a meat, poultry or fish ingredient and a fresh produce ingredient, the recipe was evaluated first as a meat, poultry or fish recipe and then as a fresh produce recipe.

^cUnique visitors obtained from Alexa Internet were for the preceding 30 days (accessed September 2017) (2). Web traffic rankings are determined by a combination of unique visits and page views. Alexa does not provide traffic estimates for all ranked blogs.

Internal Cooking Temperatures Chart” (25) webpages on the Canada.ca website. For blogs whose authors resided in the U.S. (*n* = 44), food safety messages were compared to U.S. government recommendations obtained from the “Keep Food Safe” webpage and “Safe Minimum Cooking Temperatures” chart on the FoodSafety.gov website (62, 63).

Blogger bio sections were reviewed to determine authors’ self-described professional background. Authors were classified as either amateur or professional. Amateur bloggers included those who indicated that they had no formal culinary training or professional experience. Blogs run by teams of people with professional experience, including chefs, recipe developers and food writers, were categorized as professional.

Recipes containing meat, poultry or fish as ingredients were assigned a food category based on those listed in

the Government of Canada’s “Safe Internal Cooking Temperatures Chart” (25), with some modifications (e.g., game birds were categorized together with poultry categories). Where a recipe included both a meat, poultry or fish ingredient and produce to be consumed raw, it was assessed first as a meat, poultry or fish ingredient recipe and then as a raw produce recipe.

Recipes containing meat, poultry or fish ingredients were assessed based on safe cooking practices. Those that suggested the use of a thermometer to check endpoint temperatures were coded as correct, as were those that provided an endpoint temperature that complied with government recommendations. Subjective doneness indicators used to determine whether recipes containing meat, poultry or fish were safe to eat were classified into five categories, adapted from Levine et al. (38): touch, color,

non-specific temperature, other visual, and time. These were coded as incorrect, with certain exceptions based on current evidence. Touch was coded as correct for fin fish, where a recipe instructed that it be cooked until the flesh flaked with a fork (67), and for bacon, where a recipe instructed that it be cooked until crisp (60). Color was coded as correct for crustaceans and fin fish where a recipe called for the ingredient to be cooked until opaque (67). “Other visual” was coded as correct where a recipe for shellfish included instructions to cook until shells opened (67).

Messages related to cross-contamination reduction practices were also evaluated. Both the Canadian and the U.S. governments recommend the following behaviors to reduce the risk of cross-contamination: handwashing prior to beginning food preparation, handwashing after handling raw ingredients, and sanitizing surfaces and equipment (23, 61). Recipes were coded as correct if they referenced these practices.

Both governments recommend that consumers wash all produce prior to consumption, even if produce will be peeled (23, 66). The Government of Canada’s Produce Safety webpage clarifies that this is a general tip that may not always apply, such as in the case of bananas (23). Recipes that did not suggest washing produce to be consumed raw were coded as incorrect, except where raw produce could be peeled without contaminating the inner flesh. Where recipes suggested washing some raw produce ingredients but not others, recipes were coded as partially correct. Instructions for storage times for leftovers that did not align with those provided in the Government of Canada’s “Safe Food Storage” page (24) or the U.S. Government’s “Storage Times for Refrigerator and Freezer” chart (64) were coded as incorrect. Recipes were coded as incorrect if they specifically recommended storing foods under conditions not in line with government guidelines. For example, recipes that recommended storing foods containing meat, poultry or fish ingredients at room temperature rather than in a refrigerator or freezer were coded as incorrect.

Analysis

Data were collected and descriptively analyzed using Microsoft Excel 2013 for Mac, while statistical analysis was performed using IBM SPSS Statistics, version 24. An independent-sample *t*-test was used to compare the mean number of recommendations for thermometer use between blogs based on blogger professional status. The mean number of recommendations for thermometer use by food category on each blog was compared using a one-way ANOVA test, followed by post-hoc comparisons using Tukey’s HSD. A statistical significance threshold of $P < 0.05$ was used for these tests.

RESULTS

From the 50 most popular blogs assessed, 784 recipes met the selection criteria. Amateur cooks authored 32 blogs,

accounting for 66.7% of recipes ($n = 523$), while professional chefs and teams authored 18 blogs, accounting for 33.3% of recipes ($n = 261$).

Safe cooking practices

A total of 479 recipes contained meat, poultry or fish ingredients with a cooking or reheating step. Among these recipes, 16.9% ($n = 81$) suggested the use of a thermometer to check for doneness. Where thermometer use was suggested, an endpoint temperature was provided for 97.5% ($n = 79$) of recipes. Endpoint temperatures aligned with government recommendations in 60.8% ($n = 48$) of recipes (Table 2).

Recipes containing meat, poultry or fish were assessed to determine whether professional status was related to the likelihood that a blogger would suggest the use of a thermometer to check for doneness (Table 3). The effect of blogger professional status was not significant ($t(46) = 0.580$, $P = 0.565$).

Recommendations for thermometer use were also compared among food categories (Table 4 and Table 5). Thermometer use was more likely to be recommended for some food categories than others ($F(7,201) = 11.686$, $P < 0.001$). For example, 24.1% ($n = 13$) of beef, veal or lamb recipes ($n = 54$) contained a recommendation for thermometer use, compared with 69.6% ($n = 16$) of whole poultry recipes ($n = 23$). The difference was significant ($P < 0.001$). In fact, bloggers were significantly more likely to suggest thermometer use in recipes for whole poultry than in recipes for any other food category ($P < 0.001$).

Nearly all recipes with meat, poultry or fish ingredients provided at least one subjective indicator to determine whether the food was cooked (89.6%, $n = 429$) (Fig. 1). The most common subjective doneness indicators were time (76.5%, $n = 328$), other visual cues (37.5%, $n = 159$) and color (32.4%, $n = 139$). Subjective doneness indicators were coded as correct for certain recipes: 29.4% ($n = 15$) for touch, 12.2% ($n = 17$) for color and 8.2% ($n = 13$) for other visual. Subjective indicators were provided as the only measure of doneness for 78.1% ($n = 374$) of recipes. In other cases, either thermometer use alone was suggested, or it was suggested in combination with a subjective doneness indicator.

Safe food handling and contamination reduction practices

Of 784 recipes assessed, only one suggested handwashing prior to beginning food preparation, and one recipe suggested sanitizing equipment and/or utensils (0.1% for each). Among recipes containing meat, poultry or fish ingredients ($n = 479$), one suggested handwashing after handling raw ingredients (0.2%).

Among recipes for produce intended to be consumed raw ($n = 304$), 3.3% ($n = 10$) suggested washing ingredients prior to consumption. Another 3.3% ($n = 10$) suggested washing

TABLE 2. Recipes suggesting thermometer use and providing correct endpoint temperature by blogger professional status

Blogger Professional Status	Number of Recipes	Recipes Suggesting Thermometer Use (%)	Recipes Providing Endpoint Temperature	Recipes Providing Correct Endpoint Temperature, Where Endpoint Temperature Provided (%)
Amateur	320	57 (17.8)	55	35 (63.6)
Professional	159	24 (15.1)	14	6 (42.9)
Total	479	81 (16.9)	79	48 (60.8)

TABLE 3. Comparison of blogs in recommendation of thermometer use by blogger professional status

Blogger Professional Status	Number of Blogs ^a	Mean Proportion of Recipes Suggesting Thermometer Use ^b	Standard Deviation
Amateur	32	0.178	0.141
Professional	16	0.150	0.047

^aFor each blog, the mean proportion of recipes that suggested thermometer use was calculated. Two blogs did not post any recipes containing meat, poultry or fish.

^bA *t*-test found no significant difference between these proportions ($t(46) = 0.580, P = 0.565$).

TABLE 4. Recipes suggesting thermometer use and providing correct endpoint temperature by food category

Food Category	Number of Recipes	Recipes Suggesting Thermometer Use (%)	Recipes Providing Endpoint Temperature	Recipes Providing Correct Endpoint Temperature, Where Endpoint Temperature Provided (%)
Beef, veal and lamb	54	13 (24.1)	11	1 (9.1)
Game meat	6	0 (0.0)	0	n/a
Ground meat and meat mixtures	103	8 (7.8)	8	6 (75.0)
Pork	48	14 (29.2)	14	4 (28.6)
Poultry (whole)	23	16 (69.6)	16	15 (93.8)
Poultry (pieces)	142	27 (19.0)	27	20 (74.1)
Fish	60	3 (5.0)	3	2 (66.7)
Shellfish	43	0 (0.0)	0	n/a
Total	479	81 (16.9)	79	48 (60.8)

TABLE 5. Comparison between blogs in recommendation of thermometer use by food category

Food Category	Number of Categories by Blog ^a	Mean Proportion of Recipes Suggesting Thermometer Use ^b	Standard Deviation
Beef, veal and lamb	30	0.253	0.378
Game meat	4	0.000	0.000
Ground meat and meat mixtures	38	0.058	0.131
Pork	29	0.272	0.372
Poultry (whole)	14	0.750 ^c	0.380
Poultry (pieces)	43	0.244	0.325
Fish	27	0.078	0.267
Shellfish	24	0.000 ^d	0.000
Total	209	0.195	0.023

^aFor each blog, the mean proportion of recipes that suggested thermometer use was calculated for each food category within that blog.

^bThe ANOVA indicated significant differences in this outcome by food category ($F(7,201) = 11.686, P < 0.001$).

^{c-d}The mean for whole poultry was significantly different from the means for all other food categories, while the mean for shellfish was significantly different from that of pork, for poultry pieces and whole poultry ($P < 0.05$), as determined by Tukey's HSD.



Figure 1. Meat, poultry or fish recipes providing subjective doneness indicators^a.

^aThe majority of recipes provided one or more incorrect subjective indicators to determine whether food was adequately cooked, with some exceptions. Touch, coded as correct for fin fish and bacon, was the subjective indicator most often used appropriately. Other subjective indicators used correctly were color, for fin fish and shellfish cooked until opaque, and other visual, for shellfish cooked until shells open.

some raw produce ingredients, but not others, and were coded as partially correct.

Instructions on safe storage of leftovers was provided in 4.0% ($n = 31$) of recipes. Of these, 55.0% ($n = 17$) correctly corresponded to government guidelines.

DISCUSSION

This is the first study that has exclusively evaluated food safety messages on popular recipe blogs. Results show that blog recipes often lack food safety instruction, which may have implications for consumer food handling. Findings of this study suggest that bloggers' attitudes and beliefs surrounding food safety roughly mirror those of the general public. For example, the likelihood of recommending the use of a thermometer to check for doneness varied significantly according to food category, even among different forms of the same food. Bloggers were significantly more likely to suggest thermometer use in recipes for whole poultry than in recipes for any other food category, including poultry pieces. This is in line with previous self reports of thermometer use among consumers. A survey of Canadian consumers found that up to 42% reported using a thermometer to check the temperature of whole poultry, compared with 12% for poultry pieces (44). Similarly, one survey found that 82% of U.S. consumers reported using thermometers to check for doneness of roasts, compared to 33% for chicken parts (18). Another survey found a similar disparity in thermometer use for different poultry cuts, noting that fewer than 10% of Americans who own a food thermometer report using the thermometer for all cuts (34).

Differences in recommendations for thermometer use may represent greater success in consumer food safety education for certain types of meat. For example, yearly holiday campaigns often reinforce messages surrounding food safety for whole turkey (22, 65). This discrepancy may also reflect blogger disagreement with the need for thermometer use in smaller cuts of meat, such as has been observed in previous qualitative consumer studies (71). Where thermometer use was suggested, a large portion of recipes provided an incorrect endpoint temperature. It was observed that in some recipes, bloggers actively challenged government advice concerning endpoint temperatures, arguing that lower temperatures resulted in improved flavor. Recommended temperatures were sometimes substantially lower than those specified government guidelines. This is a concern for public health, where misinformation surrounding food safety could result in illness.

Nearly all recipes (89.6%) provided a subjective indicator as a measure of doneness. In most cases (78.1%), subjective indicators were the only measure of doneness. These findings are unsurprising, as consumers report that visual inspection is their most common method of determining that meat is cooked (44). However, scientific evidence consistently demonstrates that visual inspection is not a reliable indicator of the microbiological safety of cooked meat.

For example, samples of stir-fried chicken breasts showed great variability in survival of *Campylobacter jejuni*, even when prepared according to package instructions for cooking time and when meat appeared done based on color (7). Several factors influence the color of cooked meat and its juice, including pH, packaging and cooking method (32). Ground meat in modified atmosphere packaging, in particular, is known to brown prematurely, resulting in increased survival of *Escherichia coli* O157:H7 (9). Thawing ground meat in the refrigerator overnight can similarly lead to premature browning (41).

Time was the most commonly provided subjective indicator; however, temperature variations in domestic appliances make it an unreliable predictor of whether food is sufficiently cooked (13). Current government recommendations indicate that the only way to determine that food containing meat, poultry or fish is safe to eat is to check whether it has reached a sufficient endpoint temperature, using a probe thermometer (25, 63). Subjective indicators, such as food color and time, are not reliable measures of doneness (7, 9, 57).

Though the coding tool used to evaluate subjective doneness indicators was inspired by that used by Levine et al. (38), modifications were made in order to align strictly with government food safety messaging to consumers and current scientific research. For example, in that study, color was coded as a correct subjective indicator for ground beef cooked by itself, citing a document prepared by Harrison et al. (28). However, this contradicts recommendations from the Canadian and U.S. governments (25, 63) and the already mentioned research on premature browning of ground meat (9, 41). Color was, therefore, coded as an incorrect subjective indicator for ground beef. In addition, categories were added to the coding tool that were not considered by Levine et al. to more fully capture government recommended food handling behaviors (e.g., leftover storage times, washing fresh produce and additional cross-contamination reduction practices).

Practices to reduce cross-contamination were almost never recommended in blog recipes. Recommendations to wash hands before beginning food preparation or after handling raw meat and to sanitize surfaces and equipment were each encountered only once. While such practices may be viewed as too obvious to be included in individual recipes, they are important to preventing illness. Conservative estimates indicate that the economic burden of failures in food handler hygiene amounts to \$5 billion per year in the U.S. (11). Handwashing in particular has been demonstrated to be an important factor in preventing foodborne illness (4, 51). As many as 85% of Canadians and 75% of Americans report that they always wash their hands before preparing food (36, 45). However, observations of people during food handling reveal that consumers often fail to wash their hands properly in practice (19). Research should consider whether prompts in blog recipes

might increase handwashing and cross-contamination reduction practices.

Few recipes recommended washing produce meant to be consumed raw. Previous surveys indicate that as many as 76% of Canadian consumers and 81% of U.S. consumers report rinsing fruits and vegetables before eating them (39, 45). However, as consumption of fresh produce has risen in recent years, the number of outbreaks linked to contaminated fruits and vegetables has also increased (12, 35). Between 1999 and 2008, 20.8% of *Salmonella* outbreaks and 18.4% of *E. coli* outbreaks in the U.S. were attributed to produce (5). Despite the risk, few consumers consider raw vegetables likely to be contaminated (36). Though washing produce may result only in a modest reduction in bacterial counts compared with cooking, it is still an effective method for reducing surface bacterial contamination (31), and guidance from both the Canadian and U.S. governments instruct consumers to wash all fresh produce under running water prior to consumption (23, 66). Some recipes suggested washing certain raw produce ingredients, and not others. For example, several salad recipes instructed the reader to wash, rinse and dry lettuce, but included no instruction for other ingredients, including herbs, tomatoes and green onions. It is unclear why this inconsistency exists. Future research may consider whether perception of risk varies based on type of produce.

Few recipes provided instruction on storage of leftovers. Of those that did, slightly over half provided storage times within ranges recommended by government guidelines. It has been found that nearly half of home kitchens are contaminated with at least one foodborne pathogen (10) and that kitchens may have greater levels of fecal contamination than bathrooms (52). Thus, the potential for cross-contamination is high (49). This, coupled with the fact that pathogens can survive in meat that is inadequately cooked and can multiply during storage (16), illustrates the importance of proper handling of leftovers. However, qualitative research shows that consumers often store leftovers longer than recommended (33, 58) and use unsafe sensory measures, such as smell or taste, to determine whether leftovers are still safe to eat (33). During this study, in what is hoped to have been a typo, one recipe was observed to advise that turkey leftovers could be stored up to four days at room temperature. Such troubling recommendations have the potential to negatively impact consumer health.

The lack of instruction surrounding food safety on recipe blogs reveals a gap that might be bridged by engaging bloggers as partners in promoting food safety messages. This may be challenging, given the plethora of recipe blogs, but a start might be the dissemination of recipe writing guides containing proper food safety messages. Previous research has shown that modifying food safety instructions in recipes can positively impact consumers' food handling behaviors (43). Food educators

should consider whether this intervention would be effective in this context.

Social influences are known to be important factors in determining consumer food handling behaviors (70, 71). The most popular recipe bloggers are social media influencers, celebrities in their own right, with vast reach. Marketing research has established the sway social influencers hold over purchasing behavior (37, 40). While the influence of food bloggers is less studied, a survey by Google showed producers of food videos can have a substantial impact on consumption; more than two thirds of millennial moms purchase food products recommended in online videos (17). Other studies have shown that celebrities can influence health beliefs and behaviors as well (6, 50). Consideration should be given to how recipe bloggers' beliefs and behaviors concerning food safety may affect consumer food handling.

Studies of the influence of television chefs may point to the potential of bloggers as role models. It has been found that celebrity chefs' food handling practices impact consumers' reported likelihood to practice similar behaviors (14). Celebrity chefs are far more likely to suggest the use of subjective indicators, such as color, rather than a thermometer to determine whether food is adequately cooked, possibly influencing consumers to believe that thermometer use is a mark of inexperience (42, 56). Interestingly, this study found that professional chefs were no more likely than amateurs to recommend thermometer use. Consumer perceptions of the credibility of professional chef bloggers relative to amateurs has not been studied; however, it would be interesting to know whether professional status affects bloggers' influence. Studies identifying attributes of social influencers show that certain characteristics, such as source credibility, are important in determining whether consumers are likely to be swayed by their endorsement (30, 37, 55). Research should attempt to identify those bloggers who may have the greatest impact so that they might be targeted for food safety education interventions.

This study has certain limitations. For example, the sample may not accurately represent the most popular recipe blogs. A list of blogs was obtained from Alexa Internet. Web traffic estimates are provided only for websites that have Alexa's tracking script installed and site owners may opt to keep their data private (3). Alexa acknowledges that because of statistical limitations, data are more reliable for sites ranked closer to the top of its traffic ranking list (3). Variation between recipe blogs at the top of the list and those further down was observed in this study. Blogs near the top of the list were updated frequently and received heavy web traffic, whereas some sites near the bottom of the list had not been updated in several years and received few visitors. However, these blogs were included, as they continue to attract new traffic. It was beyond the scope of this study to consider the relative influence these blogs might have.

In addition, the sample did not include sites that aggregate user-submitted recipes. Such sites would be expected to show far greater variability in food safety messaging and were excluded to avoid inconsistency in coding during evaluation. However, aggregated recipe sites are important sources of food-related information. For instance, one of the most popular of these (in fact, one of the most popular sites on the internet), Allrecipes.com, receives 1.5 billion visits annually (46). Additionally, user comments on the recipe blogs were not evaluated, although most recipes evaluated did not have any comments. Further studies might examine food safety messaging on user-submitted recipe sites, including user comments on such sites.

Several challenges were encountered in coding recipes. For example, some recipes provided an endpoint temperature lower than that recommended in government guidelines and paired it with a specified rest time, noting that temperature continues to rise after meat is removed from the oven. This was acknowledged by the USDA in 2011, when it changed its recommended endpoint temperature for pork from 160°F (71°C) to 145°F (63°C), with a three-minute rest time (68). Evidence indicates that post-cooking temperature rise is not predictable for all types of meat and can show great variability

(8); therefore, recipes that provided endpoint temperatures below government recommendations were coded as incorrect, regardless of specified rest time. Another challenge was that recipes occasionally provided ambiguous instructions, such as “continue to cook until cooked through.” Such ambiguous statements were coded as incorrect subjective doneness indicators.

CONCLUSION

Previous research has evaluated food handling behaviors of television chefs and food safety messages in magazine and cookbook recipes. This was the first study to examine food safety messaging exclusively in recipe blogs. Results showed that food handling practices were rarely recommended on popular blogs, and when provided, they often did not correspond to current government recommendations. Efforts are needed to encourage the adoption and promotion of food safety messaging on recipes blogs. As social media influencers with broad reach, recipe bloggers have the potential to play an important role in reducing foodborne illness by spreading food safety messages. Further research should examine the effect of blog recipe modification to include food safety instructions on consumer food handling behaviors.

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