

News Coverage of Cancer Research:
Does Disclosure of Scientific Uncertainty Enhance Credibility?

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Abstract

It is often assumed that news audiences prefer simple explanations of scientific research. One way to simplify science is to remove uncertainty from the message—that is, to eliminate study limitations, caveats, and hedged statements. Yet some communication scholars have suggested that it may be the opposite: including scientific uncertainty might enhance credibility judgments of both the communicator and the scientist responsible for the study. In a news experiment, we test whether amount and source of uncertainty are related to lay readers' perceptions of journalist and scientist credibility. Participants ($N = 880$) were randomly exposed to one of 16 manipulated news stories about cancer research in a 2 (high vs. low uncertainty) \times 2 (disclosure by primary vs. outside scientist) \times 4 (news article) message design and then asked about their attitudes and perceptions concerning the article. Source and amount of uncertainty were strongly related to audience ratings of journalist credibility but not scientist credibility. Specifically, journalists were perceived as more credible when their stories contained a greater amount of uncertainty disclosed by the scientist responsible for the study. Including fuller explanations of scientific uncertainty in news reports of scientific research may boost the perceived credibility of journalists, which has important implications for communicating to the public about cancer and other health risks.

Keywords: uncertainty, news credibility, science communication, science news, trust, public support for science

News Coverage of Cancer Research: Does Disclosure of Scientific Uncertainty Enhance Credibility?

The news media are recognized as an essential channel for communicating health research and recommendations to the public (Atkin & Wallack, 1990; Jensen, Krakow, John, & Liu, 2013; Johnson, 1997). News stories can educate lay audiences about methods for preventing a myriad of health risks, including cancer, the second leading cause of death among Americans (Siegel, Miller, & Jemal, 2015; Stryker, Moriarty, & Jensen, 2008). However, whether or not the public trusts a source of risk information can influence how they interpret and respond to the risks (Malka, Krosnick, & Langer, 2009; Priest, Bonfadelli, & Rusanen, 2003; Siegrist, Connor, & Keller, 2012).

Prior research in the context of health journalism has identified a connection between perceived credibility and hedging (Jensen, 2008). In general, *hedged* language is language that employs modifying devices (hedges) to make tentative statements. In a scientific context, hedging is more aptly described as the disclosure of scientific uncertainty (Hyland, 1996). It is customary for scientific research published in peer-reviewed journals to include a discussion of study limitations and caveats, and for inferences to be made cautiously (i.e., with language of restrained possibility such as *could*, *perhaps*, and *might*; Reyna, 1981; Schwartz, Woloshin, & Welch, 1999).

When reporting scientific research to the public, a journalist can choose how much uncertainty to include. Sometimes the inclusion of hedging language is at direct odds with other news values. For example, although accuracy is a strong marker of quality in newswriting (Dudo, Dahlstrom, & Brossard, 2007; Kovach & Rosenstiel, 2007), journalists are expected to present information simply and clearly to make it easier for audiences to understand (see Bender, Drager, Davenport, & Fedler, 2009). Further, journalists are expected to appeal to audiences by presenting engaging material (Groot Kormelink & Costera Meijer, 2015). This tension can lead to the omission of uncertainty for the sake of clarity, novelty, or sensation value.

Journalists also choose whether to include disclosures of scientific uncertainty from the primary scientists responsible for a study, or alternately to invite unaffiliated scientists to comment. Casting a balanced view by interviewing multiple sources is a key tenet in journalism (Bender et al., 2009). Yet attempts to create balance in science coverage are frequently made by soliciting the point of view of an outside scientist *in place of* disclosure from the primary scientist. This may create the appearance that the primary scientist failed to acknowledge the uncertainty, or that scientists are dueling about the findings, either of which could inadvertently impact perceived credibility.

The current study examines whether certain practices in journalism could be systematically lowering public perceptions of credibility with regard to cancer research reports. Though likely unintentional, this could lead to biased processing and, potentially, dismissal of health information that is important in helping the public avoid health risks. We model this study on a prior experiment by Jensen (2008), which found a link between disclosure of scientific

uncertainty attributed to the primary scientist and increased trustworthiness ratings for both the journalist and the primary scientist. We aim to see if Jensen's (2008) earlier findings hold (a) with updated news credibility measures (Yale, Jensen, Carcioppolo, Sun, & Liu, 2015), (b) in a sample that is more representative of the general public, and (c) in a more current media environment. Additionally, we explore whether source and amount of uncertainty influence public support for scientific research in general.

Capturing Perceptions of Credibility

In order to navigate the plethora of risks—including health risks—inherent in modern society, people often select other social actors in whom to trust (Kohring & Matthes, 2007). These are usually expert systems (such as news media, industry, scientists, and government) that individuals deem suitable to act on their behalf. Here, trust replaces knowledge, and individuals choose which information sources to trust based on certain criteria (Kohring & Matthes, 2007). *Credibility* is one such heuristic.

Operational definitions of credibility are complex and vary widely in the literature. Early trust and credibility research, which focused on communicators in general, identified two major subdimensions of credibility: *expertise* and *trustworthiness* (Hovland et al., 1959). Expertise was operationalized as believing an actor to be informed and intelligent, while trustworthiness reflected a belief that the actor was impartial and not intending to persuade (Hovland et al., 1959). McCroskey and Young (1981) proposed a refinement to these widely used measures of credibility, identifying three distinct factors that comprised expertise: being intelligent, competent, and an expert; and three distinct factors that comprised trustworthiness: being trustworthy, honest, and ethical.

News Credibility

In measuring perceived credibility of newspapers and TV news, Gaziano and McGrath (1986) grouped the following 12 items together as a single factor: fair, unbiased, tells the whole story, accurate, respects the privacy of people, looks out for the interests of people, is concerned about the well-being of the community, separates fact from opinion, can be trusted, is concerned about the public interest, is factual, and has well-trained reporters. Their rationale was that these concepts have typically been treated as indicators of credibility in past research.

Meyer (1988) outlined a simpler measure of credibility comprised of five items: fairness, accuracy, unbiased, can be trusted, and tells the whole story. While each of these essentially describes *believability*, according to Meyer, he argued that “[t]his redundancy provides a far more accurate measurement than could be made by one of these items alone” (p. 574). Meyer also suggested that community affiliation (e.g., being concerned about the well-being of the community and the public interest) is distinct from credibility and should be measured with a separate scale, though West (1994) later found that addition to be unreliable. West also noted that the Gaziano-McGrath measure appeared to have multiple underlying factors.

Abdulla and colleagues (2005) used a variation of the Gaziano and McGrath (1986) scale, grouping the following 11 items into three main factors: balanced, accurate, fair, objective, reports the whole story (under the primary dimension of *balance*); honest, believable, trustworthy (under the primary dimension of *honesty*); and current, up-to-date, timely (under the primary dimension of *currency*). One major difference in Abdulla et al.'s modified credibility scale is the replacement of concepts related to intent toward the receiver (e.g., community affiliation, goodwill) with concepts related to currency. A 12th item, bias, was not included in their final Abdulla et al. scale for newspaper credibility.

Recently, Yale and colleagues (2015) tested Abdulla et al.'s (2005) scale as a single second-order factor (all nine items combined), as opposed to examining the honesty, balance, and currency separately as three first-order factors. The new factor structure mitigated discriminant validity issues observed in the original scale, suggesting that when testing all three factors—balance, honesty, or currency—they should be tested as a single scale to measure credibility.

Some scholars distinguish between *source* credibility and *message* credibility with regard to evaluations of news. Kiouisis (2001) suggested that source credibility focuses on communicator variables (e.g., the individual journalist, the news outlet) while message credibility focuses on message variables (e.g., the content of news article). A third level of credibility judgment is also evident: perceived credibility of the platform. For instance, Kiouisis (2001) found credibility ratings to be higher for print news than online or TV news. However, Kiouisis noted that to some extent these layers are intertwined in audiences' minds.

The terms journalists and news media are sometimes used interchangeably in the literature (Kohring & Matthes, 2007). Frequently when communication scholars refer to trust in news media, they are actually speaking about trust in sources, such as journalists (Jensen, 2008). After all, it is journalists who select topics and facts to report, are responsible for reporting the information accurately, and offer their assessment of the issue—key dimensions of news trust, according to Kohring and Matthes (2007). Yet Kiouisis (2001) made the case that perceptions of credibility—across layers, from journalist to outlet to media platform—are likely intertwined. In the current study, we asked participants to judge the news article instead of the journalist. Our aim was to keep the focus of their assessment on the content of the article, rather than shifting their thoughts toward a judgment of the person who said it, in order to examine the effects of our message characteristic variables. However, it is plausible that credibility evaluations of the article transfer to evaluations of the journalist (and vice versa).

Scientist Credibility

Few attempts have been made to specifically measure perceived credibility of scientists. Examinations of trust in scientists and scientific institutions have typically been embedded within larger studies about public trust in expert institutions (e.g., scientists, industry, government, and nonprofits; see Malka et al., 2009; Priest et al., 2003; Siegrist et al., 2012).

Earle and Siegrist (2006) proposed a general trust model that divides trust into morality-

based and performance-based assessment, with the former influencing *social trust* and the latter influencing *perceived competence*. Siegrist et al. (2012) applied this to public trust in scientists and industry, suggesting that public trust in these groups can be examined in terms of perceived shared values and perceived competence. They proposed a multidimensional scale with items to capture subdimensions of social trust (honesty, concern for public health and the environment) and subdimensions of confidence (related to competence). Given these measures, trust and confidence factors may be closely related to perceived credibility of scientists and industry; however, this was specific to an environmental risk context.

Priest and colleagues (2003) examined trust in scientists along with industry, government, and other social institutions. They operationalized trust as “doing a good job for society,” arguing that the measure taps into a dimension of social trust (p. 754). Siegrist et al. (2012), on the other hand, reasoned that trust and confidence are related but distinct concepts; trust is based on value similarity (i.e., intentions toward society) while confidence (i.e., competence) is based on past performance. Both of these appear to mirror the traditional key subdimensions of credibility—trustworthiness and expertise—although intentions toward society may be more closely related to goodwill.

In a series of studies conducted during 1971–1975, McCroskey and colleagues identified several dimensions of source credibility, including competence, character, sociability, extroversion, and composure. McCroskey and Young (1981) evaluated multiple types of expert sources, including organizations, peers, public figures, the media, and instructors. Their dimensions pertained more to speech communication cases, where factors such as composure, sociability, and character could be evaluated. A later credibility scale developed by McCroskey examined credibility as it pertained to experts (McCroskey & Teven, 1999) and has been one of the most widely used scales to assess perceptions of credibility via the subdimensions of expertise and trustworthiness.

Sjöberg (2011, p. 189) argued that competence has two sides: “One is knowing, the other is knowing the limits of one’s knowledge.” He suggested the latter is a consideration when evaluating a source’s trustworthiness. In a science context, this aspect of competence—knowing the limits of one’s knowledge—could be measured by a scientist’s willingness to disclose uncertainty about her research, and potentially is a measure that audiences use to gauge scientist credibility.

Uncertainty and Credibility

In scientific research, uncertainty describes how well something (for instance, a study finding or a conclusion) is known (Peters & Dunwoody, 2016). It is not fully understood how lay audiences process uncertainty, and a growing body of literature has sought to understand audience reactions (Binder, Hillback, & Brossard, 2016; Guenther, Froehlich, & Ruhrman, 2015; Guenther & Ruhrman, 2016; Jensen et al., 2017; Kimmerle, Flemming, Feinkohl, & Cress, 2015; Niederdeppe et al., 2014; Post & Maier, 2016; Winter, Kramer, Rosner, & Neubaum, 2015). However, the concepts of uncertainty and credibility have previously been explored together

(Jensen, 2008; Priest et al., 2003), and there is reason to believe message characteristics—such as whether, and to what extent, uncertainty is disclosed—can influence perceived credibility (Hendriks, Kienhues, & Bromme, 2016a; Hendriks, Kienhues, & Bromme, 2016b).

Amount of Uncertainty

The inclusion of uncertainty in health news can take the form of hedging language, or presentation of the limitations and caveats of research findings. A common newswriting principle is streamlining word choice, or “cutting out the fat” (Bender et al., 2009, p. 99). For example, journalists are often instilled with a belief that most adverbs and adjectives are unnecessary (see Bender et al., 2009). Aiming for strong and simple phrasing could lead to the removal of hedging language.

Yet research suggests that scientific uncertainty may be appreciated by lay audiences as well as the scientific community. For example, after reading hedged news reports of cancer research, participants in one study were less fatalistic about cancer than their peers who read non-hedged reports (Jensen et al., 2011). Fuller expressions of uncertainty may even serve as a heuristic for news consumers with lower quantitative literacy and/or lower scientific knowledge. As Schwartz and colleagues (1999, p. 128) explain, sensing that an article has incomplete or undisclosed data can give the impression of “an underlying attempt to persuade rather than inform.” Perceived intention to persuade in turn can lower trust and credibility ratings (Hovland et al., 1959; Kohring & Matthes, 2007).

People have heuristics for assessing the credibility of information even when it is not fully understood (Chaiken & Maheswaran, 1994). Potentially, lay audiences evaluate the quality of scientific research claims in news articles by recognizing the inclusion (or omission) of ambivalent language, caution surrounding claims, and specific data to support conclusions. Indeed, a study by Dahlstrom, Dudo, and Brossard (2012) found that audiences give more weight to scientific stories about health risks when precise information is included, defined as “specificity of information about a risk’s pervasiveness, potency, or effects” (p. 156).

Elimination of uncertainty can happen at many stages of the research communication process. Journalists may assume audiences prefer streamlined health information (Allan, 2011). Potentially, the belief is that powerful (i.e., certain) language will enhance trust in the communicator or in health research in general, and thus promote positive health beliefs and behaviors. Yet, as Dorothy Nelkin (1996, p. 1601) wrote, “scientists, eager to promote their latest breakthrough, contribute to hyperbole” as well. Scientists may speak in overly certain terms about their research out of a belief that it will enhance their credibility or increase support from the public and decision-makers for their work (Star, 1983). Public relations professionals may further remove uncertainty as the information goes from journal article to press release (Nelkin, 1996).

Attempts to present research in a saleable way may be misguided. Although powerful language appears to heighten credibility in other contexts, such as business (Ober, Zhao, Davis, & Alexander, 1999) and public speaking (see Hosman, 2002), the effect might not hold when

presenting health and medical research (Jensen, 2008). In fact, scholars have argued that using powerless language in science communication is a demonstration of objectivity (Popper, 1934/2002), which could in turn reflect on scientists' credibility. Potentially, a similar pattern would hold for science journalists, as well.

In light of prior research, we predict the following about uncertainty in news coverage of scientific studies:

H1a: Cancer news reports that include a higher amount of scientific uncertainty will associate with greater perceived credibility of the *journalist*, compared with low-uncertainty coverage.

H1b: Cancer news reports that include a higher amount of uncertainty will associate with greater perceived credibility of the *scientist* leading the study, compared with low-uncertainty coverage.

Source of Uncertainty

When journalists do include uncertainty in reports of scientific research, it is often by way of a counter point of view from an expert or scientist unaffiliated with the study. Casting a “balanced” view is a basic principle of newswriting, and seeking outside commentary is a common and generally constructive practice in journalism (Bennett, 1996). However, whether news audiences associate this kind of balance with quality or credibility may be context dependent (Jensen, 2008). In science reporting, the balance frame may have unintended consequences, giving the impression that the original scientists behind the study are ignorant of—or even attempting to mask—limitations in their research (Jensen, 2008). Additionally, it may create the appearance that scientists in the scientific community are pitted against each other and lack accord on health research, even when this is not the case (Allan, 2011).

Some have suggested that the news media incorporate fringe counter-perspectives for the sake of sensationalism or to force balance where none exists (Dixon & Clarke, 2013). Journalists have been accused of treating discussions of scientific breakthroughs like “football matches” and giving equal weight to opposing viewpoints without scrutinizing the evidence behind them (Allan, 2011, p. 773). Onora O’Neill (2004, p. 269) writes that news consumers hear about highly publicized cases of “scandals, dereliction, cover up and even corruption in medicine and biomedical research”—some of which is founded, she says, but most of it is not. This suggests an already existing, biased lens through which news audiences may be processing news reports about scientific discoveries (Chingching, 2015). The dueling frame—disclosures of scientific uncertainty from an outside source, instead of the primary scientist responsible for the study—could further impact perceptions of scientist credibility. Regardless of whether the aim is to create an appearance of conflict and heighten a story’s sensation value or simply to employ a balanced frame, we predict that source attribution of uncertainty will impact credibility:

H2a: Limitations disclosed by the primary scientist, as opposed to an outside scientist, will lead to greater perceived credibility of the *journalist*.

H2b: Limitations disclosed by the primary scientist, as opposed to an outside scientist, will lead to greater perceived credibility of the primary *scientist*.

Potentially, amount of uncertainty and source attributions interact to influence credibility judgements. Jensen (2008) found a small but significant interaction between amount and source of uncertainty such that greater uncertainty, when attributed to the primary scientist, increased credibility ratings for the journalist and the scientist. In the current study, we test whether the same uncertainty amount \times source interaction emerges with updated credibility measures and a population more representative of the general public.

H3a: A high amount of uncertainty attributed to the primary scientist, as opposed to an outside scientist, will lead to greater perceived credibility of the *journalist*.

H3b: A high amount of uncertainty attributed to the primary scientist, as opposed to an outside scientist, will lead to greater perceived credibility of the *scientist*.

Support for Scientific Research

Both uncertainty and perceived credibility could be related to public support for science. First, past research has shown that the communication of scientific uncertainty is related to public engagement with science (Retzbach & Maier, 2015; Retzbach, Otto, & Maier, 2016). If uncertainty is related to engagement with science, then it stands to reason that it could also be connected to support for the scientific enterprise. Moreover, support for scientific research seems to be relatively high. As an illustration, the National Science Foundation administers a survey every two years to assess U.S. public opinion about the federal funding of scientific research. The survey has found Americans to be generally supportive of scientific research; most recently, 83% of Americans agreed or strongly agreed that the federal government should support scientific research that advances the frontiers of knowledge, even if it does not bring immediate benefits (National Center for Science and Engineering Statistics, 2014). Given that the majority of the public likely hears about scientific research through the news, perceptions of credibility in news coverage of health research could influence public support for science. This has not previously been examined. Thus, we investigate the following:

RQ1: Is there a relationship among how scientific uncertainty is disclosed in the news, perceived credibility, and support for science?

Method

Design

Participants were randomly assigned to one of 16 conditions in a 2 (uncertainty amount) \times 2 (uncertainty source) \times 4 (cancer news article) between-subjects experiment. The amount of

uncertainty was either high or low. The source of uncertainty was either the primary scientist (the scientist responsible for the study described in the article) or an outside scientist (a scientist unaffiliated with the study). Four different news articles were manipulated on these variables. Individuals completed a pretest, read a single news article, and then completed a posttest. Participants were paid \$10 for participating in the study.

Sample. Participants ($N = 880$) were recruited in seven shopping malls in the Midwest and randomly assigned to one of the 16 news article conditions. Jensen's (2008) initial study surveyed a convenience sample of college students and was considered to be a starting point for further research. Participants in the present study represent a greater diversity of educational backgrounds and thus may be more representative of the U.S. population. Participants provided demographic information, including age ($M = 35.92$, $SD = .16$; range: 18 – 84), sex (female: 66.10%), education (more than 12th grade: 53.30%), and race (83.2% Caucasian, 11.7% African American, 3.1% Hispanic, Latino, or Spanish Origin, 1.0% Asian or Pacific Islander, 1.8% American Indian or Native American, and 2.3% self-described as "other"; participants could check more than one category). The mean household income was \$51,769 ($SD = \$42,954$).

Stimulus materials. All participants randomly received a news article on one of four cancer research topics embedded within a survey. Survey questions were the same for all participants. The article was manipulated to represent one of four possible uncertainty conditions: low-uncertainty/primary scientist disclosure, high-uncertainty/primary scientist disclosure, low-uncertainty/dueling disclosure, high-uncertainty/dueling disclosure. Disclosure refers to uncertainty addressed by the scientist affiliated with the study (the primary scientist), while dueling refers to uncertainty addressed by an unaffiliated scientist.

Stimulus articles were developed by Jensen (2008) and involved the manipulation of real news articles gathered from the Lexis Nexis database. Search parameters included: U.S. news articles from major papers or Midwest regional sources that contained "cancer research" or "cancer study" in the headline, lead paragraph(s), or key terms (Jensen, 2008). Using a random number generator, four articles were selected from these search results for inclusion in the study: two articles pertaining to research about cancer treatments (nanobombs, lung cancer treatment) and two pertaining to research in cancer prevention (Mediterranean diet, lycopene pills). Full stimulus materials available in the Appendix.

Survey Measures

Journalist credibility. After reading the article, participants were asked to evaluate the journalist's credibility. Journalist credibility was treated as a single second-order factor measured by nine items (accurate, honest, believable, balanced, report the whole story, objective, up-to-date, current, and timely; $M = 3.47$, $SD = .60$, $\alpha = .88$) using a five-point scale ranging from *strongly disagree* to *strongly agree* (Yale et al., 2015). These nine items were originally argued to represent the first-order factors of honesty, balance, and currency, but discriminant validity issues suggest that—when used together in the same analysis—they should be combined into a single scale (Yale et al., 2015). In other words, researchers have the option to use a single

measure of credibility (all 9 items combined) or to investigate hypotheses about a single first-order factor separately (e.g., an analysis that just includes the items representing the first-order factor of honesty). The current study utilizes the full scale, and also tests hypotheses related to the honesty factor ($M = 3.57$, $SD = .65$, $\alpha = .80$).

Scientist credibility. Participants were also asked to evaluate the primary scientist in the article. Expert source credibility has two underlying dimensions: expertise (intelligent, expert, competent; $M = 3.65$, $SD = .68$, $\alpha = .83$) and trustworthiness (trustworthy, honest, ethical; $M = 3.48$, $SD = .68$, $\alpha = .83$). These six items were assessed on five-point scales ranging from *strongly disagree* to *strongly agree* (McCroskey & Teven, 1999). Although McCroskey and Teven (1999) proposed ‘goodwill’ as a third dimension of credibility, Jensen (2008) argued that goodwill is a separate construct and did not include it in the credibility scale used in his 2008 study. It was not included in the present study.

Support for scientific research. Participants were also asked about level of support for scientific research in general. Specifically, they reported how much they agree with the following statement: “Even if it brings no immediate benefits, scientific research that advances the frontiers of knowledge is necessary and should be supported by the Federal Government.” Answers were given on a four-point scale ranging from *strongly disagree* to *strongly agree* ($M = 3.09$, $SD = .87$). This single-item measure comes from the Science and Engineering Indicators of the National Science Foundation, published by the National Center for Science and Engineering Statistics (NCSES, 2014).

Power Analysis

G*Power was used to calculate power for the design (Faul, Erdfelder, Buchner, & Lang, 2009). Past studies have found small effects (Jensen, 2008; Jensen et al., 2011). For a three-way ANOVA with 16 cells, the design was adequately powered (.84) to detect a small effect ($f = .10$). That said, researchers should be mindful of both Type I and Type II error when searching for small effects. Type I error is guarded against via replication. Type II error is countered by focusing on effect size rather than relying heavily on the p -value logic of null hypothesis testing.

Results

Five three-way ANOVAs were conducted to test hypotheses H1a – H3b and RQ1. Uncertainty and source were fixed factors and news article was treated as a random factor (per Jackson & Brashers, 1994). News article was treated as random as the variation on that factor (i.e., 4 random news articles) represents natural variability rather than specific levels of interest (Jackson & Brashers, 1994).

The first ANOVA included the single dimension journalist credibility measure from Yale and colleagues (2015) as the outcome variable to test H1a, H2a, and H3a. The small uncertainty \times source interaction found in previous research manifested once again, $F(1, 3.15) = 6.44$, $p = .081$. No other factors or interactions were significant (see Table 1). Consistent with Jensen (2008), participants in the high uncertainty/primary scientist disclosure condition perceived

Table 1. *ANOVA Results by Outcome Variable*

	Journalist's Credibility	Journalist's Trustworthiness (Honesty)	Scientist's Trustworthiness	Scientist's Expertise	Support for Research
Uncertainty	1.15	3.28	.00	1.25	.01
Source	.06	.02	.10	1.53	.69
Article	5.69†	4.35	.81	5.66**	4.06
Uncertainty × Source	6.44†	7.58†	.04	.15	.16

Note. *F*-ratios for all main effects and the uncertainty × source interaction. † $p < .10$ ** $p < .01$

journalists as more credible than did their peers in the low uncertainty/primary scientist condition (size of the effect between conditions: $r = .10$; for means and standard deviations, see Table 2).

As a follow-up analysis, a second ANOVA was carried out using only the credibility items representing the subdimension of honesty. Using an older measure, Jensen (2008) found a significant uncertainty × source interaction for trustworthiness. Consistent with the first ANOVA and with Jensen (2008), the follow-up ANOVA revealed a small uncertainty × source interaction, $F(1, 3.18) = 7.58, p = .066$. Once again, the high uncertainty/primary scientist condition correlated with higher journalist honesty ratings compared to the low uncertainty/primary scientist condition (size of the effect between conditions: $r = .10$; for means and standard deviations, see Table 3).

Table 2. *Uncertainty × Source Interaction Effects on Journalist's Credibility*

	Disclosure	Dueling
High Uncertainty	3.52 (.56)	3.47 (.52)
Low Uncertainty	3.41 (.62)	3.48 (.68)

Note. Means and standard deviations (in parentheses). Post-hoc tests reveal that high uncertainty – disclosure is significantly different than low uncertainty – disclosure ($p < .05$). No other means are significantly different.

Table 3. *Uncertainty × Source Interaction Effects on Journalist's Trustworthiness (Honesty)*

	Disclosure	Dueling
High Uncertainty	3.63 (.62)	3.52 (.58)
Low Uncertainty	3.50 (.68)	3.56 (.72)

Note. Means and standard deviations (in parentheses). Post-hoc tests reveal that high uncertainty – disclosure is significantly different than low uncertainty – disclosure ($p < .05$). No other means are significantly different.

H1b, H2b, and H3b postulated that high uncertainty disclosed by the primary scientist would also link with higher trustworthiness ratings for the primary scientist. The credibility of experts is thought to have two underlying dimensions: trustworthiness and expertise. Two ANOVAs were conducted, one with trustworthiness as an outcome and the other with expertise as an outcome. No significant main effects or interactions were observed (see Table 1).

Using four different cancer news articles in the present experiment allowed us to generalize across articles. We were not interested in whether one topic generated more perceived credibility than another, but whether our factors would generalize above and beyond the variance that could be attributed to a particular article. The observed interaction in the high uncertainty by primary scientist condition occurred across all four articles.

RQ1 asked if uncertainty and source attribution were related to support for scientific research. No significant main effects or interactions were observed (see Table 1).

Discussion

Journalists are trusted as key translators of scientific research for the public. The news is an especially important avenue for educating people about cancer and other major health risks (Dudo, Dahlstrom, & Brossard, 2007; Jensen et al., 2013; Stryker et al., 2008). Yet current norms in news coverage of health research could systematically lower public trust in these reports. For example, journalists frequently minimize uncertainty when reporting scientific findings. They may alternatively disclose it in a dueling frame by soliciting comments from an outside source instead of the scientists responsible for the study (Jensen, 2008).

Using updated news credibility measures (Yale et al., 2015), the present experiment found that amount and source of uncertainty in cancer news articles significantly impacted audience perceptions of journalist credibility. Specifically, participants found the journalist more credible and trustworthy when the story contained a *higher* amount of uncertainty attributed to the *primary* scientist. The observed effect was small but significant and held across all four different cancer news articles. This suggests that the effect occurs systematically and was not due to features of a particular article or cancer topic.

The same conditions may affect credibility judgments for scientists, though it was not apparent in the current study. Jensen (2008) did find that high uncertainty disclosed by the primary scientist led to higher credibility ratings of both the journalist and the scientist. Thus, our study only partially replicates Jensen's earlier findings. Potentially, source and amount of uncertainty did not impact scientist credibility in our study because there are better measures that should be used to assess lay perceptions of scientist credibility (e.g., a scale specific to scientists). There is also the possibility of a small drip effect. Media effects are typically modest and often conceptualized as cumulative (Jensen, Bernat, Wilson, & Goonwardene, 2011). Thus, subtle effects that are imperceptible during a single exposure can produce larger effects over time. It could be that omitting uncertainty in scientific news coverage, or disclosing it by way of a dueling frame, steadily undercuts journalists' credibility.

Public Health Implications

Public understanding of health is in jeopardy when journalists present medical discoveries as being more definite than they actually are (Allan, 2011; Schwartz et al., 1999; Thiebach, Mayweg-Paus, & Jucks, 2015). To do so can “convey a false sense of the magnitude and certainty of the benefits of interventions, engendering unrealistic expectations” (Schwartz et al. 1999, p. 131). Unhedged depictions of health risks, meanwhile, can cause undue fear (Schwartz et al., 1999) and lead to fatalistic beliefs (Jensen et al., 2011).

Minimizing scientific uncertainty could also increase skepticism in science and medicine. Past research has suggested that streamlining (e.g., reducing the amount of uncertainty) may set up research-based recommendations for backlash or rejection (Jensen et al., 2013). Communicating in certain terms about health and medical discoveries may create public confusion and even controversy by making the findings from multiple studies appear contradictory. A survey for the World Cancer Research Fund (WCRF) found that more than half of respondents believed “scientists were always changing their minds” about cancer causes and preventive measures (BBC, 2009). Indeed, sometimes news outlets report, seemingly back to back, that the very same things can cause cancer and cure it (Anderson, Brossard, & Scheufele, 2010). These apparent extremes are likely, at times, to be the result of streamlined study conclusions and omitted caveats. Disclosure of uncertainty in a dueling frame could also be a cause.

In view of the results of this and prior studies, it seems that lay audiences have come to interpret unhedged research claims as an indicator that the journalist or the scientist is overstating study findings. This, in turn, could harm trust in these important sources of health information. Several scholars have noted that trust in sources of risk information influences how people respond to reported risks (Malka et al., 2009; Priest et al., 2003; Siegrist et al., 2012).

In the Context of an Evolving Media Environment

Because the news media have a latent influence on audience perceptions (Arendt, 2010), it is vital to examine connections among health risk perceptions, trust in information sources (e.g., scientists and journalists), and norms in science reporting (Jensen, 2008; Dahlstrom et al., 2012). The current study examined print news articles. Although newspapers have garnered higher trust ratings than other news platforms in past research (Kioussis, 2001), the majority of Americans (57%) prefer to get their news from TV, followed by 38% who prefer online; only 20% get most of their news in print, according to a Pew Research Survey (Mitchell, Gottfried, Barthel, & Shearer, 2016). Nonetheless, examining trust in print news remains important, and findings from our study likely pertain to audience trust in TV, radio, and online news domains. Kioussis (2001) suggested that layers of news credibility—the news content, the journalist, the outlet, and the media platform—are intertwined. News consumers’ criteria for assessing credibility may be constant across platforms and judgements of credibility may permeate across news media layers.

Growing concerns about fake news—fictional news stories circulated online (Barthel, Mitchel, & Holcomb, 2016)—could heighten audience skepticism toward news media. Roughly two-thirds of U.S. adults who responded to a Pew Research Center survey claimed that fake news has caused a great deal of confusion about current events (Barthel, Mitchel, & Holcomb, 2016). This could signal an era in which journalists must strive harder to win audience trust. Careful reporting of cancer and other health risk research is an important area for consideration.

Limitations and Future Directions

The current study had a number of limitations. First, the length of the articles could have influenced perceptions of credibility. Articles in the high uncertainty conditions were one or two paragraphs longer. Potentially, some readers make heuristic judgments that more information is more trustworthy (although, longer articles in the high uncertainty/dueling conditions did not increase journalist credibility ratings). Second, the study only examined the impact of exposure to a single news article. Given the small but consistent significant effect, and the possibility that true impacts of exposure manifest cumulatively, it may be worthwhile for media effects scholars to study the effects of uncertainty disclosure with longitudinal study designs. Research should also continue to investigate how norms in news coverage impact scientist credibility, especially given the observed effect on journalist credibility.

Conclusion

Despite its limitations, this study makes an important contribution to credibility measurements. It replicated one major finding from Jensen (2008) with a diverse U.S. sample that may be more representative of the population. Our results add to those of Jensen (2008) to indicate that amount of scientific uncertainty and source attributions can influence public trust in journalists. The results of our study indicate that lay audiences recognize a certain degree of uncertainty is inherent in the scientific process and in turn place greater trust in hedged research reports (or the journalists who write them).

While media are not always “exaggerating risk, whipping up hysteria and distorting reality” (Kitzinger, 1999, p. 55), this may be the perception among audiences. To counter skepticism and unintentional biases, journalists may consider which reporting practices, such as including scientific uncertainty in research reports, will foster favorable credibility judgements for both journalists and potentially also scientists.

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Appendix

Article Manipulations

Low Uncertainty-Disclosure Conditions

Cancer bomb article

'Bomb' Blasts Cancer
Tiny Tubes Deliver Chemo Directly to Targeted Cells
Wednesday, January 04, 2006
By Sharon Lem, Chicago Sun-Times

Researchers have developed a tiny cancer "bomb" that can blow up cancerous cells.

The cancer bomb uses carbon nanotubes to deliver the chemotherapy to the tumor sites. Nanotubes are smaller than a single cell. A nanotube is 10,000 times thinner than a human hair and a couple of microns long.

"We found using carbon atom nanotubes in testing of breast cancer cells can destroy cancer cells in very localized areas without any type of collateral damage," said Dr. Belaji Panchapakesan, assistant professor of electrical and computer engineering at the University of Delaware, in Newark, Del. Chemotherapy kills cancerous cells, but also normal cells.

"These nanotubes can be used in conjunction with imaging techniques to see where the cancer cells are and once you've found them, you can inject them with these nanotubes to blow them up," Panchapakesan said.

"This can be used not just for cancer ... but a wide variety of procedures, such as people with clogged arteries to remove the blockage in veins and arteries, and other minimally invasive micro-surgeries," Panchapakesan said.

Panchapakesan said once nanobombs are exposed to light and the resulting heat, they start exploding one after another.

In cancer cells, it works like a shockwave to kill not only the cancerous cells, but the cells that carry instructions to multiply into more cancerous cells and the veins that feed cancer cells.

"The nanobombs are so localized and selective and minimally invasive that it might cause what I would call a nanopain, like a prick of the finger," Panchapakesan said.

Though promising, Panchapakesan noted that it was too early to make definitive claims and that more research needed to be done.

The study is published in the journals NanoBiotechnology and Oncology Issues.

Lycopene article

Tomatoes outdo pills as cancer preventer

Wednesday, January 04, 2006

By Michael Woods, Chicago Sun-Times

The substance that makes tomatoes red, hailed as a powerful cancer preventive, has no anti-cancer effect when consumed in pure form like the pills now popular as nutritional supplements, scientists reported yesterday.

Lycopene alone did virtually nothing to protect laboratory rats against fatal prostate cancer, they found, while whole tomatoes reduced prostate cancer deaths by 26 percent.

In a study published in the latest edition of the Journal of the National Cancer Institute, researchers said it appears that an unidentified nutrient or combination of nutrients in tomatoes, perhaps including lycopene, protect against prostate cancer. Tomatoes contain hundreds of "phytochemicals," or plant-based chemicals, said Dr. Steven K. Clinton of Ohio State University, one of the lead authors of the study.

Lycopene has been in the public and scientific spotlight ever since a landmark 1996 Harvard University study found that men who ate at least 10 weekly servings of tomato sauce were a third less likely to develop prostate cancer than men who rarely ate tomatoes. Later studies found that a tomato-rich diet also may protect against other cancers, heart attacks and Alzheimer's disease.

Lycopene took credit, spawning a boom in sales of pricey lycopene pills and leading to the development of genetically engineered tomatoes that contain extra lycopene.

Dr. Peter H. Gann of Northwestern University, who was not involved in the Clinton study, described its findings as important in re-emphasizing a nagging question about naturally healthful compounds: Which is best, eating the whole food or taking a single nutrient in pill form?

Beta-carotene pills, for instance, were popular cancer preventives for years, especially among cigarette smokers. People took the pills rather than eat spinach, carrots and other foods rich in the nutrient. Then a study found that smokers who took beta-carotene pills actually had an increased risk of lung cancer.

"This study provides new evidence that eating a whole food might bring health benefits that we cannot get from taking pills that isolate one or two food ingredients," Gann said. "Fortunately, in this case, the food in question already is popular."

Americans eat an average of 100 pounds of tomatoes each year, mostly in salads, pasta and pizza sauce, chili and salsa.

Clinton's team gave three groups of rats a powerful chemical that causes prostate cancer. One group then was fed rat chow spiked with pure lycopene, another got chow plus a tomato powder

that contained lycopene and other phytochemicals, and the third group got standard rat food.

Rats on pure lycopene and ordinary chow died from prostate cancer at almost identical rates. The cancer death rate among those given tomato powder was 26 percent less. Those rats that also ate a little less chow, and thus fewer calories, cut their risk of prostate cancer even more -- by almost 33 percent.

Though promising, Clinton noted that it was too early to make definitive claims and that more research needed to be done.

Gann and Clinton had similar advice for men interested in a diet that may reduce prostate cancer risk:

Skip the lycopene pills, eat whole tomatoes and cut back on the calories.

Lung cancer article

Lung Cancer Patients Live Longer with Chemo

Wednesday, January 04, 2006

By Michelle Fay Cortez, Chicago Sun-Times

Chemotherapy following surgery to remove early lung cancer prolongs patients' lives by an average of almost two years, a study in the June 23 New England Journal of Medicine found.

Patients traditionally were monitored for new tumors without drug treatment, as the toxic side effects of chemotherapy were thought to outweigh the benefits.

The study, conducted by a team of researchers led by Timothy Winton, an oncologist at the National Cancer Institute of Canada in Kingston, Ontario, found that patients taking two generic drugs lived an average of almost eight years, compared with six for those without, at the expense of nausea, fatigue, vomiting, diarrhea and low white-cell counts.

The results should alter treatment for early-stage patients with lung cancer, researchers said. Lung cancer claims more than 160,000 lives annually and is the leading cause of cancer death in the United States. About half of those with early-stage disease survive at least five years. The findings were presented at the American Society of Clinical Oncology meeting in New Orleans last year.

Though promising, Winton noted that it was too early to make definitive claims and that more research needed to be done.

The current study suggests that chemotherapy "can be safely administered in the outpatient setting with limited toxicity and is beneficial in non-small-cell lung cancer," Winton said. "We believe that a brief course of such chemotherapy should become the standard of care for patients

with good performance status after complete resection of stage IB or stage II non-small-cell lung cancer."

Most of the side effects, including low levels of infection-fighting white blood cells, were resolved in about three months, the study of 482 patients in North America showed.

Mediterranean diet article

Recent Study Reinforces Benefits of Mediterranean Diet

Wednesday, January 04, 2006

By Stacie Bearing, Chicago Sun-Times

When I was growing up in California, I remember seeing a tantalizing TV ad. A large family was joyously dining at a huge table artfully placed in the middle of a vineyard.

Never mind that the ad came from a vineyard known at the time for its jug wine. The diners were eagerly helping themselves to pasta, fresh fruits and vegetables and freshly baked bread. Wine, of course, was in ample supply.

I fantasized that this wasn't California, but somewhere on the Mediterranean coast: soft, gentle breezes, the scent of ripening olives, and of course, the soundtrack from "Zorba the Greek."

My fantasy resurfaced as I read a recent study that again extolled the health benefits of the so-called Mediterranean diet.

The traditional Mediterranean diet includes lots of vegetables, legumes, fruits, nuts, whole grain cereals (no Cocoa Puffs), and lots of olive oil.

Saturated fats are at a minimum. Fish is a frequent menu item, while meat and poultry are not. Dairy products show up occasionally, mostly in the form of cheese and yogurt.

Finally, the Mediterranean diet contains a moderate amount of alcohol, mostly in the form of wine (hence, the vineyard), and mostly with meals.

Researchers from the University of Athens and Harvard Medical Schools followed more than 22,000 men and women in Greece for an average of 44 months.

They wanted to know if the classic Mediterranean diet helped protect against cancer and heart disease, and if mortality rates were lower in the group that ate that kind of diet.

They started off by interviewing each participant about their diet and lifestyle habits. Study participants were graded on a scale of 0 to 9, with 0 being the least adherence to the Mediterranean diet and 9 being the best.

The researchers looked at mortality rates over the time period of their study. Not surprisingly, the

mortality rate was higher in men than in women (sorry, guys), increased with age (the older you get, the more likely you are to die), and was inversely related to exercise and educational level (those who exercised the least and those with less education had higher mortality rates).

They also found that with every increase of two points in the Mediterranean-diet scale, there was a 25 percent reduction in total mortality. This association was slightly stronger for deaths due to heart disease than for cancer deaths, but deaths due to both were reduced significantly.

Interestingly, these figures held true regardless of gender, smoking status, level of education, body-mass index, and level of activity. (No, this does not mean that it's OK to be a chain-smoking couch potato!)

The findings of this study match those of earlier investigations. A study published in 1994 also looked at the Mediterranean diet.

After an average follow-up of 27 months, they found a 73 percent reduction in the rate of subsequent "cardiac events" and a 70 percent reduction in mortality in a group following the Mediterranean diet. A study in India had similar results.

Though promising, the researchers responsible for the present study noted that it was too early to make definitive claims and that more research needed to be done.

So what are we waiting for? My postage-stamp of a back yard may not be bathed in Mediterranean ocean breezes, but it's not bad. Local farmers' markets offer the most delicious fresh vegetables this time of year; it would be silly not to take advantage.

Here's what I suggest: Splurge on a nice, fruity olive oil and some fine balsamic vinegar. Mix the two with a bit of sugar and toss with fresh tomatoes, cucumbers, avocados, fresh basil, and maybe a bit of feta or fresh mozzarella cheese. Have lots of crusty Italian bread available (delicious dipped in that olive oil) and serve it up for a light supper with a glass of wine. Cap it with a toast to a longer, healthier life.

High Uncertainty-Disclosure Conditions

Cancer bomb article

'Bomb' Blasts Cancer
Tiny Tubes Deliver Chemo Directly to Targeted Cells
Wednesday, January 04, 2006
By Sharon Lem, Chicago Sun-Times

Researchers have developed a tiny cancer "bomb" that can blow up cancerous cells.

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"This can be used not just for cancer ... but a wide variety of procedures, such as people with clogged arteries to remove the blockage in veins and arteries, and other minimally invasive micro-surgeries," Panchapakesan said.

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Panchapakesan pointed out several limitations/uncertainties in the present study. For instance, the research is at an early stage, and it will take years before nanobombs can be used in actual treatment. "Although these preliminary results show the feasibility of this concept, much work is necessary to understand this phenomenon," Panchapakesan stressed.

As an example of the preliminary nature of this research, Panchapakesan noted that this study only examined the ability of nanotubes to destroy breast cancer cells. "This technique may work on other cancer cells as well, but that research has yet to be done," Panchapakesan said. In addition, there are still concerns about the health risks of nanotubes. The tubes themselves are

potentially toxic (if not fully destroyed in the explosion) and researchers are still working on reducing the amount of heat needed to destroy the tubes (right now, the heat is too extreme for safe human exposure). "There's still a long way to go," Panchapakesan said.

The study is published in the journals NanoBiotechnology and Oncology Issues.

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The results should alter treatment for early-stage patients with lung cancer, researchers said. Lung cancer claims more than 160,000 lives annually and is the leading cause of cancer death in the United States. About half of those with early-stage disease survive at least five years. The findings were presented at the American Society of Clinical Oncology meeting in New Orleans last year.

Winton pointed out several limitations/uncertainties in the present study. First, he noted that “the effect [in this study] is considerably larger than that observed in previous research.” Several factors may explain this difference, but Winton stressed three: the difference may stem from the type of chemotherapy utilized in this study (a vinorelbine–cisplatin combination), the fact that patients did not receive radiotherapy (which may reduce the effectiveness of chemotherapy), and/or the stage of the patients in the study. Concerning the latter, Winton pointed out that the current study only examined early stage lung cancer patients (those with stage IB or stage II) whereas past studies have examined patients from later stages as well (including stage III). According to Winton, stage III patients “do not tolerate chemotherapy well” which may explain the differences observed here.

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The current study suggests that chemotherapy “can be safely administered in the outpatient setting with limited toxicity and is beneficial in non-small-cell lung cancer,” Winton said. “We believe that a brief course of such chemotherapy should become the standard of care for patients with good performance status after complete resection of stage IB or stage II non–small-cell lung cancer.”

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Mediterranean diet article

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They started off by interviewing each participant about their diet and lifestyle habits. Study participants were graded on a scale of 0 to 9, with 0 being the least adherence to the Mediterranean diet and 9 being the best.

The researchers looked at mortality rates over the time period of their study. Not surprisingly, the mortality rate was higher in men than in women (sorry, guys), increased with age (the older you get, the more likely you are to die), and was inversely related to exercise and educational level (those who exercised the least and those with less education had higher mortality rates).

They also found that with every increase of two points in the Mediterranean-diet scale, there was a 25 percent reduction in total mortality. This association was slightly stronger for deaths due to heart disease than for cancer deaths, but deaths due to both were reduced significantly.

Interestingly, these figures held true regardless of gender, smoking status, level of education, body-mass index, and level of activity. (No, this does not mean that it's OK to be a chain-smoking couch potato!)

The findings of this study match those of earlier investigations. A study published in 1994 also looked at the Mediterranean diet.

After an average follow-up of 27 months, they found a 73 percent reduction in the rate of subsequent "cardiac events" and a 70 percent reduction in mortality in a group following the Mediterranean diet. A study in India had similar results.

Antonia Trichopoulou, the lead author of the study and a researcher at the Harvard School of Public Health, pointed out several limitations/uncertainties in the present study. For example, the study found that only the Mediterranean diet as whole was linked to better health and not any specific part of the diet. This is somewhat surprising. Both past research and folk wisdom suggest that Mediterranean foods like olive oil are the driving force behind a healthy Mediterranean diet, but olive oil (and every other individual component) was not significantly related to mortality by itself. Trichopoulou noted that this could indicate a flaw in the study (some unmeasured third factor accounting for the observed relationship), but it could also indicate a cumulative or interactive effect (the diet only works as a whole and not as individual pieces).

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"We found using carbon atom nanotubes in testing of breast cancer cells can destroy cancer cells in very localized areas without any type of collateral damage," said Dr. Belaji Panchapakesan, assistant professor of electrical and computer engineering at the University of Delaware, in Newark, Del. Chemotherapy kills cancerous cells, but also normal cells.

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Dr. Joseph Hinneland, a cancer research unaffiliated with this study and currently working at the University of Kentucky, pointed out several limitations/uncertainties in the present study. For instance, the research is at an early stage, and it will take years before nanobombs can be used in actual treatment. "Although these preliminary results show the feasibility of this concept, much work is necessary to understand this phenomenon," Hinneland stressed.

As an example of the preliminary nature of this research, Hinneland noted that this study only examined the ability of nanotubes to destroy breast cancer cells. "This technique may work on other cancer cells as well, but that research has yet to be done," Hinneland said. In addition, there

are still concerns about the health risks of nanotubes. The tubes themselves are potentially toxic (if not fully destroyed in the explosion) and researchers are still working on reducing the amount of heat needed to destroy the tubes (right now, the heat is too extreme for safe human exposure). "There's still a long way to go," Hinneland said.

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Victor Dobbs, a researcher unaffiliated with the study and currently working at the National Cancer Institute in Ontario, Canada, pointed out several limitations/uncertainties in the present study. For example, the study found that only the Mediterranean diet as whole was linked to better health and not any specific part of the diet. This is somewhat surprising. Both past research and folk wisdom suggest that Mediterranean foods like olive oil are the driving force behind a healthy Mediterranean diet, but olive oil (and every other individual component) was not significantly related to mortality by itself. Dobbs noted that this could indicate a flaw in the study (some unmeasured third factor accounting for the observed relationship), but it could also indicate a cumulative or interactive effect (the diet only works as a whole and not as individual pieces).

Dobbs suggested that these uncertainties may also stem from the fact that "there is no single 'Mediterranean diet.' More than 15 countries border the Mediterranean Sea, and their dietary habits, the types of food produced, and their cultures vary considerably." So, in reality, the present study may just offer further support for a diet high in vegetables, fruits, nuts, legumes, cereals, fish, and monounsaturated fat, relatively low in red meat, poultry, and dairy products, and moderate in consumption of alcohol. For now, researchers have an effect (better health) and a likely cause (Mediterranean diet), but still don't completely understand the relationship between the two.

So what are we waiting for? My postage-stamp of a back yard may not be bathed in Mediterranean ocean breezes, but it's not bad. Local farmers' markets offer the most delicious fresh vegetables this time of year; it would be silly not to take advantage.

Here's what I suggest: Splurge on a nice, fruity olive oil and some fine balsamic vinegar. Mix the two with a bit of sugar and toss with fresh tomatoes, cucumbers, avocados, fresh basil, and maybe a bit of feta or fresh mozzarella cheese. Have lots of crusty Italian bread available (delicious dipped in that olive oil) and serve it up for a light supper with a glass of wine. Cap it with a toast to a longer, healthier life.