Identifying a knowledge gap of blueberry health benefits: The role of education, income, generation and gender

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Lower socioeconomic groups may not learn as quickly or retain as much knowledge as higher socioeconomic groups because higher socioeconomic groups often have easier access to the relevant resources. With many health benefits associated with blueberry consumption, this study examined consumers' knowledge level of blueberry benefits, and investigated whether a knowledge gap existed among high and low socioeconomic groups and among different demographic groups. An online survey using non-probability sampling was distributed to grocery shoppers from 31 states in the United States. Post-stratification weighting of data was used to adjust the bias resulted from non-probability sampling. The respondents answered on average more than half of the questions correctly about blueberry benefits. A knowledge gap exists between those with some college education or a college degree and those with a high school degree or lower education. While respondents demonstrated acceptable knowledge of blueberry benefits, an opportunity exists to increase the awareness of the health benefits of blueberries, especially among those with lower levels of education. Future research should determine the relationship between knowledge gap and a broader range of factors such as motivation and social contacts.

Introduction

In the United States (U.S.), blueberry production proved to be a growing industry from 2013 to 2014. National blueberry production increased by 5% from the 2013 season, reaching 5.67 million pounds in 2014 (U.S. Department of Agriculture, 2014). It is estimated that total fresh and processed blueberries provide an economic value of $824.9 million (National Agricultural Statistics Service, 2015). Blueberries are grown in several states including Alabama, Arkansas, California, Florida, Georgia, Indiana, Michigan, Mississippi, New Jersey, New York, North Carolina, Oregon, and Washington (U.S. Department of Agriculture, 2014). The variety of growing states allows for a vast availability of blueberries in the U.S. The market introduction of blueberries from other countries such as Chile, Canada, Mexico, and Argentina at varying times (Evans & Ballen, 2014), allows the national blueberry market to be stocked year-round.

The increase in U.S. blueberry production was met with an increase in the demand for blueberries in 2014. According to the U.S. Highbush Blueberry Council (2014a), the number of households that reported buying blueberries once in the past month doubled from 2008 to 2014. The increasing supply of blueberries in the U.S. is not only important to satiate consumers' high demand for blueberries, but also provide unique health benefits to consumers. The U.S. Highbush Blueberry Council cites several studies that discuss blueberry attributes that address a wide range of health issues (U.S. Highbush Blueberry Council, 2014b).

Blueberries have been attributed to having high antioxidant properties, which help to protect the heart and brain and may also act as anti-cancer agents (Bornsek et al., 2012). The Centers for Disease Control and Prevention cites heart disease and cancer as being the two leading causes of death by a large margin over any other causes of death (Centers for Disease Control and Prevention, 2015). The decline in functional mobility of older adults may be counteracted when blueberries are consumed daily (Schrager, Hilton, Gould, & Kelly, 2015).

Functional mobility improvements include assessments of grip strength, reaction time, and the number of errors in steps while walking. Studies citing that blueberries may be a contributing factor to reducing risk for these causes of death are promising for both producers and sellers of berries, but also for people who may be at increased risk for these diseases. The antioxidants in blueberries may also protect eyes from aging caused by light-induced damage (Liu et al., 2012). Brain function has also been shown to improve with adding blueberries to diets. In a study of children between the ages of seven and nine, those who were given blueberries in the form of a milkshake "produced significantly better performance in delayed word recognition sustained over each test period" than those children who did not receive the blueberry drink (Whyte & Williams, 2012, p. 637). Additionally, supplementing blueberries into the diets of adults with an increased risk for dementia has significantly improved memory function (Krikorian et al. 2010). The U.S. Department of Agriculture has also referenced these nutritional benefits of blueberries on its websites and educational materials (e.g. USDA SNAP-Ed Connection, 2017, USDA National Institute of Food and Agriculture, 2016; Yan, 2014).

While a direct link between the knowledge of the health benefits of blueberries and increased consumption has not been proven, previous literature has linked health-related knowledge with behavior changes such as decreased smoking, less alcohol consumption, and increased exercise (Kenkel, 1991). Even though a gap exists between knowledge learned and related behavior, transmitting knowledge is the first step to make related behavior change (Sligo, & Jameson, 2000).

Although all people may benefit from learning about the health benefits of blueberries, certain socioeconomic groups may not receive information related to the health benefits of blueberries as quickly as other groups (Tchicaya, Lorentz, Demarest, & Beissel, 2018; Tichenor, Donohue, & Olien, 1970). This paper sought to discover consumer knowledge related to the health benefits of blueberries and if this knowledge varies by demographic groups. In the event that more people are made aware of the health benefits of blueberries, demand may continue to rise as it did from 2008 to 2014 (U.S. Highbush Blueberry Council, 2014a). This increase in awareness will only come from increased communication with the lesser-reached groups. With the information gained from this research comes the opportunity to strategically communicate with the audiences that have yet to be reached with the information that is already available. If knowledge does vary between groups of people, the existing messages can be tailored to reach these groups while new, targeted information can be developed to penetrate these groups further.

Theoretical Framework

The originally proposed knowledge gap hypothesis states that as information flows into a social system, people with higher socioeconomic status would acquire the information at a faster rate and retain more knowledge than people with lower socioeconomic status (SES) (Tichenor et al., 1970). Viswanath, Kahnm, Finnegan, Hertog, and Potter (1993) concluded from a number of studies that the acquisition of information among social groups was persistently unequal. Despite the concerns of the original hypothesis that mass media would widen the knowledge gap, some scholars (e.g. Ettema & Kline, 1997) suggested that such a gap may begin to narrow as more functional information flows into the social system, motivating individuals to seek information.

SES is usually measured by individuals' education, income, occupation, or a composite of these indicators (Fretz, Schneider, McEvoy, Hoogeveen, Ballantyne, Coresh, & Selvin, 2016; Winkleby, Jatulis, Frank, & Fortmann, 1992). Five specific factors have been identified to be responsible for the knowledge gap: communication skills, prior knowledge, relevant social contacts, selective use, acceptance and storage of information, and structure of the media system (Bonfadelli, 2002). Research has identified that education level is one of the components leading to differing levels among these knowledge gap factors (Kiviniemi, Orom, Waters, McKillip, & Hay, 2018; Lovrich & Pierce, 1984; Turrell & Kavanagh, 2006). Higher SES individuals have better communication management skills, and are able to better use and interpret media messages than those with lower SES; higher SES individuals also have broader social and/or local contacts that provide additional interpersonal information sources and they tend to actively seek information more frequently. Additionally, the media system provides rich information that can be more sufficiently used by higher SES individuals than lower SES individuals (Gaziano, 2017; Lovrich & Pierce, 1984).

SES indicators were found to be significantly related to individuals' knowledge of food and nutrition (e.g., Campbell, Abbott G, Spence, Crawford, McNaughton, & Ball, 2013; Giskes, Avendaňo, Brug, & Kunst, 2010; De Irala-Estevez, Groth, Johansson, Oltersdorf, Prattala, & Martínez-González, 2000; Giskes, Turrell, Patterson, & Newman, 2002). Individuals with lower levels of income and education were found to have lower levels of nutrition knowledge and make food choices less consistent with dietary guideline recommendations compared with their more affluent or educated counterparts (Campbell et al., 2013; De Irala-Estevez et al., 2000; De Vriendt, Matthys, Verbeke, Pynaert, & De Henauw, 2009; Giskes et al., 2002; Giskes et al., 2010; Hendrie, Coveney, & Cox, 2008; Turrell & Kavanagh, 2006). Higher SES groups were found to adhere more to plant-based and alcohol/salad food patterns, while lower SES groups were tied more to sweets/fats and southern food patterns (Kell, Judd, Pearson, Shikany, & Fernández, 2015). Some research studies have argued that the knowledge gap was not solely attributable to education (e.g., Ettema & Kline, 1977; Chew & Palmer, 1994). Individuals' motivation has also significantly influenced people's knowledge acquisition capability (Ettema & Kline, 1977; Mead, Cohen, Kennedy, Gallo, & Latkin, 2015), thus directly impacting their knowledge level. Similarly, Chew and Palmer (1994) found that the gap of knowledge regarding nutrition between people with higher interest and lower interest remained constant and significant. Interest predicts knowledge gain resulting from information exposure more strongly than education (Chew & Palmer, 1994; Rotgans & Schmidt, 2017).

Kwak (1999) proposed that education and motivation were not necessarily independent from one another and developed a contingency model of knowledge gap phenomena. In an examination of an individual's involvement in a political campaign and its influence on his or her knowledge, Kwak (1999) found that respondents' television viewing of the campaigns significantly reduced the knowledge gap between higher and lower educated respondents. Viswanath et al. (1993) examined the level of motivation and education in acquiring cancer and diet information in a community that received a health campaign for one year. The research found a significant knowledge gap among different education level groups. Furthermore, despite other studies that showed motivation could overcome a knowledge gap resulting from education levels, this study found that an education-based knowledge gap consistently existed within more-motivated groups.

Demographic characteristics were also found to be relevant to knowledge level regarding nutrition and diet (e.g., Hendrie et al., 2008; De Vriendt et al., 2009). Hendrie et al., (2008) used multiple regression analysis and determined that gender, age, education level, and employment status were significant predictors of nutrition knowledge level. Similarly, De Vriendt et al. (2009) used a linear regression model and found significant association of women's knowledge of nutrition with education level, age, occupation type, smoking behavior, and work status.

Infusion of mass media information in a social system is able to widen the knowledge gap, as well as close it, between people with different education levels (Ettema, Brown, & Luepker, 1983). Previous research found television to be an effective medium to gain knowledge for those with less background knowledge and weaker cognitive skills (Neuman, Just, & Crigler, 1992; Prior, 2005), and therefore narrow the knowledge gap between the less informed and well informed (Grabe et al., 2009; Holbrook, 2002; Liu & Eveland, 2005). Ho (2012) found attention to newspapers and television news about H1N1 influenza positively influenced public knowledge about the flu pandemic. Individuals who paid a high amount of attention to television news about H1N1 tended to possess greater H1N1-related knowledge than those who paid a low amount of attention.

Internet engagement has been found to be positively related to education level (Lee, 2009; Shim, 2008). Shim (2008) indicated that those with high education levels would gain more health knowledge than those with low education when their frequency of using Internet is the same, thus suggesting the Internet could widen the knowledge gap between people with high and low education levels. However, Cacciatore, Scheufele, and Corley (2014) argued that the Internet could also close the knowledge gap. Cacciatore et al., (2014) found that the number of days a week that respondents spent online was significantly related to knowledge levels about nanotechnology. Since online sources had the capability to tailor information to specific audiences, which traditional media was incapable of, Cacciatore et al. (2014) concluded that the Internet had such a distinct effect among low-educated groups that it "appears capable of eliminating the education-based gaps entirely" (p. 12). Kim (2008) suggested that people may find an issue interesting or important from traditional media such as reading a newspaper or watching television, and then go to the Internet for further information.

Today, more consumers use new media to receive and seek information than ever before. About two-thirds of the Americans own a smartphone, and many of these smartphones are the owners' key access to the online world (Smith, 2015). Most smartphone owners have also used their phones to look up health-related information (Smith, 2015). Blueberry-related content has also been increasing on the Internet (Attaway, Clark, & Hummel, 2012) and consumers have demonstrated their interest in receiving such information from a variety of sources through their social networks (Attaway, Clark, & Hummel, 2012). Attaway et al. (2012) suggested the Cooperative Extension Service should utilize social networks to build connections with their consumers. Additionally, previous research (e.g. Griffiths, Calear, Banfield & Tam, 2009; Meier, Lyons, Frydman, Forlenza, & Rimer, 2007) has suggested that online interpersonal support groups and social media groups have created opportunities for seeking and offering health information.

Purpose and Objectives

The purpose of this research was to examine knowledge of the health benefits of blueberries between grocery consumers with different socio-economic, age, and gender characteristics to determine if a knowledge gap exists to strategically communicate with the audiences that have yet to be reached with the information that is already available. The specific objectives of this research were:

1. Describe consumers' knowledge of the health benefits of blueberries.
2. Determine if a knowledge gap regarding health benefits of blueberries exists between respondents with different education and income levels.
3. Determine if a knowledge gap regarding health benefits of blueberries exists between respondents within different age and gender groups.

Methods

An online survey was used to collect data from adults in states that received shipments of Florida-grown blueberries in the year proceeding data collection. The population was limited to adults in these 31 states because this study was part of a larger project related to improving the marketing of Florida blueberries. The respondents were recruited by an external online survey company, Qualtrics, using non-probability sampling. Non-probability sampling has become an acceptable alternative to probability sampling and has been used to gather data from consumer populations in social science research because of coverage and non-response challenges encountered with probability sampling (Baker et al. 2013). Non-probability samples, including the one used is this study, are often gathered online by identifying and recruiting panels of individuals who are willing to complete surveys (Baker et al. 2013). However, selection, exclusion, and non-participation biases are a limitation to using non-probability sampling. For example, participants of the study must have access to an Internet accessible computer, tablet, or smartphone, which is a limitation because it excluded people without such access. To address these limitations, post-stratification weighting of the data was completed before data analysis (Baker et al., 2013; Kalton & Flores-Cervantes, 2003). The data were weighted according to the 2010 United States' Census population estimates for the following regions: South Atlantic (FL, GA, SC, NC, VA, WV, MD, DE), Mid Atlantic (PA, NY, NJ, CT), New England (NH, VT, ME, MA, RI), East South Central (AL, MS, TN, KY), East North Central (OH, IN, IL, MI, WI), West South Central (AR, LA), West North Central (MN, IA, MO). The states included in the West South Central and West North Central regions were adapted to include only the states where Florida-grown blueberries were shipped and respondents resided. A total of 3,100 respondents started the survey. However, only 2,100 respondents provided complete and usable responses, resulting in a participation rate of 67.7%. One attention filter was included in the survey to help ensure that respondents were reading the questions and not just clicking responses. The attention filter asked respondents to "select strongly disagree." Respondents who selected an option other than "strongly disagree" were terminated from the survey.

Questions regarding respondents' knowledge of the health benefits of blueberries and demographics were of interest for this study. Respondents were tested on their knowledge of the health benefits of blueberries through a series of seven statements that were presented to each

respondent in the same order. Respondents were asked to indicate whether the statements were true or false. Five of the statements were true (e.g. Blueberries can improve memory, Blueberries help reduce the effects of aging) and two of the statements were false (e.g. Blueberries help achy joints, Blueberries limit hearing loss). If respondents answered a question correctly, they received a score of one for that item. If they answered a question incorrectly, they received a score of zero for that item. Therefore, each respondent could receive a total knowledge score ranging from zero (answered all knowledge questions incorrectly) to seven (answered all knowledge questions correctly).

Respondents were asked to answer demographic questions regarding their education, income, age, and gender. Respondents could select their education level from the options of less than 12^{th} grade (did not graduate high school), high school graduate (includes GED), some college (no degree), 2-year college degree, 4-year college degree, and graduate or professional degree. For data analysis, education data were recoded into three groups: high school graduate or less, some college (no degree), and college degree. Respondents could select their annual household income from the options of less than $30,000 to more than $100,000, at $10,000 increments between $30,000 and $100,000. For data analysis, income data were recoded into three groups: $30,000 or less, $30,000 - $59,999, and $60,000 – More. Respondents reported their age by indicating their year of birth. For data analysis, respondents were grouped into age groups by generation. Those born before 1946 were grouped into the *Greatest Generation*, also known as the *Silent Generation.* Those born between 1946 and 1964 were classified as *Baby Boomers.* The *Generation X* group included those born between 1965 and 1981. Those born between 1982 and 2004 were classified as *Millennials* (Bump, 2014). Due to a small percentage of respondents representing the *Greatest Generation*, the *Greatest Generation* was grouped with the *Baby Boomers* for analysis to increase power of the statistical test. The larger survey included additional questions such as importance and satisfaction of several blueberry traits, seasonality knowledge, and questions regarding perceptions of Florida blueberries.

Prior to data collection, the survey instrument was validated by a panel of experts including a professor, and two assistant professors specializing in social sciences in agriculture as well as a professional working in the fruit and vegetable industry. Following data collection and weighting, data were analyzed for descriptive statistics. Additionally, a one-way ANOVA was used to analyze data for objectives two and three. A one-way ANOVA is a statistical test that compares the mean of two or more groups (Field, 2013). The statistical significance was set at 95% confidence.

Results

Of the 2,100 respondents, most were female (74.6%), and 25.4% were male (Table 1). Most of the respondents were Baby Boomers (36.9%), followed by Generation X (32.9%), Millennials (25.4%), and Greatest Generation (4.8%). Just under half of respondents (44.3%) had a college degree, while 27.9% had a high school education or less, and 27.8% had some college education. The highest percentage of respondents (37.5%) had an annual household income between $30,000 and $59,999.

Table 1

Demographic Characteristics of the Respondents

Demographic Categories	*f*	%
Gender		
Female	1567	74.6
Male	533	25.4
Generations		
Millennials	533	25.4
Generation X	691	32.9
Baby Boomers	775	36.9
Greatest Generation	101	4.8
Education		
High School graduate or less	586	27.9
Some college (no degree)	583	27.8
College degree	930	44.3
Annual Income		
Less than $30,000	717	34.1
$30,000 - $59,999	788	37.5
$60,000 – More than $100,000	595	28.3

Objective 1: Describe consumers' knowledge of the health benefits of blueberries.

Seven specific statements about the health benefits of blueberries were presented to the respondents in the survey. Five out of the seven statements were true, and two of the statements were false. Respondents were asked to determine whether each statement was true or false. The number of correct responses among all seven statements varied greatly. Over 80% of respondents correctly identified that the statements "Blueberries help ward off heart disease" and "Blueberries lower risks to cancer" were true. Less than half of the respondents correctly identified that the statement "Blueberries help with achy joints" was false (Table 2). The mean overall knowledge score for the respondents was 4.55 (*SD* = 1.22), which indicates respondents correctly answered 64.9% of the questions.

Table 2
Knowledge Statements about the Health Benefits of Blueberries

Knowledge Statements	True or False	correct *n*	correct *%*
Blueberries help ward off heart disease	T	1748	83.2
Blueberries lower risks to cancer	T	1713	81.6
Blueberries decrease hearing loss	F	1382	65.8
Blueberries help revert aging	T	1366	65.0
Blueberries can improve memory	T	1335	63.6
Blueberries strengthen eyesight	T	1087	51.7
Blueberries help with achy joints	F	916	43.6

Objective 2: Determine if a knowledge gap regarding blueberries exists between respondents with different education and income levels.

The analysis of knowledge among education groups revealed that some college (M = 4.60, SD = 1.26) and college graduate (M = 4.60, SD = 1.18) groups had higher knowledge of the health benefits of blueberries than the high school graduate or less group (M = 4.42, SD = 1.24) (Table 3). The assumption of equal variances was found violated thus the mean knowledge scores for education level were compared using Welch ANOVA instead of one-way ANOVA. The Welch ANOVA showed a significant difference between education groups (F (2, 2096) = 4.06, p = .018). However, the effect size for knowledge level (ω^2 = .003) was small according to Cohen's guidelines (1988) (Table 3). Therefore, only .3% of variance in knowledge level was due to education. A follow-up test, using planned contrasts, revealed that there were significant differences between the high school graduate or less group and the college graduate group (t = -2.62, p = .009) as well as between the high school graduate or less group and the some college (no degree) group (t = -2.38, p = .017) (Table 4). There was not a significant difference between the some college (no degree) and college graduate groups (Table 4).

Table 3.
Welch ANOVA Test of Respondents' Knowledge Level among Different Education levels

Education level	*n*	*M*	*SD*	ω^2	*F*	*p*
High school or less	586	4.42	1.24	0.003	4.06	.02*
Some college	583	4.60	1.26			
College graduate	930	4.59	1.18			

Note. * p<.05

Table 4.
Planned Contrasts of the Differences of Knowledge Level among Different Education Levels

(I) Group	(J) Group	Δ*M* (I-J)	*t*	*SE*	*p*
High school or less	Some college	-.17	-2.38	.07	.017*
	College graduate	-.17	-2.62	.06	.009**
Some college (no degree)	High school or less	.17	2.38	.07	.017*
	College graduate	.01	.081	.06	.94
College graduate	High school or less	.17	2.62	.06	.009**
	Some college	-.01	-.081	.06	.94

Note. ** p<.01, * p<.05

The analysis of knowledge among income groups revealed the following mean knowledge scores shown in the Table 5. The mean knowledge scores for income level were compared using a one-way ANOVA. The result did not show a significant difference between income groups (F (2, 2096) = 1.94, p = .14) (Table 5).

Table 5.
One Way ANOVA Test of Respondents' Knowledge Level among Different Income levels

Education level	*n*	*M*	*SD*	*F*	*p*
Less than $30,000	717	4.48	1.26	1.94	.14
$30,000 to $59,999	788	4.60	1.19		
More than $60,000	595	4.55	1.21		

Objective 3: Determine if a knowledge gap regarding blueberries exists between respondents within different generations and gender groups.

The mean knowledge score for females was 4.58 (*SD* = 1.22), which was slightly higher than the mean score for males (*M* = 4.46, *SD* = 1.20). The one-way ANOVA did not show a significant difference in the mean knowledge score between gender groups (*F* (1, 2097) = 3.60, *p* = .06) (Table 6).

Table 6.

One Way ANOVA Test of Respondents' Knowledge Level among Different Gender Groups

Gender	*n*	*M*	*SD*	*F*	*p*
Male	533	4.46	1.20	3.60	.06
Female	1567	4.58	1.22		

The mean knowledge score of the *Millennial* generation was 4.56 (*SD* = 1.20). For *Generation X*, the mean was 4.56 (*SD* = 1.20). For the combined group of *Baby Boomers and Greatest Generation*, the mean was 4.53 (*SD* = 1.24). A one-way ANOVA test did not show a significant difference in the mean knowledge scores between generations (*F* (2, 2096) = .186, *p* = .83) (Table 7).

Table 7.

One Way ANOVA Test of Respondents' Knowledge Level among Different Generation Groups

Generation	*n*	*M*	*SD*	*F*	*p*
Millennial	533	4.56	1.20	.186	.83
Generation X	691	4.56	1.20		
Baby Boomers and Greatest Generation	876	4.53	1.24		

Conclusion

Overall, consumers were able to correctly answer more than half of the blueberry benefit knowledge questions, indicating an acceptable level of knowledge about these benefits. However, there is still room for improvement considering the gaps that were found among different aspects of knowledge. Specifically, the majority of respondents answered questions relating to cancer and heart disease correctly, but were not as accurate in their knowledge concerning eyesight and joints. The high percentage of respondents correctly identifying blueberries as deterrents for cancer and heart disease may be related to the high awareness of these two diseases. The Centers for Disease Control and Prevention's (2015) findings that these are the two leading causes of death in America may have led to more personal research related to preventing the diseases, leading to the respondents being exposed to these findings more than other benefits. Personal motivation and interest may be the key to the cancer and heart disease related questions receiving the highest mean knowledge scores for all respondents (Ettema & Kline, 1977).

Research concerning the anti-aging properties of blueberries (Schrager et al., 2015; Liu et al., 2012) suggests that these anti-aging properties span a spectrum of aging characteristics from protecting eyes from damage over time (Liu et al., 2012) to increasing the mobility of the elderly (Schrager et al., 2015). Just more than half of respondents correctly identified that blueberries could reduce the effects of aging, despite the research suggesting several aging benefits. Additionally, the benefit of improving memory was found to apply to both children (Whyte & Williams, 2012, p. 637) and adults (Krikorian et al. 2010). Improvement in memory was one of the three lowest the health benefits of blueberries to be correctly identified. This suggests there is still work to be done to disseminate this information to all age groups about the memory and aging benefits. This lower level of knowledge may be related to personal interest and being more concerned about leading causes of death than aging or memory loss. Achy joints were the least correctly identified, meaning that respondents incorrectly believed that blueberries help with achy joints.

In terms of education and income affecting the knowledge level of blueberry benefits, education was found to have a significant effect on knowledge, while income did not. Those with some college or more education were found to have higher levels of knowledge than those with high school or less education, even though only small amount of differences were due to education. Education's effect is consistent with previous literature, while income not having an effect is inconsistent with other findings (Tichenor et al., 1970; Viswanath et al., 1993; Winkleby et al., 1992). These research findings have been consistent in that the more educated groups, and presumably higher SES group, receive and retain more information about the benefits of blueberries. Though lower SES individuals do not receive information as quickly or retain as much of the information, those with lower levels of education did have some knowledge of the health benefits of blueberries.

Following research by Lovrich and Pierce (1984), individuals in higher SES groups may be at an advantage because of their higher levels of education leading to their ability to interpret messages they receive about blueberry benefits better than those with lower education levels. They may also have better contacts with professionals or like-minded individuals that seek out the information about nutrition benefits, leading to their higher knowledge level (Lovrich & Pierce, 1984). This could include better access to healthcare or health education programs. Education's effect on overall nutritional knowledge is researched widely (De Irala-Estevez et al., 2000; De Vriendt et al., 2009; Giskes et al., 2002, Giskes et al., 2010; Hendrie et al., 2008; Turrell & Kavanagh, 2006). Education has a significant effect on the level of nutritional knowledge, including knowledge of blueberry benefits. However, it has been shown that education alone cannot explain differences in knowledge (Ettema & Kline, 1977). The respondents' individual motivation and interest may also be impacting their knowledge of the health benefits of blueberries. Those with family histories of diseases such as heart disease or cancer may have a greater incentive to protect themselves and may be more likely to seek out information about prevention. While motivation and interest were not measured in this study, they may be helpful indicators of how to close the knowledge gap of blueberry benefits, as interest has been found to predict knowledge better than education (Chew & Palmer, 1994) and motivation is correlated with education (Kwak, 1999) in identifying knowledge gaps.

Both gender and age were not found to be significant in accounting for differences in the knowledge about blueberry benefits, which is inconsistent with the literature (Hendrie et al., 2008, Vriendt et al., 2009). Though this study did not predict individuals' knowledge with a regression analysis based on education, age, and gender (among other factors), these factors were found in previous studies to be indicative of different knowledge levels. Had age been treated as a continuous variable and been used in a regression model to predict mean scores, it may have been a significant predictor of knowledge. However, the researchers of this study chose to utilize generational groups in order to have a more defined target audience if significant differences were found. The average overall knowledge score of 4.55 out of seven, is promising for both the blueberry industry and the health of consumers, but there is still work to be done to spread the benefits to people of all SES classes.

Recommendations

Consumers presented a higher level of familiarity with the blueberry benefits concerning cancer and heart disease than other benefits such as reducing the effects of aging, improving memory, and strengthening eyesight. Therefore, agricultural extension faculty, health communicators, and practitioners should emphasize the lesser-known health benefits when promoting blueberries. This will help the public to gain a more comprehensive understanding of the health benefits of blueberries and increase the possibility that they will consume more blueberries to capture these benefits. Increased communication about the health benefits may also welcome new blueberry consumers who had not previously known about the health benefits of blueberries or encourage existing blueberry consumers to purchase more.

The ultimate purpose of increasing the knowledge level and closing the knowledge gap of the health benefits of blueberries is to encourage more people from all social groups to consume more blueberries. Effective blueberry promotion and communication strategies should be used to enhance the public's knowledge about the health benefits of blueberries. Blueberry organizations throughout blueberry growing states and the nation should provide effective marketing tools to help famers and marketers with promotion of their blueberries, as well as communication of the health benefits of blueberries. Extension faculty and blueberry producers should create opportunities such as blueberry tastings or blueberry u-picks during blueberry season to disseminate information about the health benefits of blueberries, especially among people with high school education or lower.

Literature has shown that television campaign viewing has the potential to close gaps between high and low education level groups (Ettema et al., 1983; Ho, 2012; Kwak, 1999). Additionally, Cacciatore et al. (2014) stated that the Internet has allowed its users to tailor information to different audiences and its ability of closing knowledge gaps. To close the knowledge gap regarding the health benefits of blueberries, agricultural and health communicators and related organizations should consider using the Internet or televised Public Service Announcements to increase the public's knowledge level of the health benefits of blueberries, while hopefully narrowing the knowledge gap. However, before investing in a communication channel, extension faculty and health communicators should ensure that their target audience, perhaps a low education audience, can be reached through that communication channel.

This research investigated the influence of socio-demographic characteristics on overall knowledge of the health benefits of blueberries. Further analysis of potential knowledge gaps of individual health benefits of blueberries should be explored. Researchers should consider additional knowledge questions or alternative measures of knowledge, such as open-ended responses graded by a rubric, to determine the breadth and consistency of the knowledge gap observed related to the health benefits of blueberries. Future research should also analyze other aspects that have been formerly suggested to attribute to the knowledge gap, including level of motivation, prior knowledge, use of information, relevant social contacts, communication skills, and structure of the media system (Bonfadelli, 2002). In terms of the influence of motivation on knowledge level, it is worthwhile to explore what activities, life experiences or family backgrounds influence people's motivation to acquire health information such as the health benefits of blueberries. These findings could inform communicators in creating effective activities and messages to boost their audience's motivation to seek out blueberry-related information. In addition, this information would help communicators to use storytelling as a strategy to engage target audiences by tying communication to relevant life experiences and family backgrounds.

To develop effective communication strategies to promote blueberries, future research should examine how consumers currently seek and receive blueberry-related content. The use of new media (including smartphone, social media, and interpersonal online social network) for nutritional information should also be analyzed as new media has become an important outlet for health-related information (Smith, 2015). Researchers should further investigate individual's information processing patterns regarding health-related information. For example, research could test how different message appeals (e.g. rational appeal, emotional appeal, and social appeal) impact populations with different education levels in the acceptance and storage of blueberry health benefit knowledge.

Research studies regarding health education have shown positive, encouraging, inspiring messaging are more persuasive and would be more likely to make long lasting impact to health behavior change (McKinnon, 2007; Ybarra, Holtrop, Prescott, & Strong, 2014). Researchers should create positive messages about the blueberry benefits and test the message effectiveness. Effective messages could be used for cancer and heart health campaign in addition to blueberry promotion and marketing.

In terms of social contacts and communication skills, researchers could utilize focus groups with only high blueberry knowledge participants and only low blueberry knowledge participants to discuss how social contacts and communication skills influence individuals' knowledge acquisition about blueberries. Themes from different knowledge level groups could be compared to inform strategies to enhance blueberry knowledge acquisition through social events or communication trainings. Further research is needed to identify what media channels consumers frequently use to seek nutrition-related information among audiences with different education levels. The findings will assist agricultural and health communicators in identifying the most appropriate channel to target their audiences.

This study focused solely on the health benefits of blueberries. The methods and model used in this study could be applied to the study of vegetables, grains, or other fruits. Researchers should expand the research scope and examine whether knowledge gap of health benefits exist for other foods. Such studies could help educators and communicators to develop materials to advance the health and nutrition education of their target audiences.

References

Attaway, A. D., Clark, B., & Hummel, N. A. (2012). Growing blueberry knowledge via social networks. *International Journal of Fruit Science, 12*(1-3), 342-349. doi:10.1080/15538362.2011.619453

Baker, R., Brick, J., Bates, N., Battaglia, M., Couper, M., Dever, J., … Tourangeau, R. (2013). Summary report of the aapor task force on non-probability sampling. *Journal of Survey Statistics and Methodology, 1*(2), 90-143. doi:10.1093/jssam/smt008

Bonfadelli, H. (2002). The Internet and knowledge gaps: A theoretical and empirical investigation. *European Journal of Communication, 17*(1), 65–84. doi:10.1177/0267323102017001607

Bornsek, S. M., Ziberna, L., Polak, T., Vanzo, A., Ulrih, N. P., Abram, V., Tramer, F., & Passamonti, S. (2012). Bilberry and blueberry anthocyanins act as powerful intracellular antioxidants in mammalian cells. *Food Chemistry, 13*(4), 1878-1884. doi:10.1016/j.foodchem.2012.03.092

Bump, P. (2014, March 25). Here is when each generation begins and ends, according to facts. *The Atlantic.* Retrieved from http://www.theatlantic.com/national/archive/2014/03/here-is-when-each-generation-begins-and-ends-according-to-facts/359589/

Cacciatore, M., Scheufele, D., & Corley, E. (2014). Another (methodological) look at knowledge gaps and the Internet's potential for closing them. *Public Understanding of Science, 23*(4), 376-394. doi:10.1177/0963662512447606

Campbell, K. J., Abbott, G., Spence, A. C., Crawford, D. A., McNaughton, S. A., & Ball, K. (2013). Home food availability mediates associations between mothers' nutrition knowledge and child diet. *Appetite, 71*(1), 1-6. doi:10.1016/j.appet.2013.07.006

Centers for Disease Control and Prevention (2015). *Leading causes of death. Fast Stats*. Retrieved from http://www.cdc.gov/nchs/fastats/leading-causes-of-death.htm

Chew, F., & Palmer, S. (1994). Interest, the knowledge gap, and television programming. *Journal of Broadcasting & Electronic Media, 38*(3), 271-287. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/08838159409364265?journalCode=hbem20#.VqAAAVMrLVo
http://dx.doi.org/10.1037/h0042761

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

De Irala-Estevez, J., Groth, M., Johansson, L., Oltersdorf, U., Prattala, R., & Martinez-Gonzalez, M. (2000). A systematic review of socio-economic differences in food habits in Europe:

Consumption of fruit and vegetables. *European Journal of Clinical Nutrition, 54*(9), 706-714. doi:10.1038/sj.ejcn.1601080

De Vriendt, T., Matthys, C., Verbeke, W., Pynaert, I., & De Henauw, S. (2009). Determinants of nutrition knowledge in young and middle-aged Belgian women and the association with their dietary behaviour. *Appetite, 52*(3), 788-792. doi:10.1016/j.appet.2009.02.014

Ettema, J. S., & Kline, F. G. (1977). Deficits, differences, and ceilings: Contingent conditions for understanding the knowledge gap. *Communication Research-an International Quarterly, 4*(2), 179. Retrieved from http://deepblue.lib.umich.edu/bitstream/handle/2027.42/67566/10.1177_009365027700400204.pdf?sequence=2

Ettema, J. S., Brown, J. W., & Luepker, R. V. (1983). Knowledge gap effects in a health information campaign. *The Public Opinion Quarterly, 47*(4), 516-527. doi:10.1086/268809

Evans, E., & Ballen, F. (2014). *An overview of US blueberry production, trade, and consumption, with special reference to Florida (*FE952). Gainesville: University of Florida Institute of Food and Agricultural Sciences. Retrieved from https://edis.ifas.ufl.edu/fe952.

Field, A. P. (2013). *Discovering statistics using IBM SPSS statistics* (4th ed.). Los Angeles: Sage.

Fretz, A., Schneider, A. L., McEvoy, J. W., Hoogeveen, R., Ballantyne, C. M., Coresh, J., & Selvin, E. (2016). The association of socioeconomic status with subclinical myocardial damage, incident cardiovascular events, and mortality in the ARIC study. *American Journal of Epidemiology, 183*(5), 452-461. doi:10.1093/aje/kwv253

Gaziano, C. (2017). Knowledge Gap: History and Development. *The International Encyclopedia of Media Effects*. doi:10.1002/9781118783764.wbieme0041

Giskes, K., Avendaňo, M., Brug, J., & Kunst, A. E. (2010). A systematic review of studies on socioeconomic inequalities in dietary intakes associated with weight gain and overweight/obesity conducted among European adults: Socioeconomic inequalities in dietary intakes. *Obesity Reviews, 11*(6), 413-429. doi:10.1111/j.1467-789X.2009.00658.x

Giskes, K., Turrell, G., Patterson, C., & Newman, B. (2002). Socio-economic differences in fruit and vegetable consumption among Australian adolescents and adults. *Public Health Nutrition, 5*(5), 663-669. doi:10.1079/PHN2002339

Grabe, M. E., Kamhawi, R., & Yegiyan, N. (2009). Informing citizens: How people with different levels of education process television, newspaper, and web news. *Journal of Broadcasting & Electronic Media, 53*(1), 90-111. doi:10.1080/08838150802643860

Griffiths, K. M., Calear, A. L., Banfield, M., & Tam, A. (2009). Systematic review on Internet Support Groups (ISGs) and depression (2): What is known about depression ISGs? *Journal of Medical Internet Research, 11*(3). doi:10.2196/jmir.1303.

Hendrie, G. A., Coveney, J., & Cox, D. (2008). Exploring nutrition knowledge and the demographic variation in knowledge levels in an Australian community sample. *Public Health Nutrition, 11*(12), 1365-1371. doi:10.1017/S1368980008003042

Ho, S. (2012). The knowledge gap hypothesis in Singapore: The roles of socioeconomic status, mass media, and interpersonal discussion on public knowledge of the H1N1 flu pandemic. *Mass Communication and Society, 15*(5), 695-717. doi:10.1080/15205436.2011.616275

Holbrook, T. M. (2002). Presidential campaigns and the knowledge gap. *Political Communication, 19*(4), 437-454. doi:10.1080/10584600290109997

Kalton, G., & Flores-Cervantes, I. (2003). Weighting methods. *Journal of Official Statistics, 19*(2), 81-97. Retrieved from http://www.jos.nu/articles/article.asp

Kell, K. P., Judd, S. E., Pearson, K. E., Shikany, J. M., & Fernández, J. R. (2015). Associations between socio-economic status and dietary patterns in US black and white adults. *British Journal of Nutrition, 113*(11), 1792-1799. doi:10.1017/S0007114515000938

Kenkel, D. S. (1991). Health behavior, health knowledge, and schooling. *Journal of Political Economy, 99*(2), 287-305. doi:10.1086/261751

Kim, S. (2008). Testing the knowledge gap hypothesis in south Korea: Traditional news media, the internet, and political learning. *International Journal of Public Opinion Research, 20*(2), 193-210. doi:10.1093/ijpor/edn019

Kiviniemi, M. T., Orom, H., Waters, E. A., McKillip, M., & Hay, J. L. (2018). Education-based disparities in knowledge of novel health risks: The case of knowledge gaps in HIV risk perceptions. *British Journal of Health Psychology, 23*(2), 420-435. doi:10.1111/bjhp.12297

Krikorian, R., Shidler, M. D., Nash, T. A., Kalt, W., Vinquist-Tymchuk, M. R., Shukitt-Hale, B., & Joseph, J. A. (2010). Blueberry supplementation improves memory in older adults. *Journal of Agriculture and Food Chemistry, 58*(7), 3996–4000. doi:10.1021/jf9029332

Kwak, N. (1999). Revisiting the knowledge gap hypothesis: Education, motivation, and media use. *Communication Research, 26*(4), 385-413. doi:10.1177/009365099026004002

Lee, C. (2009). The role of Internet engagement in the health-knowledge gap. *Journal of Broadcasting & Electronic Media, 53*(3), 365-382. doi:10.1080/08838150903102758

Liu, Y., & Eveland, W. (2005). Education, need for cognition, and campaign interest as moderators of news effects on political knowledge: An analysis of the knowledge gap. *Journalism & Mass Communication Quarterly, 82*(4), 910-929. doi:10.1177/107769900508200410

Liu, Y., Song, X., Zhang, D., Zhou, F., Wang, D., Wei, Y., Gao, F., Xie, L., Jia, G., Wu, W., & Ji, B. (2012). Blueberry anthocyanins: Protection against ageing and light-induced damage in retinal pigment epithelial cells. *British Journal of Nutrition, 108*(1), 16-27. doi:10.1017/S000711451100523X

Lovrich, N. P., & Pierce, J. C. (1984). "Knowledge gap" phenomena: Effect of situation-specific and transsituational factors. *Communication Research, 11*(3), 415-434. doi:10.1177/009365084011003005

Mead, E. L., Cohen, J. E., Kennedy, C. E., Gallo, J., & Latkin, C. A. (2015). The role of theory-driven graphic warning labels in motivation to quit: a qualitative study on perceptions from low-income, urban smokers. *BMC public health, 15*(1), 92. doi:10.1186/s12889-015-1438-6

Meier, A., Lyons, E. J., Frydman, G., Forlenza, M., & Rimer, B. K. (2007). How cancer survivors provide support on cancer-related internet mailing lists. *Journal of Medical Internet Research, 9*(2). doi:10.2196/jmir.9.2.e12

National Agricultural Statistics Service (2015). *Noncitrus Fruits and Nuts 2014 Summary* (ISSN: 1948-2698). Washington, D.C. United States Department of Agriculture. Retrieved from http://usda.mannlib.cornell.edu/usda/current/NoncFruiNu/NoncFruiNu-07-17-2015.pdf

Neuman, R., Just, M. R., & Crigler, A. N. (1992). *Common knowledge: News and the construction of political meaning*. Chicago, IL: University of Chicago Press.

Prior, M. (2005). News vs. entertainment: How increasing media choice widens gaps in political knowledge and turnout. *American Journal of Political Science, 49*(3), 577-592. doi:10.1111/j.1540-5907.2005.00143.x

Reeves, J. A. (2016). *Sugar-sweetened beverages: Closing the nutrition knowledge gap with innovative front-of-package labeling and strategically placed educational signage* (Master's thesis). California State University, Sacramento, California.

Rotgans, J. I., & Schmidt, H. G. (2017). The role of interest in learning: Knowledge acquisition at the intersection of situational and individual interest. In *The Science of Interest* (pp. 69-93). Springer, Cham.

Schrager, M. A., Hilton, J., Gould, R., & Kelly, V. E. (2015). Effects of blueberry supplementation on measures of functional mobility in older adults. *Applied Physiology, Nutrition, and Metabolism, 40*(6), 543-549. doi:10.1139/apnm-2014-0247

Shim, M. (2008). Connecting Internet use with gaps in cancer knowledge. *Health Communication, 23*(5), 448-461. doi:10.1080/10410230802342143

Sligo, F. X., & Jameson, A. M. (2000). The knowledge—behavior gap in use of health information. *Journal of the American Society for Information Science, 51*(9), 858-869. doi:10.1002/(SICI)1097

Smith, A. (April, 2015). U.S. Smartphone Use in 2015. [Pew Research Center Website]. Retrieved from http://www.pewinternet.org/2015/04/01/us-smartphone-use-in-2015/

Tchicaya, A., Lorentz, N., Demarest, S., & Beissel, J. (2018). Persistence of socioeconomic inequalities in the knowledge of cardiovascular risk factors five years after coronary angiography. *European Journal of Cardiovascular Nursing, 2018*(17), 136-147. doi: 10.1177/1474515117720789.

Tichenor, P. J., Donohue, G. A., & Olien, C. N. (1970). Mass media flow and differential growth in knowledge. *The Public Opinion Quarterly, 34*(2), 159-170. doi:10.1086/267786

Turrell, G. & Kavanagh, A. M. (2006). Socio-economic pathways to diet: Modelling the association between socio-economic position and food purchasing behaviour. *Public Health Nutrition, 9*(3), 375-383. doi:10.1079/PHN2005850

U.S. Department of Agriculture. (2014). *2014 Blueberry Statistics.* New Jersey Field Office. Retrieved from http://www.nass.usda.gov/Statistics_by_State/New_Jersey/Publications/Blueberry_Statistics/2014%20Blueberry%20Statistics.pdf

USDA National Institute of Food and Agriculture. (April, 2016). Investigating the health benefits of berries. [United States Department of Agriculture Website]. Retrieved from https://nifa.usda.gov/announcement/investigating-health-benefits-berries

USDA SNEP-Ed Connection. (2017). Seasonal Produce Guide: What's in Season? Blueberries. [United States Department of Agriculture Website]. Retrieved from https://snaped.fns.usda.gov/seasonal-produce-guide/blueberries

U.S. Highbush Blueberry Council. (2014a). *Blueberry Demand on the rise in U.S., Consumers trending younger.* Folsom, CA. Retrieved from http://www.blueberrycouncil.org/blueberry-demand-rise-u-s-consumers-trending-younger/

U.S. Highbush Blueberry Council. (2014b). *Health Research.* Folsom, CA. Retrieved from http://www.blueberrycouncil.org/health-professionals/health-research/

Viswanath, K., Kahn, E., Finnegan, J. R., Hertog, J., & Potter, J. D. (1993). Motivation and the knowledge gap: Effects of a campaign to reduce diet-related cancer risk. *Communication Research, 20*(4), 546-563. doi:10.1177/009365093020004003

Whyte, A., & Williams, C. (2012). The cognitive effects of acute blueberry interventions on 7-9 year old children. *Appetite, 59*(2), 637. Retrieved from http://www.sciencedirect.com/science/article/pii/S0195666312003637

Winkleby, M. A., Jatulis, D. E., Frank, E., & Fortmann, S. P. (1992). Socioeconomic status and health: How education, income, and occupation contribute to risk factors for cardiovascular disease. *American Journal of Public Health, 82*(6), 816-820. doi:10.2105/AJPH.82.6.816

Yan, L. (2014). Blueberry and health. [United States Department of Agriculture: Agricultural Research Service Website]. Retrieved from https://www.ars.usda.gov/plains-area/gfnd/gfhnrc/docs/news-2014/blueberries-and-health/

Ybarra, M. L., Holtrop, J. S., Prescott, T. L., & Strong, D. (2014). Process evaluation of a mHealth program: Lessons learned from Stop My Smoking USA, a text messaging-based smoking cessation program for young adults. *Patient education and counseling*, *97*(2), 239-243.

McKinnon, R. (2007). Lessons from VERB: A case for branding in nutrition education. *Journal of nutrition education and behavior, 39*(2), S53-S54.