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The Changing Role of Fat Perceptions in Fluid Milk Labeling: Would the Dairy Industry Sell More if 2% Milk Was Called "98% Fat Free"?

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Abstract

U.S. consumers' perceptions of fat content in food may have changed substantially over the past few decades. This is particularly relevant for the dairy industry as fluid milk is marketed with many different fat content options. Using a stated preferences contingent valuation experiment, this article explores consequences of framing effects of fat on the fluid milk label. Specifically, we investigate whether using alternative but equivalent labels of 96.75% fat free, 98% fat free and 99.98% fat free, whole, 2% fat, and skim milk change consumer willingness to pay. Results indicate that such framing effects rarely have the intended effect and that consumers would actually pay *less* for 2% fat milk if it were called 98% fat-free milk.

Keywords: willingness to pay, consumer behavior, fluid milk fat preferences

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Introduction

For over a century, policy makers have focused on the importance of food packaging and labeling. Indeed, the way information is presented matters, as design, color choice, use and placement of labels, and symbols and icons on food packages all contribute to consumer perceptions (Cavanagh, Kruja, and Forestell 2014; Newman, Howlett, and Burton, 2014; Becker et al., 2015; Cho and Baskin, 2018; Goodman et al., 2018; Roseman, Joung, and Littlejohn, 2018; Muller, Lacroix, and Ruffieux, 2019; Garber, Burke, and Jones, 2000). Health outcomes are of particular importance to policy makers as health policy has been a focus of food policy for decades. One such policy focus area has been fat consumption. During the past 50 years, the heath impacts of fat consumption have been heavily discussed in both scientific literature and media. Initially, higher consumption was linked to health problems in a straightforward way, and limited intake of fat was recommended. More recently, however, those direct links have been challenged. It is possible that the well-established narrative of "fat is bad for health" still influences consumers and their purchasing decisions. But it is also possible that the challenge to the narrative has induced a change in consumer attitudes toward fat consumption.

This study focuses on the framing effects of consumers' perceptions of fat content in fluid milk. Liquid milk is recognized as a source of fat, and fat content is a key attribute consumers reference when choosing milk (Harwood and Drake, 2018). Prior studies have documented the impact of "framing" (the way information is presented) and "nudges" (interventions designed to influence consumer behavior) on consumer behavior within a variety of contexts, though few studies have focused on framing effects of milk fat. We seek to fill that gap in the literature by exploring whether reframing milk fat labels might alter consumer demand for fluid milk products.

We contribute to the literature in three ways. Specifically, our objectives are to (i) find out if a reframing of milk fat content ("fat content" versus "fat-*free* content") changes consumer willingness to pay (WTP) for fluid milk, (ii) identify other factors that influence consumer WTP when framing effect is present, and (iii) draw on the results to infer consequences for the producers and sellers of fluid milk. To accomplish these objectives, we analyze data collected from a web-based survey where primary shoppers from 883 U.S. households answered questions about their willingness to pay for a half-gallon of milk. These types were labelled as 2% reduced-fat milk, vitamin D whole milk, skim milk, 98% fat-free milk, 96.75% fat-free milk, and 99.8% fat-free milk. We also explore the moderating effects of consumer demographics and dietary habits as they relate to consumer willingness to pay for these milk varieties.

Background

The FDA regularly updates food label regulations to better reflect the best available health and food safety research (NPD, 2020). In the 1970s, the Senate Select Committee on Nutrition and Human Needs released "Dietary Goals for the United States," seeking to promote healthy diets and reduce prevalent diet-related diseases. Based on the best scientific knowledge available at the time, the dietary goals made certain nutrition recommendations. As an example, influential studies such as Keys et al. (1986) suggested dietary fat and cholesterol were strongly correlated with heart attacks. In response, reducing overall fat and saturated fat consumption (dairy, eggs, red meat) along with consuming a balance of polyunsaturated and monounsaturated fats (fish, fruits, and vegetables) was recommended. Whole milk fat content is more than 60% saturated fat, so the Committee suggested replacing it with low-fat milk types. Other suggestions included attaining about 50% of total energy intake from consuming complex carbohydrates and “naturally occurring” sugar. Since 1980, the U.S. Department of Agriculture and the Department of Health and Human Services have been jointly publishing *Dietary Guidelines for Americans* in 5-year intervals.

More recently, the direct link between fat consumption and human health has been called into question. For example, a meta-analysis failed to find a correlation between saturated fat and cardiovascular diseases (Siri-Tarino et al., 2010). Evidence of an association between whole-fat dairy and cardiovascular disease, obesity, and diabetes is inconsistent (Mozaffarian, 2016). The 2015 Dietary Guidelines reflected the evolving science, dropping fat as a “nutrient of concern” and imposing no upper limit on total fat consumption, but still recommended keeping saturated fat intake within less than 10% of total calorie intake (Astrup et al., 2020).

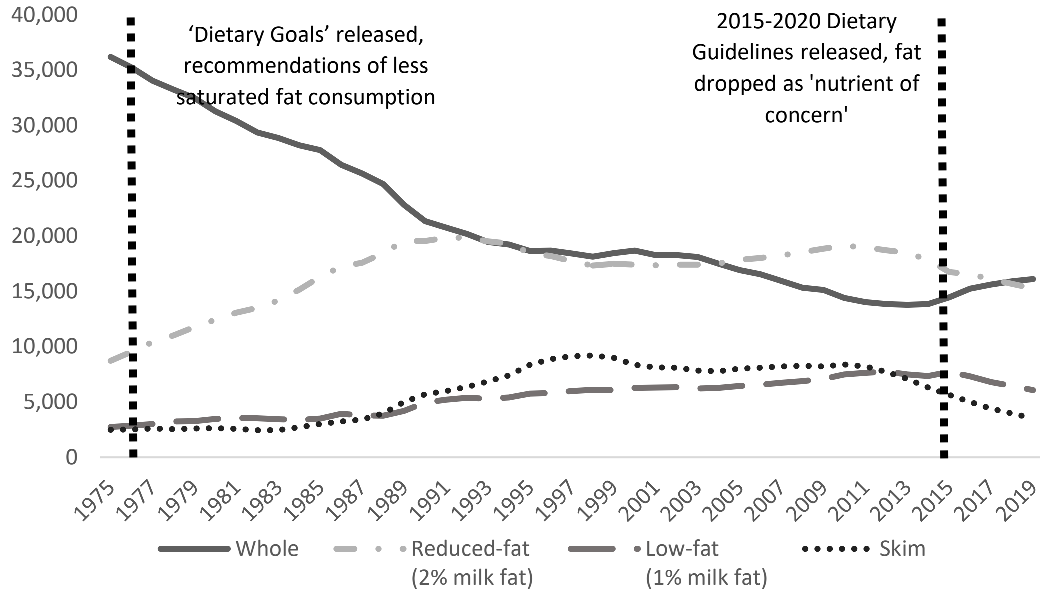
Indeed, the scientific consensus regarding the link between fat and health risks has changed relative to the prior decades. Lower-fat food used to be promoted heavily to be unambiguously health beneficial by the federal government, public health institutions, the food industry, and popular media (La Berge, 2008), but the modern debate has led to front-page popular press articles with titles such as “Eat Butter. Scientists Labeled Fat the Enemy. Why They Were Wrong” (Walsh, 2014), “How the Sugar Industry Shifted Blame to Fat” (O’Connor 2016), and “For decades, the Government Steered Millions Away from Whole Milk. Was That Wrong?” (Whoriskey, 2015).

Fluid Milk Consumption Trends

Demand shifts over time often reflect changes in consumer preferences. While overall per capita consumption of dairy products in the United States has been rising, categories of dairy products have followed different trends. Per capita cheese and butter consumption continues to rise, and yogurt sales witnessed a sharp upward incline in the 2000s. In contrast, aggregate fluid milk consumption has been declining over nearly the last 50 years (USDA-ERS, 2020). Figure 1 presents changes in annual U.S. fluid milk sales broken down by product.

Total sales of fluid milk continue to trend downward, but not all varieties are in decline. Between 2010–2015, trends in whole-milk, 2% milk, and skim milk sales seem to have reversed compared to prior years. Skim milk sales peaked in 1998 and have now decreased to nearly 1975 levels.

Meanwhile, following decades of decline, aggregate whole milk consumption has increased each year since 2013 with 2019 being 17% higher than 6 years earlier. In 2018, whole milk passed 2% (reduced-fat) milk as the largest milkfat category consumed.



Source: (USDA-ERS 2020)

Figure 1. Fluid Beverage Milk Sales Quantities by Product (millions of pounds), 1975–2019

Why the dramatic shift? Fluid milk consumption trends have been much discussed and dissected in the academic literature with both domestic and international policy implications (Vitaliano 2016). Possible—though incomplete—explanations range from generational shifts in preferences (Stewart, Dong, and Carlson, 2013) to increasing demand for plant-based alternatives (Wolf, Malone, and McFadden, 2020).

Despite the downward trend in fluid milk sales, the consumption of butter and cheese has risen 177% and 23% between 1975 and 2018 (USDA-ERS, 2020). While the increase in cheese consumption reflects the increased popularity of home-delivery options for food such as pizza, the increase in butter has mostly happened since 2010 (Wolf, Malone, and McFadden, 2020). Indeed, the changing consumer dynamic of milk beverage preferences with the backdrop of possible alteration in public health views regarding fat provides an interesting context for a deeper investigation into consumer motivations.

Framing Effects and Behavioral Nudges

Framing effects are decision biases that occur when objectively equivalent information is presented in different references, often from either positive or negative terms (Denburg and Hedgcock, 2015). Closely related to framing effects is the idea of behavioral "nudge," described as "any aspect of the choice architecture that alters people's behavior in subtle but predictable ways without forbidding any options or significantly changing their economic incentives." (Thaler and Sunstein, 2008, p. 6). These concepts combined demonstrate the effects of changes in the presentation of information while not changing the information itself.

Using different terms for the same product has been consistently shown to evoke different consumer attitudes (Bryant and Barnett, 2019). This concept has become particularly appealing to the food marketing literature as nudges can invoke healthier eating behavior in consumers (Vecchio and Cavallo, 2019). Simple changes on a product label can allow marketers and policy makers to induce changes to the nutritional profile of a consumer's plate (Just and Gabrielyan, 2016; Matjasko et al., 2016; Roberto and Kawachi, 2014). Consumers may choose healthier options or reduce their portion sizes based on how the product information is framed (Roseman, Joung, and Littlejohn, 2018; Alcantara et al., 2020) .

The food marketing literature is full of framing effects. Prior studies have found that framing a giveaway as "free" is a more effective marketing strategy than advertising the product as "Get it for $0" (Koo and Suk, 2020). Loss-framed messages (highlighting a forgone chance of reducing infection by not consuming intervention-treated cattle beef) induced a higher WTP for food safety technologies in beef purchases than gain-framed messages (highlighting the chance of avoiding infection by consuming intervention-treated beef) (Britwum and Yiannaka, 2019). Consumers are more open to purchasing raw milk if the frame presenting it resonates with them (Rahn, Gollust, and Tang, 2017). More closely related to the current research, researchers have explored the moderating effects of educational messaging on WTP for skim and 2% milk varieties under "Certified Fresh Taste" labeling despite the inability to sense a difference in the milk product (Paterson and Clark, 2020).

Methods

Given the highlighted change in health perceptions of fat consumption along with the prior literature on framing effects in food marketing, this study hypothesizes that presenting "fat" versus "fat-free" framing of liquid milk labels will influence consumers in believing the health considerations of the purchase and nudge them toward making a more health-conscious decision while buying milk.

We seek to explore whether WTP for fluid milk might be affected by the framing of fat content on a product label. We anticipate that consumers should at least be willing to pay the same, if not more, for a milk product with a label that implies that the the same product is healthier. To test this hypothesis, our experiment reframes fluid milk labels. For example, in one frame, fat content is presented in the common reduced-fat manner (e.g., "2% fat"). An alternative frame is also presented that represents the same fat content as "98% fat free." If consumers see higher fat content milk as healthier, everything else remaining equal, we would not see consumers willing to pay more for "fat-free" frames. We use paired t-tests to compare differences in WTP between the two alternatives.

Our study utilizes a between-subjects survey experiment with 883 respondents. The survey was first piloted with 131 participants via Amazon Mechanical Turk (MTurk) in October 2018. After adjusting the survey, the experiment was then conducted with a follow-up group of 74 participants on March 13, 2019. The final experiment was carried out from March 18 to March 25, 2019, and data were collected via a panel of participants from across the United States provided by the professional sampling company SSI-Dynata. Participants were paid the equivalent of approximately $1.50 in incentives, such as cash, airline miles, and gift cards to complete the survey. Descriptive characteristics of the sample are shown in the Table 1, where they are contrasted with corresponding 2019 America Community Survey data from the U.S. census (U.S. Census Bureau, 2020).

Table 1. Sample Characteristics

Variable	Category Levels	Sample	2019 Census
		%	%
Gender	Female	60.8	50.8
Ethnicity	White	57.2	60.1
	Black or African American	20.2	13.4
	Hispanic, Latino, or Spanish	12.1	18.5
	American Indian or Alaskan Native	0.1	1.3
	Asian or Pacific Islander	7.4	6.1
	Other	3.1	0.6
Education	High school/GED or less	23.6	38.0
	Some college	23.7	15.6
	2-year college degree (associate's)	11.7	10.4
	4-year college degree (BA/BS)	27.8	22.6
	Advanced degree (MS, PhD, JD)	13.4	13.4
Household income	Less than $20,000	19.7	13.1
	$20,000–$39,999	24.4	15.9
	$40,000–$59,999	19.1	15.3
	$60,000–$79,999	15.9	12.1
	$80,000–$99,999	9.5	9.5
	$100,000–$119,999	4.0	7.6
	$120,000–$159,999	4.0	10.3
	$160,000 or greater	3.5	16.3
Children under 12 years old in household	Yes	22.3	N/A
	No	77.7	
On a diet	Yes	16.1	
	Maybe	11.3	N/A
	No	72.6	

Number of participants: 883

More than half the participants identified as Caucasian, and more than half identified as female. Most made annual incomes under $80,000 and did not have children under age 12 in the household. About 28% of the participants had completed a 4-year college degree and few indicated being on a diet. Females, African Americans, and college-educated consumers were oversampled relative to the U.S. census (Smith et al., 2016). It is important to note, however, that our sample frame primarily focused on primary food shoppers of U.S. households, so it is reasonable to anticipate some differences between the census and our participants.

Participants answered 1.5 bounded contingent valuation questions. Contingent Valuation (CV) is a common approach to stated preference modeling and commonly applied via survey to elicit consumer-placed values on goods, services, and amenities where revealed preference approaches are not feasible (Boyle, 2003). We opted to utilize the CV approach as opposed to other approaches, such as a discrete choice experiment, to reduce the length of the online survey, as prior studies have indicated issues with measurement error as the survey instrument increases in length and complexity (Malone and Lusk, 2018a, 2018b, 2019). In the current context, this method provides estimated values that consumers are willing to pay for liquid milk products under hypothetical labels. A dichotomous choice question in CV asks individuals whether they are willing to pay a certain amount for a specific good. A one-and-a-half bounded CV question includes one dichotomous choice question and follow-up "payment card" question, which gives a range for possible amounts individuals would be willing to pay and lets them choose from that range.

Figure 2 presents an example of one of the CV questions asked of survey respondents. Each participant provided their WTP for two randomly assigned half-gallons of milk from two equivalent sets of three. Set 1 included milk labels generally used: 2% reduced-fat milk, Vitamin D whole milk, and skim milk. Set 2 included milk labels in "% fat free" format to highlight their health attribute: 98% fat-free milk, 96.75% fat-free milk, and 99.8% fat-free milk. This resulted in (2 x 883) = 1,766 WTP observations. We use OLS estimation and t-tests to compare the respondents' WTP for the same half-gallons of milk that are labeled differently.

We estimate three models. First, we compare WTP across the six different milk categories. The statistical model is specified as:

$$WTP_n = \sum_i \beta_i^M \cdot Milk_{i,n} + \mu_{n,} \quad (1)$$

where WTP_n is the *n* participants' WTP for i^{th} category of milk, $Milk_{i,n}$ is the indicator variable of type of milk the respondent is pricing and μ_n is the statistical error term assumed $iid{\sim}N(0,\sigma)$. i represents the set of milk varieties inclusive of {2% Reduced Fat, 98% Fat Free, Vitamin D whole, 96.75% fat free, skim, and 99.8% fat free}.

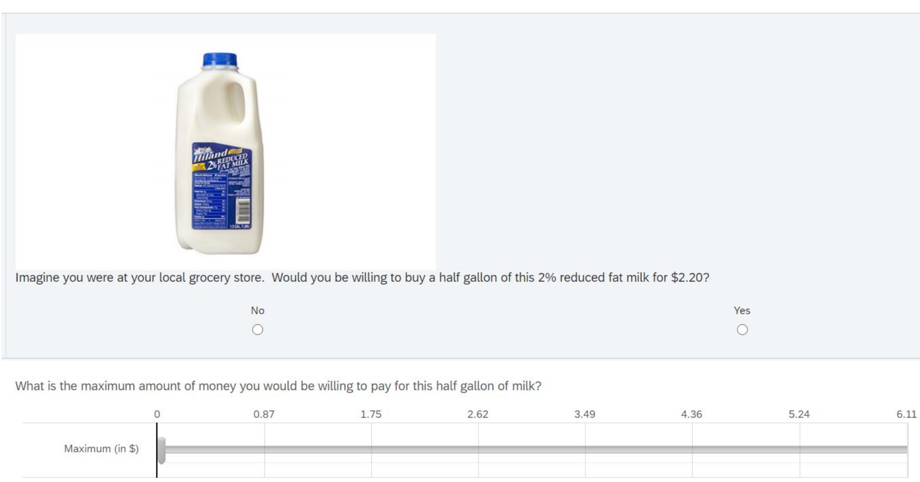


Figure 2. Sample Contingent Valuation Question

We anticipate that several other external factors might impact effect size. In the marketing literature, influencing factors are often referred to as moderating and mediating effects, depending on how they influence the final consumer response (Zanoli et al., 2015). Previous dairy research on nudging and framing effects have suggested that moderating factors might alter consumer preferences (Jung et al., 2017). In this case, education levels should reduce the impact of framing effects on WTP but may be associated with expansive effect size through the relationship between education and healthy food choice (Rothman et al., 2006). We also anticipate that income levels will expand effect size, as higher income consumers will exhibit higher WTP for desired attributes. Health-related restrictions in consumer diets is also likely to be relevant for consumer WTP across the different varieties and associated implied health attributes.

We estimate effect size in stages where moderating effects are added sequentially to a main effects model. For generality, we drop observation subscripts, n, in our subsequent model depictions. Starting with the model of main effects, the statistical model is specified as:

$$WTP = Constant + \sum_i \beta_i^M \cdot Milk_i + \beta_0^F \cdot Female + \beta_0^C \cdot Children +$$

$$\sum_r \beta_r^R \cdot Race_r + \beta_0^E \cdot College + \beta_0^I \cdot Inc + \beta_0^D \cdot Diet + \mu, \quad (2.a)$$

where *Female* is the indicator variable taking the value 1 for Female and 0 otherwise. *Children* is the indicator variable denoting the presence of children under age 12 in the household (1 = Children; 0 = No children present). $Race_r$ is an indicator variable showing fixed effects for self-selected race category the respondent identifies. Category levels are White, Black or African American, Hispanic, Latino or Spanish, American Indian or Alaskan Native, Asian or Pacific Islander, and Other Ethnicity. *College* takes the value 1 for the respondents who completed a college degree or higher and 0 otherwise; *Inc* is a continuous representation using midpoint values of 9 income categories ranging from less than \$20,000 to \$160,000 and greater, measured in thousands of dollars, and *Diet* is a binomial indicator taking the value 1 if the respondent indicated being on a calorie-constrained diet at the time of the survey or zero for otherwise.

From this model, each subsequent model entails adding moderating interactions between milk categories and demographic moderators to the main effects model. Model 2.b adds interaction between $College$ and $Milk_i$ to model 2.a.

$$WTP = Constant + \sum_i \beta_i^M \cdot Milk_i + \beta_0^F \cdot Female + \beta_0^C \cdot Children +$$

$$\sum_r \beta_r^R \cdot Race_r + \beta_0^E \cdot College + \beta_0^I \cdot Inc + \beta_0^D \cdot Diet +$$

$$\sum_i \beta_i^{E,M} \cdot (College \cdot Milk_i) + \mu \quad (2.b)$$

Model 2.c adds interaction between Inc and $Milk_i$ to model 2.b.

$$WTP = Constant + \sum_i \beta_i^M \cdot Milk_i + \beta_0^F \cdot Female + \beta_0^C \cdot Children +$$

$$\sum_r \beta_r^R \cdot Race_r + \beta_0^E \cdot College + \beta_0^I \cdot Inc + \beta_0^D \cdot Diet +$$

$$\sum_i \beta_i^{E,M} \cdot (College \cdot Milk_i) + \sum_i \beta_i^{Inc,M} \cdot (Inc \cdot Milk_i) + \mu \quad (2.c)$$

Model 2.d adds interaction between $Diet$ and $Milk_i$ to model 2.c.

$$WTP = Constant + \sum_i \beta_i^M \cdot Milk_i + \beta_0^F \cdot Female + \beta_0^C \cdot Children +$$

$$\sum_r \beta_r^R \cdot Race_r + \beta_0^E \cdot College + \beta_0^I \cdot Inc + \beta_0^D \cdot Diet +$$

$$\sum_i \beta_i^{E,M} \cdot (College \cdot Milk_i) + \sum_i \beta_i^{Inc,M} \cdot (Inc \cdot Milk_i) +$$

$$\sum_i \beta_i^{D,M} \cdot (Diet \cdot iMilk_i) + \mu \quad (2.d)$$

Akaike information criterion (AIC) model fit statistics are used to compare model specifications.

Because the frequency with which one consumes milk will likely have implications on their familiarity with beverage milk options and WTP, another model was specified that accounts for consumption frequency. We hypothesize that participants who consume milk less frequently might be more susceptible to nudge bias from framing effects. In this final model (Model 3), we control for consumption frequency (CFreq) of 2%, Vitamin D Whole, and Skim milk along with interaction effects to look for possible moderating effects. As in model 3.a, we only have the main effects while model 3.b. adds the interaction effects.

$$WTP = Constant + \sum_i \beta_i^M \cdot Milk_i + \sum_k \beta_k^{CR} \cdot CFreq_k + \mu \quad (3.a)$$

and

$$WTP = Constant + \sum_i \beta_i^M \cdot Milk_i + \sum_k \beta_k^{CR} \cdot CFreq_k +$$

$$\sum_k \sum_i \beta_{i,k}^{CR,M} \cdot (CFreq_k \cdot Milk_i) + \mu \quad (3.b)$$

Here, *CFreq* is a variable indicating consumption of milk type *k* with four categorical levels: 1 = *Regular part of my diet*, 2 = *Consume, but not on a regular basis*, 3 = *Limit my consumption,* and 4 = *Don't consume at all*. For parsimony, we treat the variable as continuous.

Results

Table 2 shows the simple differences in WTP across the six milk labels where the first column displays mean WTP and standard errors. The lower diagonal shows the level of statistical significance between the corresponding pairs. Skim Milk and 99.8% Fat-Free Milk labels generated lower WTP than 2% Fat and Whole Milk labels. Willingness to pay estimates indicate that average WTP for 2% Fat and Whole Milk are consistent. That said, while WTP for 2% Fat and Whole Milk are not statistically different, consumers perceive a clear delineation between 2% Fat and alternatively labeled, but equally attributable, 98% Fat Free.

Table 2. Simple Differences in Willingness to Pay (Model 1**)**

		Significance of Difference					
	Mean WTP	**2% Fat**	**98% Fat free**	**Whole Milk**	**Skim**	**96.75% Fat free**	**99.8% Fat Free**
2% fat	$2.27 (0.052)						
98% fat free	$2.08 (0.061)	**					
Whole milk	$2.29 (0.060)		**				
Skim	$2.07 (0.060)	**		***			
96.75% fat free	$2.18 (0.063)						
99.8% fat free	$2.01 (0.061)	***		***		*	

Note: Standard errors in parentheses.
Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% levels.

Table 3 presents our statistical analysis for Model 2, which tests for interaction effects among milk categories and demographic moderators. Model fit statistics across all models indicate that the parsimonious main effects model is preferred over the progressively complicated models. The findings show, again, that the simple reversal of the default fat content does not have substantially different impacts on consumer WTP across varieties of milk except for 2%. Model 2.a in Table 3 starts with a simple mean WTP model with the base indicated by the 2% Fat Milk label and adds control-variable main effects. The inclusion of the model main effects does not detract from differences in WTP relative to the results presented in Table 1. However, several of the main effects are significantly correlated with expected WTP. Both African American and Hispanic respondents indicated a higher WTP in general. Similarly, those indicating completion of a college degree or higher and those with higher incomes were found to have a higher WTP in general. Finally, though weakly significant, those who indicated being on a calorie-constrained diet indicated a higher WTP overall.

Table 3. Main Effects Model with Demographic Moderators (Model 2)

Independent Variable	Model 2.a	Model 2.b	Model 2.c	Model 2.c
98% Fat free	-0.175 (0.085)**	-0.108 (0.099)	-0.238 (0.146)	-0.227 (0.209)
Whole	0.021 (0.084)	0.061 (0.099)	0.097 (0.144)	0.363 (0.203)*
96.75% Fat free	-0.094 (0.083)	-0.043 (0.099)	-0.007 (0.145)	0.152 (0.210)
Skim	-0.203 (0.084)**	-0.153 (0.099)	-0.155 (0.145)	-0.080 (0.213)
99.8% Fat free	-0.265 (0.084)***	-0.246 (0.100)**	-0.175 (0.144)	0.032 (0.207)
Female	0.076 (0.051)	0.075 (0.052)	0.075 (0.052)	0.074 (0.052)
Children	0.023 (0.058)	0.026 (0.059)	0.027 (0.059)	0.025 (0.059)
African American	0.233 (0.063)***	0.231 (0.064)***	0.235* (0.064)***	0.232* (0.064)***
Hispanic	0.365 (0.076)***	0.361 (0.077)***	0.363* (0.077)	0.360* (0.077)***
American Indian	0.429 (0.720)	0.458 (0.721)	0.477 (0.721)	0.500 (0.724)
Asian/Pacific Islander	0.066 (0.097)	0.054 (0.098)	0.054 (0.098)	0.055 (0.098)
Other ethnicity	-0.165 (0.143)	-0.165 (0.143)	-0.170 (0.143)	-0.176 (0.143)
College	0.114 (0.055)**	0.248 (0.133)*	0.247 (0.135)*	0.251 (0.135)*
Inc	0.002 (0.001)***	0.002 (0.001)***	0.002 (0.002)	0.002 (0.002)
Diet	0.107 (0.057)*	0.108 (0.057)*	0.110 (0.057)*	0.274 (0.143)*
98% Fat free x college		-0.253 (0.192)	-0.297 (0.195)	-0.308 (0.195)
Whole x college		-0.138 (0.186)	-0.126 (0.189)	-0.121 (0.189)
96.75% Fat free x college		-0.175 (0.183)	-0.167 (0.185)	-0.171 (0.185)
Skim x college		-0.179 (0.189)	-0.180 (0.192)	-0.191 (0.192)
99.8% Fat free x college		-0.065 (0.187)	-0.037 (0.190)	-0.032 (0.190)
98% Fat free x inc			0.002 (0.002)	0.003 (0.002)
Whole x inc			-0.001 (0.002)	-0.001 (0.002)

Table 3. (cont)

Independent Variable	Model 2.a	Model 2.b	Model 2.c	Model 2.c
96.75% Fat free x inc			-0.001 (0.002)	-0.001 (0.002)
Skim x inc			0.000 (0.002)	0.000 (0.002)
99.8% Fat free x inc			-0.002 (0.002)	-0.001 (0.002)
98% Fat free x diet				-0.012 (0.197)
Whole x diet				-0.364 (0.194)*
96.75% Fat free x diet				-0.206 (0.197)
Skim x diet				-0.100 (0.198)
99.8% Fat free x diet				-0.274 (0.198)
Constant	1.922 (0.087)***	1.884 (0.094)***	1.878 (0.117)***	1.755 (0.154)***
AIC	5071.5	5089.3	5084.7	5088.8

Note: Standard errors in parentheses.
Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% levels.
Base Case: 2% milk, not female, no children under 12 in HH, Caucasian, no college/higher degree, not on a diet

The second column in Table 3 (Model 2.b) expands the main effects model by adding college education moderating effects on WTP. Not surprisingly, the college interaction variable detracts from the college variable main effects. It also reduces the significance of the base differences in WTP across milk labels. However, this model retains the overall significance of having at least a 4-year degree. Accordingly, only the fictitious 99.8% fat-free label draws a significant base differential WTP to 2% Fat. Because the interaction terms of college education by milk label do not enter the model significantly, we are left to deduce that college education does not moderate WTP across labels—even when the 2% fat label is reframed as 98% fat-free. Though we anticipated that more educated participants might be able to recognize 98% fatfree milk as equivalent to 2% Milk, the analysis does not indicate a significant effect. As such, we conclude that a college degree may not insulate one from this framing effect.

The third model (Model 2.c) adds moderating effects of income on WTP by label. Adding income interactions mitigates income main effects as expected and further erodes the base WTP differentials. Like education, income interaction effects do not appear to moderate WTP for the different labels. That is, like education, higher income households are equally susceptible to the change in milkfat framing effects.

The fourth and final model (Model 2.d) adds diet interaction effects to the model. Diet interaction effects largely do not enter the model significantly, though there appears to be a weak association with lower WTP for whole milk in dieters relative to 2% fat. This is consistent with (Liebman et al., 2001) who found an association between reduced-fat intake and dieters. This effect is also observed in the model base WTP differentials indicating that whole milk label direct effects are positive relative to the 2% fat label. That premium is offset by the *diet* x *Whole Milk* interaction.

The final model estimates main and interaction effects for the frequency of consumption of whole, 2% fat, and skim milk. The conjecture is that frequent consumption will have a positive effect on WTP overall but will eliminate the framing effect (Table 4). Model 3.a is limited to main effects, where significance of WTP differentials largely reflect those shown in Model 2.a of Table 3. However, the factor variables differ in Model 3.a below, indicating that increased frequency of consumption for all three categories have a significant and negative effect on WTP. This may indicate that individuals who do not purchase milk regularly are less susceptible to behavioral anomalies (List, 2003). Either way, the more interesting question is how frequency of consumption moderates WTP differentials across labels. As shown in Model 3.b, introducing interactive terms reduces the significance of main effects. However, as 2% fat is the base case, it does not interact directly with the WTP for its corresponding milk category like the other two measures of consumption frequency. In Table 4, the bolded interaction rows show the pairing of consumption frequency with the label, both of which largely reflect the negative association shown in the main effects of Model 3.a. Hence, Table 4 shows that frequency of consumption does posit a bit of a moderating effect on WTP and that it is largely associated with the pairing of the frequency of consuming the product for which WTP is assessed. That is, as higher frequency of consuming skim milk decreases the WTP for all milk types through main effects, it has an additional negative effect on WTP for skim milk. Interestingly, frequency of consuming skim milk also showed a negative moderating effect on one's WTP for the 98% fat-free converse of the standard 2% fat label.

Table 4. Main Effects Model with Frequency of Consumption Moderators (Model 3)

Independent variable	Model 3.a			Model 3.b		
98% fat free	-0.148	(0.083)	*	0.510	(0.368)	
Whole	0.094	(0.082)		0.217	(0.359)	
96.75% fat free	-0.075	(0.081)		0.169	(0.335)	
Skim	-0.201	(0.082)	**	0.138	(0.346)	
99.8% fat free	-0.234	(0.083)	***	-0.183	(0.343)	
CF:2% fat	-0.101	(0.020)	***	-0.141	(0.049)	***
CF:Whole	-0.094	(0.020)	***	-0.055	(0.051)	
CF:Skim	-0.178	(0.022)	***	-0.108	(0.052)	**
98% fat free x CF:2% fat				-0.024	(0.069)	
Whole X CF:2% fat				0.106	(0.069)	
96.75% fat free X CF:2% fat				0.034	(0.068)	
Skim X CF:2% fat				0.040	(0.070)	
99.8% fat free X CF:2% fat				0.101	(0.070)	
98% fat free X CF:whole				0.005	(0.072)	
Whole X CF:whole				**-0.187**	**(0.070)**	***
96.75% fat free X CF:whole				-0.060	(0.070)	
Skim X CF:whole				0.025	(0.071)	
99.8% fat free X CF:whole				-0.019	(0.071)	
98% fat free X CF:skim				-0.186	(0.078)	**
Whole X CF:skim				0.030	(0.076)	
96.75% fat free X CF:skim				-0.052	(0.074)	
Skim X CF of CF:skim				**-0.152**	**(0.076)**	**
99.8% fat free X CF:skim				-0.078	(0.074)	
Constant (base: 2% milk)	3.31661	(0.114)	***	3.083	(0.241)	***

Note: Standard errors in parentheses.
Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% levels.
Base Case: 2% milk

As Table 3 shows, college degrees resulted in higher WTP for milks (relative to 2%). But this characteristic did not moderate differences in WTP for milk types, nor did it indicate that college-educated respondents recognized that the milk labeled as 98% fat free was the same product as 2% fat. Survey participants with higher income also had higher WTP for the average milk in the sample, which makes intuitive sense. Higher income levels are correlated with higher education levels, which indicates a possible indirect moderating effect. Participants on a diet were willing to pay more for milk types (relative to 2%), but this variable had weak statistical significance. Participants who consume milk more frequently showed less WTP for milk types. This finding may indicate that their familiarity with the products enabled them to choose WTPs closer to regular market prices. This also explains why consumption of a certain type of fluid milk helped moderate WTP for that milk for participants.

Relative to Caucasian consumers, African American and Hispanic consumers were willing to pay more for fluid milk. Prior studies suggest that both African Americans and Hispanics consume less dairy than Caucasians (Bailey et al., 2013; Fulgoni III et al., 2007). This conclusion implies their inflated WTP for liquid milk types may be caused by less familiarity with regular prices of the products. Relative to 2% milk, respondents with higher education were also willing to pay more for other milks. That said, this characteristic does not moderate differences in WTP for milk types, nor did it moderate the effectiveness of these consumers in identifying the 98% fat-free label as equivalent to 2%. This result indicates that academic education may not be necessarily associated with a reduced susceptibility to framing effects. Indeed, survey participants with higher income were willing to pay more in general as higher income levels are correlated with higher education levels. Since we could not identify a moderating effect for advanced education, we can expect that we also would not find one for income levels. Participants on a diet were willing to pay more for milk types (relative to 2%), but this variable had weak statistical significance. Participants who consume milk more frequently showed less willingness to pay for milk types. This result may indicate that their familiarity with the products enabled them to choose WTPs closer to regular market prices. This also explains why consumption of a certain type of fluid milk helped moderate WTP for that milk for participants.

Discussion

This article used a contingent valuation survey experiment to explore the framing effects of fat content on fluid milk labels. Our results indicate that, at least on average, consumers were willing to pay *less* for 2% milk when it is labeled as "98% fat-free milk." Our study indicates that consumers were not willing to pay a different price for 2% and whole milk, but that they would pay less than that for equivalent milk types labeled skim or 99.8% fat free.

Why the decrease in WTP? It is possible that consumers today might perceive "with-fat" milks to be healthier than "non-fat/fat-free" milks. In this case, the presence of "fat-free" framing might nudge consumers away from this option due to its perceived lack of a desirable attribute (higher fat content), in terms of taste or health. Lending credence to this explanation, we found consumer WTP for whole milk to be at least as much as 2% milk but less for skim milk.

Consumer perceptions regarding milk fat have substantially shifted for some time, with likely connections to many overlapping food values. In addition to changes in health perceptions, U.S. consumer dietary habits are also going through generational changes as well as increasing concern regarding environmental sustainability and animal cruelty. In addition, the availability of plant-based substitutes has emerged as a small, but growing, alternative to dairy milk consumption. As such, this study is limited in its scope to capture a comprehensive picture of consumer behavior in the middle of such shifting dynamics. Furthermore, self-reported WTP values may not always reflect real-market payment situations, though this limitation matters insomuch as the bias might vary between each treatment.

As fluid milk sales have declined, milk producers and sellers might benefit from further research on the consequences of framing effects and nudges to dairy consumers. We find that consumers across education and income level are likely to be influenced by labeling changes. In this case, our results suggest that milk marketers are unlikely to experience a benefit from changing the label to

"98% fat free," as consumers would be willing to pay *less* for milk thus labeled. However, this study investigates an area of research—label framing effects in dairy consumption—that is largely unexplored. This study represents only a first step into multiple relevant avenues for future research. Future studies would benefit from a time series approach to understanding how changes in perceptions of fat content have influenced consumer willingness to pay for fluid milk. Furthermore, there is likely to be value in understanding differences in consumer demand for other contexts for different dairy products. There would also be value in considering framed field experimental methods to explore demographic differences regarding how fat content alters the health perceptions of fluid milk for unique consumer populations (Bakke, Shehan, and Hayes, 2016; Ortez et al., 2021). Though our study includes controls for demographic variables, further research may reassess each of these important demographic characteristics more rigorously, focusing on specific sections of the population. There also might be value in exploring the differences between objective knowledge and subjective perception of fluid milk fat in U.S. consumer populations. In addition to studies focused on fat content, framing effects of other important attributes highlighted on milk labels may provide other relevant research questions. Indeed, our study emphasizes the potential of creative thinking for commodity labeling in a rapidly evolving food environment. By exploring characteristics that place an ever-increasing emphasis on nutritional labeling and understanding what information to highlight on labels, promotional ideas might emerge as additional mechanisms relevant for boosting fluid milk sales.

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