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Featured Article

Integrating Educational, Environmental, and Behavioral Economic Strategies May Improve the Effectiveness of Obesity Interventions

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Abstract *Interventions that change the food environment, provide nutrition education, and employ behavioral economics strategies can potentially contribute to healthier diets and reduce the risk of chronic disease, but no attempt has been made to integrate these into the same conceptual framework. We present case studies of three multilevel, integrated interventions implemented by Johns Hopkins University between 2004–2011. We develop a conceptual model based on these case studies. Interventions and policies should effectively maximize opportunities to nudge healthier behaviors. We believe that the integration of educational, environmental, and behavioral economic strategies will balance the strengths and limitations of each approach.*

Key words: Food environment, Behavioral economics, Nutrition education, Food store interventions, Food policy, Obesity, Behavior change theory.

JEL codes: I18, I28, D00, I12, I18.

Introduction and Background

The dramatic rise of obesity in the United States over the past few decades has led policy-makers, economists, clinicians, and public health researchers to consider a range of intervention approaches. Early efforts to address the epidemic focused mainly on education—working under the premise that if people are aware of the risks, and that healthier choices exist, they will make rational decisions and modify their behavior accordingly (Schmitz and Jeffery 2000). In the past decade, however, it has become clear that the health decisions that people make are constrained by their environments (Sallis and Glanz 2009). In terms of food, the availability, cost, location, and other factors work together to determine the range of choices accessible to people. These choices differ by setting, ethnicity and socio-economic status (SES), with low-income minority populations experiencing inequitable access to healthy foods (Drewnowski 2009; Neff,

Palmer, McKenzie, & Lawrence 2009; Raja, Ma, & Yadav 2008). Many levels of environments can be considered—household, community, school—however, the community food environment has come under increasing scrutiny as being centrally important for both understanding and addressing the obesity epidemic (Holsten 2009; Kaufman 2004; Morland, Wing, & Diez Roux 2002).

Educational Approaches and their Limitations (Demand)

Contento (1995) defines nutrition education as "any set of learning experiences designed to facilitate voluntary adoption of eating and other nutrition related behavior conducive to health and well-being." Nutrition education has long been the central method of dietary interventions, working under the assumption that sufficient knowledge will induce appropriate behavior change (Schmitz and Jeffery 2000). However, it is clear that human decision-making is multifactorial, and not predictably based on the perceived long-term value of current behaviors (Ortendahl and Fries 2002). It is therefore insufficient to teach individuals about healthy choices; they must also have the option of—and motivation to—make those choices.

Indeed, the complexity of dietary decision-making and eating behaviors have made effective change through exclusive educational interventions difficult, often with less than ideal results (Rothman, Gillespie, & Johnson-Askew 2009). Behavioral interventions commonly target fruit and vegetable consumption given that the overwhelming majority of Americans do not meet the recommended daily intake (Blank, Gillespie, Kimmons, Seymour, & Serdula 2008, Thomson and Ravia 2011). However, reviews of the effectiveness of behavioral interventions for fruit and vegetable consumption consistently find modest increases in serving sizes (less than 1.5), with greater increases for those with elevated disease risk (Ammerman, Lindquist, Lohr, & Hersey 2002; Pomerleau, Lock, Knai, & McKee 2005; Thomson and Ravia 2011). Given the challenges of achieving adequate intake, the authors suggest enhancing behavioral interventions with social marketing, behavioral economics, and technology-oriented approaches (Thomson and Ravia 2011).

Recent work suggests that successful behavioral change needs to incorporate environmental solutions as well as advance the science of behavior change (Wing 2003; Baranowski, Cullen, Nicklas, Thompson, & Baranowski 2003; Bowen & Beresford 2002). Multi-component interventions also demonstrate promise, with a review finding strongest evidence in favor of multi-component interventions to increase fruit and vegetable consumption in children (Knai, Pomerleau, Lock, & McKee 2006).

Environmental Approaches and their Limitations (Supply)

Significant associations between the food environment and obesity have been well-documented in the scientific literature. For example, food availability is associated with diet and higher youth Body Mass Index (BMI) (French, Story, & Jeffery 2001). Distance and accessibility to stores also play a role, with a distance from home to grocery store of 1.76 miles or greater being predictive of increased BMI (Inagami, Cohen, Finch, & Asch 2006). The types of food sources available directly impact health; fewer supermarkets are associated with higher BMI and chronic disease rates (Bodor, Rice, Farley, Swalm, & Rose 2010; Morland, Diez Roux, & Wing

2006). The presence of more small stores and prepared food sources is also associated with higher BMI rates (Bodor et al. 2010; Maddock 2004).

Given the evidence of association between access to different food sources and obesity, environmental interventions have been tested as a means of improving access to foods within retail food stores and prepared food sources. Environmental intervention strategies may involve decreasing the availability of less healthy foods, increasing the availability of healthy foods in small stores, changing the physical location of foods (e.g., store layout), renovating stores (e.g., adding refrigeration units for produce), and manipulating price, among other strategies.

In the past decade, a number of food environment interventions have incorporated the above strategies with measured success in a variety of settings, including supermarkets, restaurants, and cafeterias (Seymour et al. 2004). A systematic review of small food store interventions identified increasing the availability of healthier foods (particularly produce), point-of-purchase promotions (shelf labels, posters), and community engagement as the most common intervention strategies (Gittelsohn, Rowan, & Gadhoke 2012). The review found significant effects for increased availability of healthy foods, improved sales of healthy foods, and improved consumer knowledge and dietary behaviors (Gittelsohn et al. 2012). Trial impact appeared linked to both the increased provision of healthy foods (environment) and health communications (education) designed to increase consumption. Despite these positive initial findings, much less is known about which kinds of environmental strategies are most effective, and how best to use them in combination with other approaches.

Behavioral Economics in Nutrition and Dietary Interventions

More recently, behavioral economics concepts have been applied to obesity prevention (Loewenstein, Asch, Friedman, Melichar, & Volpp 2012; Just and Payne 2009). Behavioral economists study the effects of social, cognitive, and emotional factors on the economic decisions of individuals and institutions, and the consequences of these decisions. The field draws substantially on psychological principles to suggest means of motivating individuals and groups to change their behavior. The perspectives of standard economic theory apply rationalist thinking to decision-making, which assumes that individuals will make decisions that optimize benefits and minimize costs (Just and Payne 2009; Sobal and Bisogni 2009). These standard approaches to obesity prevention have not generated much success, as they do not account for group-level thinking, judgment under uncertainty, non-rational decision processes, and calculations of costs and benefits (Sobal and Bisogni 2009). In contrast, behavioral economics recognizes that individuals often make decisions based on heuristics, or rules of thumb (e.g., status quo) that may appear counterintuitive (Just and Payne 2009). Behavioral economic applications to dietary and obesity interventions therefore incorporate heuristic-based strategies to packaging, price, and promotion necessary to counter food marketers' use of these strategies. Defaults are a central method to facilitate desired behaviors, given the tendency for individuals to exhibit status quo bias (Johnson and Goldstein 2003; Kahneman, Knetsch, & Thaler 1991; Samuelson and Zeckhauser 1988). Underscoring the power of defaults, opt-out policies for organ donation and retirement plans have

unequivocally demonstrated dramatic increases in program enrollment (Thaler and Sunstein 2009).

Behavioral economic strategies nudge individuals toward healthier selections while preserving their freedom of choice, thereby following the notion of libertarian paternalism (Thaler and Sunstein 2009). Individuals may not always make decisions that are in their best interest; hence, policy-makers make assumptions to design interventions that promote favorable options (Just and Payne 2009). The concept of "libertarian paternalism" occupies the space between required policy regulations and voluntary individual choices by urging or restricting choices for the individual's welfare (Skipper 2012; Camerer et al. 2003).

A number of behavioral economics studies have been conducted in real-world settings to effectively change food purchasing behavior. To our knowledge, none have been large-scale programs, partly due to the nascent application of behavioral economics to health behavior change. A 2007 U.S. Department of Agriculture Economic Research Report affirmed that the most successful behavioral economic studies for healthy eating required high school students to pay cash for desserts and soft drinks (Just, Mancino, & Wansink 2007). Without the option of charging desserts or soft drinks to credit or debit cards, the saliency of losing cash for discretionary foods decreased those purchases. Importantly, the altered purchasing behavior did not decrease school lunch revenue or participation, but generated the intended effects of increasing sales of more nutritious items, and lowering sales of less nutritious items (Just and Wansink 2009). Another school lunchroom study created a convenience line that offered only healthier food options, which nudged students to increase purchases of healthier foods by 18% (Hanks, Just, Smith, & Wansink 2012).

Further research on behavioral economic strategies applied to dietary change is needed, because while many studies demonstrate efficacy in experimental trials, the implications for long-term behavior change in real-world settings is less clear. Longitudinal studies could shed light on school lunchroom or supermarket purchasing patterns, such as whether behaviors persist or whether adaptations emerge over time. Moreover, the measurement of actual *consumption* or *preparation* of healthy foods would shed light on interventions that typically end with *purchasing* as the outcome. Other types of behavioral economic strategies such as deposit or commitment contracts (e.g., using external incentives as motivators for weight loss) have produced mixed results (Halpern, Asch, & Volpp 2012). More research is needed on how to incentivize healthier choices (monetary and non-financial modes) and how to effectively deliver health communication messages (Gneezy, Meier, & Rey-Biel 2011; Storey et al. 2011). While innovative behavioral economics approaches show promise, more has yet to be learned about their applications to obesity and sustaining behavior change.

Need for Integrating Approaches

Educational, environmental and behavioral economic approaches have all shown promise individually as a means of addressing the obesity epidemic. Yet each has its own limitations. To our knowledge, no attempt has been made to integrate educational, environmental and behavioral

economic strategies into the same conceptual framework. In this paper, we address this gap in two ways:

1) We present several case studies that demonstrate successful multilevel, integrated interventions and describe some of the limitations of each.
2) Based on these examples, we develop a conceptual model linking educational, environmental, and behavioral economic strategies to guide nutrition interventions.

We then draw upon the following case examples and the conceptual framework to provide recommendations for future work.

Case studies

This section presents several short case studies of interventions that have combined educational, environmental, and behavioral economic strategies to some degree.

Case #1: Baltimore Healthy Stores

Intervention Description. The Johns Hopkins Bloomberg School of Public Health implemented the Baltimore Healthy Stores (BHS) project in food stores located in two low income areas of Baltimore, MD. The store sample consisted of 2 supermarkets and 7 small stores per area, with one area serving as the intervention area and the other as comparison (Gittelsohn, Song et al. 2010). Korean-owned small corner stores comprise the main type of retail food establishments in East Baltimore. A consumer sample was also recruited, with approximately 87 respondents per area. Formative research and community planning were used to identify barriers to healthy eating, and to plan a culturally appropriate intervention strategy (Gittelsohn, Suratkar et al. 2010; Gittelsohn et al. 2007). Small store owners perceived low consumer demand as the primary challenge to stocking healthy foods, stating that consumers were not interested in healthier foods and did not purchase healthy foods even if they stocked them. Consumers described a lack of availability of healthy foods in corner stores—and high prices or poor quality, when available—as their primary barriers to consumption.

The corner store intervention therefore focused on changing the food environment and providing education to store owners and adult customers as a means of addressing this difference in viewpoint. Environmental changes centered on increasing the availability of healthy items, but did not directly influence access to unhealthy foods. The intervention ran in five themed phases of two months each from February to November 2006 and focused on specific foods and food-related behaviors, with input evaluation assessments in the several months pre and post this period (Gittelsohn, Suratkar et al. 2010). Corner stores were incentivized to stock one to three new healthier foods per store per phase. For storeowners, incentives and the provision of information included stocking guidelines, promotional materials to create demand, an incentive card to wholesalers, and providing a small supply of the promoted food when necessary. As an incentive to stock promoted foods while minimizing financial risks, the storeowners were given $25 to $50 gift cards for food wholesale stores, fruit baskets with five pounds of fresh fruit, and 5-7 loaves of whole wheat bread. To increase consumer demand, locally appropriate visual materials (e.g., posters, flyers) conveyed the health benefits of healthier

foods, and interactive sessions (e.g., educational displays, giveaway items, taste tests) were conducted in the food stores.

Key Findings. Stores increased their stocking and sales of healthier promoted foods (Song et al. 2009). The consumer results showed a significant improvement in cooking methods and frequency of purchase of promoted food, as well as a positive trend for healthy food intentions (Gittelsohn, Song, et al. 2010). Impact on diet has not yet been analyzed.

Intervention Limitations. The BHS intervention addressed the availability of healthy foods, but did not impact their cost or location within the store. The educational component was detailed and multi-component, but passive. Drawing upon the behavioral economics concept of preference construction (Sobal and Bisogni 2009), possible strategies could have involved relative placement on shelves, thereby making the healthier choices more visible or accessible, modifying the pricing of healthy vs. unhealthy foods, or framing messages to improve perceived palatability of healthier options. Point-of-purchase promotions have the ability to nudge individuals toward healthier food purchases. For instance, promotional materials such as flyers and signage could incorporate framing effects, and also test the effectiveness of gain frame (benefits) versus loss frame (costs) messaging to increase consumer demand for healthier foods. Studies find that the framing of messages can influence perceptions and preferences, though complexities exist in the internalization of the frame, perceived risk, and the nature of the behavior (e.g., promotive or preventative) (Rothman and Salovey 1997; Tversky and Kahneman 1981).

Case #2: Navajo Healthy Stores

Intervention Description. The Navajo Healthy Stores (NHS) program goals were to increase the availability of healthy foods in local stores on the Navajo Nation, and to provide culturally appropriate nutrition education so individuals could make healthy choices at the point-of-purchase. NHS partnered with the Navajo Nation Special Diabetes Program, as well as large and small stores to create a sustainable program. The intervention goal involved a locally implemented and sustained intervention with some management support provided by Johns Hopkins Bloomberg School of Public Health. Initial formative research and community workshops were conducted to plan the intervention (Young et al. 2006; Vastine et al. 2005).

Navajo Healthy Stores was a six phase intervention program conducted over 14 months, from 2007 to 2009. The program took place in 15 large and small food stores, with each phase focused on key foods and behaviors. Intervention activities were reinforced with in-store materials, interactive sessions, and community media. The six phases were: healthy beverages and breads; healthy cooking methods; healthier luncheon meats and eating in moderation; better, healthier meals; healthier snacks and dessert; and planning ahead for healthy and affordable meals. NHS materials included educational displays, posters, shelf labels, and flyers, radio announcements, and promotional items. Evaluation took place six months immediately pre and post intervention.

Key Findings. After adjusting for levels of exposure, respondents who were more exposed to the intervention had significantly increased food intentions, healthier cooking methods, increased frequency of purchase of

healthier foods, and reduced BMI (Gittelsohn, Kim, He, & Pardilla, under review).

Intervention Limitations. NHS was a heavily educational intervention, where messages were delivered at the point of purchase by local Navajo educators. Healthier foods were largely already available in larger stores, and were difficult to increase in terms of availability in small chain food stores, due to lack of interest at the level of upper management Individually owned small food stores were amenable to increasing the availability of healthier foods. No effort was made to modify other aspects of access, such as price and location. Framing, messaging, or relative placement was not strategically informed by behavioral economic principles, though point-of-purchase messaging holds potential for nudging behavior in this setting.

Case #3: Baltimore Healthy Carryouts

Intervention Description. The Baltimore Healthy Carryouts (BHC) intervention was conducted from February to September 2011, with data collection occurring several months before and after the intervention period. BHC aimed to develop, implement, and evaluate the feasibility of a culturally appropriate multi-component carryout restaurant intervention to reduce risk factors for diet-related chronic diseases in low income areas of Baltimore City. Formative research was first conducted on the availability, pricing, and consumption of carryout foods, upon which an intervention was developed and tested (Lee et al. 2010; Lee, Hoffman, Bleich, & Gittelsohn, forthcoming; Lee, Kim, et al. 2012; Noormohamed, Lee, Batorsky, Jackson, Newman, & Gittelsohn 2012).

The BHC pilot trial consisted of four carryouts in the intervention group, and four in the comparison group. Each group consisted of African American-owned carryouts ($n = 2$) and first generation Korean American-owned carryouts ($n = 2$), matched on ethnicity, location, and the physical environment of the carryout. The intervention was conducted in three phases: phase 1 modified menu boards and menu labeling; phase 2 promoted healthy sides and beverages; and phase 3 focused on affordable healthy combination meals. In phase 1, owners expressed reluctance and concern about changing the items they sold. Menu analysis was conducted to define healthy items. A healthy entrée was defined as less than 600 kcal and less than 20 g of fat, while a healthy side dish was defined as less than 200 kcal. Phase 2 promoted currently available healthy sides and beverages (e.g., collard greens, corn, salads, soups, water, diet soda, 100% fruit juice), introduced new healthy sides (e.g., yogurt, fresh fruits, fruit cups, baked chips), and provided initial stocks of healthy sides. Phase 3 created affordable healthy combo meals through two main strategies. First, food preparation methods were improved, such as providing an indoor grill to implement grilled chicken. The second strategy involved healthy combo meal promotion with price reduction, where owners agreed to reduce up to $2.50 per healthy combo meal without compensation, and providing a combo meal with free baked chips. Point-of-purchase posters accompanied the intervention activities.

Key Findings. Significant increases were found in the intervention group relative to the comparison group in both outcomes; that is, the odds of proportion of healthy sides & beverages and healthy entree sales adjusted

for total sales from baseline. In the intervention group, total revenue from healthy food sales increased significantly (while unhealthy food sales decreased significantly) from baseline, resulting in no change in the overall revenue compared to baseline (Lee, Kim, et al. 2012).

Intervention Limitations. The BHC intervention worked at multiple levels to lead to behavioral change in food choices. At the environmental level, phase 2 increased the availability of healthy options, while phase 3 increased access through a price reduction strategy. No attempt was made to reduce access to less healthy foods, although study findings revealed a proportionate decrease in the purchase of these foods. A wide variety of passive educational approaches were used, though interactive sessions were not heavily featured, unlike the BHS and NHS trials. Menu labeling strategies "placed" healthier options in a more visible manner.

Several of the strategies employed in BHC drew upon behavioral economic principles to enhance the intervention. Under preference construction, the relative pricing of healthy to unhealthy foods could have anchored consumer decisions for choosing a healthier option. The menu labeling strategies which increased visibility of healthier options could have also tapped into convenience and appeal to nudge the consumer toward a healthier choice. While these measures incorporated behavioral economic strategies to some degree, more explicit manipulation in future studies (e.g., side-by-side comparison of attributes favoring a healthy default choice) may enhance the intervention's intended effects.

Integration of Educational, Environmental, and Behavioral Economic Strategies

These three case studies indicate that there are multiple paths to intervention success (table 1). Baltimore Healthy Stores emphasized environmental change via increased availability of healthy foods, and employed a relatively passive educational approach. Materials were developed to increase demand and motivation at both the store-owner and consumer levels. Store level impacts in terms of stocking and sales were clear, but consumer-level impacts were modest. The relative success of the Navajo Healthy Stores intervention was attributed to a heavily educational approach at point of purchase, but did not include behavioral economic approaches or substantial environmental changes. We surmise that educational strategies were effective and successful for a subset of motivated individuals, that is, those who were most exposed to the intervention (Gittelsohn, Kim, He, & Pardilla, under review). In addition, the delivery of educational messages at the point of purchase by local Navajo educators may have facilitated behavioral adoption. The Baltimore Healthy

Table 1 Comparison of the Three Case Study Programs in Terms of Emphasis on Each Intervention Approach

Intervention Approach	BHS	NHS	BHC
Environmental	+++	++	+++
Educational	+++	++++	++
Behavioral economic	+	+	++

Carryouts intervention combined environmental, educational and behavioral economic approaches more evenly, and saw positive impacts at both the carryout and consumer levels.

Based on these case studies, we hypothesize that approaches combining educational, environmental, and behavioral economic strategies will be more successful, and will ultimately impact more individuals. In any given setting, different strategies will be effective with different people, given the diversity in food choice values, cultural values, personal and social factors, resources, and context (Sobal and Bisogni 2009). Persuasive strategies that promote knowledge and attitudes, create structural change, and nudge individuals toward healthier choices can better address the multifactorial issues contributing to an unhealthy diet or food environment.

Conceptual Model

Based on this experience and our review of the literature, we propose a conceptual framework that combines educational, environmental, and behavioral economics strategies (figure 1). From the standpoint of population health, influences on food choices lie on a spectrum of distal, or upstream, factors to more proximal, or downstream, factors. Distal influences tend to exist at the societal level, and shape proximal determinants that lie closer to individual-level psychology (WHO 2002). For instance, the macro environment that governs food access (e.g., supply) lies distal to decision-making, though it bears significant impact in shaping downstream behavior (e.g., demand). Cognitive and affective factors, such as beliefs and attitudes, are proximal determinants of behavior and are considered more amenable to change through education, though they generally lead to less population impact given the difficulty of reaching sufficient numbers of people through this approach.

Health interventions frequently focus on proximal factors to help individuals gain knowledge, identify and overcome barriers, enhance risk perceptions, change attitudes, and build self-efficacy to engage in healthier lifestyles (Glass and McAtee 2006). At the distal level, environmental, sociopolitical, and cultural factors structure the landscape of choices – essentially, the food environment that individuals live in – which in this case includes access to healthy foods. Changes to the food environment are a critical intervention target.

We further conceptualize behavioral economics strategies as situated last in the pathway from distal to proximal decision-making, with framing approaches potentially more proximal, and convenience more distal. By interacting with individual choices and responding to environmental cues, behavioral economic strategies can subtly nudge individuals toward healthier behaviors.

Our intervention framework suggests that a mixed educational-environmental-behavioral economic approach will work because it addresses different components of individual (and group) decision-making. Decisions should be informed (educational), constrained (environmental), and guided (behavioral economics). Educational approaches engage with individuals to provide them with the rational tools and knowledge to make the best choices for themselves, which is integral for intentional behavioral change. While individuals govern their choices, the environmental context of their choices also matters (Fisher 2008). The supply of

Figure 1 Conceptual Model of Multi-Frame Approach for Improving Dietary Interventions

Approach to behavior change	Specific strategies	Psychological basis (Decision-making)	
Environmental	Availability Affordability Location Transportation	Distal	Limiting or enhancing choices available for decision-making Modifying structures
Education	Point of purchase promotions (signage) Community promotion Interactive sessions, classes Handouts (flyers, brochures) Media (radio, television)	Somewhat proximal	Providing information to enhance decision-making Promoting knowledge and attitudes Building self-efficacy Enhancing risk perceptions
Behavioral economics	Convenience Anchoring (relative placement or pricing) Defaults/ status quo bias (opt-out for unhealthier option) Framing (loss, gain)	Proximal	Nudging decisions Weighing choices Determining what activates behavior

available and affordable foods largely defines this context. Lastly, interventions that alter the convenience, appeal, and relative pricing and availability of foods at the point-of-purchase can influence intuitive, heuristic-based decisions to guide healthier choices.

Discussion

This paper is the first, to our knowledge, to posit a nutrition intervention framework combining educational, environmental, and behavioral economic approaches. Obesity is a multifactorial problem impacted by access to foods (supply) and food choices (demand). Neighborhood environments constrain the food choices available to individuals, while complex dietary decisions are driven by taste, cost, nutrition, convenience, and weight concerns (Glanz, Basil, Maibach, Goldberg, & Snyder 1998). The complex nature of dietary choices therefore requires informed educational approaches that are strategically combined with guided nudges, and environmental interventions that improve access to promote healthier eating. Moreover, multi-institutional collaborations will likely be necessary to address the obesity epidemic.

Complementary to multi-frame intervention strategies, policy measures would ideally support these combined educational, environmental, and behavioral economic approaches. Two categories of policies can promote healthy eating: measures that communicate information, and measures that target the market environment (Brambila-Macias et al. 2011).

Menu-labeling policies exemplify the educational approach, though the appeal of such measures should undergo careful evaluation for effectiveness in specific populations and contexts prior to implementation (Loewenstein et al. 2012). At the environmental level, policy interventions could mandate or incentivize greater presence of supermarkets, or equip small food stores with the infrastructure and refrigeration to stock fresh produce. Within schools, guidelines for school lunch offerings could increase the availability of fruits and vegetables while limiting lower nutrient food options. Such changes are now taking effect after the passage of the Healthy, Hunger-Free Kids Act of 2010 (USDA 2010).

Given that consumers often draw upon heuristics at the point of purchase, interventions and policies should effectively maximize opportunities to nudge desired behaviors. For instance, policies informed by behavioral economic studies may need to consider the effect of debit cards and vouchers in food purchases, and the impact of cashless systems on healthy food purchases. Policies may also alter the layout of stores to create more favorable defaults (e.g., placing candy bars or sugary cereals in the least convenient locations), and strategic placement, packaging, and/or marketing of healthier items. Despite the appeal of libertarian-paternalist policies that are low-cost and unobtrusive, Loewenstein and colleagues caution that, "though nudges have their place, occasionally a good shove advances individual and social welfare considerably more," (Lowenstein et al. 2012). We agree that there is no substitute for conventional policies to fundamentally change the food environment. For instance, clear agricultural policies are needed to address upstream corn subsidies that make foods containing high fructose corn syrup cheaper than fruits and vegetables (Loewenstein et al. 2012).

We believe that none of the strategies alone are effective for all individuals–rather, that the integration of educational, environmental, and behavioral economic strategies will balance the strengths and limitations of each approach.

For instance, behavioral economics studies without any educational component have shown that making smaller cookies successfully reduces childrens' caloric intake, by altering perceptual cues (i.e., more cutoff points) about the appropriate quantity of consumption (Marchiori, Waroquier, & Klein 2012). Dietary behaviors, however, involve repeated exposures to foods that may be partly guided by cognitive frameworks for intentional action. While producing smaller cookies may have short-term dietary benefits, the success of this stand-alone strategy is likely dependent upon constrained situations that are time- or situation-bound. Over time, children will undoubtedly be exposed to cookies in other settings with varying presentations and packaging. If they are not equipped with knowledge of appropriate serving sizes or not taught the importance of moderation, future consumption would likely increase when presented with larger cookies or when navigating an unhealthy food environment. We therefore believe that integrating behavioral economic strategies, for example, visual cues to alter consumption, with education, can better equip individuals with the understanding requisite for long-term dietary change. Again, at the macro-environmental level, barriers that limit access to healthy foods may require structural changes. Despite the potential impact of persuasive nudges and health education delivered at the individual level, such choices may be constrained by the greater food

environment, which would require systemic changes to address structural barriers to healthy food access. Wansink compellingly states that, "changing behavior is a combination of all educational and behavioral tools used in creative ways," (Wansink 2012). We extend this argument and suggest that these educational and behavioral tools should be combined with structural tools to improve the food environment. Integrating environmental, behavioral economic, and educational strategies in interventions would thereby create a valuable multi-frame approach from which to approach dietary change.

While this paper has highlighted only nutrition interventions, we can apply the same integrated multi-level approach to physical-activity promotion to address the obesity epidemic. For instance, we may implement environmental changes (e.g., safe spaces for walking), behavioral economic strategies (e.g., defaults of normative stair climbing), and health education approaches (e.g., messaging about the benefits of physical activity). Conceptually, an integrated multi-level approach would bridge the supply (structural possibilities) and demand (informational strategies) of healthy lifestyle behaviors through additional help from behavioral economics (changing defaults). Further research is needed to systematically examine physical activity interventions under this conceptual framework.

Limitations exist for our conceptual model. First, we pose an integration of strategies but need more studies to incorporate and test all three approaches in a single intervention to generate an understanding of its effectiveness. Second, while we believe we offer a perspective beneficial for advancing nutrition interventions, we do not consider the framework to be comprehensive. The model highlights decision-making primarily at the individual level, influenced by proximal to distal factors. We recognize, however, that in between psychosocial and macro-environmental factors lies interpersonal networks at the household and community levels that significantly impact health and food choices. Social networks, for instance, have been found to increase the likelihood of obesity if social ties are also obese; this even holds across geographical boundaries (Christakis and Fowler 2007). We also recognize that both social support and strain can exist from friends and family for engaging in healthy lifestyle changes (Kiernan et al. 2012). Eating and food choices will often interact with family and household factors, adding to the complexity of dietary decision-making (Gillespie and Johnson-Askew 2009; Gittelsohn 1991; Rothman et al. 2009). Based on the case studies, however, we believe that our integration of the three frames within a multi-level perspective can generate useful intervention strategies for obesity prevention.

We provide the following recommendations for future progress in this area: while nutrition interventions for obesity prevention show promise, ample opportunities remain for researchers, economists, and policymakers to collaborate on the development, implementation and testing of innovative and multi-faceted approaches to obesity prevention. Policy mandates that support educational approaches could increase funding for longer-term, larger-scale longitudinal programs with appropriate resources to evaluate behavior change. Multi-institutional interventions that work in multiple aspects of the food environment (e.g., food stores, restaurants, schools, and worksites) should be tested. More experimental research on pricing is necessary to identify price sensitivity for consumer demand, the amount of price change needed for a desired outcome, and

possible substitution effects between healthy or less healthy choices (Epstein et al. 2012). Often the healthy eating discussion focuses on the retailer-consumer food system, but engagement with retailers, distributors, producers, and manufacturers could also greatly influence dietary outcomes.

Conclusions

We presented several case studies and a conceptual model to provide a guiding framework for future nutrition interventions to address obesity and diet-related chronic diseases. We offer two main conclusions: 1) An integrated multi-frame intervention may bring about the greatest effectiveness by drawing upon the distinctive strengths of educational, environmental, and behavioral economic approaches; 2) We explicitly create a space for behavioral economics strategies in the conceptual model given its relative lack of emphasis in existing health behavior change frameworks. The act of changing defaults and nudging behaviors may facilitate communication between educational and environmental levels to improve dietary choices.

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