Designing a Short-Form Survey Instrument to Evaluate the Healthfulness of Corner Stores

by

Robin Sue DeWeese

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Graduate Supervisory Committee:

Punam Ohri-Vachaspati, Chair
Michael Todd
Allison Karpyn
Meg Bruening
Christopher Wharton

ARIZONA STATE UNIVERSITY

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ABSTRACT

Individuals in urban low-income areas often do not have easy access to large grocery stores and supermarkets, and regularly shop at nearby small/corner stores. These stores stock an abundance of processed, energy-dense, nutrient poor foods, combined with few nutrient-dense products. A high concentration of small/corner stores is associated with poor diets by nearby residents. Interventions that target small food stores for increasing the availability and sale of healthy foods have been launched in many communities, and validated survey instruments have been developed to evaluate the effectiveness of the interventions. However, in-store surveys can take up to thirty minutes to conduct and require individual visits from investigators. Many projects assess the food environment in a large number of stores spread across broad geographical areas, making in-person evaluations infeasible and resource-prohibitive. The purpose of this study was to develop a valid and feasible short survey that could be used in-store or over the phone to capture the healthfulness of corner stores. An adapted version of the Nutrition Environment Measures Survey for Corner Stores (NEMS-CS) was used to conduct store audits of 230 corner stores in four New Jersey cities. Audit results were used in exploratory factor analysis and item response theory to develop a seven-item survey. The short survey was highly correlated with the full survey (r=0.79), and the short survey's classification of stores as healthy (top 20% of scores) versus unhealthy (bottom 80% of stores) matched NEMS-CS categorizations in 88% of cases. A second round of audits was conducted in 100 corner stores to confirm the validity of the seven-item survey and to test its feasibility as a phone audit tool. Complete phone responses were obtained from 86% of stores. Response matches indicated that store owners did not distinguish between 2% and low-fat milk, and tended to round up the fruit and vegetable count to five if they had fewer varieties. The seven-item short survey discriminates between healthy and unhealthy stores and is feasible for use as a phone audit tool.

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CHAPTER 1

INTRODUCTION

In the 1960s and continuing through the 1980s, residents of US inner/central cities migrated in droves to the suburbs where land and privacy were abundant.[1] The US Census Bureau estimated that central cities lost approximately 40% of their residents between 1970 and 1988.[2] Businesses, including supermarkets (defined as stores offering a full line of groceries, meat, and produce with at least $2 million in annual sales)[3], followed the customers.[4] Socially disadvantaged low-income residents who could not afford to migrate to the suburbs were left in the inner cities with 25% fewer chain supermarkets than middle-income neighborhoods have.[5] Although the recent housing market crash resulted in inner city population growth,[6] supermarket density did not increase proportionally to this growth.[7] While close proximity (within one mile)[8] to supermarkets may not be critical for access to these stores by residents with automobiles, many low-income residents cannot depend on availability of personal vehicles for food shopping and must walk or use public transportation to travel to and from their food-shopping destination. This can increase the time it takes to shop, and/or restrict the amount and type of groceries they are able to purchase.[9,10]

In contrast to a lack of supermarkets, low-income areas have two to four times as many small food retailers as high-income areas have.[5,11] Small food retail stores include corner stores, convenience stores, bodegas, small grocery stores, and any other food stores with limited physical space and food selection.[12] Whereas supermarkets sell a great variety of healthy foods that are usually of higher quality[13] and lower cost than are foods in these small retail stores,[14] small retailers tend to stock and promote highly processed, energy-dense, nutrient-poor foods,[15] and sell little fresh produce, whole grains, and low-fat dairy products.[16] This is of particular concern because small food stores tend to concentrate near schools,[17] and in low-income areas.[5,11] Forty percent of 4th-6th grade students from ten urban elementary schools shopped twice a day at corner stores located within four blocks of their schools, purchasing chips, candy, and sugary beverages.[16] These highly-processed, energy-dense, nutrient-poor diets high in total calories and saturated fats may be associated with the lower intakes of vitamin C, β-carotene, folate, vitamin E, iron, calcium, potassium, vitamin D, and fiber consistently found among individuals from low-income households.[18]

While living near a supermarket may be associated with consumption of a healthier diet,[19] a high concentration of small food retailers and unhealthy foods is associated with poor diets and negative health effects on nearby residents. Proximity to a corner store is associated with higher rates of obesity and diabetes,[20,21] and corner store density is associated with higher rates of mortality, obesity, and diabetes.[21,22] However, residents near neighborhood food stores consume more fruits and vegetables when these stores devote more shelf space to produce.[23,24]

Although federal programs such as the Healthy Food Financing Initiative (HFFI) exist to incentivize supermarkets to re-build in lower income areas,[25] inner city infrastructure and zoning laws make this difficult. Adequately-sized sites are rare, and parking space is limited.[26] It is important, therefore, to bring healthy food to these areas in alternative ways, such as incentivizing existing small retail food stores to stock and promote healthy foods. The ubiquity of small retail food stores ensures that if they could maintain or increase profits while stocking and promoting healthy foods, consistent access to these foods would be attainable for individuals and families of all income levels.

A number of interventions have been conducted in recent years to increase the availability of healthy foods in small retail food stores. These interventions seem to have resulted in increased stocking and sales of more nutritious foods such as fruits and vegetables, low-fat milk, high-fiber cereals, and water.[27] However, few of the intervention evaluations have used objective measures that can be reported in peer-reviewed journals. The Healthy Corner Store Initiative (HCSI), a partnership between the Philadelphia Department of Public Health and The Food Trust, a non-profit organization in Philadelphia, was established to increase the availability and awareness of healthy foods in corner stores by providing technical assistance and training to store owners.[28] Similar initiatives have been adopted in many jurisdictions across the country, resulting in corner store upgrades of varying magnitudes.[29]

As corner store initiatives continue to expand, valid and reliable measures of assessment and evaluation of programs are needed to gauge the effectiveness and impact on communities of the interventions designed to encourage small retail stores to carry healthier options. The validated survey instruments currently available for these types of assessments require an in-person evaluation of each store, with every survey taking up to thirty minutes to complete. This makes the tools resource-prohibitive and infeasible for large-scale projects that may cover wide geographical areas and include large numbers of stores. Although many large-scale studies tend to rely on commercial data sources to classify stores, these data sources have inaccuracies and misclassification and missing-data biases[30] and are unable to capture incremental changes that may take place as a result of interventions, necessitating the need for objective assessments of stores.

The Nutrition Environment Measures Study in Corner Stores (NEMS-CS), adapted from the NEMS-S (stores), is used to objectively evaluate the foods available in corner stores. Unlike many of the other available validated survey instruments, it is designed specifically for use in small retail stores rather than in supermarkets and large grocery stores. Like other instruments currently used in the field, it requires an in-person evaluation of each store, and takes approximately fifteen minutes to complete.[31]

As more of the nearly 150,000 corner stores currently open in the US[32] participate in healthy store initiatives, the need for rapid measures of assessment and a tool that does not require an in-person evaluation will increase. Such a tool would make large-scale evaluations of the impact of changes in these small retail food stores on the health of US residents more feasible. The instrument would also be useful for screening stores for eligibility to participate in an intervention or program, as well as screening for selection for a detailed assessment. The assessments could more efficiently inform programs to make much-needed changes to the food environment among residents who have poor access to supermarkets and who must rely on small food stores for food procurement.

Project aims:

1. To develop a short (5 minutes or less) survey instrument to capture the healthfulness of small retail food stores such as convenience stores, corner stores, bodegas, small grocery stores, and other food stores with limited physical space and food selection.
2. To test the convergent validity of the short instrument compared to the availability portion of the NEMS-CS instrument.

3. To test the feasibility of using the short instrument over the phone.

Delimitations:

1. The study was conducted in small retail food stores in the metro areas of Newark, Camden, New Brunswick, and Trenton, New Jersey.
2. Stores were considered small retail food stores if they carried a limited selection of staples and other convenience goods and generated approximately $1 million in sales annually, or were national/regional franchisees such as 7-11, Wawa, and QuikTrip.

Limitations:

1. The short survey instrument is only able to assess availability of items and not quality or price.
2. Only key features of healthfulness of a store are included in the short survey; as a result, small, uncommon features are not captured.
3. Telephone respondents sometimes give inaccurate responses.
4. The audits were conducted in similar geographic areas; as a result the short survey developed may not be valid in dissimilar areas.

CHAPTER 2

REVIEW OF LITERATURE

Dietary Guidelines

The 2010 Dietary Guidelines for Americans (DGA), developed by the US Department of Agriculture (USDA) and the US Department of Health and Human Services (HHS), recommends reducing some foods and food components, and increasing other foods and nutrients. Key recommendations concerning foods to increase include:

1) Increase vegetable and fruit intake.
2) Eat a variety of vegetables, especially dark-green and red and orange vegetables and beans and peas.
3) Consume at least half of all grains as whole grains. Increase whole-grain intake by replacing refined grains with whole grains.
4) Increase intake of fat-free or low-fat milk and milk products, such as milk, yogurt, cheese, or fortified soy beverages.
5) Replace protein foods that are higher in solid fats with choices that are lower in solid fats and calories and/or are sources of oils.[33]

These recommendations are supported by scientific evidence that fruits and vegetables (FV), whole grains, fat-free or low-fat dairy, and lean meats may increase consumption of important nutrients, reduce disease incidence and prevalence, and contribute to achieving and maintaining a healthy weight.[33]

Fruits and vegetables

In 2005 Lock et al[34] combined information on FV consumption across worldwide regions with estimates of the association between FV intake and chosen health outcomes, including ischemic heart disease, cerebrovascular disease, and lung, stomach, esophagus, colon, and rectal cancers. A minimum intake of 600 g (7.5 servings) per day in adults was set as the theoretical lowest relative risk (RR) level. This was estimated based on the maximum intake observed across the populations being examined. With each 80 g increase (the size of one standard serving) in FV consumption, a significant RR decrease ($p < 0.05$) was estimated for ischemic heart disease (RR 0.90, 95% CI 0.82-0.99), ischemic stroke (RR 0.94, 95% CI 0.89-0.99), and lung cancer (RR 0.96, 95% CI 0.93-0.99). If each individual consumed 7.5 servings of FV per day, worldwide ischemic heart disease would potentially decrease by 31%, esophageal cancer by 20%, ischemic stroke and stomach cancer by 19%, lung cancer by 12%, and colorectal cancer by 2%.

While human randomized controlled trials are not feasible for identifying health outcomes such as cancer or cardiovascular disease (CVD) incidence resulting from varying amounts of FV intake, cross sectional studies can identify associations between intake and health outcomes, and prospective cohort studies combined with meta-analyses can paint a picture of the large-scale implications of dietary choices. Although results vary as to the precise health outcomes of a diet rich in or lacking in FV, the vast majority of research in healthy populations supports consuming ample amounts.

Overall mortality

Prospective cohort analyses consistently demonstrate reduced overall mortality rates among those with higher levels of FV consumption compared to those with the lowest levels of intake. Among a population-based cohort of 71,706 Swedish men and women, those who never consumed FV experienced a 3-year decrease in life expectancy and a 53% higher mortality rate compared to those who consumed 5 servings per day.[35]

Lock et al[34] estimated that if individual FV intake increased to 600 grams (7.5 servings) per day, the worldwide mortality rate of 2.6 million deaths attributable to inadequate FV intake could potentially decrease by 7.6% and 7.4% in males and females respectively in developed countries, and by 3.5-5% in developing countries.

The "5 A Day for Better Health" campaign, rolled out nationally in 1991,[36] was replaced in 2007 by "Fruits & Veggies – More Matters" due to lack of consensus on the ideal number of FV servings for optimal health. Although the amount differs depending on the health outcome under investigation, it is interesting to note that, similar to the Bellavia et al[35] results, a 2014 meta-analysis of 16 cohort studies also found consumption of five FV servings per day to be the ceiling for the lowest risk of all-cause mortality.[37] Hazard ratios (HR) decreased in a dose-dependent manner up to five servings, after which no change was observed. Compared to individuals who did not consume FV, HR estimates were as follows: 0.92 (95% CI 0.90 to 0.95) for one serving/day, 0.85 (95% CI 0.81 to 0.90) for two servings/day, 0.79 (95% CI 0.73 to 0.86) for three servings/day, 0.76 (95% CI 0.69 to 0.83) for four servings/day, 0.74 (0.66 to 0.82) for five servings/day, and 0.74 (0.65 to 0.82) for six or more servings/day.

Cancer

The association between FV intake and cancer risk is equivocal, and varies among cancer types. In 2007 the World Cancer Research Fund and American Institute of Cancer Research published a comprehensive meta-analysis of nutritional epidemiological studies. Evidence for cancer risk modification was classified as convincing, probable, limited but suggestive, and unlikely. While no research has provided convincing evidence that any foods reduce any cancers, probable evidence has been found to support consumption of certain FV to decrease the risk for developing cancers of the mouth, pharynx, larynx, esophagus, stomach, colorectum, lung, pancreas, and prostate.[38]

Colorectal cancer associations are particularly inconsistent. A pooled analysis of fourteen cohort studies revealed only an insignificant inverse association between lower versus higher study-specific quintiles of FV intake with colon cancer RR. This association held when identical absolute cut points among studies were analyzed.[39]

In contrast, in a meta-analysis[40] including 19 cohort studies, a small but significant reduced risk was observed when comparing study-specific low versus high FV intakes, as well as fruit intake only and vegetable intake only. Colorectal cancer RR (95% CI) for high versus low FV, fruits, and vegetable intakes were 0.92 (0.86, 0.99), 0.90 (0.83, 0.98), and 0.91 (0.86, 0.96), respectively. Colon cancer RR's (95% CI) were 0.91 (0.84, 0.99), 0.89 (0.81, 0.97), and 0.87 (0.81, 0.94) for FV, fruit, and vegetable levels, respectively. These small risk reductions may be responsible for estimates that colorectal cancer incidence would decrease two percent if worldwide consumption of FV increased to 600 grams per day.[34]

One mechanism by which FV may reduce colorectal cancer risk is specific to the colon. The fiber content of FV increases stool bulk, reducing transit time through the large intestine, thus decreasing the amount of time the intestine is exposed to potential carcinogens.[38] Additionally, since overweight/obesity is a risk factor for colorectal cancer,[38] another potential risk-reducing mechanism may simply be the reduced risk of overweight/obesity with high FV intake.[41]

The European Prospective Investigation into Cancer and Nutrition (EPIC), a multicenter cohort study involving 521,468 men and women ages 25 to 70 years from 10

European countries, investigated a number of relationships between FV intake and various forms of cancer. Lung cancer risk was reduced in both smokers and nonsmokers with increasing overall intake of fruit (HR per 100 g of fruit: 0.86 [0.78-0.95]) and of fruits and vegetables combined (HR 0.895 [0.830-0.978]).[42] Greater variety of vegetable intake was associated with a lower risk of lung cancer among current smokers (HR 0.73 [0.57-0.93]), but not nonsmokers.[43] Bladder cancer, on the other hand, does not seem to be associated with either amount[44] or variety[45] of FV intake.

Certain FV have been found to be more highly associated with cancer risk reduction than have others. With the exception of bananas (RR of ≥1/2 serving/d compared to 0 servings/d: 0.88 [0.78 to 0.99]), and spinach (RR of ≥1 serving/wk compared to 0 servings/d: 0.89 [0.82 to 0.97]), no specific FV were found to be significantly correlated with colon cancer risk in the pooled analysis by Koushik et al.[39] A meta-analysis of 21 studies comprised of 543,220 subjects revealed an inverse association between gastric cancer risk and *Allium* vegetables (onions, garlic, shallots, leeks, and chives). Chronic *Helicobacter pylori* infection is associated with gastric cancer,[46] and in vitro and in vivo studies have shown *Allium* vegetables to reduce *H pylori* bacteria in the gut.[47] Unfortunately, only one of the 21 studies[48] in the meta-analysis controlled for a history of *H pylori* infection, precluding moderation analysis of this association.

Decreases in cancer risks are suspected to be due to individual micronutrients. However, it is impossible to definitively attribute sole credit to single constituents because of the complex combination of vitamins, minerals, phytochemicals, and other bioactive compounds contained in foods, combinations of which may be necessary to observe beneficial effects.[38]

Many FV are good sources of folate, and its role in DNA synthesis may play a role in cancer risk reduction. Folate methylates DNA and synthesizes thymine. If folate is deficient, uracil, rather than thymine, may be incorporated into DNA strands, resulting in chromosomal breakage.[49] Further, the antioxidants contained in FV reduce oxidative stress and inflammation, neutralizing the free radicals that may damage DNA.[40]

Cardiovascular disease

A number of meta analyses and prospective population-based cohort studies have shown the risks of stroke and coronary heart disease (CHD) to be inversely associated with FV consumption. A meta analysis of eight prospective cohort studies[50] including 257,551 individuals from ages 25-103 at baseline found the pooled RR of stroke to be 11% lower (RR, 0.89; 95% CI 0.83-0.97, p =.005) in those who consumed 3-5 servings of FV per day, and 26% lower (RR, 0.74; 95% CI 0.69-0.79, p < .0001) in those who consumed more than five FV servings per day compared to those who consumed fewer than 3 servings per day. These associations held regardless of sex, follow-up duration (average follow-up across all eight studies was 13 years), dietary assessment method (food frequency questionnaire [FFQ] or others), dietary instrument administration (self- or interview-administered), type of stroke (ischemic or hemorrhagic), and specific dietary intake (fruits or vegetables) among those who consumed greater than five FV per day.

Larsson et al[51] found similar results in a cohort of 74,961 Swedish men and women with 10 years of follow-up. After adjusting for demographics and lifestyle factors, RR of stroke decreased with increasing intakes of fruit and of FV combined.

Individuals in the highest quartile of consumption (>6 servings/d) of FV combined had a 20% lower risk (RR, 0.87; 95% CI 0.78-0.97) for stroke than did those in the lowest quartile of consumption (<2.3 servings/d).

A meta analysis of nine prospective cohort studies with 5-19 years of follow-up, including 91,379 men and 129,701 women also observed an inverse association between FV intake and CHD risk.[52] Intakes of FV combined and fruit only were associated with 4% (RR, 0.96; 95% CI, 0.93–0.99, $p = 0.0027$) and 7% (RR, 0.93; 95% CI, 0.89–0.96, $p < 0.0001$), respectively, lower risks of CHD incidence.

The mechanism by which FV are associated with lower risk for cardiovascular diseases is uncertain but may be related to their blood pressure-lowering effects.[53] As is the case when trying to ascertain mechanisms for reduction of other diseases such as cancer, attempting to pinpoint specific components in foods that are responsible for stroke risk reduction is difficult because of the variety of bioactive components that work together. The 2010 dietary recommendation changes reflected this uncertainty. Rather than prescribing intake of at least five FV per day as previous guidelines had advised,[54] the recommendation only encourages eating a variety of different FV, as well as a variety of different colors.[33]

The Monitoring Project on Risk Factors and Chronic Diseases in the Netherlands (MORGEN Study), a Dutch population-based cohort study that included 20,069 participants from ages 20-65 years at baseline, aimed to specify the associations between stroke risk and FV color,[55] variety,[56] and raw versus processed FV[57] to shed light on specific components responsible for beneficial disease risk associations. At baseline, subjects filled out a self-administered FFQ, supplied information about behaviors, education, and family history, and underwent a physical examination in which anthropometrics were obtained and blood drawn. The average time of follow-up from baseline was 10 years.

Phytochemicals in FV confer varying colors and nutritional benefits on the foods in which they exist. Therefore, the nutrient profile of a specific fruit or vegetable can be somewhat ascertained by its color.[58] Using this reasoning, Oude Griep el al[55] classified FV into four color groups (green, orange/yellow, red/purple, white) according to the most prominent color visible on the edible portions. After adjusting for lifestyle and dietary factors, the HR for consuming the highest quartile (>171 g/d) compared to the lowest quartile (≤78 g/d) of white FV was 0.48 (95% CI, 0.29-0.77) for incident stroke. Further, each 25 g/d increase in consumption of white FV was associated with a 9% lower risk of stroke (HR, 0.91; 95% CI, 0.85– 0.97). Consumption of the other three color groups showed no significant association with stroke risk.

Larsson et al[51] analyzed the association of stroke risk by subcategories of FV, including apples/pears, bananas, citrus fruits, berries, root vegetables, leafy vegetables, cruciferous vegetables, and onions and leeks. Their results agreed with those of Oude Griep et al.[55] The highest (1 serving/d) versus lowest (0.1 serving/d) quartile of apple and pear intake was associated with an 11% (RR, 0.89; 95% CI, 0.80– 0.98) lower risk of stroke incidence after adjustment for demographic, lifestyle, and other dietary factors. No other subgroup associations were significant when analyzing the difference between highest versus lowest categories of intake.

Oude Griep et al[55] theorized that because apples and pears comprised the majority of the white FV category in the cohort studied, the flavonol quercitin, contained in apples, may be a strong contributor to the beneficial effect of white FV on stroke risk reduction. A meta analysis of six prospective cohort studies showed flavonols to be associated with a 20% reduction in stroke incidence.[59]

Investigating the association of FV variety with disease incidence can get at the issue of whether or not all FV have equal effect on risk. Additionally, results showing variety to be more effective than quantity at reducing disease risk would indicate that the synergistic effects of all bioactive components in FV were more responsible for their benefits than was any single component. This was not the case, however, in the MORGEN Study.[56] Although a greater variety of FV intake was associated with greater intakes of vitamin C, carotenoids, flavonoids, and dietary fiber, variety was not associated with either stroke or CHD incidence. Similar to other studies,[60,61] variety was directly related to amount of FV intake, but the authors controlled for quantity when analyzing the association between variety and disease incidence.

Neither did FV variety confer beneficial effects on CHD risk in the Nurses Health Study (NHS) cohort and the Health Professionals Follow-up Study (HPFS) cohort.[62] Both are prospective cohort studies, with 71,141 women and 42,135 men included in the CHD analysis. Participants complete an FFQ every four years. This analysis was conducted after 24-26 years of follow-up and controlled for anthropometric, lifestyle, and dietary factors. Just as was the case in the MORGEN Study,[56] variety of FV intake was highly correlated with quantity, and higher quintiles of intake were inversely associated with CHD incidence. However, when adjusted for quantity, variety of FV intake showed no association with CHD risk.

Processing FV can also potentially impact their effectiveness in combating disease. Heating some vegetables induces loss of bioactive compounds, while lycopene and carotenoids from tomatoes and carrots, respectively, become more bioavailable when heated. The MORGEN Study thus explored the difference in CHD and stroke risk between raw and processed FV consumption.[57,63] After adjusting for lifestyle and dietary factors, overall highest intake (>475 g/d) versus lowest intake (≤241 g/d) of FV combined was associated with lower incidence of CHD (HR: 0.66; 95% CI: 0.45–0.99). Neither raw nor processed combined FV intake, however, was associated with CHD incidence.[63] In contrast, an inverse association was found between the highest quartile versus lowest quartile (>48 vs ≤14g/day) of raw vegetable intake and stroke incidence (HR: 0.53; 95% CI: 0.36–0.80)[57] These results indicate that processing FV attenuates their beneficial effect on stroke risk, while not affecting CHD risk. The MORGEN Study, which should be replicated in other cohorts, seems to indicate that processing whole FV maintains components such as phytochemicals that are beneficial for reducing CHD risk, in spite of the loss through heating of some fiber and other bioactive components.

One limitation to these prospective cohort studies is that most do dietary assessments at baseline only, thereby missing any dietary changes that may occur over time. Additionally, some error always exists in FFQs, one of which is the fact that some vegetables are commonly used in mixed dishes, resulting in underreporting of their intake. Furthermore, greater FV intake is associated with an overall healthier, more educated lifestyle,[52] contributing to reduction in disease risk. Although most studies adjust for a great number of dietary and lifestyle factors, residual confounding may still explain part of the beneficial associations of FV intake and disease risk.

Disease costs

Heart disease, cancer, stroke, and diabetes, diseases all associated with dietary intake, were part of the 10 leading causes of death in the US in 2010, the latest year for which this data is published.[64,65] While CVD death rates have been declining every year since 2000, more than one in three adults has some form of CVD.[66] Cardiovascular diseases include hypertension, CHD, myocardial infarction, angina, heart failure, and stroke. Similarly, overall cancer death rates began declining in 1991, but cancer incidence between 2006 and 2010 decreased only 0.6% in males, and remained stable in females.[67] Conversely, both diabetes prevalence and mortality are on the rise. The number of adults diagnosed with diabetes has tripled since 1980,[68] and deaths attributable to diabetes increased 29% in North America between 2007 and 2010.[69]

The economic cost associated with these diet-related diseases is in the hundreds of billions of dollars annually due to medical costs and lost productivity.[66,70] Cardiovascular disease was responsible for 15% of healthcare expenditures in 2011.[66] This was more than any other diagnostic group, including cancer, which was estimated to cost $216.6 billion.[71] Direct and indirect costs attributable to CVD are estimated at $320.1 billion, $195.6 billion of which are direct expenditures such as physicians, hospital services, and medication. Lost productivity costs are estimated to add up to $124.5 billion.[66] Costs attributable to diabetes were estimated in 2012 to total $245 billion – $176 billion in direct costs, and $69 billion in lost productivity.[70]

The Chicago Western Electric Study was conducted in part to analyze the difference FV intake might make on individual medical costs. A cohort of middle-aged men received physical examinations, and were interviewed for dietary information at baseline in 1957 and 1958 when they were between 40 and 55 years old. Their average annual total hospital related charges from 1984-2000 were then examined. Charges among men who had been in the highest tertile of fruit consumption (>42 cups/28 days) at baseline were more than $2000 lower than were those of the men who had been in the lowest tertile (<14 cups/28 days) ($p < 0.05$). Similar results were found when examining combined FV consumption, with men in the highest tertile accumulating $2000 less in charges than those in the lowest tertile, with the difference trending toward significance ($p = 0.057$).[72]

US diet and disparities

Despite the vast evidence linking diet and disease risk, the majority of Americans do not consume what would be considered a healthy diet according to the DGA.[73] Moreover, diet quality disparities by race, ethnicity, and income are evident in the US. While all Americans, on average, consume a diet insufficient in whole grains and FV,[73] poor dietary quality disproportionately affects racial and ethnic minorities[74] and individuals of low socioeconomic status (SES).[18] Low-income families have lower intakes of vitamin C, β-carotene, folate, vitamin E, iron, calcium, potassium, vitamin D, and fiber.[18] Therefore, this population is at a higher risk of developing diseases that could be prevented with a healthy diet.

The "Western diet" or "standard American diet" consists largely of refined carbohydrates, fatty meats, and added fats, rather than the FV, whole grains, and lean meats recommended by the 2005 and 2010 DGAs. The National Health and Nutrition Examination Survey (NHANES) includes a What We Eat in America (WWEIA) survey to assess the national diet. While the 2005 DGA recommended consuming 3 ounceequivalents (oz-eq) of whole grains per day, 2005-2006 NHANES data showed that Americans averaged 0.9 oz-eq. The recommendation for FV consumption was 2 cups and 2.5 cups, respectively, per day. Actual intake was 0.9 cups of fruit, and 1.7 cups of vegetables.[73] These numbers translate to a low percentage of adults and children meeting or exceeding the dietary recommendations. NHANES data for 2001-2004 revealed that 17.5 ± 1.08%, 12.9 ± 1.22%, and 0.8 ± 0.15% of adults met or exceeded the recommended daily intakes of fruits, vegetables, and whole grains, respectively. Fruit intake among children was a bit better, with 28.7 ± 1.52% meeting or exceeding recommended intakes. However, only 6.6 ± 0.95% ate enough vegetables, and 0.5 ± 0.14% met whole grain recommendations.[75]

Various tools are used to assess dietary adequacy. Mean adequacy ratio (MAR) was used in the Seattle Obesity Study (SOS) a cross-sectional study of 1266 adults living in King County, Washington. Higher MAR scores, and thus, a diet closer to meeting the DGA, were found among participants with higher incomes and higher education levels.[76] The Healthy Eating Index assesses diet in relation to the DGA, and is also used as measure of dietary adequacy. The 2003-2004 NHANES survey found that increased income was associated with higher diet quality among adults, but not among children.[77] Aggarwal et al[76] used mediation analysis to demonstrate that the higher cost of higher quality diets led to the positive association between income and dietary quality.

While SES contributes to diet disparities, some of the disparities may be due to race/ethnicity, even after controlling for SES. Bahr[78] observed that, after controlling for SES, many studies found that blacks still had a lower diet quality than that of whites. In his own analysis, he observed significantly lower intakes of vegetables, low-fat dairy, and high-fiber cereals, and higher intakes of deep-fried foods and snacks among blacks compared to whites, after controlling for SES. He did not, however, distinguish between ethnicities.

Non-Hispanic black populations seem to fare worse regarding dietary quality than do other minority groups as well. Cross-sectional analysis of the 2001-2004 NHANES data showed that, compared to Non-Hispanic blacks, a higher percentage of Mexican Americans met the recommendations for total fruit intake (16.9 ± 1.31% vs 22.8 ± 2.66%; $p < 0.05$). Only 5.7 ± 0.90% of Non-Hispanic blacks met the recommendations for total vegetable intake, compared to 13.7 ± 1.75% and 14.1 ± 1.33% of Mexican Americans and non-Hispanic whites, respectively. The percent of Non-Hispanic whites whose whole grain intake equaled or exceeded recommendations was significantly higher (0.9 ± 0.18%) than were the percentages of non-Hispanic blacks (0.4 ± 0.11%) and Mexican Americans (0.2 ± 0.11%).[75] However, NHANES 2003-2006 data shows that non-Hispanic whites have higher intakes of saturated fatty acids, added sugars, and sodium than do non-Hispanic blacks.[79]

These diet disparities may be important contributors to the health disparities observed in the US. Between 2006 and 2010, black males had a higher incidence of, and mortality rate from, cancer (all sites combined) compared to males in other racial/ethnic groups including non-Hispanic whites and Hispanics.[67] Non-Hispanic black men and women consistently had higher prevalence rates of hypertension than did non-Hispanic white men and women and Mexican-American men and women for NHANES survey years 1988-1994, 1999-2006, and 2007-2012.[66] Approximately 14% of both male and female non-Hispanic blacks, and 12% of male and female Hispanics have been diagnosed with diabetes mellitus, compared to 7.6% of white males and 6.1% of white females.[66] This prevalence rate discrepancy holds regardless of education level, with Non-Hispanic blacks and Hispanics of all education levels having higher rates of diabetes prevalence than the prevalence rate at each education level (less than high school, high school, more than high school) of non-Hispanic whites.[66] When examining CVD as a whole, prevalence rates among non-Hispanic blacks (males: 46%; females: 48.3%) are higher than those of Non-Hispanic whites (males: 36.1%; females: 31.9%) and Hispanics (males: 32.4%; females: 32.5%).[66]

Individual behavior change theories

Improving dietary intakes in the US to reduce the incidence of diet-related diseases, and decreasing socioeconomic and racial/ethnic disease disparities are crucial matters, and have been addressed by interventions that utilize health behavior theories. Evidence shows that interventions based on theories are more effective than are those that are not theory-based.[80] In the 1970s and 1980s, the primary theories used in behavior change interventions were those that targeted individual knowledge, attitudes, skills, and behaviors.[81]

The Health Belief Model (HBM) is one such theory, and has been widely used since the early 1950s to explain individual behaviors associated with refraining from engaging in programs that would reduce disease risk.[82] Its underlying principles are (a) the assumption that individuals value being well and are averse to illness, and (b) that individuals expect certain behaviors to help them avoid illness. Therefore, a person's decision to act on a behavior related to illness/disease is predicated on five constructs, which are utilized by interventions implementing the model. (1) Perceived susceptibility to the condition – which populations are at risk for developing the disease (e.g., stroke risk is higher in hypertensive individuals). (2) Perceived severity of the condition – an individual's opinion about the seriousness and consequences of a condition (e.g., losing a leg as a result of diabetes). (3) Perceived benefits of taking action to prevent the condition – some health-related and some not (e.g., eating healthy to prevent diabetes). (4) Perceived barriers to action – negative aspects of a healthy action or aspects preventing action (e.g., lack of time to prepare vegetables). (5) Cues to action – internal and/or external strategies to activate readiness (e.g., going to the kitchen to cut vegetables during television commercial breaks).[83]

Abood et al[82] used the HBM in a worksite intervention focusing on dietary changes to reduce the risk of CVD and cancer. An intervention group received eight weekly one-hour educational sessions addressing all HBM constructs, with perceived benefits and perceived barriers given priority. Participants took a pretest and a posttest assessing the HBM health beliefs, nutrition knowledge, and dietary behavior. The control group took the pretest and posttest with no educational sessions. The posttest revealed the success of the model, as significant decreases in intake of total calories, total fat, percent calories from fat, saturated fat, and total cholesterol were reported by the intervention group, while no changes were reported by the control group.

The Theory of Reasoned Action/Planned Behavior (TRA/TPB) also focuses on individual-level determinants of behavior change. The TRA posits that the most important determinant of behavior is intention, which in turn is influenced by attitude toward and subjective norm associated with the behavior. Attitude is determined by beliefs about the outcome of performing the behavior, weighted by the evaluation of the outcome as positive or negative. Subjective norm is determined by an individual's belief about how much a referent individual approves or disapproves of the behavior, weighted by the motivation to comply with the referent person's point of view. The TPB is an elaboration of the TRA, in that it accounts for the role of perceived control as a predictor of intention and behavior and as a potential moderator of the association between intention and behavior. The extent to which perceived control matches actual control should influence behavior performance.[83]

Kothe et al[84] examined the effect on FV intake of an intervention based on the TPB. Participants completed a questionnaire at baseline and post-intervention assessing intention, attitude, subjective norm, and perceived control regarding consumption of two servings of fruit and five servings of vegetables per day. The intervention consisted of automated emails sent to participants over the course of 30 days. Emails contained (a) information about FV intake including information about consequences (attitude); (b) information about others' FV intake and whether others approved of the behavior (subjective norm); (c) arguments to bolster self-efficacy for FV intake, and instructions (perceived control). All TPB variables, including FV intake, increased significantly post-intervention, as did reported intention to consume the recommended servings of FV.

The transtheoretical model of behavior change (TTM) combines principles from multiple individual-level theories, emphasizing the construct of behavior change as a process that happens in stages rather than as a single event. The stages of change are defined as (a) Precontemplation – no thought is given to changing behavior within the next six months. (b) Contemplation –intent to change behavior in the next six months. (c) Preparation – plans are made and steps have been taken to begin behavior change within the next 30 days. (d) Action – engaging in behavior change for less than six months. (e) Maintenance – the behavior change has occurred for more than six months. (f) Termination – the initial behavior is no longer even considered. The TTM designates five cognitive and five behavioral processes in which individuals engage while changing behavior, and acknowledges the role of self-efficacy – one's perceived ability to perform a behavior – and decisional balance – pros and cons of deciding on a behavior – in behavior change. When conducting interventions aimed at changing behavior, the TTM emphasizes understanding the processes of change as they relate to stages of change in order to match intervention methods to the needs and readiness of the individual.[83]

The TTM uses information gathered about an individual to decide on an intervention focus that has the best chance of success. The SENIOR Project intervention determined the numbers of FV consumed per day by participants and used a stage of change instrument to assess readiness to consume five FV per day. Participants received stage-based FV newsletters every month addressing stage-appropriate processes of change. In intent-to-treat analysis, participants who had received the intervention increased FV consumption by 0.5 – 1 serving per day more than did those who had not received the treatment. Individuals with complete dietary data were more likely to be in the action or maintenance stage of change compared to those with incomplete data and those who did not complete the study.[85]

A shift in behavior-change focus began to occur in the late 1980s, with the recognition that individual behaviors do not occur in a vacuum, and that attempting to intervene at an individual level is inefficient and ineffective.[81] For example, although Abood et al[82] observed beneficial changes in the diets of participants when the HBM was used as a framework, the benefits were similar to those observed in scores of behavior change interventions, the vast majority of which do not result in long-term adherence to the behavior change.[86] Instead, McLeroy et al[87] promoted the use of ecological models for health behaviors.

Social ecological model

The social ecological model (SEM) focuses not only on the individual, but on the people and environment surrounding the individual as well. It operates under the same principles as environmental ecology, defined as "a branch of science concerned with the interrelationship of organisms and their environments."[88] While this definition was derived from the biological sciences, behavioral scientists and public health practitioners have adopted it to describe the interrelationships between people and their physical and sociocultural surroundings.[89]

The framework for the SEM comes from Urie Brofenbrenner's 1977 ecological model of behavior. He proposed that behavior at each of four different levels influences and is influenced by the other three levels. The microsystem refers to one-on-one face-to-face interactions; the mesosystem refers to the interrelationships between microsystems; the exosystem refers to the larger social system; and the macrosystem refers to culture and values.[87]

McLeroy et al[87] proposed that this model could be used in health promotion programs rather than continuing to utilize only individual behavior theories that do not take into consideration the effects of the broader community, organizations, or policies. They specified and expanded Brofenbrenner's levels a bit more. Intrapersonal and interpersonal factors coincide with the micro- and meso- systems, respectively.

Intrapersonal factors refer to individual characteristics such as knowledge; interpersonal processes are social networks such as friends and family; institutional (or organizational) factors are organized social institutions with formal or informal rules; community factors are relationships among organizations or informal networks that have defined boundaries; and the public policy level deals with local, state, and national laws and policies.[87]

Reciprocal determinism summarizes the rationale for utilizing the SEM as a model for health behavior change. It proposes that an individual can simultaneously be changed by the environment while also being the agent of change, and that, if these changes occur simultaneously, they are more likely to be maintained.[90] Figure 1 illustrates the concentric levels of influence. Each successive layer moving outward represents a level that encompasses a wider range of influence than the level below it. But every sphere is part of all the other spheres, and thus each level influences all levels.

Figure 1. The Social Ecological Model. Concentric levels of influence each exert influence on each of the other levels. (Adapted from culturegenderhealth.blogspot.com)

SEM and food intake

The SEM can be used to explore food intake. Eating is a complex behavior that is much more than simply consuming nutrients in order to stay alive. It is related to mood and emotions, as well as to social and environmental factors.[91] Thus, it is important to understand how factors at each level of the SEM affect what individuals purchase and eat, and how each factor impacts factors in other levels.

Individual level

Elements at the individual/intrapersonal level that influence food intake can be divided into psychosocial, biological, behavioral, and lifestyle factors.[92] The most intuitive factor – a simple preference for certain tastes, smells, textures, temperatures, and appearance of foods – is psychosocial.[92] Preference, however straightforward it seems, is not. For example, although specific gene polymorphisms have been identified that can predict individual differences in flavor perception,[93] those perceptions do not necessarily correlate with the subjective sensation of liking or disliking.[94] Furthermore, preferences can be shaped not only by early exposure to specific foods, but also later in life by social and environmental factors such as exposure to new foods while in a supportive environment.[93]

Another psychosocial aspect of eating behavior is nutritional knowledge. Individual knowledge concerning FV and fat has been shown to be correlated with healthier intakes of these foods.[95] Among American Indians, knowledge about fiber, calories, cooking methods and label reading predicted food related behaviors. When examining relationships among SES, nutrition knowledge, and eating behavior, lower SES predicted less healthy eating behaviors, and higher levels of nutrition knowledge in each SES tertile predicted healthier food intake.[96] Similarly, self-efficacy for shopping for and consuming healthy foods is associated with higher intakes of those foods.[97,98]

Even hunger as a biologic determinant of food intake is not independent of other factors, some at the individual level, and some at other levels of the SEM. One aspect that moderates the relationship between hunger and food intake is impulsivity. A well-known recommendation, supported by empirical evidence,[99] is to never shop when hungry so as not to make unneeded high calorie purchases. Evidence suggests that the tendency to purchase high calorie foods when hungry is moderated by an individual's impulsivity level. Levels of calorie intake and purchase are highest in hungry people with high impulsivity compared to each of the other three conditions (sated high and low impulsivity and hungry low impulsivity). Further, although it seems that hunger should be the main driver of food intake, in fact, the actual driver of food intake is appetite. Appetite is distinct from hunger in that appetite refers to the desire for food, regardless of satiety level and can be manipulated by factors like marketing. Hunger is a physiological true need for food, and can only be manipulated by biological processes.[100]

Examining these individual-level determinants alone demonstrates the complexity of eating behaviors, illustrating the shortcomings of interventions that focus solely on this level. All individual behaviors are influenced by, and influence, multiple other factors, including those that follow.

Interpersonal level

The parent (caregiver)/young child relationship is the most basic with regard to food intake at the interpersonal level. Children's diets are completely dependent on their parents, who continue to influence their children's diets into adolescence. The National

Longitudinal Study of Adolescent Health surveyed 18,177 adolescents across the US. It revealed that the more evening meals an adolescent ate with at least one parent present, the less likely the adolescent was to skip breakfast or have poor FV consumption,[101] an effect that even persists into young adulthood.[102]

Parents and peers influence youth dietary behaviors differently across age and sex. When youths were provided meal and snack foods to consume as desired with either their mothers or a same-sex friend, food intake varied systematically according to age and/or sex of the child.[103]

Minnesota high school and middle school students completed surveys identifying their friends at the school, and reporting dietary behaviors. When associations between adolescents' and their friends' eating behavior reports were examined, breakfast, vegetable, whole grain, and dairy intakes were observed to be significantly correlated.[104]

Peer influence is not restricted to children and youth. Salvy et al[105] examined the influence of a social situation on eating behaviors among young adults. Participants were paired with a same-sex friend, same-sex stranger, opposite-sex stranger, or their romantic partner for a 10-minute conversation. Each participant received a bowl of snacks during the conversation. Males paired with male friends consumed significantly greater amounts of snacks than did any other groups, including males with male strangers, males with female strangers, or males with a romantic partner. Females paired with female friends consumed significantly more snacks than did females paired with female or male strangers. However, females consumed the most when paired with a romantic partner. More interesting was the observation that each member of a pair matched their snack consumption to that of their conversation partner in the cases of female and mixed pairs.

Male pairs, however, regardless of whether they were friends or strangers, did not match their snack consumption to their conversation partner. A similar finding was observed among young women consuming a meal with a female stranger who was part of the study, although participants were unaware of her confederacy. Participants who ate with a companion who consumed a small amount of the meal consumed significantly less than did those who ate with a companion who consumed a large amount of the meal.[106]

Pelletier et al[107] demonstrated that, among young adults, perceptions of friends' and family's eating behaviors also influenced their own food intake. Participants who reported high levels of sugar sweetened beverage and fast food intakes by their families, friends, and significant others reported significantly greater intakes themselves compared to participants reporting lower intakes. The same result was observed for FV intake, although it only trended toward significance among family members.

Interviews of a multi-ethnic sample of 86 adults throughout the life course (ages 18 to 80 years) revealed how role transitions such as marrying or becoming a parent influence FV consumption. New parents reported eating and serving more FV than before becoming parents to set an example for their children. Many interviewees commented on how their and their spouse's personal food systems had to mesh when they got married. One woman explained that she thought it was her role as a wife to encourage her husband to eat more FV. A 19-year-old single mother of four reported that when her mother moved in after a house fire and took over the cooking responsibilities, it changed the types of foods and meals the family ate. Likewise, when a single father's daughter moved back in with him, he began preparing more regular balanced meals.[108]

Behavioral interventions must account for the home and social environments in order to have a higher chance of success. A school in Alabama recognized that an intervention to get fourth graders to eat FV would be more successful if it involved the entire family. They initiated the Hi5+ program, in which families participated in fun nutrition related activities at home.[109] The intent of other interventions is to educate children at school about nutrition and encourage them to ask their parents for healthy foods in an attempt to use pestering power to influence the home nutrition environment.[110] Likewise, the school food environment itself, at the organizational level of the SEM could, even in the absence of nutrition education, also initiate pestering power by children.

<u>Organizational level</u>

The two organizational contexts most integral to US society are schools for children and youth, and the workplace for adults. Roughly 97% of 5 to 17-year-olds are enrolled in school,[111] and 63% of adults are employed.[112] The substantial portions of the day spent at school and work translate to numerous potential eating occasions spent at those sites. Therefore, the foods available there influence food choices.

Studies published before the Healthy Hunger Free Kids Act (HHFKA) became effective in 2012 painted a somewhat unfavorable picture of the school food environment, particularly with regard to the availability of competitive foods. The Third School Nutrition Dietary Assessment Study (SNDA-III) found that competitive foods – foods sold à la carte or in vending machines and not offered as part of the National School Lunch Program (NSLP) or School Breakfast Program (SBP) – were available in 73% of elementary schools, 97% of middle schools, and all high schools analyzed,[113] despite containing more fat, fewer nutrients, and more calories than did NSLP foods.[114] And while more than 85% of NSLP lunches met the standards established by the USDA for the target nutrients protein, vitamins A and C, calcium, and iron, only 6% of school lunches met all standards.[115]

In 2007 60% of students who attended NSLP schools ate the NSLP lunch each day.[116] Between 35% and 47% of students' total daily energy intake comes from foods and beverages obtained from and eaten at school.[116] These numbers demonstrate the impact the school food landscape has on children's diets, particularly those of children from low-income households, who comprise 60% of NSLP recipients each day.[117] Furthermore, from surveys of 1542 parents and their adolescent child who regularly ate lunch/breakfast at school once a week, Longacre et al[118] found that among students/parents surveyed during times when school was not in session (e.g., summer break), each increasing increment of household income category was associated with a student consuming FV 1.04 more times per week ($p < 0.001$). In contrast, when school was in session, no significant difference in FV intake was observed among income categories, indicating that school lunches/breakfasts hold the potential to reduce diet disparities due to income.

While it is still too early to comprehensively ascertain the impact the HHFKA will have on the school food environment, and thus on children's food intake, an assessment from four schools in low-income areas comparing plate waste and consumption before HHFKA implementation to the same outcomes after implementation observed significant increases in percents of entrees (15.6% increase, $p < 0.0001$) and vegetables (16.2% increase, $p < 0.0001$) consumed, as well as an increase in the amount of vegetables consumed (0.18 cups/day increase, $p < 0.001$).[119]

The nutritional state of workplaces is not as well studied as is that of schools. Numerous individual-level worksite interventions have been conducted[120] similar to the one by Abood et al[82] in which utilizing the HBM to tailor education sessions resulted in less fat and fewer calories consumed by the intervention group.

A growing number of worksites are incorporating wellness programs that include adding healthy food options in cafeterias and/or vending machines. Two such programs, Steps to a Healthier Austin working with Austin's Capital Metropolitan Transportation Authority,[121] and the Step Ahead program in six Massachusetts hospitals,[122] have not gathered information about the impact of the programs on dietary intake measures, but have observed other positive outcomes such as decreased health care costs and absenteeism rates.[121]

Just as availability of healthy foods in the workplace has the potential to affect dietary intake, so too does the price of those foods. When healthy foods were added to vending machines and priced lower than unhealthy foods in bus garages, employees in the intervention condition purchased five times as many healthy snacks as did employees in the control condition in which prices between healthy and unhealthy snacks were similar.[123] While it was a small change as part of a fairly small study, this type of change on a population level could have a substantial impact.

Community/Environment level

The community level of the SEM is defined in various ways, depending on the behavior under examination and the context in which it is being evaluated. With regard to food intake, an increase in research into food access disparities led to the recognition that those disparities could be associated with the observed diet intake disparities. This has resulted in a growing body of literature examining food outlet access and its association with dietary quality and intake.

However, results have been far from definitive due to differences in methodologies, measurements, and definitions. Lytle[124] examined the state of the science and identified four limitations that arise when investigating relationships between diet and food access. (1) psychometric standards are not defined; (2) obesogeneity and disease risks related to environments are not quantified; (3) the best study designs have not been identified for assessing environmental factor importance; and (4) interactions among physical and social environments and food choice are difficult to measure.

A study of 9-10 year-old children in Norfolk, England illustrates the ambiguous association between food store outlets and dietary intake. For every one-kilometer increase in distance children lived from the nearest supermarket, their FV consumption increased 0.11 portions per week ($p < 0.05$); yet higher supermarket density near their homes was associated with higher vegetable intake as well. Each additional supermarket per square kilometer was also associated with increased intakes of sweets, sugar-sweetened beverages, cereal, and white bread. Convenience store associations were as expected, with greater distance to the nearest store associated with decreasing consumption of chips, sweets, chocolate, and white bread.[125]

Owing to the exceptional complexity of natural experiments, most studies have been cross-sectional, preventing inferences about the directionality of associations. Nevertheless, cross-sectional research is an important first step in assessing whether or not differences occur in any systematic fashion. Conducting longitudinal research on a community-scale without first observing differences in cross-sectional observations would be a waste of resources.

The most consistent associations between food outlets and dietary intake have come when examining store counts and presence versus absence of specific store types within a certain distance threshold. SNAP participants in Fayette County, Kentucky with at least one supermarket or farmers' market within 0.5 mile of home were more likely to consume at least one serving of vegetables per day compared to SNAP participants without supermarket or farmers' market availability within 0.5 mile.[126] Ollberding et al[127] assessed the relationship between FV intake and healthy food outlet density in Hawaii. A greater density of healthy food outlets within 0.5 km of participants' homes was associated with greater intake of FV, but distances beyond 0.5 km showed no such associations. Laska et al[15] observed that the presence of any retail facilities, including restaurants, convenience stores, and grocery stores, within 800, 1600, and/or 3000 meters of adolescents' homes or schools was directly associated with sugar sweetened beverage intake. Low- and middle-income children participating in the 2006 Health Behavior in School Aged Children Study had lower odds of consuming FV when they attended schools in areas with a high density of fast food outlets and low density of supermarkets.[128] Others, however, have observed no associations between food outlet availability and food intake.[129-131]

Distance and travel time relationships are less consistent, with a substantial number of studies demonstrating no association between distance to outlets and food intake.[23,132-136] However, a population-wide US analysis utilizing the Behavioral Risk

Factor Surveillance System (BRFSS) for FV consumption demonstrated that, in metropolitan areas, as the distance to a supermarket increased, the odds of consuming five or more FV per day decreased. [137] The Brazos Valley Health Assessment, conducted among seniors living in rural areas of Texas, showed similar results.[138]

Results of the few longitudinal analyses that have been conducted are equivocal as well. The Research with East London Adolescents: Community Health Survey (RELACHS) examined the change from 2001 to 2005 in the number of takeaway fast food restaurants and grocery stores, convenience stores, and supermarkets within 800 meters of a secondary school. Small but significant increases in healthy diet scores were correlated with increased distances from school to any type of food store, and small decreases in unhealthy diet scores correlated with increasing distance to fast food takeaways.[139] Combining convenience stores with grocery stores and supermarkets prevented discrimination between differing store types, but the authors pointed out that the types of foods adolescents are likely to purchase from any retail establishment during a school commute are snack foods such as chips and sugar-sweetened beverages.

To date, only one natural experiment in the US has investigated how adding a supermarket to a neighborhood previously without one affects FV intake.[140] However, rather than comparing pre- post-intervention FV consumptions within the intervention neighborhood, intakes between the control and intervention neighborhoods were compared, precluding an assessment of the store's impact on the community in which it was located. Furthermore, in order for natural experiments to be valid they must account for the myriad of potentially relevant covariates, none of which were controlled for in this study. At least three major multi-city natural experiments are currently underway in the eastern US that can potentially shed more light on how food environments impact health.

Public policy level

Policy is often thought of solely as state or federal government level intervention. In reality, policies can be enacted in any organizational structure. For example, a family may have a policy that they always eat dinner sitting at the table. Clubs, schools, and workplaces all have policies that, if enforced, have a greater reach than do attempts to change the same behavior at lower levels of the SEM. Public health – 'the science and art of preventing disease, prolonging life, and promoting health through the organized efforts of society[141] – takes a policy level approach in order to achieve the widest possible reach. This approach is sometimes controversial, with some arguing that promoting and maintaining the health of the population is not a societal role, and that efforts to act at the public policy level are paternalistic.

However, public health approaches are potentially multiple times more efficient and effective than are interventions at the lower levels of the SEM. A classic example of using a public health approach to fight disease was London physician John Snow's removal of the Broad Street water pump handle in 1854 to stem a cholera epidemic. Rather than warning individuals against the dangers of water from the Broad Street well, or organizing community meetings to explain the source of the sickness, Snow acted 'upstream' of all these solutions by removing the pump handle at the well, ending the epidemic.[142] This sort of upstream approach has effectively improved population health in a number of areas. Policies that require clean water and sanitation,[143] child immunizations,[144] and clean air[145] have saved more lives, more cost-effectively than all downstream interventions dealing with these issues would have over the course of 50 years.[142]

In the early 1900s vitamin and mineral deficiency diseases were prevalent in the US until Recommended Dietary Allowances established fortification amounts of vitamins and minerals to the food supply. Food fortification was used in cases where "there exist deficiencies of vitamins and minerals in the diets of significant segments of the population…which cannot promptly be corrected by public education."[146] As a result of nutrient fortification, by 1954 frank deficiency diseases such as pellagra (niacin) and beriberi (thiamin) had been practically eliminated from the US population.[147]

Kersh and Morone[148] used the examples of alcohol, illegal drugs, tobacco, and sexuality to illustrate that, before a private individual behavior is intervened upon at the public level, seven different conditions have already been met: (1) social disapproval from private groups; (2) medical science warning of harm; (3) self-help groups formed (e.g., Alcoholics Anonymous); (4) users demonized; (5) industry demonized; (6) mass movements formed (e.g., "Just Say No" antidrug crusades); and (7) interest-group action. With each condition a wider net is spread and more people express concern about the issue. If any of the seven actions had solved the problem, public action would be unnecessary.

Opponents of public health approaches argue that (a) policies may lead to unintended consequences or even counteract the policy's intent, (b) are not always supported by evidence of effectiveness,[149] (c) restrict freedom of choice, and (d) remove individual responsibility.[145] Fluoride was added to the public water supply in the US in the 1940s due to its beneficial effects on tooth decay prevention in children.[150] It is considered particularly effective for individuals of low SES who may not be able to afford advanced dental care.[151] However, ingestion of fluoride has been linked in some cases with dental fluorosis, a condition that may result in weakening of the enamel and tooth discoloration.[152] Some groups therefore argue that, although the practice benefits most, its potential harm to a few should preclude its mass administration without consent.[153]

Iron and folate fortifications in the food supply have also met with resistance due to possible unintended consequences. Hemochromatosis, a hereditary condition resulting in highly efficient iron absorption that causes iron accumulation in the tissues, rose by 60% over a period from 1979 to 1992.[154] This rise coincided with increasing levels of iron fortification in the food supply that went beyond the levels originally specified for fortification.[154] The argument against folate fortification is that it targets a small, poorly defined population (women who might become pregnant), and increases the risk that vitamin B_{12} deficiencies in the elderly will be masked.[147]

When New York mayor Michael Bloomberg proposed a ban on large sugary beverages in New York City in 2013, a lawyer for the American Beverage Association labeled the proposed ban as ‘government coercion of lifestyle decisions,’[155] while Forbes labeled Bloomberg a ‘nutritional nanny.’[156] Those who hold that individual freedom, choice, and responsibility are sacrificed as a result of public policy believe the individual interventions of the 1970s and 1980s are the appropriate models for behavior change. Individuals should be educated about health behaviors and then have the freedom to decide what they will do with the information, rather than having the decision mandated to them.[145]

A popular notion espoused by those who oppose any dietary government intervention is that individuals consume unhealthy diets because of irresponsibility. However, in spite of the increase in diet-related diseases, evidence indicates that other responsible behaviors, such as drinking less alcohol or not riding with an impaired driver, seem to be increasing.[144] It is unlikely that responsibility would increase in other health related behaviors, but decrease in diet related behaviors.[144] A more likely scenario is that many individuals do not have access, either geographically or financially, to healthy foods and must therefore rely on cheaper, less healthy foods.[157] Rather than removing choice, policies enacted to increase access would also increase choice.

Ideally, public health is about making the healthy choice the easy, or default, choice rather than about mandating behaviors. Organ donation policies in various countries illustrate this principle. In some countries, citizens are organ donors by default unless they opt out, and in others, citizens are not organ donors unless they opt in. In countries in which donation is the default, 98% of citizens are donors. In countries where not donating is the default, 15% of citizens are donors.[144] Freedom and choice are identical in both cases. Many policies, such as menu labeling, actually increase the public's choice, and yet are opposed by the food industry.[158]

<u>Social norms</u>

Policies exert influence upstream of all other SEM levels – when they are enforced and/or followed. A policy is only truly a policy when humans with free will act in accordance with it. While consequences may result from noncompliance, individuals are still free to choose between acquiescing or accepting the results of not complying. Ultimately then, although influenced by multiple levels, settings, and people, human behavior comes down to individual choice, making the most effective behavioral change 'interventions' those in which individuals choose, or believe they choose, a behavior.

Societal norms can have such an effect. Social norms have been described as 'the grammar of society,' defining implicit societal behavioral patterns just as linguistic rules define a language.[159] Perception is an inherent component of social norms. It differentiates descriptive norms – simple perceptions of what normal behavior is in specific situations – from injunctive norms – the perceptions about what is normally approved or disapproved of within a specific culture.[160]

Prinsen et al[161] conducted two experiments to test the effect of social norm perceptions on behavior. In both experiments, a bowl of wrapped chocolates were available to participants. In one condition a second bowl of empty wrappers was present beside the chocolate bowl, while in the other condition an empty bowl was beside the chocolates. In both cases a higher percentage of participants took chocolate when empty wrappers were present, resulting in significantly higher odds of participants taking chocolate when wrappers were present compared to when they were absent.

Normative messaging interventions based on social norms have become common methods of targeting negative behaviors, particularly drinking on college campuses.[162] Normative messages can backfire though and result in a boomerang effect. For example, messaging that provides information about the amount of alcohol college students normally drink may be intended to get those who drink more than the normal amount to reduce alcohol consumption. The message may result, however, in a student who drinks less than this amount to increase his/her drinking to match the norm.[160]

In spite of attempts to manipulate both descriptive and injunctive norms to change behavior, the most influential behavioral norms are not those that are written or codified, or produced by human design or planning. They are those that that are discovered by observing others to learn what is acceptable or not in a social group.[159] Social norms function like policies, use interpersonal influences, and convince people that their behavior is the result of their own individual knowledge and preferences.

Indeed, perhaps no other level of the SEM demonstrates the reciprocal determinism of the model better than this one does. Social norms are composed of influences from every level of the SEM. Matching eating behaviors to those of peers demonstrates the effect of social norms at the interpersonal level, and social norms are responsible for the acceptability of neighborhoods having access to only stores full of unhealthy snacks at the community level.

Human behavior is complex and, as such, completely disentangling levels of influence is impossible. Individual tastes are both inborn and learned from others; businesses are more likely to carry specific foods when adults, who may be influenced by their children, purchase those foods; policies are enacted when enough people demand them; and individuals may know eating foods like fruits, vegetables and whole grains is a healthy behavior, but if the only stores accessible to them sell energy-dense, nutrient-poor foods, that knowledge is useless.

Disparities in food access

Disparities in access to healthy food may be a primary contributor to the observed disparities in the consumption of healthy foods. Powell et al[5] examined food store availability across the US side by side with neighborhood characteristics. Food store data was obtained from a business list from Dun and Bradstreet, and 2000 Census information was used to obtain racial and ethnic characteristics, SES, and population of neighborhoods. Low-income neighborhoods had 75% as many chain supermarkets as middle-income neighborhoods had, and, after controlling for income, African-American and Hispanic neighborhoods had 52% and 32%, respectively, as many chain supermarkets as did white neighborhoods.

Moore and Roux[11] conducted a similar study in North Carolina, Maryland, and New York. They also used commercially available data to obtain food store information, and 2000 Census data to obtain demographic information. Similar to the national study by Powell et al, minority neighborhoods had half as many supermarkets and twice as many small grocery stores as did white neighborhoods. Minority neighborhoods also tended to have fewer fruit and vegetable markets than white neighborhoods had.[11]

Using Census data from 2010, two 2010 commercial lists of food stores, and 2006-2010 American Community Survey (ACS) data on income and vehicle availability, the USDA's Economic Research Service found that the distance to the nearest supermarket did not change from 2006 to 2010 in the population overall. However, the number of people in low-income areas who were more than a mile from the nearest supermarket increased 8.4 percent from 2006 to 2010. This increase was likely due to the rise in the number of low-income areas as a result of the recession during that time period. Although vehicle availability, which may be a key indicator of a household's ability to get to a supermarket, increased overall from 2006 to 2010 for those living at least one mile from a supermarket, among low-income households the increase was only observed in those who lived within a half-mile from a supermarket.[7]

Inequality in the availability of individual foods has been recognized as well. Leone et al[163] observed that, across store types, the availability of FV, as well as shelf space for low-fat milk and whole wheat bread were significantly higher in stores located in high-income areas compared to those in low-income areas. In a nationwide assessment in which store audits were conducted in 8959 food stores in 468 communities, the odds that stores in majority Hispanic neighborhoods would stock low-fat milk were observed to be 50-58% lower compared to white neighborhoods. Further, low-income communities were 32-44% less likely to carry low-fat milk than were high-income communities.[164] Separate analysis from the same project revealed that, across store types, the proportion of healthier to less healthy foods was significantly lower in minority and low-income communities compared to white and high-income communities, respectively.[165]

Healthier foods are often more expensive in low-income areas[23] because they are sold in small food stores which must increase food prices to make a profit.[166] Leone et al[163] assessed food price and availability in 73 supermarkets, grocery stores, and convenience stores in Florida. Fruit and low-fat milk were significantly more expensive in convenience stores compared to supermarkets. Vegetable prices could not be compared due to limited availability in convenience stores. All supermarkets in the sample, 63% of grocery stores, and 11% of convenience stores carried low-fat half-gallon milk, and just 7% of convenience stores sold whole wheat bread.

In response to these food access disparities, in 2004 The Food Trust created the Pennsylvania Fresh Food Financing Initiative (FFFI), a public private partnership that helped open or revitalize supermarkets and fresh food outlets in areas of Pennsylvania that had little access to fresh food.[167] In 2009 PolicyLink and The Reinvestment Fund joined with The Food Trust to initiate a national campaign to adopt the program at a federal level,[167,168] and in 2011 $400 million of the federal budget was allocated to the HFFI.[167] As of December, 2014, the HFFI has supported over 100 successful projects by leveraging over $1 billion using its public-private partnership model.[169] The HFFI was formally established as part of the Farm Bill in 2014, and other states and metropolitan areas have established their own financing initiatives.[169]

Projects funded by the HFFI are not restricted to any particular type of food store. Grocery stores, farmers' markets, corner stores, food hubs, urban farms, and other healthy food retailers have all been created and/or expanded by the utilization of HFFI funding.[169] Although the HFFI decreases the financial risk of establishing healthy food outlets in high-risk areas,[170] locating supermarkets in urban areas can be difficult due to barriers such as lack of land space,[26] local regulations, lack of a local workforce,[171] and excessive crime and vandalism in these areas that make it difficult to obtain insurance.[172]

The city of St. Petersburg, Florida addressed the barrier of land space availability by purchasing 32 parcels of land in the Midtown neighborhood, from which they cleared liens and rezoned the area for commercial development. The city further leased the property to a supermarket developer for $5 per year.[171] While the original supermarket has since closed, it was replaced within a year by a Walmart Neighborhood Market,[173] which will continue to supply groceries to the area.

Low-income urban areas often lack a workforce with suitable job training for supermarket employment. Individuals with training in specialized areas such as produce and meat handling are particularly scarce. The Project TEN (Train Employees Now) program in Lorain County, Ohio provides a viable solution to this barrier by using federal funds to provide employees with job training. Fligner's Market in Lorain utilized the program to send employees to an Ohio Department of Agriculture training where they received meat handling certifications, which they put to use immediately in the grocery store.[171]

Although supermarket development is increasing in underserved areas due to efforts such as these, many areas continue to lack access to supermarkets, while maintaining an abundance of small retail food stores. The Food Trust responded to this issue as well in 2004 by launching the HCSI in Philadelphia. The HCSI works with corner store owners to make gradual modifications to their stores, incentivizing additional levels of change. The program is implemented in five phases. In the first three phases, stores become part of the Philadelphia Healthy Corner Store Network and agree to introduce four new healthy products (phase one) and to display marketing materials to guide customers to healthier items (phase two). Once a store owner completes the first two phases he/she receives a $100 incentive for each year of participation. During phase three store owners receive training on selling healthy products. In phase four stores that have met the goals of phases one and two are eligible to be a part of the Philadelphia Healthy Corner Store Network Conversion, in which they receive conversions that may include free or reduced cost shelving and refrigeration for prominently displaying their healthy inventory. Stores that agree to stock an even larger inventory of healthy foods can become a certified store as part of phase five. Fresh Corner Store Conversions and the Heart Smarts Program expand the program to include infrastructural improvements and in-store health screenings.[174]

In an action parallel to its expansion of the Pennsylvania FFFI to the national HFFI, The Food Trust extended the HCSI to found the National Healthy Corner Store Network (HCSN) to encourage and support healthy upgrades to corner stores around the country.[29,175] A number of communities have instituted Healthy Corner Stores programs, many utilizing the resources of the HCSN.[175] As interventions in small stores accumulate, early results demonstrate good success at increasing the availability of healthy foods.

In Philadelphia, 211 HCSI stores were assessed in 2011 pre-intervention, and one year later post-intervention. Stores received incentives to implement the phase one through phase three basic intervention, in which they added and marketed new healthy products, and received business training on procurement, promotion, and pricing of healthy foods. A conversion intervention (phase four), provided to stores with greater potential for larger inventory changes, included mini grants for shelving and refrigeration of healthy foods. At post-intervention compared to pre-intervention, significant increases were observed in the availability of apples, oranges, grapes, and broccoli in stores in the conversion intervention condition.[176] Four stores in Michigan that were selected for interventions as part of the Project FIT program received an intervention similar to that of the Philadelphia HCSI. Three of the four increased overall availability of healthy foods in their stores during the 6-month intervention period.[177]

The Baltimore Healthy Stores intervention was one of the earliest to utilize pre- and post-assessments of intervention stores, along with comparisons of non-intervention stores.[178] After a 10-month program in which intervention store owners were encouraged to stock and promote specific foods, significantly more intervention stores stocked low-sugar cereals, baked/low-fat chips, low-salt crackers, and cooking spray compared to control stores. Weekly sales of the aforementioned items, plus whole wheat bread and 100% fruit juice tended to increase from baseline to post-intervention in intervention stores, while decreasing in comparison stores.[179]

The Healthy Bodegas Initiative was established in 2006 to improve the overall store environment of New York City bodegas. An evaluation of 60 of the more than 1000 corner stores the initiative has worked with was conducted in 2009. The goal of the initiative in these stores was to increase fresh produce and to stock healthier snacks and beverages, and to work with community organizations and residents to increase purchases of these healthy foods. Similar to the results of the Baltimore Healthy Stores Intervention, sales of the promoted healthier versions of foods (e.g., low-fat milk, whole grain bread) increased from 5% to 16% after the six-month intervention.[180]

Both the Navajo Healthy Stores intervention, implemented in trading posts and convenience stores on the Navajo Nation, and the Vida Sana: Hoy y Mañana intervention, implemented in tiendas in central North Carolina, assessed self-reported changes in individual food intake behaviors after intervention implementation. In the Navajos, increased exposure to intervention stores was associated with significant improvements in healthy cooking methods and in acquisition of healthy foods.[181] Customers who shopped at tiendas participating in the Vida Sana: Hoy y Mañana intervention reported consuming almost an additional serving of FV each day ($p \leq 0.06$) post-intervention compared to pre-intervention.[182]

Changes in adolescent and child purchasing behaviors in response to corner store interventions have been less promising. The Boston Middle School Corner Store Initiative (CSI) targeted beverage consumption in six middle schools and eight corner stores. The intervention included classroom education, a "Drink Smart" social marketing campaign, and making smaller, less expensive bottles of milk, 100% juice, and water available in stores. Structured store observations revealed no differences in purchases of sugar-sweetened beverages among students between pre- and post-intervention.[183]

Lent et al[184] demonstrated similar results among fourth-, fifth-, and sixth-grade students using the first randomized controlled corner store study that employed objective evaluation of purchases. Five schools and the 12 corner stores within four blocks of them were randomized to the Snackin' Fresh intervention, while five other schools and the 12 corner stores within four blocks of them were randomized as non-intervention controls. Store owners in the intervention condition were incentivized for displaying study-provided marketing materials, stocking a minimum number of healthy foods being targeted by the intervention, and grouping healthy foods together for easy identification. The intervention, which lasted for two years, also included nutrition education classes and social marketing and signs promoting healthy eating. At baseline and years one and two, intercept interviews of students were conducted outside of stores to obtain nutrition information on purchased items. No significant differences in calories, fat, sodium, carbohydrates, sugar, protein, or fiber were observed between control and intervention conditions at baseline, year one, or year two.

Tools used for store evaluations

In order to accurately evaluate the effectiveness of interventions designed to increase the healthfulness of the food environment, valid instruments must be used. A number of assessment tools have been developed for specific interventions, but few report their development methods or the reliability of the instrument, and they may not be designed for use across studies. Other tools are more comprehensive and have been used in multiple interventions.

The purpose of the Nutrition Environment Measures Study was to develop reliable observational measures of the food environment that could be used and adapted by other studies across diverse communities. The NEMS-S was created by consulting nutrition environment researchers, reviewing the literature and tools already available, assessing the most common unhealthy foods consumed and the healthiest foods recommended for consumption, pretesting the proposed measures, and making adjustments to address issues discovered during pretesting. Once complete, store assessments were conducted by trained raters in four communities that differed according to walkability and SES. Inter-rater reliability and test-retest reliability were assessed, and both found to be high, with kappa (κ) statistics ranging from 0.75 to 1.00. The NEMS-S measures the availability of foods in 10 categories: (1) fresh fruit, (2) fresh vegetables, (3) milk, (4) ground beef, (5) hot dogs, (6) frozen dinners, (7) beverages, (8) baked goods, (9) bread, and (10) snack chips. It also measures the quality of fresh FV, and compares prices between healthy and unhealthy versions of the other eight categories (e.g., skim vs whole milk).[185]

The Communities of Excellence in Nutrition, Physical Activity, and Obesity Prevention (CX^3) program is a project of the Network for a Healthy California. A portion of the project is dedicated to assessing local food environments; thus a food availability and marketing survey was developed. Similar to the NEMS-S, the CX^3 survey assesses price and availability of foods, as well as quality of FV. In addition to assessing the presence of foods, the CX^3 survey includes sections to audit conditions of and advertising on store exteriors, and marketing and promotions inside stores. Inter-rater reliability κ statistics and intraclass correlation coefficients (ICC) for food item assessments all were above 0.7; measuring exterior ads was less reliable, with κ statistics as low as 0.372.[186]

Bridging the Gap is a research program that identifies environmental and policy factors affecting food and physical activity behaviors in youth. As part of a national study, the program developed a Food Store Observation Form (BTG-FSOF) by building on the NEMS-S, the CX^3 survey, and other observational tools. The BTG-FSOF combined NEMS-S assessments of food items with CX^3 evaluations of interior and exterior conditions and marketing, adding additional items as well. Reliability testing revealed ICCs ranging from 0.32 to 1.00 on product pricing measures, and κ/ICCs ranging from 0.45 to 1.00 for exterior advertisements and interior/exterior store characteristics.[187]

While all three of these tools, as well as others, are designed to assess a variety of store types, the food environment of supermarkets is much different than that of small retail stores like convenience and corner stores. Therefore, in order to assess the Philadelphia HCSI intervention, the NEMS-CS was adapted from the NEMS-S and developed for use in corner stores. The NEMS-CS includes all of the NEMS-S items plus frozen and canned FV, total types of fresh FV, 100-calorie snacks, and cereal. Surveys also assess space designated for food, and marketing materials visible in the store. After completing the NEMS-CS in 233 small retail food stores in Philadelphia, the inter-rater reliability κ for availability of FV ranged from 0.79 to 1.00, depending on the product evaluated, and κ values for test-retest reliability ranged from 0.37 to 1.00, depending on the product evaluated.[31]

In-store observational surveys are thorough in their evaluations of all types of food stores. As successive tools build on knowledge gained from previous instruments, audits evolve to provide more well-rounded inclusive assessments that encompass measures of food availability, quality, price, space, and promotion. Data collectors must visit stores in-person to use these instruments, and audits require approximately thirty minutes to complete.

At present, due to the need for accurate assessments, no short instruments have been developed that have been validated against the longer surveys. However, if a shorter survey existed, it could be used for rapid assessments of stores' healthfulness, and to screen stores for eligibility for participation in evaluations that use a long-form instrument.

CHAPTER 3

METHODS

Study design

The study was conducted in two rounds. In round one, a comprehensive in-person instrument currently used to assess in-store food environments of small retail food stores (NEMS-CS) was adapted and used to develop a short-form version of the instrument; the validity of the short form was assessed against the full instrument. Round two tested the feasibility of using the newly developed short-form instrument on the phone to rate the healthfulness of a store's offerings, and was used to confirm round one findings. The sampling frame for the two rounds of data collection consisted of small food stores listed in 2013 commercially available business lists (InfoUSA and Nielsen) for the metro areas of Camden, Newark, Trenton, and New Brunswick, New Jersey. These communities have received funding to upgrade a selection of small retail food stores to stock and promote healthier options, thus providing variability in food offerings among stores to allow for discrimination between stores that carry healthy options compared to those that do not. Small retail food stores (convenience stores, corner stores, bodegas) are defined as stores that (a) carry primarily convenience goods and a limited selection of staples,[3] (b) generate approximately $1 million in sales annually,[3] and/or (c) are franchisees of national/regional convenience store chains such as 7-Eleven, Wawa, and QuikTrip. This study did not involve human subjects and was therefore granted an exemption from IRB review by the Arizona State University IRB (Appendix A).

Sampling, data collection, and analysis procedures for round one (development of a validated short form) and round two (testing the feasibility of using the short form over the phone) will be described separately.

Round one: Development of validated in-store audit instrument

All item categories included in the NEMS-CS were included in the current in-store audit instrument. The NEMS-CS assesses the availability of items in 13 different categories (milk, fresh fruit, frozen and canned fruit, fresh vegetables, frozen and canned vegetables, ground meat, hot dogs, frozen dinners, baked goods, beverages, bread, baked chips and snacks, and cereal). It also assesses the size/amount and price of each item, and the quality (acceptable vs unacceptable) of fresh produce. The intent of the current project was to develop a short-form instrument that can be used over the phone; therefore data on price and quality, which are difficult to obtain reliably via telephone, were excluded from the in-store audit instrument. Items that assessed availability were retained. The items included as part of the 13 categories will be referred to as a group as 'original NEMS-CS items.' NEMS-CS availability items focus primarily on the absolute availability of healthier food options rather than the availability of the options as a proportion of all options available.

Items added to NEMS-CS

The New Jersey Child Health Study (NJCHS) is a 5-year longitudinal National Institutes of Health-funded project examining how changes to the built environment affect children's health. Part of the project involves assessing changes made to upgrade the offerings in small retail stores. Therefore, project personnel work closely with HCSN partners to learn which store owners have agreed to upgrade their stores, as well as to what extent stores have undergone healthy upgrades. The HCSN emphasizes not only increasing the availability of healthy items, but also promoting those items through signs, shelf markers, fliers, and other means. In addition, if a store does not have refrigeration for storing perishable items such as fresh fruits and vegetables the HCSN will provide one, or help restore refrigerators in disrepair.

To develop survey items to add to the original NEMS-CS items for the current project, HCSN partners in each study city provided a list of participating stores that had agreed to any form of upgrade, and then advised project staff about the types of changes these stores had made or were planning to make. An expert panel was then engaged to identify healthy changes to small stores in other cities in order to give the short instrument a higher level of external validity. The experts were researchers in the field of public health nutrition interventions, with expertise in helping establish corner store conversion programs and in conducting large-scale evaluations of those programs across the US. This process resulted in the development of questions regarding promotions and signage for healthy items, WIC and SNAP certification, cold storage equipment for fresh foods, availability of specific items at the checkout, and availability of single-serve fruit/vegetable snack packs. The items, which were added to the original NEMS-CS availability items in round one will be referred to as ‘added items.’

Six raters were trained on the added items by being shown photographs of examples of each feature and given instructions, with photographs, describing which areas of the store were considered to be ‘at the checkout.’ Five stores were assigned to each of three pairs of raters. Each rater in a pair independently audited the five stores, and their ratings were compared using the κ statistic to determine inter-rater reliability of the added items. Kappas of 0.8, 0.7, and 0.5 represent very good agreement, good agreement, and moderate agreement, respectively. Table 1 shows the κ values for each added item. Eight items had κ values over 0.7, and only one had a value under 0.5. Items with a κ statistic below 0.7 were modified and targeted for additional clarity during training of data collectors.

Table 1. Kappas for inter-rater reliability of items added to original NEMS-CS

n=25[a]	Kappa	p
Marketing materials	0.610	<.001
SNAP	0.555	0.005
WIC window signs	0.917	<.001
WIC shelf signs	0.884	<.001
Refrigeration	0.865	<.001
See-through refrigeration	0.790	<.001
Refrigeration visible from door	0.939	<.001
Checkout candy	0.834	<.001
Checkout fruit	0.733	<.001
Checkout vegetables	0.468	.006
Checkout water	0.706	<.001
Checkout SSB	0.658	<.001
Endcaps marked healthy	1	
# of healthy snacks on endcap	1	
Snack shelves marked healthy	1	
# of healthy snacks on shelf	1	
Single-serve fruit	0.603	.001
Single-serve vegetables	1	

[a]Includes the 10 stores in which practice audits were conducted during data collection training (described later)

Paper and electronic construction of instrument

Once the in-store audit instrument was set, a paper copy was created for in-store use (Appendix B), and an electronic version was created in the Qualtrics survey program.

The Qualtrics offline app was installed on iPads so results from paper copies could be entered into Qualtrics immediately after completion of each store audit.

Round one: Sample

At initiation of round one, 33 stores in the Newark and Camden metro areas had agreed to participate in a healthy conversion program (HSCN), and will be referred to as 'upgraded' stores. Addresses of all stores in Newark and Camden were geocoded using ArcGIS to obtain GEOID numbers which coded for state and county code, Census tract code, and Census block group code. Store names and addresses were matched with their corresponding block group's characteristics including education level, median income, ratio of income to poverty level, race/ethnicity, total population, household type (whether female-headed household or not), presence of people under 18 years old in household, public assistance income, employment status, vacant housing units, and occupancy status. Block group characteristics were obtained from the ACS Summary File Retrieval Tool.[188]

A sample size of 200 stores was selected based on simulation studies examining required sample sizes for exploratory factor analysis (EFA) models. These studies have yielded sample size recommendations ranging from as few as 60 cases[189] to as many as 1000.[190] Findings from Mundfrom et al[191] represent a middle ground and suggest that under conservative assumptions about factor structure (< 3 factors; > 4 variables per factor), n=200 stores would allow for a good match between sample-based and population-based solutions. To identify a sample of 167 non-upgraded stores that most closely matched the sample of 33 upgraded stores in terms of block group-level characteristics, an algorithm using nearest-neighbor propensity score matching with calipers was used. This procedure, however, did not result in appreciably better balance on covariates (or matching) than randomly matching non-upgraded (‘control’) stores to upgraded (‘treatment’) stores. Accordingly, a sample of 167 stores was randomly selected from the pool of 615 non-upgraded stores to reach the desired round one sample size of 200 stores. Additional audits were completed in 30 stores in New Brunswick and Trenton from July through September, 2014. These stores were added to the round one sample, for a total of 230 stores audited in round one.

Round one: Data collection

Training

Training and data collection took place in June, 2014. Data collection team members – six data collectors and four assistants/drivers – received classroom and fieldwork training over a two-day period. Day one training lasted from 9:30 am until 4 pm. It consisted of classroom training, which included the following:

- Explanation of the project as a whole and the benefits to creating a short-form instrument
- Training on understanding food labels
- Protocol for determining stores to be visited each day, and route planning
- Protocol for store visits (Appendix C)
- In-depth instruction, which included photographs of items assessed, on how to complete each item on the store audit
- Protocol for entering survey results into the Qualtrics app on iPads, and uploading them when Wi-Fi could be accessed
- Protocol for recording which stores were visited each day
- Practice store audit exercise using pictures on PowerPoint slides

- Review of the practice audit

During day two of training, which lasted from 9:30 am to 3 pm, team members paired up and were assigned nearby stores in which to conduct practice audits. Team members went together but were instructed to complete the audits independently without consulting one another. Upon returning, audit results were compared within pairs and team members received feedback to improve rating performance. These surveys were included in the reliability testing of the added items using the κ statistic (Table 1). The afternoon of day two was spent evaluating, discussing, and answering questions about the store auditing process, as well as discussing logistics of the upcoming store audits.

Store audits

Each data collection group consisted of a data collector, assistant, and driver. Drivers planned the route between stores, dropped the data collector and assistant off at each store, and remained in the car during in-store audits. The initial reasoning behind having one person assigned to driving only was to deal with the potential lack of parking. The vast majority of the corner stores have only street parking available. If necessary, the driver could drive around while audits were being completed. Having a separate driver was discovered to substantially speed up the entire store-visiting process since it allowed the data collector and assistant to focus entirely on completing and recording store audits, without also having to navigate to subsequent stores.

Data collectors and assistants carried ID badges and a letter from the principal investigators of the NJCHS explaining the project. In order to quell suspicions that the raters were from the health department or another regulatory agency, data collectors were instructed not to wear the badges, but only to show them if store employees questioned their identity or the purpose of the audit. The data collector and assistant entered the store together and briefly explained the project to an employee. If the employee denied the request to conduct the audit, the team members left the store and returned at a later date hoping to talk with a different employee. If the employee agreed to the audit, the data collector, with the help of the assistant, completed a paper version of the survey. The assistant always double-checked the paper survey at the end of the audit while still in the store. Before leaving they purchased a small bag of chips and a snack-sized fruit or vegetable and recorded the purchase and the price of each item. These purchases were used to conduct a small secondary study comparing the prices of healthy versus unhealthy snacks. The data collection team entered audit results from the paper survey into the electronic version on an iPad. This was uploaded into Qualtrics once the teams were finished for the day and had Wi-Fi access. At the end of each day, store audit forms from each rater were randomly selected and reviewed for completeness and discrepancies between the paper and electronic versions.

In cases in which store owners did not allow an audit, a store was not found in the field, or a store was permanently closed, a replacement in close proximity to the original store was audited if it was not already included in the sample.

Round one: Statistical analysis

Multiple analytic approaches were undertaken to determine which of the in-store audit items would be retained for use in the short-form audit. First, response frequencies were analyzed to determine which items had sufficient variability to be considered for inclusion in the brief phone survey. Items with low variability (i.e., items with splits more extreme than 90%/10% on yes/no questions) were excluded from consideration for the short form. When referring to variability in added items, the two WIC items (window signs and shelf signs) are combined, and sub-items (see-through refrigeration, refrigeration visible from door, number of healthy snacks on endcaps and shelves) are excluded, leaving 13 items. Excluding individual FV, 17 items (original and added combined) had at least a 90/10 percentage split in variability. Both light and regular hot dogs had a 90/10 percentage split; thus, only light hot dogs were retained for consideration for inclusion in the short form. Fresh vegetables exceeded the 90/10 percentage split by 0.4% (90.4% of stores had fresh vegetables) but were included due to their importance in measuring a store's healthfulness. This set of 17 items (does not include regular hot dogs, and does include fresh vegetables) will be referred to as the items with sufficient variability.

NEMS-CS points for the in-store audits were then calculated using the availability portion of the NEMS-CS scoring algorithm (Appendix D). Availability is scored on a scale of 0-34, and is calculated by adding scores from each of the 13 categories. Within each category the availability of particular food items is weighted based on different criteria for each item. For example, three points are possible in the bread category. Two points are awarded if a store carries whole grain bread, and another point is awarded for having more than two varieties of whole grain bread. To determine if the retained added items discriminated stores based on their NEMS-CS availability scores, stores were classified based on their responses to the retained added items, and groups of stores were compared using independent-groups t-tests. For example, NEMS-CS availability scores for stores with SNAP signs were compared to those of stores without SNAP signs. Groups of stores were also created using various cut-points for numbers of fresh fruits and fresh vegetables (e.g., 5 or more fresh fruits vs fewer than 5 fresh fruits; 4 or more fresh fruits vs fewer than 4 fresh fruits). Independent-group t-tests of differences in NEMS-CS points were conducted for these groupings as well.

Next, NEMS-CS points were divided into deciles. Frequencies were run in each decile on dichotomized original NEMS-CS items (food item was available vs not available) that had sufficient variability, as well as on added items in which the aforementioned t-tests revealed significantly different NEMS-CS points according to the presence or absence of the item. Results revealed the percentage of stores in each decile with the presence of the specific items. Mean fruit, vegetable, and frozen vegetable quantities were also calculated for each NEMS-CS score decile.

To check for potential redundancy among the 13 weighted NEMS-CS scores, inter-item Pearson correlations were computed and examined for signs of collinearity. A strong inter-item correlation could indicate a pair of items that might measure the same construct, thus providing a rationale for retention of only one item from that pair. Fresh fruits and fresh vegetables were the only item pair with a correlation over 0.6 ($r = 0.616$). However, both items are central to a store's healthfulness and are the primary focus when stores are targeted for healthy changes; thus both items were retained.

The magnitude of multicollinearity among the thirteen items was also examined by computing a variance inflation factor (VIF) value for each item within a set of 13 ordinary least squares regression models. In each model, one of the 13 NEMS-CS availability items was treated as the dependent variable, and the remaining 12 items were treated as predictors. This approach allowed for calculation of a VIF value for each of $p = 13$ items within the context of 13 unique sets of $p = 1$ items. AVIF value greater than five would indicate sizable multicollinearity (overlap) between an item and one or more of the other items in the regression model. All VIF values were less than three; therefore items were retained for the EFA stage.

To identify and describe latent constructs[192] that might underlie and explain the observed correlation structure of the measured variables, an EFA was conducted on the set of 17 items with sufficient variability comprising 12 original NEMS-CS items and 5 added items. Exploratory factor analysis was conducted in Mplus. Fruit and vegetable cut points of less than five versus five or more were used. These cut points were based on the literature[193] and on means observed in the sample. Eigenvalues were plotted in a scree plot to help determine the factor solution that would best account for the common variance in the measured variables. The inflection point in a scree plot is a visual indicator of the number of factor solutions accounting for the most variance. The scree plot suggested a three-factor solution. As such, one-, two-, and three-factor EFA models with principal axis factoring and Promax rotation were estimated. Of these models, the one-factor model proved to be the most interpretable solution with respect to a hypothesized healthfulness construct. Ten of the included items had strong loadings (>.45) on this factor and were thus retained as potential indicators of a healthfulness construct.

The final analytic approach for selecting items to be used for the brief audit was item response theory (IRT) analysis. Item response theory models posit latent traits presumed to underlie and thus be responsible for observed responses to survey items. The underlying latent trait posited in the IRT models reported in this case is a store's healthfulness, and is denoted as theta (θ). The IRT models estimated here include two parameters – item difficulty and item discrimination. An item's difficulty is defined as the score on θ that is associated with a 50% likelihood of a 'yes' (presence) response to that item. The item's discrimination parameter determines the amount of information provided by an item, modeling the strength of the item's relationship to the healthfulness construct. Item response theory analyses yield a maximum reliability value for the composite of items being considered that combines the discrimination values of every item. The goal for this analysis was a maximum reliability value of no less than 0.8.

The first IRT model included the 11 original NEMS-CS food items that had at least 90%/10% variability (this quantity excludes regular hot dogs), plus the three added items with significantly different NEMS-CS scores by presence/absence. The other three items included in EFA were not included in this analysis based on t-test and EFA results. Item difficulties were examined for similar values. When items have similar difficulty they provide redundant information about a store's level of healthfulness. Discrimination estimates were examined for low values, which would indicate that an item had a weak relationship to the healthfulness construct. Checkout fruit, canned fruit, light hot dogs, and low-calorie drinks all had low discrimination values, and were thus excluded. This resulted in a 10-item instrument that included the same 10 items that constituted a healthfulness construct in EFA analysis.

The 10-item set was therefore selected to explore its correlation with the NEMS-CS score. Scores were calculated for the item set by adding all 'yes' (presence) items for a possible score of 10. A Pearson correlation was run between 10-item scores and NEMS-CS points. NEMS-CS points and 10-item scores were divided into tertiles and crosstabs were run.

Sensitivity/specificity analysis was also conducted to assess the degree of agreement between the reduced item-set classification of stores as healthy or unhealthy versus the NEMS-CS score classification of stores as healthy or unhealthy. Item-sets were divided according to the bottom 80% ('unhealthy') versus top 20% ('healthy') of scores, and crosstabs run. In this case sensitivity is the ability of the instrument to correctly classify a store as being in the lower 80% of healthfulness. Specificity is the ability of the instrument to correctly classify a store as being in the upper 20% of healthfulness. Positive predictive value (PPV) and negative predictive value (NPV) were also calculated. Positive predictive value specifies the chance that a store categorized as unhealthy by the reduced-item instrument is truly unhealthy, as assessed by the NEMS-CS. Conversely, NPV specifies the chance that a store categorized as healthy by the reduced-item instrument is truly healthy, as assessed by the NEMS-CS.

Audits were conducted in 10 small retail food stores in the Phoenix, Arizona metro area to test the feasibility of obtaining reliable telephone responses about the availability of each of the 10 items in the store. After visits were completed, stores were called and the 10-item survey was administered. Respondents could not distinguish between whole grain versus non-whole grain bread, low-sugar versus non-low-sugar cereal, and low-fat versus non-low-fat frozen dinners. Those items were therefore excluded, and the same correlations that were examined in the 10-item set were examined using the seven-item set. The maximum reliability value of the seven-item set was also examined using IRT analysis. Although the value did not reach the goal of 0.8, the seven-item instrument was selected for round two testing based on the aforementioned feasibility trial.

Round two: Short-form instrument construction

The seven-item survey instrument developed in round one was entered into Qualtrics. A question about store hours was added at the beginning to ensure that respondents understood the language being spoken and were not simply answering 'yes' or 'no' without comprehension. The purpose of the refrigeration question was to assess quality of FV and ground meat, and was therefore skipped if respondents reported having no FV or ground meat. Questions about restocking FV were added at the end of the survey as a potential means of examining discrepancies between in-store findings and telephone survey responses (Appendix E).

Round two: Sample

At initiation of round two, only seven additional stores had been added to the HCSN list. Given that in round one the attempt at matching stores did not result in appreciably better balance on covariates than randomly matching non-upgraded ('control') stores to upgraded ('treatment') stores, and given the small number of 'treatment' stores in round two, matching was not attempted in the second round. The round two sample included seven upgraded stores and 93 randomly selected non-upgraded stores, all of which were different from the round one sample. This is a large enough sample to assess convergent validity against the round one results from 230 stores, and to examine the feasibility of conducting phone audits using the short-form instrument.

Round two: Data collection

Two separate teams of data collectors were used for round two. Nine telephone data collectors, two of whom were bilingual in Spanish and English, received a two-hour training on the protocol for using the seven-item short phone instrument (Appendix F). Training included instructions on the following:

- Schedule of data collector availability
- Checking the list of stores ready to be called, and interpreting entries
- When to call stores
- Conducting surveys and entering results in Qualtrics
- Recording results of phone calls
- Protocol to follow when unable to complete phone survey

Five in-store data collectors, only one of whom did not participate in round one, and two assistants/drivers who both participated in round one received a day of classroom refresher training on in-store audits. The training was identical to the classroom training for round one with three exceptions: an overview of the project was not included, instruction on marketing materials was less rigorous in response to results obtained in round one, and instructions were provided on entering post-audit store information into the Google doc shared with phone auditors.

In-store data collection for round two was identical to that of round one, with the exception of returning to stores where employees refused an audit. Because store matching was not conducted on the round two sample, if an employee refused the audit, a replacement store was immediately found with no return visit to the original store. When replacements were required, the replacement candidate was checked against the round one sample list to ensure it had not been previously audited, as well as against the round two sample list to avoid duplication.

After each in-store audit was completed, the store name (and address in the case of replacements) and primary language spoken by store employees were recorded on a Google doc to which the telephone data collection team had access. Bilingual callers handled calls to Spanish-speakers. In order to minimize the chances of finding differences due to restocking issues, calls were made within two hours after the visit the same day of the in-store audit, or the next day within a four-hour window (two hours before and two hours after) of the time visited the previous day to conduct the brief telephone survey. Responses were recorded in Qualtrics.

Telephone data collectors searched the Internet for alternate phone numbers when the one listed was incorrect. Once a number was found to belong to the correct store, the store was called until responses were obtained to every question. This sometimes required multiple calls by multiple callers over a period of several days.

Round two: Confirmatory analysis

As in round one, EFA, IRT, and sensitivity/specificity analyses were conducted in the round two sample to confirm selection of the seven-item survey.

Round two: Feasibility testing

Characteristics and NEMS-CS scores of the 86 stores from which responses to all telephone survey questions were obtained were compared to those of the 14 stores from which complete responses were not obtained. Simple frequencies were conducted to examine differences/similarities between telephone responses and in-store audit findings for each of the seven items. Frequencies and percentages were also compared between in-store findings and telephone responses according to total quantity of items found/reported.

CHAPTER 4

RESULTS

Round one

Audits of 230 stores were completed in round one. The 200 audits in Newark and Camden were completed over the course of 11 days in June, 2014. The remaining 30 audits in New Brunswick and Trenton were completed during July, August, and September, 2014.

Store characteristics were obtained from the InfoUSA dataset, and block group characteristics of neighborhoods in which stores were located were obtained from ACS. Mean sales volume of all stores was \$763,539 ± \$255,642 (Table 2). Block groups were predominately low-income and high-minority.

Table 2. Round 1 store characteristics and block group characteristics in which stores were located

Store characteristics	**Round 1 (n=230)**	
	Means	Range
Number of employees	2.85 ± 1.83	1-27
Sales volume (\$)	763,539 ± 255,642	277,000 – 3,000,000
Square footage (ft^2)	1276 ± 324	1000 - 6000
Block group characteristics		
HS/GED (proportion)	0.68 ± 0.13	0.33 – 1.00
White, non-Hispanic (proportion)	0.06 ± 0.08	0 – 0.40
Black, non-Hispanic (proportion)	0.46 ± 0.34	0 – 1.00
Hispanic/Latino (proportion)	0.45 ± 0.30	0 – 0.98
Median HH income (\$)	33,223 ± 12,498	8814 – 79,659
HH income <150% FPL (proportion)	0.48 ± 0.18	0 – 0.88
Unemployed (proportion)	0.12 ± 0.06	0 – 0.27
Female-headed HH w/children (proportion)	0.29 ± 0.13	0 – 0.83
Vacant housing units (proportion)	0.20 ± 0.13	0 – 0.56

Employees in five stores, none of which were upgraded stores, refused audits on the original visit. Three of the five agreed to an audit on a subsequent visit. Different data collectors visited the other two stores on three different occasions, but were refused each time. Seven stores were not found in the field or were no longer small food stores. Nineteen stores were permanently closed. Replacements were found for all three conditions. Average time for store audits was 13.96 ± 5.2 minutes, with a range of 6-38 minutes. Time was recorded from when data collectors entered the store until completion of the audit, before making the purchases that were used as part of a small secondary study.

Round one: Item variability

Adequate variability was observed in 5 of the 13 items added to the in-store instrument (Table 3). Items with adequate variability included marketing materials, SNAP and WIC signs, refrigeration, and fruit at the checkout.

Twelve of the 30 individual original NEMS-CS items, excluding individual FV, had adequate variability (Table 3). Half of the fresh fruits, including cantaloupe, peaches, strawberries, honeydew, and watermelon, had limited variability. Fresh vegetables with low variability included broccoli, corn, and cauliflower.

Nearly all stores stocked baked goods of any kind, but only five percent of them carried the low-fat options (bagels, English muffins, low-fat muffins) listed on the audit instrument. Eighty-two percent of stores stocked fresh fruits, with an average of 3.5 ± 3.3 varieties per store (Table 4). Ninety percent of stores stocked fresh vegetables, with an average of 4.8 ± 3.3 varieties per store.

Table 3. Frequencies/percentages of items in round 1 in-store audits

	Round 1 (n=230)		
	Frequencies	Percentages	Adequate variability
Rater ID			
00	27	11.7	
01	69	30	
02	69	30	
03	19	8.3	
04	30	13	
05	16	7	
06	0	0	
07	0	0	
17	0	0	
Number of cash registers			N[a]
1	221	96.1	
2	8	3.5	
3+	1	0.4	
Space for food			N[a]
Low (less than 25%)	3	1.3	
Moderate (25-50%)	7	3	
Most (>50%)	220	95.7	
Marketing materials for healthy foods			Y[b]
Window clings only	41	17.8	
Fliers only	1	0.4	
Awnings only	68	29.6	
Other	5	2.2	
Multiple	24	10.4	
None	91	39.6	
Healthy corner store initiative			Y[a]
Camden Healthy Corner Store Network	19	8.3	
Other	5	2.2	
None	206	89.6	
SNAP signs			Y[b]
No	78	33.9	
Yes	152	66.1	
Any WIC signs (windows or shelves)			Y[b]
No	160	69.6	
Yes	70	30.4	
Accept both WIC and SNAP			combined items
No	176	76.5	
Yes	54	23.5	
Refrigeration for FV and/or meat			Y[b]

No	36	15.7	
Yes	194	84.3	
See-through refrigeration			
No	4	2.1	
Yes	190	97.9	
Refrigeration & contents visible from door			
No	124	63.9	
Yes	70	36.1	
Candy/cookies/snack cakes at checkout			N[b]
No	3	1.3	
Yes	227	98.7	
Fresh fruit at checkout			Y[b]
No	144	62.6	
Yes	86	37.4	
Fresh vegetables at checkout			N[b]
No	217	94.3	
Yes	13	5.7	
Bottled water at checkout			N[b]
No	228	99.1	
Yes	2	0.9	
SSB at checkout			N[b]
No	227	98.7	
Yes	2	0.9	
Endcaps marked as healthy			N[b]
No	229	99.6	
Yes	1	0.4	
Shelves marked as healthy			N[b]
No	229	99.6	
Yes	1	0.4	
Upgraded store			Y[c]
No	167	83.5	
Yes	33	16.5	
MILK			N[a]
No	12	5.2	
Yes	218	94.8	
Lowest fat milk			Y[a]
Skim	25	10.9	
1%	24	10.4	
2%	131	57	
None	50	21.7	
FRESH FRUIT			Y[a]
No	41	17.8	
Yes	189	82.2	

Bananas			Y[a]
No	64	27.8	
Whole/cut-up multi-serve only	166	72.2	
Cut-up/single-serve only	0	0	
Both	0	0	
Apples			Y[a]
No	112	48.7	
Whole/cut-up multi-serve only	117	50.9	
Cut-up/single-serve only	0	0	
Both	1	0.4	
Oranges			Y[a]
No	117	50.9	
Whole/cut-up multi-serve only	113	49.1	
Cut-up/single-serve only	0	0	
Both	0	0	
Grapes			Y[a]
No	196	85.2	
Whole/cut-up multi-serve only	27	11.7	
Cut-up/single-serve only	7	3	
Both	0	0	
Cantaloupe			N[a]
No	218	94.8	
Whole/cut-up multi-serve only	11	4.8	
Cut-up/single-serve only	1	0.4	
Both	0	0	
Peaches			N[a]
No	209	90.9	
Whole/cut-up multi-serve only	20	8.7	
Cut-up/single-serve only	1	0.4	
Both	0	0	
Strawberries			N[a]
No	212	92.2	
Whole/cut-up multi-serve only	13	5.7	
Cut-up/single-serve only	5	2.2	
Both	0	0	
Honeydew			N[a]
No	225	97.8	
Whole/cut-up multi-serve only	4	1.7	
Cut-up/single-serve only	1	0.4	
Both	0	0	
Watermelon			N[a]
No	207	90	
Whole/cut-up multi-serve only	16	7	
Cut-up/single-serve only	5	2.2	

Both	2	0.9	
Pears			Y[a]
No	198	86.1	
Whole/cut-up multi-serve only	32	13.9	
Cut-up/single-serve only	0	0	
Both	0	0	
Other types of whole/cut-up non-mixed fruits			
0	104	45.2	
1	61	26.5	
2	32	13.9	
3	15	6.5	
4	6	2.6	
5	5	2.2	
6+	7	3	
Mixed cut-up, single-serve fruit			N[b]
No	217	94.3	
Yes	13	5.7	
Frozen fruit			N[a]
No	219	95.2	
Yes	11	4.8	
Canned fruit			Y[a]
No	62	27	
Yes	168	73	
FRESH VEGETABLES			N[a]
No	22	9.6	
Yes	208	90.4	
Carrots			Y[a]
No	170	73.9	
Whole/cut-up multi-serve only	60	26.1	
Cut-up/single-serve only	0	0	
Both	0	0	
Tomatoes			Y[a]
No	52	22.6	
Whole/cut-up multi-serve only	178	77.4	
Cut-up/single-serve only	0	0	
Both	0	0	
Bell peppers			Y[a]
No	82	35.7	
Whole/cut-up multi-serve only	148	64.3	
Cut-up/single-serve only	0	0	
Both	0	0	
Broccoli			N[a]
No	223	97	

Whole/cut-up multi-serve only	7	3	
Cut-up/single-serve only	0	0	
Both	0	0	
Lettuce			Y[a]
No	93	40.4	
Whole/cut-up multi-serve only	137	59.6	
Cut-up/single-serve only	0	0	
Both	0	0	
Corn			N[a]
No	217	94.3	
Whole/cut-up multi-serve only	13	5.7	
Cut-up/single-serve only	0	0	
Both	0	0	
Celery			Y[a]
No	184	80	
Whole/cut-up multi-serve only	46	20	
Cut-up/single-serve only	0	0	
Both	0	0	
Cucumbers			Y[a]
No	184	80	
Whole/cut-up multi-serve only	46	20	
Cut-up/single-serve only	0	0	
Both	0	0	
Cabbage			Y[a]
No	156	67.8	
Whole/cut-up multi-serve only	74	32.2	
Cut-up/single-serve only	0	0	
Both	0	0	
Cauliflower			N[a]
No	229	99.6	
Whole/cut-up multi-serve only	1	0.4	
Cut-up/single-serve only	0	0	
Both	0	0	
Other types of whole/cut-up non-mixed vegetables			
0	38	16.5	
1	22	9.6	
2	81	35.2	
3	25	10.9	
4	20	8.7	
5	16	7	
6+	28	12.2	
Mixed cut-up, single-serve vegetables			N[b]
No	226	98.3	

Yes	4	1.7	
Frozen vegetables			Y[a]
No	108	47	
Yes	122	53	
Canned vegetables			N[a]
No	6	2.6	
Yes	224	97.4	
Any single-serve fruits or vegetables			combined items
No	210	91.3	
Yes	20	8.7	
GROUND BEEF/GROUND TURKEY			Y[a]
No	191	83	
Yes	39	17	
Lean ground beef/turkey			N[a]
No	222	96.5	
Yes	8	3.5	
HOT DOGS			Y[a]
No	29	12.6	
Yes	201	87.4	
98% fat-free wieners			N[a]
No	230	100	
Yes	0	0	
Light wieners			Y[a]
No	109	47.4	
Yes	121	52.6	
REDUCED FAT FROZEN DINNERS			Y[a]
No	202	87.8	
Yes	28	12.2	
BAKED GOODS			N[a]
No	5	2.2	
Yes	225	97.8	
Single bagels			N[a]
No	213	94.7	
Yes	12	5.3	
Packages of bagels			N[a]
No	209	98.1	
Yes	4	1.9	
English muffins			N[a]
No	209	100	
Yes	0	0	
Low-fat muffins			N[a]
No	208	99.5	
Yes	1	0.5	

BEVERAGES			
Diet soda			N[a]
No	20	8.7	
Yes	209	90.9	
100% juice			N[a]
No	10	4.3	
Yes	220	95.7	
Bottled water			N[a]
No	4	1.7	
Yes	226	98.3	
Non-carbonated zero or low-calorie drinks			Y[a]
No	28	12.2	
Yes	202	87.8	
WHOLE GRAIN BREAD			Y[a]
No	149	64.8	
Yes	81	35.2	
BAKED CHIPS			N[a]
No	215	93.5	
Yes	15	6.5	
100-CALORIE SNACKS			N[a]
No	209	90.9	
Yes	21	9.1	
LOW-SUGAR CEREAL			Y[a]
No	40	17.4	
Yes	190	82.6	
Number of varieties of low-sugar cereal			
0	40	17.4	
1	35	15.2	
2	33	14.3	
3+	122	53	

Y: Yes; N: No; [a]Original NEMS-CS items; [b]Added items; [c]Not a food item

Table 4. Means and ranges for round 1 continuous variables

	n=230	
	Means	Range
Fresh fruit varieties	3.49 ± 3.34	0-15
Fresh vegetable varieties	4.84 ± 3.26	0-14
NEMS-CS points	12.67 ± 4.34	0-23

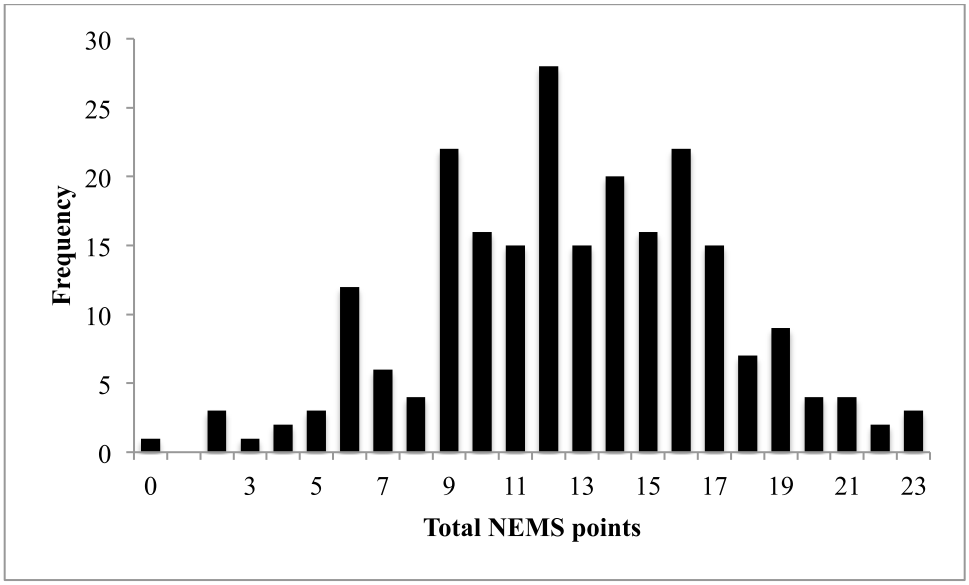

Figure 2. Round 1 NEMS-CS points distribution

Round one: NEMS-CS score associations

NEMS-CS points ranged from 0 to 23, with an average score of 12.75 ± 4.38 (Table 4; Figure 2). No significant differences in NEMS-CS points were observed between upgraded and non-upgraded stores ($p = 0.35$) (Table 5). Stores with signs indicating they accepted WIC had significantly higher NEMS-CS points than did stores without WIC signs ($p < 0.001$). Stores with refrigeration for storing fresh fruits and vegetables and/or meat, and stores that had fresh fruit at the checkout had significantly higher NEMS-CS scores than did stores without refrigeration or checkout fruit ($p < 0.001$; $p = 0.01$, respectively). When stores stocked at least five different varieties of fruits and/or vegetables, their NEMS-CS scores were significantly higher than when they stocked four or fewer varieties ($p < 0.001$ for both) (Table 6).

Table 5. Round 1 NEMS-CS points comparisons on items added to original NEMS-CS

	n	Mean NEMS-CS points	p-value
Upgraded store	33	13.33 ± 4.8	0.35
Non-upgraded store	166	12.55 ± 4.3	
Marketing materials			
None	91	12.22 ± 4.6	
Window clings, brochures, fliers, other	71	12.72 ± 4.3	0.19
Awnings	68	13.50 ± 4.1	
Shelf signs for WIC	48	16.38 ± 3.2	<.001
No shelf signs for WIC	182	11.80 ± 4.1	
Window signs for WIC	62	15.52 ± 4.1	<.001
No window signs for WIC	167	11.68± 4.0	
Shelf OR window signs for WIC	70	15.40 ± 4.1	<.001
No shelf or window signs for WIC	160	11.59 ± 4.0	
SNAP signs	152	13.08 ± 4.2	0.11
No SNAP signs	78	12.12 ± 4.7	
SNAP signs but no WIC	98	11.63 ± 3.6	0.44
No SNAP signs and no WIC	78	12.12 ± 4.7	
Refrigeration for storing FV and/or meat	194	13.50 ± 3.9	<.001
No refrigeration for storing FV and/or meat	36	8.72 ± 4.9	
Fresh fruit at checkout	86	13.66 ± 3.6	0.01
No fresh fruit at checkout	144	12.21 ± 4.7	
Single-serve fruits or vegetables	20	13.65 ± 5.0	0.34
No single-serve fruits or vegetables	210	12.67 ± 4.3	

Table 6. Round 1 NEMS-CS points comparisons by varieties of fresh fruits and fresh vegetables

	n	Mean NEMS-CS points	p-value
0-4 varieties of fresh fruits	170	11.39 ± 3.9	<.001
5-15 varieties of fresh fruits	60	16.61 ± 3.4	
0-4 varieties of fresh vegetables	116	10.07 ±3.6	<.001
5-14 varieties of fresh vegetables	114	15.48 ±3.3	

NEMS-CS points were grouped by decile to ascertain the percentages of stores in each decile containing listed items, and to examine the differences in mean quantities of fresh FV and frozen vegetables within each decile. A higher percentage of stores in the top deciles of NEMS-CS points tended to have WIC signs, skim or 1% milk, frozen vegetables, and 100% whole grain bread than did stores in the lower deciles (Table 7). Varieties of fresh FV and frozen vegetables also tended to be higher with increasing NEMS-CS score deciles.

Table 7. Round 1 Top: Percent of stores in each NEMS-CS score decile with the listed item; Bottom: Means of continuous variables by NEMS-CS score decile

	Top 10% (n=29) 18-23 pts	80th % (n=15) 17 pts	70th % (n=22) 16 pts	60th % (n=16) 15 pts	50th % (n=20) 14 pts	40th % (n=15) 13 pts	30th % (n=43) 11-12 pts	20th % (n=16) 10 pts	10th % (n=32) 7-9 pts	Lowest 10% (n=22) 0-6 pts
Percents										
Any WIC signs	76	47	41	50	30	20	19	0	13	14
Refrig for FV/meat	97	80	100	94	90	93	93	81	75	36
Fresh fruit @ checkout	35	47	36	44	50	60	47	44	19	9
Skim or 1% milk	69	40	36	19	15	13	12	6	3	0
Frozen veg	90	100	77	63	60	40	47	25	31	9
Canned fruit	100	73	86	81	75	87	77	81	53	23
Ground beef/turkey	41	47	23	13	15	13	14	0	6	0
Light wieners	66	67	32	69	80	73	58	63	34	5
Low-fat frzn dinners	52	13	23	6	15	7	2	0	0	0
Low-cal drinks	93	100	86	100	95	100	95	75	78	59
100% whole grain bread	97	87	59	69	40	20	5	0	9	0
Low-sugar cereal	100	100	96	100	90	100	100	63	53	27
Means										
Total fruit varieties	7.83	5.67	5.50	3.44	3.25	3.20	2.58	2.00	1.44	0.59
Total veg varieties	8.83	6.87	6.50	5.56	4.75	5.00	4.30	3.13	3.13	0.91
Frzn veg varieties	4.97	5.33	3.64	2.69	2.75	1.87	2.07	0.69	1.09	0.32

Round one: Multicollinearity testing

Pearson correlations between the 13 weighted NEMS-CS item-scores were examined for multicollinearity to determine which items might measure the same construct. The correlation between fresh vegetables and fresh fruit was 0.616. The correlation was 0.518 between frozen and canned vegetables and fresh vegetables (Table 8). All other correlations were below 0.5.

Table 8. Inter-item correlations among weighted scores in 13 NEMS-CS categories

n=230	Milk	Fresh fruit	Frzn/ cnd fr	Fresh veg	Frzn/ cnd veg	Grnd beef	Hot dogs	Frzn dinn	Bkd goods	Bevrg	Bread	Chips/ snks	Cereal
Milk (3)	1												
Fresh fruit (3)	.395	1											
F&C fruit (2)	.170	.240	1										
Fresh veg (3)	.426	**.616**	.235	1									
F&C veg (2)	.336	.357	.204	**.518**	1								
Grnd beef (4)	.005	.062	.017	.168	.129	1							
Hot dogs (3)	.156	.078	.050	.234	.079	-.065	1						
Frzn dinn (2)	.262	.215	.087	.177	.239	.133	-.019	1					
Bkd goods (2)	.127	.178	.060	.049	.043	-.053	-.031	.047	1				
Bevrg (3)	.229	.074	.095	.113	.058	-.079	.162	.066	.009	1			
Bread (3)	.445	.431	.213	.411	.316	.129	.080	.236	.061	.046	1		
Chips & Snks (6)	.046	-.013	.184	-.099	-.056	-.077	-.096	.052	.108	.098	.104	1	
Cereal (2)	.332	.273	.283	.325	.212	-.001	.231	.136	-.002	.315	.220	.011	1

Numbers in parentheses after items indicate the number of points possible in NEMS-CS scoring in each category

Round one: Exploratory factor analysis

Exploratory factor analysis was conducted to examine the dimensionality (i.e., number of latent factors underlying) of the items from the full instrument and to identify a conceptually meaningful set or sets of like items. The scree plot of eigenvalues can help identify the factor solution to retain for further consideration (Figure 3). The inflection point in the scree plot indicates that a three-factor solution is optimal. Factor correlations were examined to ensure each factor was measuring an independent construct. Low correlations confirmed independence of the three factors (Tables 9a and 9b). Table 10 shows factor loadings for one- two- and three-factor solutions. Ten of the included items had strong factor loadings (>0.45) on the first factor and held together strongly enough to be considered as possibly constituting a healthfulness construct. Those 10 items included:

- Any WIC signs
- Refrigeration
- Low-fat milk
- Fruit categories
- Vegetable categories
- Frozen vegetables
- Ground meat
- Low-fat frozen dinners
- Whole grain bread
- Low-sugar cereal

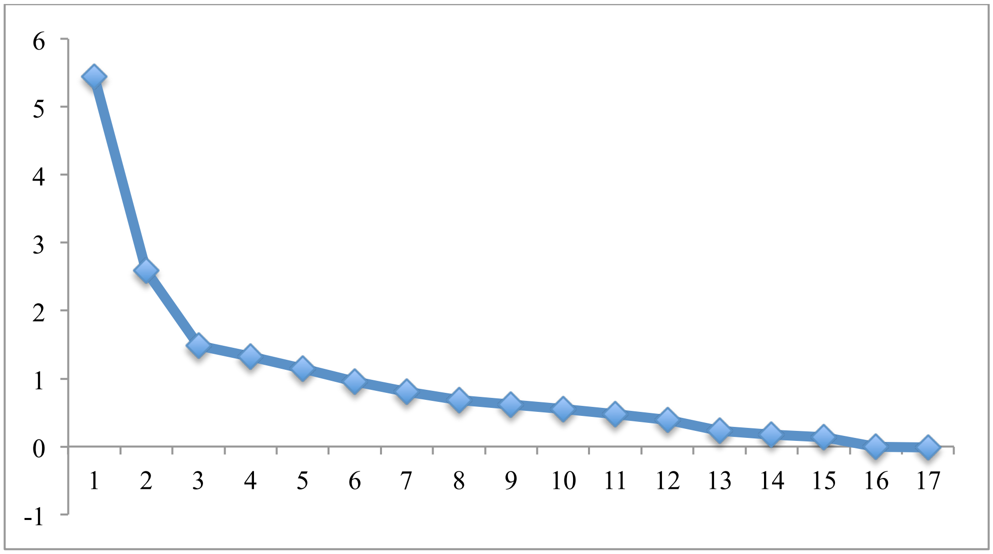

Figure 3. Scree plot showing eigenvalues of the 17 items included in round 1 EFA

Table 9a. Round 1 EFA correlations between factors in two-factor solution

	1	2
1	1	
2	0.211	1

Table 9b. Round 1 EFA correlations between factors in three-factor solution

	1	2	3
1	1		
2	0.329	1	
3	-0.274	-0.109	1

Table 10. Round 1 EFA factor loadings for 1-factor, 2-factor, and 3-factor solutions

	1-factor solution	2-factor solution		3-factor solution		
	1	1	2	1	2	3
Marketing materials	0.145	0.111	0.080	0.303	-0.030	0.396
HCSN (Healthy Corner Store Network)	-0.066	-0.322	**0.482**	-0.371	**0.520**	0.027
SNAP signs	0.159	0.111	0.106	0.177	0.065	0.158
Accept WIC	**0.721**	**0.745**	-0.002	**0.741**	-0.033	-0.045
Refrigeration	**0.540**	0.338	0.434	0.327	0.416	0.050
Fruit at checkout	0.184	-0.076	**0.517**	-0.018	**0.469**	0.222
Lowfat milk	**0.667**	**0.759**	-0.157	**0.679**	-0.142	-0.253

Fruit categories (<5/≥5)	**0.749**	**0.807**	-0.080	**0.840**	-0.137	0.014
Canned fruit	0.434	0.270	0.344	0.012	0.482	-0.489
Veg categories (<5/≥5)	**0.830**	**0.804**	0.114	**0.880**	0.036	0.140
Frozen vegetables	**0.656**	**0.615**	0.153	**0.634**	0.109	0.041
Ground meat	**0.547**	0.341	0.535	0.290	**0.545**	-0.005
Light hot dogs	0.243	-0.137	**0.767**	0.004	0.769	0.582
Frozen dinners	**0.482**	**0.473**	0.065	0.382	0.094	-0.214
Low calorie drinks	0.368	0.019	**0.668**	-0.095	**0.711**	-0.091
Bread	**0.820**	**0.845**	0	**0.771**	0.010	-0.201
Cereal	**0.721**	0.459	0.610	0.350	**0.633**	-0.128

Bolded items are those that seem to measure the same construct in each column

Round one: Item response theory analysis

Item response theory analysis was also conducted to identify which items might be part of a latent healthfulness trait in the survey. The item characteristic curve plot for the 14-item model was examined first for overlapping difficulties values. Similar values provide information about the same types of stores with regard to healthfulness. Before eliminating items with overlapping values, the item information curve (IIC) plot was examined to identify items with low discrimination values, indicating that presence versus absence of the item in a store did not provide substantial information about the healthfulness of that store. In other words, the item's presence did not discriminate between healthy and less-healthy stores. The IIC in Figure 4, panel B shows that four items – low-calorie drinks, canned fruit, light hot dogs, and checkout fruit – had minimal areas-under-the-curve.

The four non-discriminating items were excluded, leaving a 10-item model. Figure 5, panel A shows its item characteristic curve plot. Difficulties do not overlap and include a spectrum from a θ of -2 to 2, indicating that the items provide information about a broad spectrum of stores with regard to healthfulness. Figure 5, panel B shows the amount of information on healthfulness supplied by each of the 10 items.

Panel C in Figures 4 and 5 show the total information curves for each model. The total information curve (TIC) combines the information from each individual item. Maximum scale reliability is calculated as 1 – 1/height of the TIC curve. The 14-item model reveals a maximum scale reliability of 0.84 (1 – 1/6.25); the 10-item composite a maximum scale reliability of 0.80 (1 – 1/5).

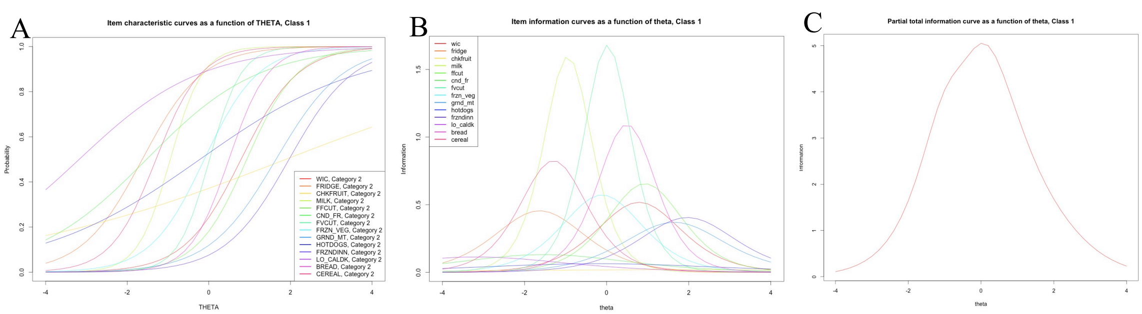

Figure 4. Item characteristic curves (Panel A), Item information curves (Panel B), and Total information curve (Panel C) for 14 items

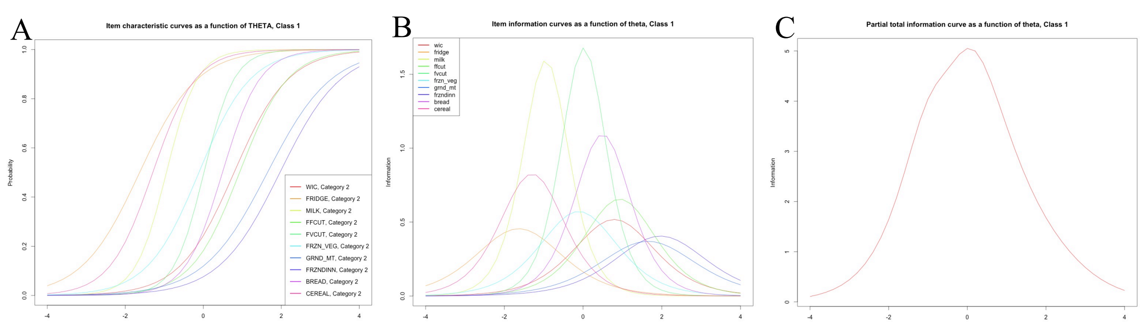

Figure 5. Item characteristic curves (Panel A), Item information curves (Panel B), and Total information curve (Panel C) for 10 items

Round one: Item-set correlations with NEMS-CS

The same 10 items were identified by both EFA and IRT analyses as comprising a healthfulness construct. The Pearson correlation between the 10-item set and NEMS-CS scores was r=0.88. The 10-item-set scores and NEMS-CS scores were divided into tertiles and crosstabs were run. Relatively good agreement was observed between 10-item-set categories and NEMS-CS score categories (Table 11). Seventy-five percent of stores were classified identically. One store was categorized in the healthiest tertile according to the 10-item-set, whereas it was in the lowest NEMS-CS score category.

Table 11. Round 1 10-item set tertiles by NEMS-CS points tertiles

		NEMS-CS points			
		0-10 points	11-14 points	15-23 points	Total
10-item set[a]	0-2 points	57	11	0	68
	3-4 points	12	45	10	67
	5-10 points	1	23	71	95
	Total	70	79	81	230

[a]WIC, refrigeration, skim/1% milk, fresh fruit cuts (<5/≥5), fresh vegetable cuts (<5/≥5), frozen vegetables, ground meat, low-fat frozen dinners, whole grain bread, low-sugar cereal

The 10-item-set and NEMS-CS points were also divided into the top 20% (healthy classification) and bottom 80% (unhealthy classification) of scores. Sensitivity/specificity analyses were conducted to test the ability of the 10-item-set to correctly classify a store as healthy versus unhealthy. Overall, the reduced-item-set classified 90% of stores correctly (Table 12). Positive predictive value (PPV) and sensitivity both assess the probability that a store classified as unhealthy by the reduced-item-set is also classified as unhealthy by NEMS-CS score. Sensitivity and PPV in this case were 0.93 and 0.94, respectively. Negative predictive value (NPV) and specificity assess the probability that a store categorized as healthy by the reduced-item-set is categorized the same by NEMS-CS score. Specificity and NPV of the 10-item-set were 0.74 and 0.71, respectively.

Table 12. Round 1 sensitivity/specificity analysis comparing 10-item set to NEMS-CS points

		NEMS-CS points			
		0-16 points	17-23 points	Total	
10-item set[a]	0-6 points	174 True unhealthy	11 False unhealthy	185	PPV 174/185 = 0.94
	7-10 points	13 False healthy	32 True healthy	45	NPV 32/45 = 0.71
	Total	187	43	230	
		Sensitivity 174/187 = 0.93	Specificity 32/43 = 0.74		Accuracy (174+32)/230 = 0.90

[a]WIC, refrigeration, skim/1% milk, fresh fruit cuts (<5/≥5), fresh vegetable cuts (<5/≥5), frozen vegetables, ground meat, low-fat frozen dinners, whole grain bread, low-sugar cereal

Ten stores in the Phoenix, Arizona metro area were visited and called to test the feasibility of using the 10-item survey. Store employee responses did not match in-store findings at least 80% of the time for bread, cereal, and frozen dinner items (Table 13). These items were therefore excluded from the reduced-item-set. Although respondents also were not able to discriminate between five or more versus less than five fruits and vegetables, these items are central to a store's healthfulness and are the primary focus when stores are targeted for healthy changes; thus both items were retained.

Table 13. Number of Phoenix stores with phone responses matching in-store audits

n=10 stores	Correct	Incorrect
Milk (skim/1%)	9	1
Fresh fruit (≥5)	6	4
Fresh vegetables (≥5)	7	3
Frozen vegetables	9	1
Ground meat	10	0
Bread (whole grain)	5	5
Cereal (low-sugar)	6	4
Frozen dinners (low-fat)	7	3
Refrigeration	4	1
WIC	9	1

After dropping three items from the reduced-item-set the same crosstabs were run on the seven-item-set as were run on the 10-item-set. Lower agreement was observed across tertile categories of the 7- versus 10-item set (Table 14). Sixty-eight percent of stores were classified identically between seven-item set tertiles and NEMS-CS score tertiles. Three stores were categorized by the seven-item-set in the extreme opposite category as their NEMS-CS categorization. The Pearson correlation between the seven-item set and NEMS-CS points was r=0.79.

Overall accuracy of the seven-item-set in sensitivity/specificity analysis was slightly lower than that of the 10-item-set (Table 15). Sensitivity and PPV were almost identical between the 7- and 10-item-sets. Specificity and NPV of the seven-item set were 0.70 and 0.67, respectively.

Table 14. Round 1 7-item set tertiles by NEMS-CS points tertiles

		NEMS-CS points			
		0-10 points	11-14 points	15-23 points	Total
7-item set[a]	0-1 points	48	15	1	64
	2-3 points	20	47	19	86
	4-7 points	2	17	61	80
	Total	70	79	81	230

[a]WIC, refrigeration, skim/1% milk, fresh fruit cuts (<5/≥5), fresh vegetable cuts (<5/≥5), frozen vegetables, ground meat

Table 15. Round 1 sensitivity/specificity analysis comparing 7-item set to NEMS-CS points

		NEMS-CS points			
		0-16 points	17-23 points	Total	
7-item set[a]	0-4 points	172 True unhealthy	13 False unhealthy	185	PPV 172/185 = 0.93
	5-7 points	15 False healthy	30 True healthy	45	NPV 30/45 = 0.67
	Total	187	43	230	
		Sensitivity 172/187 = 0.92	Specificity 30/43 = 0.70		Accuracy (172+30)/230 = 0.88

[a]WIC, refrigeration, skim/1% milk, fresh fruit cuts (<5/≥5), fresh vegetable cuts (<5/≥5), frozen vegetables, ground meat

Item response theory was conducted on the 7-item-model, and a maximum scale reliability value of 0.74 (1-1/3.85) was obtained (Figure 6).

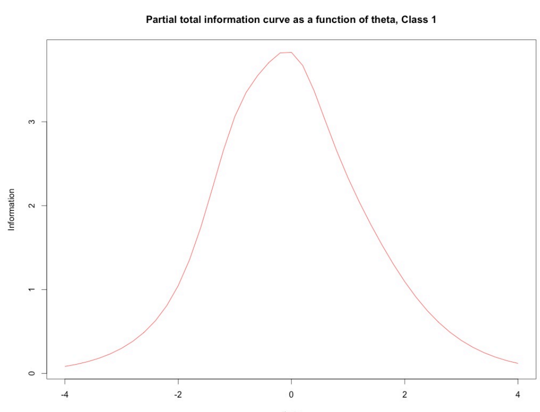

Figure 6. Total information curve for 7 items

Round two

In-store audits of 100 stores were completed in round two over the course of nine days in December, 2014. Employees in nine stores, none of which were upgraded stores, refused audits. Four stores were not found in the field or were no longer small food stores, and nine were permanently closed. Replacements were found for all three conditions. Average time for store audits was 12.49 ± 4.7 minutes with a range of 6-33 minutes.

Round two: Confirmatory analysis

As in round one, EFA, IRT, Pearson correlations, and sensitivity/specificity analyses were conducted in the round two sample to confirm selection of the seven-item survey. Results were similar (correlation of r=0.73 between NEMS-CS score and seven-item set) and confirmed the seven-item-set selection (Appendix G).

Round two: Feasibility testing

Valid telephone numbers were obtained for 88 stores. Complete responses were gathered from 86 stores. An average of 3.03 ± 2.65 calls per store were required to complete phone audits, with a range of 1 to 15 calls. Fifty-one percent of the calls were completed within the designated window of time. Among calls not completed within the designated time window, the mean number of days required for completion was 5.77 ± 3.09, with a range of 2-14 days. Stores that completed the phone survey were significantly larger in square footage than were stores that did not complete the phone survey (Table 16). Thirteen of the replacement stores were not listed in the InfoUSA dataset; therefore store characteristic information is not available for those stores.

Table 16. Comparisons between stores with complete phone surveys and those without complete phone surveys

	Means	p-value
NEMS-CS points		
No phone survey (n=14)	11.79 ± 4.5	.78
Phone survey completed (n=86)	12.09 ± 3.8	
Employees		
No phone survey (n=14)	2.57 ± 0.8	.26
Phone survey completed (n=73)	3.66 ± 3.6	
Sales volume		
No phone survey (n=14)	$753,571 ± $276,468	.44
Phone survey completed (n=73)	$964,137 ± $993,678	
Square footage		
No phone survey (n=14)	1250 ± 0	.01
Phone survey completed (n=73)	1668 ± 1384	

Table 17 shows the results of the in-store audits for the 86 stores with complete phone responses. Frequencies were similar to those observed in round one. A higher percentage of stores had fresh vegetables at the checkout in round two compared to round one due completely to the presence of avocados. A lower percentage of stores had any fresh vegetables. Eighty-one percent of stores stocked fresh fruits, and 85% stocked fresh vegetables.

Table 17. Frequencies/percentages of round two in-store audits of 86 stores with complete phone surveys

	Frequencies	**Percents**
Rater ID		
00	27	31.4
02	16	18.6
03	1	1.2
06	7	8.1
07	5	5.8
17	30	34.9
SNAP signs		
No	41	47.7
Yes	45	52.3
Any WIC signs (windows or shelves)		
No	69	80.2
Yes	17	19.8
Refrigeration for FV and/or meat		

No	17	19.8
Yes	69	80.2
See-through refrigeration		
No	0	0
Yes	69	100
Refrigeration & contents visible from door		
No	43	62.3
Yes	26	37.7
Candy/cookies/snack cakes at checkout		
No	1	1.2
Yes	85	98.8
Fresh fruit at checkout		
No	45	52.3
Yes	41	47.7
Fresh vegetables at checkout		
No	76	88.4
Yes (avocados)	10	11.6
Bottled water at checkout		
No	86	100
Yes	0	0
SSB at checkout		
No	83	96.5
Yes	3	3.5
MILK		
No	2	2.3
Yes	84	97.7
Lowest fat milk		
Skim	14	16.3
1%	7	8.1
2%	46	53.5
None	19	22.1
FRESH FRUIT		
No	16	18.6
Yes	70	81.4
Bananas		
No	23	26.7
Whole/cut-up multi-serve	63	73.3
Cut-up/single-serve	0	0
Both	0	0
Apples		
No	42	48.8
Whole/cut-up multi-serve	42	48.8
Cut-up/single-serve	0	0
Both	2	2.4
Oranges		

No	45	52.3
Whole/cut-up multi-serve	41	47.7
Cut-up/single-serve	0	0
Both	0	0
Grapes		
No	72	83.7
Whole/cut-up multi-serve	9	10.5
Cut-up/single-serve	5	5.8
Both	0	0
Cantaloupe		
No	83	96.5
Whole/cut-up multi-serve	1	1.2
Cut-up/single-serve	1	1.2
Both	1	1.2
Peaches		
No	86	100
Whole/cut-up multi-serve	0	0
Cut-up/single-serve	0	0
Both	0	0
Strawberries		
No	84	97.7
Whole/cut-up multi-serve	2	2.3
Cut-up/single-serve	0	0
Both	0	0
Honeydew		
No	85	96.5
Whole/cut-up multi-serve	0	0
Cut-up/single-serve	0	0
Both	1	1.2
Watermelon		
No	83	96.5
Whole/cut-up multi-serve	0	0
Cut-up/single-serve	3	3.5
Both	0	0
Pears		
No	81	94.2
Whole/cut-up multi-serve	5	5.8
Cut-up/single-serve	0	0
Both	0	0
Other types of whole/cut-up non-mixed fruits		
0	58	67.4
1	17	19.8
2	4	4.7
3	4	4.7
4	1	1.2

5	0	0
6+	2	2.3
Mixed cut-up, single-serve fruit		
No	77	89.5
Yes	9	10.5
Total fruit varieties		
<5	75	87.2
≥5	1	12.8
<4	54	62.8
≥4	32	37.2
Frozen fruit		
No	84	97.7
Yes	2	2.3
Canned fruit		
No	21	24.4
Yes	65	75.6
FRESH VEGETABLES		
No	13	15.1
Yes	73	84.9
Carrots		
No	65	75.6
Whole/cut-up multi-serve	20	23.3
Cut-up/single-serve	1	1.2
Both	0	0
Tomatoes		
No	26	30.2
Whole/cut-up multi-serve	60	69.8
Cut-up/single-serve	0	0
Both	0	0
Bell peppers		
No	33	38.4
Whole/cut-up multi-serve	53	61.6
Cut-up/single-serve	0	0
Both	0	0
Broccoli		
No	83	96.5
Whole/cut-up multi-serve	3	3.5
Cut-up/single-serve	0	0
Both	0	0
Lettuce		
No	29	33.7
Whole/cut-up multi-serve	57	66.3
Cut-up/single-serve	0	0
Both	0	0
Corn		

No	85	98.8
Whole/cut-up multi-serve	1	1.2
Cut-up/single-serve	0	0
Both	0	0
Celery		
No	75	87.2
Whole/cut-up multi-serve	15	12.8
Cut-up/single-serve	0	0
Both	0	0
Cucumbers		
No	78	90.7
Whole/cut-up multi-serve	8	9.3
Cut-up/single-serve	0	0
Both	0	0
Cabbage		
No	81	94.2
Whole/cut-up multi-serve	5	5.8
Cut-up/single-serve	0	0
Both	0	0
Cauliflower		
No	84	97.7
Whole/cut-up multi-serve	2	2.3
Cut-up/single-serve	0	0
Both	0	0
Other types of whole/cut-up non-mixed vegetables		
0	22	25.6
1	8	9.3
2	35	40.7
3	5	5.8
4	11	12.8
5	3	3.5
6+	2	2.3
Mixed cut-up, single-serve vegetables		
No	80	93.0
Yes	6	7.0
Total vegetable varieties		
<5	59	68.6
≥5	27	31.4
<4	37	43.0
≥4	49	57.0
Frozen vegetables		
No	54	62.8
Yes	32	37.2
Canned vegetables		
No	10	11.6

Yes	76	88.4
GROUND BEEF/GROUND TURKEY		
No	76	88.4
Yes	10	11.6
Lean ground beef/turkey		
No	10	100
Yes	0	0
HOT DOGS		
No	20	23.3
Yes	66	76.7
98% fat-free wieners		
No	65	98.5
Yes	1	1.5
Light wieners		
No	30	46.2
Yes	35	53.8
REDUCED FAT FROZEN DINNERS		
No	75	87.2
Yes	11	12.8
BAKED GOODS		
No	0	0
Yes	86	100
Single bagels		
No	75	87.2
Yes	11	12.8
Packages of bagels		
No	74	98.7
Yes	1	1.3
English muffins		
No	74	100
Yes	0	0
Low-fat muffins		
No	74	100
Yes	0	0
BEVERAGES		
Diet soda		
No	3	3.5
Yes	83	96.5
100% juice		
No	2	2.3
Yes	84	97.7
Bottled water		
No	0	0
Yes	86	100
Non-carbonated zero or low-calorie drinks		

No	10	11.6
Yes	76	88.4
WHOLE GRAIN BREAD		
No	60	69.8
Yes	26	30.2
BAKED CHIPS		
No	78	90.7
Yes	8	9.3
100-CALORIE SNACKS		
No	72	83.7
Yes	14	16.3
LOW-SUGAR CEREAL		
No	18	20.9
Yes	68	79.1
Number of varieties of low-sugar cereal		
0	18	20.9
1	18	20.9
2	10	11.6
3+	40	46.5

In-store findings vs phone responses

Phone responses to each of the seven items on the brief survey were compared to in-store findings of the same seven items. Skim or 1% milk was observed in 24% of stores during in-store audits (Table 18). Fifty-eight percent of phone respondents reported having skim or 1% milk. Five or more fresh fruits were found in 13% of stores; 41% of phone respondents reported having five or more fresh fruits. Five or more fresh vegetables were found in 31% of stores, and 51% of respondents reported having five or more fresh vegetables. Thirteen percent and 26% more phone respondents reported having frozen vegetables and ground meat, respectively, compared to the percent of stores observed during audits to have those items. Refrigeration and WIC item responses both differed by 8% compared to in-store audit observations.

In order to investigate whether discrepancies between FV phone reports versus in-store observations were potentially due to rounding by respondents, the percentage of stores found by in-store audits to have four or more fruits and four or more vegetables were calculated. Table 18 shows that fruit responses only differed by 3.5% and vegetable responses by less than 6% when comparing the responses to in-store observations of four or more FV.

Skim, 1%, and 2% milk in-store findings were combined and compared to low-fat milk phone responses to investigate the possibility that store employees included the availability of 2% milk when responding to the question about low-fat milk (Table 18). Phone respondents over-reported the presence of low-fat milk by 33.7%. However, if they did include 2% milk availability when responding, they under-reported by 19.8%.

Table 18. Comparisons between in-store findings and phone responses

n=86 stores	In-store	Percent	Telephone	Percent
Skim/1% milk				
No	65	75.6	36	41.9
Yes	21	24.4	50	58.1
Skim/1%/2% milk				
No	19	22.1		
Yes	67	77.9		
5 or more fruits				
No	75	87.2	51	59.3
Yes	11	12.8	35	40.7
4 or more fruits				
No	54	62.8		
Yes	32	37.2		
5 or more vegetables				
No	59	68.6	42	48.8
Yes	27	31.4	44	51.2
4 or more vegetables				
No	37	43.0		
Yes	49	57.0		
Frozen vegetables				
No	54	62.8	43	50.0
Yes	32	37.2	43	50.0
Ground meat				
No	76	88.4	54	62.8
Yes	10	11.6	32	37.2
Refrigeration				

No	17	19.8	7	12.3
Yes	69	80.2	50	87.7
Accept WIC				
No	69	80.2	62	72.1
Yes	17	19.8	24	27.9

To further break down comparisons between in-store audits and phone responses on the fruit, vegetable, and milk items, Tables 19 and 20 show the frequencies and percents of stores in which phone responses matched in-store findings, as well as a breakdown of how phone responses differed from in-store observations. Phone responses matched in-store findings on both fruits and vegetables about 70% of the time. In-store audits and phone responses on the milk item matched about half the time. Fewer than 5% of store employees reported having five or more fruits or five or more vegetables when none had been observed during in-store audits. Eighteen percent of respondents reported having low-fat milk when no or only whole milk had been observed during store audits.

Table 19. Comparisons of in-store findings with phone responses to fresh fruits and vegetables items

	Fruit	Percent	Vegetables	Percent
Phone answer matched in-store findings	62	70.5	65	73.9
Phone answer was ‘yes’ to ≥5; 4 varieties found with in-store audits	10	11.4	15	17.1
Phone answer was ‘yes’ to ≥5; 3 varieties found with in-store audits	4	4.5	3	3.4
Phone answer was ‘yes’ to ≥5; 2 varieties found with in-store audits	3	3.4	1	1.1
Phone answer was ‘yes’ to ≥5; 1 variety found with in-store audits	6	6.8	0	0
Phone answer was ‘yes’ to ≥5; None found in store	3	3.4	4	4.5
Total	88	100	88	100

Table 20. Comparisons of in-store findings with phone responses to milk item

	Milk	Percent
Phone answer matched in-store findings	48	54.5
Phone answer was 'yes' to skim or 1%; 2% (but not lowfat) milk found with in-store audits	24	27.3
Phone answer was 'yes' to skim or 1%; Only whole milk or no milk found with in-store audits	16	18.2
Total	88	100

CHAPTER 5

DISCUSSION

The shortage of supermarkets combined with the prevalence of small food stores in urban low-income areas has led to increasing numbers of communities utilizing corner store upgrades to expand healthy food access in neighborhoods otherwise lacking nutritious options. As corner store initiatives spread, assessments of the healthfulness of the businesses will become necessary both for identifying stores to be included in interventions and to establish compliance levels for stores already enrolled. The purpose of this study was to fill the need for a rapid-assessment tool by developing and validating a brief survey instrument that can be used either over the telephone or in-store.

Based on knowledge gained through established intervention efforts, a few key criteria have been identified for selecting a store for intervention participation. Store owner agreement is imperative; gauging an owner's level of interest, motivation to make positive changes, and capacity to learn new skills are primary considerations for inclusion. Other considerations include a store's overall viability and quality, its infrastructure and potential for improvement, its location relative to other community establishments like schools and public transit stops, and store/community relationships.[175,194]

Each of these steps is important in order to ascertain the potential sustainability of a store upgrade. Establishing relationships with owners is particularly crucial and cannot be rushed. Therefore, in some cases it may be important to conduct a pre-screening assessment of a store's healthfulness before going through such a time- and resource-intensive screening process. The short survey developed in the present study could identify a store's basic level of healthfulness to evaluate its fit for a particular program before commencement of the aforementioned involved screening process. In other words, the brief instrument could be used to assess whether a store meets the minimum criteria for inclusion in a program.

Once stores with potential for sustained success are identified, detailed assessments of their overall healthfulness are conducted.[194] The assessments must be accurate and comprehensive due to their role in informing the design and implementation of proposed interventions. This step requires thorough assessments using full store audits such as the NEMS-CS, rather than a brief instrument. As initiatives progress, businesses are evaluated for ongoing compliance. This is another function the short survey could serve, quickly and efficiently assessing a basic level of compliance. In this case the short instrument would be used to identify stores that have not yet progressed through the program and thus are not yet eligible to advance to the next level. Any that do meet the criteria as assessed by the short instrument should be further assessed by a longer audit. However, those found by the short instrument to not meet the criteria would not also require a full audit, thus saving time and resources that could be allocated to other intervention activities.

Corner stores play an important role in the urban food environment. While increasing the availability of supermarkets may be a more ideal solution to increasing healthy food access, locating supermarkets in urban areas is not always viable. Issues of land access and lack of a potential workforce often prevent establishing supermarkets in areas of greatest deprivation.[26,171] On the other hand, corner stores in urban low-income areas are ubiquitous and intermingled with homes, making them readily accessible to local residents. In interviews with New Orleans residents, interviewees reported shopping at neighborhood corner stores an average of 12 times per month, far more than they shopped at supermarkets. Proximity may have been primarily responsible for the discrepancy, as 60% of residents reported living three or more miles from the nearest supermarket, while the majority walked to the corner stores in their neighborhoods.[195]

Although small-store owners cite lack of consumer demand as a barrier to stocking healthy items such as FV,[179,180] evidence suggests that devoting more shelf space to produce in neighborhood stores is associated with higher consumption of FV among residents living in the neighborhoods in which those stores are located.[23,24] Furthermore, the Baltimore Healthy Stores intervention demonstrated an increase in weekly sales of healthy food items that were stocked and promoted as part of the intervention.[179]

The majority of small-store conversions utilize at least one type of promotion.[176,177,179,181-184,196] Interventions that assess the effect of promotions have reported a greater impact of the intervention on food behaviors with increasing levels of exposure to promotional materials.[178,181] In the present study, items were added to the in-store audit tool to assess levels of healthy food promotion. In order to avoid excluding any attempts stores may have made at promoting healthy items, data collectors were instructed to record all instances of pictures/photos of or promotional references (e.g., signs, fliers) to healthy foods such as FV, whole grains, or low-fat milk when assessing the presence of marketing materials for healthy foods. Intentional promotions were few, and were present primarily in HCSN stores. However, a large majority of stores had awnings and/or windows covered with pictures of FV, regardless of actual store inventory. This phenomenon skewed the results for the marketing materials item, creating the appearance that marketing materials were common in stores in this sample, when in fact they were extremely rare. A more accurate assessment of healthy marketing materials in stores in these cities would be obtained by revising the question to specify the presence of HCSN marketing materials.

Changing the placement of healthy items to make them more visible to customers is a relatively simple way of promoting the items. Small urban corner stores have limited space, but placing healthy items such as fruit at the checkout requires little effort or rearranging. Almost 40% of the stores in this sample had fruit at the checkout. In some cases this was the only fruit or vegetable in the store and may have been overlooked by customers had it not been at the checkout.

The WIC and SNAP items added to the survey were intended to assess promotion in a slightly different manner, and to examine whether the presence of either or both signs was associated with NEMS-CS scoring. Requirements for WIC vendors are more stringent than are SNAP vendor requirements and this was reflected in NEMS-CS scores. Stores that had either shelf or window signs for WIC had significantly higher NEMS-CS scores than did stores without any WIC signs. Conversely, NEMS-CS scores in stores with SNAP but no WIC signs did not differ from those in stores without SNAP or WIC signs. These results demonstrate that a potential strategy for increasing the healthfulness of corner stores is to incentivize them to become WIC vendors. The program and criteria for inclusion are already well-established, leaving the logistics of meeting the criteria as the primary issue for store owners and/or project directors to address.

One of the approaches encouraged by The Food Trust and used by Philadelphia's HCSI and other corner store initiatives is to provide small stores with refrigeration for storing fresh FV to preserve their quality.[28] The intent of the present study was to develop a survey that could be used over the phone, and therefore did not include the quality assessment piece of the NEMS-CS during in-store audits. However, an item assessing the presence of refrigeration for storing FV or fresh meat was added as a surrogate for quality, and was also included in the brief survey. Although asking store employees to rate the quality of their FV would be burdensome and unreliable, asking about the presence of refrigeration for their FV is an objective proxy for obtaining a more reliable evaluation of quality.

Creating a short survey instrument that would provide similar results to the full in-store audit was of utmost importance in this study. The primary intent of the short survey was to discriminate between healthy versus unhealthy stores. Therefore, in-store audit items with a lack of variability were automatically excluded from the brief survey due to their inability to make the healthy/unhealthy distinction. However, in some cases, items not included in the short instrument may be areas of focus for store upgrade initiatives. Indeed, in the current study, questions concerning the presence of endcaps and shelves marketing healthy snacks were added to the full instrument because they have been targeted as a healthy promotion strategy. While results of the in-store audits indicate that the strategy has not yet been initiated, once it is, these items could be added to the brief instrument, an approach that could be used in other interventions as well.

A dichotomous measure of healthy versus unhealthy was used to assess positive and negative predictive values, sensitivity and specificity, and overall accuracy.

However, one of the confounding issues when attempting to assess food environments is the lack of criteria for what constitutes healthfulness.[124] For this study, stores with NEMS-CS scores and short-item scores in the top 20% were classified as healthy, and those in the bottom 80% classified as unhealthy. This distinction was chosen because it was discriminating, yet not overly exclusive, particularly with regard to the items included in the brief instrument.

The ‘healthy’ versus ‘unhealthy’ designations utilized in this study should not be interpreted as descriptions, but rather as cut points chosen for comparison. As such, the seven items included in the brief survey are not uniquely nutritious items that automatically qualify a store as healthy. The items chosen for inclusion in the brief survey were limited by those included in the full audit tool, which consisted of the availability portion of the NEMS-CS plus the items added specifically for this study. Items for NEMS retail instruments, including the NEMS-CS, were carefully selected using an iterative process that included obtaining information about the foods that contribute the most fat and calories to the American diet and the foods recommended as most healthful in the diet, conducting fieldwork, and consulting experts.[185]

Overall accuracy for in-store use of the short survey was 88%. Positive predictive value and sensitivity were higher than were NPV and specificity, indicating that the tool is more effective at identifying an unhealthy store as truly unhealthy than it is at identifying a healthy store as truly healthy. While a finding of ‘false positive,’ analogous to a ‘false unhealthy’ outcome in the current analysis, would cause substantial undue anguish in medical situations, in the present study, although not ideal, it is less concerning than is a 'false healthy' outcome. Considering the results in these terms, 6.5% of stores were incorrectly classified as healthy by the short survey.

Telephone respondents tended to over-report the presence of items in the store. When responding to the questions about the presence of five or more fresh FV, it appears that respondents rounded up. Given the small inventory of fresh produce in most corner stores, restocking becomes a substantial issue in reporting varieties currently in stock. A customer's purchase of a single fruit or vegetable could make the difference between an accurate and an inaccurate response to questions with specific cut points, such as the FV ones used in the short survey. Employees in almost half of the 34 stores that had any discrepancies between fruit and/or vegetable phone responses versus in-store findings reported that FV had been restocked between in-store audits and the time of the phone call.

The discrepancy in milk reporting was likely due to respondents not discriminating between the presence of 2% milk versus skim or 1% milk. While respondents over-reported the existence of low-fat milk by 30%, had the survey question been about the presence of low-fat and 2% milk, the responses would have represented an under-reporting by 20%. Thus, it appears that approximately a quarter of the respondents did not discriminate between 2% versus low-fat milk.

In order to investigate the inconsistencies between observed and reported presence of ground meat, a team revisited the 16 stores in Newark in which discrepancies were observed. Data collectors first scanned the store for ground meat, after which they asked a store employee if it was sometimes/always stored where customers could not see it. Employees in six stores reported that, while available for purchase, the ground meat was stored in a freezer out of sight of customers. Although it would seem that an out-of-view item is not actually available, it is likely a case of local residents being familiar with stores' inventories and understanding the protocol for obtaining stocked items that may be stored out of view. Therefore, more reliable in-store assessments of the presence of ground meat may be obtained by asking employees whether or not they have the product for sale.

The restocking issue may have been partially responsible for discrepant findings in other items as well. In order to control for this issue, telephone data collectors attempted calling each store within two hours after the in-person visit, or the next day within a four-hour window (two hours before; two hours after) of the time the store had been visited. Telephone audits were completed within the desired time frame in about half of the 88 stores from which responses were obtained. While it is possible that other items were restocked along with FV, employees were only questioned about FV restocking so it is impossible to ascertain if in-store and phone results differed due to restocking.

The 88% response rate was attained due to the persistence of the nine telephone data-collectors. Because shifts were assigned throughout the day, stores that had not been reached within the designated windows of time could then be called at all times of day without undue stress on any one data collector. In one case three calls from three separate data collectors were required to get through every audit item. In spite of the difficulties associated with reaching stores over the phone – including obtaining correct numbers – the phone audits still required considerably less time and expense than did in-store audits.

Most stores were contacted within a week, each call took less than five minutes, and all phone audits were conducted from 2500 miles away.

Commercial datasets such as Dun & Bradstreet and InfoUSA are commonly used to identify stores in which to conduct interventions. The lists are limited, however, by both missing-data bias and misclassification bias.[193,197,198] Missing-data bias occurs when existing businesses are absent from the list. In order to mitigate this problem, researchers use a combination of lists. Misclassification bias is due to store owners misclassifying their businesses. The sole strategy to remedy this type of bias is by directly evaluating stores to determine if they meet specific classification criteria. Conducting full audits of all stores in a large-scale study to ensure their correct classification would be time- and resource-prohibitive. For example, during initial testing of the NEMS-S instrument, full corner store audits required approximately 15 minutes to complete.[185] The 2014 InfoUSA retail list in Newark, NJ includes 700 listings.[199] Thus, conducting full audits of all 700 stores would require 22 eight-hour days. However, a short survey like the one developed in the present study could be used to more efficiently gather only the information necessary for classification.

Limitations of telephone audits should be considered before interpreting results. While respondents tended to overestimate the presence of items during phone audits, in this sample it is safe to assume that those who responded in the affirmative to the presence of five or more FV truly did stock FV, the most important items for store upgrades. The short audit tool should be tested over the phone in other corner store samples to assess its external validity. Further, the short instrument is not intended for in-depth evaluations of a store's inventory or quality, but rather for rapid assessments. Full in-store audits are required for detailed assessments of corner stores.

The items included in the short instrument appear to be robust for obtaining healthy versus unhealthy store designations that are similar to those obtained by a full in-store availability audit. A number of statistical methods were utilized to ensure inclusion of the most informative items and exclusion of extraneous items, with a high level of agreement among all methods. Although the short instrument may have been more reliable in-store by including the three items IRT analysis designated for inclusion, preliminary feasibility testing indicated incorrect telephone responses would have resulted in lower reliability. Another consideration with using the instrument over the phone was keeping the survey as short as possible to reduce participant burden and obtain responses to all items.

Valid overall results depended on in-store data collection accuracy, which was a strength of the study. The original intent of three-person data collection teams was to deal with parking issues that may have arisen due to the absence of parking lots at corner stores. As the project evolved, it became clear that three-person teams reduced data collector fatigue. By utilizing a driver whose only responsibility was planning the route between stores and driving to subsequent stores, data collectors and assistants could focus on data collection and take a break between stores. A further benefit of having a separate driver was that, if the driver was also a trained data collector, s/he could enter results from the paper survey into the iPad while the data collector and assistant were in the store. Entering results immediately after store visits ensured that errors could be corrected while an audit was still fresh in the data collector's mind.

As was the case during NEMS and BTG-FSOF reliability testing,[185,187] in this sample very few store employees refused the request to conduct an audit. Both the NEMS and BTG-FSOF training were used as models for the current study, and both instructed data collectors to approach employees as they felt comfortable upon entering a store.[185,187] Most employees in this sample were suspicious if not approached, and almost always questioned team members about the purpose of their visit. Employees were more receptive to audits when a team member approached them immediately upon entering the store. Issues about which employees expressed the most concern included: (1) theft – audits required slowly moving about the store and lingering in some areas, which could be perceived as a method used to shoplift; (2) price-comparing by the competition – a few employees expressed concern that the auditors were from Rite Aid; and (3) believing the data collectors to be health inspectors. As suggested by NEMS training materials, data collectors and assistants dressed casually and carried identification badges and a letter explaining the study in order to ameliorate these concerns. As the majority of store employees spoke Spanish, a bilingual in-store team also greatly facilitated the process.

Future directions

The development of this brief instrument is timely due to the current state of the science regarding utilization of corner store initiatives as a means to improve urban food environments. The instrument is validated and requires fewer resources compared to full audits in this expanding field. In order to confirm and/or improve its usefulness across programs, further testing should include:

(a) Testing in other communities – The short instrument should be tested in demographic areas that differ from the ones in which the current study was conducted.

(b) Testing in stores that vary according to the types of healthy conversion programs in which they are involved

(c) Testing in conjunction with interventions to assess the ability of the instrument to capture changes to a store's food environment

(d) Testing to assess the usefulness and utility of using the short instrument in conjunction with a more comprehensive measurement

(e) Testing to assess the instrument's ability to predict purchasing changes in response to interventions

Further, the instrument must be disseminated to researchers and practitioners. The NEMS model should be followed in encouraging instrument users to adapt the tool to their specific situations, with the understanding that validity measures would change. In some cases it may be necessary to expand the instrument to include items specifically targeted by a program or intervention. As with all such instruments, the more the current one is used, the more its strengths and weaknesses will be exposed, and the more it can be refined.

Conclusion

The seven-item instrument developed in the current study provided valid information about stores' healthfulness. Assessing the presence of the seven items – (1) skim or 1% milk, (2) 5 or more different types of fresh fruits, (3) 5 or more different types of fresh vegetables, (4) frozen vegetables, (5) ground meat, (6) refrigeration for FV or ground meat, and)7) WIC participation – exhibited the same level of discrimination as a longer instrument in 88% of cases. Using the instrument to conduct audits over the phone was found to be feasible as well. Complete phone audits were obtained from 86% of stores, half of which were completed within 26 hours of conducting in-store audits. Discrepancies between in-store observations and phone reports should be taken into consideration when interpreting results. Phone responses to the FV and milk questions may be indicative of whether stores have a small variety of FV and 2% or low-fat milk. More accurate assessments of the presence of ground meat may be obtained during in-store audits by asking employees about its presence, rather than by depending solely on observation. The short form instrument fills the need for a rapid assessment tool for screening stores for inclusion in interventions, for assessing compliance levels of stores already participating in healthy conversion projects, and/or for confirming or correcting commercial database classifications.

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APPENDIX A

IRB EXEMPTION

ASU Knowledge Enterprise Development

EXEMPTION GRANTED

Punam Ohri-Vachaspati
SNHP - Nutrition
602/827-2270
Punam.Ohri-Vachaspati@asu.edu

Dear Punam Ohri-Vachaspati:

On 8/15/2014 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Designing a short-form instrument to evaluate the healthfulness of corner stores
Investigator:	Punam Ohri-Vachaspati
IRB ID:	STUDY00001460
Funding:	Name: USDA: Department of Agriculture;
Documents Reviewed:	• Store audit protocol.docx, Category: IRB Protocol; • Rutgers IRB approval data collectors 6 9 14.pdf, Category: Off-site authorizations (school permission, other IRB approvals, Tribal permission etc); • store audit phone questions.pdf, Category: Other (to reflect anything not captured above); • NJCHS store audit, Category: Recruitment Materials; • USDA NIFA grant application, Category: Sponsor Attachment;

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 8/15/2014. In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

Susan Metosky

Susan Metosky

IRB Administrator

cc: Robin DeWeese
Gabriela Jimenez
Vesna Babanovski
Sarah Syed
Punam Ohri-Vachaspati
Michael Todd

APPENDIX B

NJCHS CORNER STORE ASSESSMENT TOOL

New Jersey Child Health Study

Conducted by Rutgers Center for State Health Policy and ASU School of Nutrition and Health Promotion

Corner Store Assessment Tool

1. Rater ID______________________ 3. Date ________________

2. Store ID ______________________ 4. Start time ____________

5. Number of cash registers [Circle one]
   1 2 3+

6. General store comments

7. How much of the store space is for FOOD?
   ☐ Low (less than 25%) ☐ Moderate (25-50%) ☐ Most (>50%)

8. Does the store have marketing materials promoting the availability of healthful items? (fruits, vegetables, low-fat milk, fresh meat, whole grains, healthy snacks, signage suggesting healthy items)
   ☐ Window clings ☐ Brochures ☐ Fliers ☐ None
   ☐ Other (specify) ____________________

9. Does the store identify as being part of a healthy corner store initiative?
   ☐ The Camden Healthy Corner Store Network ☐ None
   ☐ Other (specify) ____________________

10. Are there signs on the store windows/door or on/near cash registers indicating that SNAP/EBT/Food Stamps are accepted?
   ☐ Yes ☐ No

15a. How many types of healthy snacks are on the snack shelf? (pick any 3 from the shelf) [circle one]
   0 1 2 3

16. Are there signs on shelves indicating if a food is WIC eligible?
   ☐ Yes ☐ No

17. Is **MILK** (any size or brand) sold at this store?
   ☐ Yes ☐ No *[if no, go to 18]*

17a. What is the lowest fat milk available?
   ☐ Skim ☐ 1% ☐ 2% ☐ None *[if none, go to 17c]*

17b. Shelf space for lowest fat milk
   ____ Pint (16 oz) ____ Quart (32 oz) ____ Half gallon ____ Gallon ____ Other

17c. Shelf space for whole milk
   ____ Pint (16 oz) ____ Quart (32 oz) ____ Half gallon ____ Gallon ____ Other

18. Is **FRESH FRUIT** sold at this store?
   ☐ Yes ☐ No *[if no, go to 18c]*

18a. Are these fresh fruits available?

	Whole or cut-up multi-serve	No	Cut-up single-serve
Bananas	❍	❍	❍
Apples	❍	❍	❍
Oranges	❍	❍	❍
Grapes	❍	❍	❍
Cantaloupe	❍	❍	❍
Peaches	❍	❍	❍
Strawberries	❍	❍	❍
Honeydew Melon	❍	❍	❍
Watermelon	❍	❍	❍
Pears	❍	❍	❍

18b. How many other types of whole or cut-up (non-mixed) fresh fruits are available? [Circle one]
0 1 2 3 4 5 6+

18c. Are **mixed fresh fruit** cut-up single-serving snack packs available?
☐ Yes ☐ No

18d. Is frozen fruit available?
☐ Yes ☐ No *[if no, go to 18f]*

18e. Number of varieties of frozen fruit (no sugar added) [Circle one]
1 2 3 4 5 6+

18f. Is canned fruit available?
☐ Yes ☐ No *[if no, go to 19]*

18g. Number of varieties of canned fruit (in light syrup, natural juice or water) [Circle one]
1 2 3 4 5 6+

19. Are **FRESH VEGETABLES** sold at this store?
☐ Yes ☐ No *[if no, go to 19c]*

19a. Are these fresh vegetables available?

	Whole or cut-up multi-serve	No	Cut-up single-serve
Carrots	❍	❍	❍
Tomatoes	❍	❍	❍
Bell peppers	❍	❍	❍
Broccoli	❍	❍	❍
Lettuce	❍	❍	❍
Corn	❍	❍	❍
Celery	❍	❍	❍
Cucumbers	❍	❍	❍
Cabbage	❍	❍	❍
Caulifower	❍	❍	❍

11. Are there signs on the store windows/door or on/near cash registers indicating that WIC is accepted?
☐ Yes ☐ No

12. Is there refrigeration for storing fruits, vegetables, and/or fresh meat?
☐ Yes ☐ No *[if no, go to 13]*

12a. Is the refrigeration unit see-through, and/or does it contain signage indicating it contains fruits, vegetables, and/or fresh meat?
☐ Yes ☐ No *[if no, go to 13]*

12b. Is the refrigeration unit **and** the fruits, vegetables, fresh meat, **or** signage clearly visible from the front door?
☐ Yes ☐ No

13. Are these items available at the checkout?

	Yes	No
Candy/cookies/snack cakes	❍	❍
Fresh fruit	❍	❍
Fresh vegetables	❍	❍
Bottled water	❍	❍
Sugar-sweetened beverages	❍	❍

14. Are there endcaps marked as containing healthy snacks?
☐ Yes ☐ No *[if no, go to 15]*

14a. How many types of healthy snacks are on the endcap? (pick any 3 from the endcap) [circle one]
0 1 2 3

15. Are there snack shelves marked as containing healthy snacks?
☐ Yes ☐ No *[if no, go to 16]*

19b. How many other types of whole or cut-up (non-mixed) fresh vegetables are available? [Circle one]

0 1 2 3 4 5 6+

19c. Are **mixed fresh vegetable** single-serving snack packs or salads available?

☐ Yes ☐ No

19d. Are frozen vegetables available? *[if no, go to 19f]*

☐ Yes ☐ No

19e. Number of varieties of frozen vegetables (in water/without sauce) [Circle one]

1 2 3 4 5 6+

19f. Are canned vegetables available?

☐ Yes ☐ No *[if no, go to 20]*

19g. Number of varieties of canned vegetables (in water/without sauce) [Circle one]

1 2 3 4 5 6+

20. Is **GROUND BEEF/GROUND TURKEY** sold at this store?

☐ Yes ☐ No *[if no, go to 21]*

20a. Is lean ground beef/ground turkey, (≥90% lean, ≤10% fat) available?

☐ Yes ☐ No *[if no, go to 21]*

20b. Number of varieties of lean ground beef/ground turkey (≤10% fat) [Circle one]

1 2 3 4 5 6+

21. Are **HOT DOGS** sold at this store?

☐ Yes ☐ No *[if no, go to 22]*

21a. Are 98% fat-free wieners (0.5g fat/serving) available?

☐ Yes *[if yes, go to 22]* ☐ No

27. Are non-carbonated, zero or low-calorie (≤10 kcal/serving) drinks available (any size) (e.g., Crystal Light iced tea, Diet Snapple)?

☐ Yes ☐ No *[if no, go to 28]*

27a. Number of varieties of non-carbonated, zero or low-calorie (≤10 kcal/serving) drinks available [Circle one]

1 2 3 4 5 6+

28. Is 100% whole wheat or whole grain **BREAD** available in loaves?

☐ Yes ☐ No *[if no, go to 29]*

28a. Number of varieties of 100% whole wheat and whole grain bread (all brands) [Circle one]

1 2 3 4 5 6+

29. Are **BAKED CHIPS** sold at this store?

☐ Yes ☐ No *[if no, go to 30]*

29a. What is the smallest size (in ounces) package of baked chips available?

______ oz

29b. Number of varieties of low-fat chips (any brand) [Circle one]

0 1 2 3 4 5 6+

30. Are **100-CALORIE SNACKS** available?

☐ Yes ☐ No *[if no, go to 31]*

30a. What types of 100-calorie snacks are available?

____

30b. Number of varieties of 100 calorie snacks (any brand) [Circle one]

1 2 3 4 5 6+

31. Is **CEREAL** with <7 g/serving of sugar available (e.g., Cheerios, Special K, Total Whole Wheat, Rice Krispies, Corn Flakes)

☐ Yes ☐ No *[if no, go to 32]*

31a. What is the smallest size (in ounces) of healthier cereal available, excluding single-serving sizes?

______ oz

31b. Number of varieties of healthier cereals (excluding single-serving sizes) [Circle one]

1 2 3+

32. End time ________________________________

PURCHASE ITEMS

Individual size bag of chips (smallest that you see)
Size (ounces) ___________ Price $________________

Healthy snack (piece of fruit, cut-up individual size fruit or veggie, 100-calorie snack)
Item __________________ Price $ ________________

HEALTHY SNACKS CRITERIA

- **≤200 kcal, 7 g fat, 2 g saturated fat, & 15 g sugar per serving**
- Do not have sugar or high fructose corn syrup as first ingredient
- Examples:
  - Fresh or dried fruits and vegetables
  - Whole grain snacks (≥2 g fiber/serving)
  - Energy bars (≤14 g sugar/serving)
  - Nuts & seeds

21b. Are light wieners (>0.5 g and <9 g of fat per serving) available?

☐ Yes ☐ No

22. Are reduced-fat **FROZEN DINNERS** available? (≤9 g of fat per 8-11 oz package)

☐ Yes ☐ No

23. Are **BAKED GOODS** (excluding bread) sold at this store?

☐ Yes ☐ No *[if no, go to 24]*

23a. Are single bagels available?

☐ Yes *[if yes, go to 24]* ☐ No

23b. Are packages of bagels available?

☐ Yes *[if yes, go to 24]* ☐ No

23c. Are English muffins available? (individual or packaged)

☐ Yes *[if yes, go to 24]* ☐ No

23d. Are low-fat muffins available? (look for individually-sold before packaged)

☐ Yes ☐ No

BEVERAGES

24. Is diet soda available in ≤24 oz bottles/cans?

☐ Yes ☐ No

25. Is 100% juice available in ≤24 oz bottles/cans?

☐ Yes ☐ No

26. Is bottled water (any size) available?

☐ Yes ☐ No

APPENDIX C

RATER FIELDWORK PROCEDURES, IN-STORE PROTOCOL

NJCHS Corner Store Assessment Rater Field Work Procedures & Checklist

I. Before going into the field:

1. Write your initials in the *"In route"* column of the google docs store list beside each store you intend to visit for the day

2. Gather Materials:

___ NJCHS Corner Store Assessment Tool	___Itinerary
___ Store measures protocol	___Maps/directions
___ Store letter	___iPad
___ Study ID	___Cell phone
___ Pens/pencils	___Snacks/lunch (optional)
___ Clipboard (optional)	___$2 for snacks in store

3. Complete the Rater ID number, Store ID number, and date on the cover sheet.

- You will have a complete list with names and addresses of all the businesses you should visit and observe in the field. It is possible that some establishments on your list have closed permanently or do not exist. If this is the case and you have a form for a store that you believe does not exist, record under "General Store Comments," "permanently closed/does not exist." Write this also in the "Notes" column on the store list.

- It is possible that some establishments on your list are not present at the street address that we have provided. If this is the case and if you are able to find the establishment at another address on the same street or on another nearby street, record "address changed to…." under "General Store Comments." Record the changed address also in the "Notes" column on the store list. Continue with your observation of the food store. Do not continue to look for mislabeled establishments if you have to drive out of your way to find them. In such cases record "does not exist" under "General Store Comments" and also in the "Notes" column on the store list.

- If a food store exists at the address on the itinerary but has a different name than is listed on the itinerary, under "General Store Comments" record "name changed to…." Record the changed name also in the "Notes" column on the store list. Continue with your observation of the food store.

- It is possible that there are other food stores in addition to those on your list. Do not observe these establishments if they are not on your itinerary.

- This work is conducted in teams of 3 for safety and efficiency. One person will be the driver, one support, and one data collector. When arriving at the store, if no parking is available, the driver will let out the support person and data collector to enter the store and complete the survey. The driver will either find parking close by or drive around until data collection is complete.

II. **At the Store:**

1. Take into the store:
    a. 1 NJCHS Corner Store Assessment Tool
    b. In-store protocol
    c. Store letter
    d. Study ID
    e. Pen/Pencil
    f. Clipboard if needed
    g. $2 to make a purchase
    h. Cell phone for time and/or to text driver when finished
2. Record the start time upon entering the store.
3. Make a purchase (anytime).
4. If needed, introduce yourself and briefly explain study.
5. Clearly fill in boxes/circles (color in, check, x, whatever is clearest) Once a page is complete, circle the page number in the bottom left corner of each page.
6. Complete the survey.
7. **Double check that every item has been completed.**
8. Record the end time immediately after you complete the last measure.
9. Note in "General Store Comments anything special about the store, or any issues encountered.
10. If, at any time after explaining the study, a store employee asks you to leave, thank him/her, and politely leave. If you have not completed the survey at that point, under "General Store Comments" record "asked to leave." Record the same thing in the *"Notes"* column of the store list beside the appropriate store.

*Exercise good judgment regarding potentially unsafe situations. If it appears unsafe to enter a facility, or if it feels unsafe inside, leave. It may be possible to return at a later time.

III. **Upon returning to the car:**

1. Support person directs driver to next store
2. Data collector enters survey results into iPad. Double check for accuracy and completeness (more important than speed). Only enter completed surveys. If

the store audit was not completed for any reason, do not enter it into the iPad. Note in the General Comments (on the paper survey) the reason it was not completed.

IV. At the end of data collection for the day:

Check form(s) for completeness, accuracy, and readability for the following:

___ Rater ID number
___ Store ID number
___ Date
___ Start and end times
___ Number of cash registers
___ Yes or No items and other choices filled in for every **required** indicator
___ Legible writing (may need to rewrite some items)

As soon as possible, go to an area with wifi and do the following (data collection for the day is not complete until these steps are taken):

1. Upload all completed surveys from the iPad. Write your initials in the *"Uploaded"* column of the store list (e.g., **Newark store list**) on google docs beside each store for which you uploaded data.

2. Write your initials in the *"Completed Forms"* column of the store list on google docs beside each store you completed that day. Do not initial any that were not completed for any reason, including being asked to leave, store was closed, or store does not exist.

3. Record any notes you made on the paper survey in the *"Notes"* column of the store list on google docs.

4. Complete the **"Completed stores log-in sheet"** on google docs, writing in the date of your store visit, location (city), rater ID number, and store ID number for each store that was completed that day (don't record store IDs of stores from which you were asked to leave, for stores found not to exist, stores that are closed, or for any surveys that were not completed for any reason and for which the data has not been uploaded.) ***This sheet is only completed for stores which need no further attention (store audit was completed, and the data has been uploaded in Qualtrics).***

5. Return completed forms to Robin or Michelle as soon as possible. Once the paper forms have been physically submitted, initial the *"Submitted Forms"* column of the store list on google docs beside the stores for which the forms were submitted.

Review of completed forms by independent reviewers

An independent reviewer will review surveys for completeness and discrepancies. The reviewer will tab and discuss questions/discrepancies with raters

Reimbursement

Drivers complete the Taber form for mileage reimbursement.
Data collectors complete the Taber form for in-store purchase reimbursement.

*If you have any questions at any time while in the field, call or text Robin (913.634.1098) or Michelle (732.690.6876).

New Jersey Child Health Study

Conducted by Rutgers Center for State Health Policy and ASU School of Nutrition and Health Promotion

Corner Store Assessment Tool

In-Store Protocol

Complete corner store measures between 9am and 4pm. (This helps to ensure that you are not in the way during a busy time as these stores are small.)

Before entering the store, fill in the 1. Rater ID, 2. Store ID, and 3. Date

Although you will develop a method that works best for you when completing the audit, this method may be effective to begin with: 1) When walking up to the store entrance, scan the windows and doors for the items asked about in questions 8-11 (marketing materials promoting healthy items, healthy corner store initiative signage, SNAP/EBT/Food Stamps and WIC signage). 2) Upon entering the store pause just inside the entrance and scan the store for refrigeration storing fruits, vegetables, and/or fresh meat (question 12b). 3) Make one pass through the entire store checking for all forms of signage asked for in the audit instrument (questions 8-11; 14-16). During this pass you can also get an idea of the locations of all items in the audit instrument. 4) Complete items as you see them, not necessarily in the order they appear in the instrument.

It is up to your discretion whether or not you introduce yourself to a store employee.

Once a page is complete, circle the page number in the bottom left corner.

Once in the store, fill in the following (in the order that makes the most sense for you):

<u>General Items</u>

4. Start time: The time upon entering the store

5. Number of cash registers in the store; do not include those dedicated to Lottery sales only.

6. Note anything unusual in the store under the General Store Comments, if necessary. Note also store name changes or name and address of replacement stores.

7. The amount of store space designated for food.

8. Note any marketing materials promoting healthy items such as fruits and vegetables, low-fat milk, fresh meat, whole grains, healthy snacks, or signage for

an overall "healthier store." This could include window clings, brochures, fliers, or other materials. If there are others, specify what they are.

9. Note if any Healthy Corner Store Initiative materials are visible in the store. Specify which ones.

10. Look on the store windows or near the cash register inside the store for signage that mentions food stamps. The federal food stamp program is currently called SNAP (Supplemental Nutrition Assistance Program) and the name of the food stamps EBT (electronic benefits transfer) card on which the benefits are placed is called "Families First" in New Jersey. Record whether you found signage.

11. Look on the store windows or near the cash register inside the store for signage that mentions WIC (Women, Infants, and Children) coupons. Record whether you found signage.

12. Look for any type of cold storage – reach-in (see-through or non-see-through doors), display (with or without doors) storing any fruits, vegetables, and or fresh (not deli) meat.

12a. Is it clear by looking at the outside of the refrigeration unit that it contains fruits, vegetables, and or fresh meat?

12b. Stand at the front door of the store and look to see if the entire refrigeration unit is visible **and** that you can clearly see from there that it contains fruits, vegetables, and/or fresh meat. Answer "yes" only if both parts are true.

13. Note whether the listed items are available at the checkout. Consider "at the checkout" to be the items displayed near the area where customers complete their purchases (e.g., on a stand, on or below the counter). If the cashier is surrounded by plexiglass, items behind the counter also count as "at the checkout."
    a. Candy: Chocolate, gummy, licorice, hard candy, etc. Do not count gum or mints.
    b. Cookies: Can include both pre-packaged items from an outside food manufacturer or cookies made in the store's own bakery or from another local bakery.
    c. Snack cakes: Can include Ho Hos, cupcakes or Swiss Rolls or equivalent items. Can include both pre-packaged items from an outside food manufacturer (e.g., Hostess, Little Debbie, TastyKake, Drake's, Bimbo) or cupcakes and other individually-sized and individually-wrapped snack cakes made in the store's own bakery or from another local bakery.

14. *Endcap*: Display (not just storage) of products placed at the end of an aisle. *Healthy snacks*: Contain ≤200 kcal, 7 g of fat, 2 g of saturated fat, & 15 g of sugar per serving. Do not have sugar or high fructose corn syrup listed as first

ingredient. Examples: fresh or dried fruits and vegetables, whole grain snacks (≥2 g of fiber per serving), energy bars (≤14 g of sugar per serving), nuts & seeds. *Marked as containing healthy snacks*: Any posted call-out or indicator, not including the price tag, that is larger than what you would normally see. Clearly displayed, simple, easily visible, easy-to-read signs designating an endcap as healthy. Examples: *On-shelf communication*: describes specific product features without price promotion; *Overhead signs that are not aisle demarcations*: include any overhead communication that is not the aisle number/product category sign; *Floor graphics*: on the floor.

14a. Pick any 3 items from the endcap that seem like they should fit the healthy snack criteria above (#14), and record how many of those 3 actually do fit the criteria for healthy snacks.

15. See number 14, but look for shelves rather than endcaps.

15a. Pick any 3 items from the shelf that seem like they should fit the healthy snack criteria above (#14), and record how many of those 3 actually do fit the criteria for healthy snacks.

16. WIC signs near WIC-approved products: Signage indicates which products are eligible for purchase with WIC benefits and may say "WIC approved item" (e.g., cheese, some cereals, and canned/dried beans).

<u>Specific Food Items</u>

MILK (17-17c)
Milk Definitions
1. Low-fat milk – skim/fat-free and 1%
2. Reduced fat milk – 2%
3. Whole milk – full fat (3.25%)

Measurement Procedures

1. Find where the milk is located in the store.

2. Mark "yes" or "no" if the store sells unflavored milk, any size or brand. If yes, continue to follow steps listed below. If no, skip to *question 18*.

3. Look for the lowest-fat milk available in any brand. Select the lowest fat milk available (2%, 1% or skim). If no low fat or reduced fat milk is available select "None" and skip to *question 17c.*

4. **Shelf space:** Count and record the **number** of columns of each requested milk

item (pint of the whole, quart of whole etc.). Count the lowest fat milk available as recorded previously. Count only columns that have (any) milk there, but not empty slots where it may need to be restocked. If there are none of a particular item, write "0" in the box. Mark "other" **ONLY IF** there are none of the listed 4 sizes, but there is a different size (e.g., 20 oz). (Note: If milk is placed randomly on the shelf with no discernible columns, when a size is available, record "1" for the number available in that size.)

FRUIT (18-18g)

Measurement Procedures

1. Find the produce section in the store.

2. Mark "yes" or "no" if fresh fruit is available. If no, skip to *question 18c*. If yes, continue to follow steps listed below.

3. Look for the fruit listed. If it is available whole or cut-up in a **non-single-serve** container, and not mixed with any other fruit, select "whole or cut-up multi-serve." If it is not available, mark "no." If the item is sold out, mark "no" and enter "sold out" beside the "no" bubble. If it is available cut-up in a **single serve** container, and not mixed with any other fruit, mark "cut-up single serve." (Note 1: Some fruits may be available both as whole/cut-up multi-serve, and as cut-up single-serve. Note 2: Grapes and strawberries may be in containers, but not cut-up)

- If the fruit is available but mixed with other fruit in a container, mark "no" for available.

4. Mark how many other types of whole or cut-up (any size container) non-mixed fresh fruits are available, other than those listed.

5. *Question 18c:* Mark whether single-serving **mixed** fresh fruit snack packs are available. These must be **single serving** packs, *and* **mixed** fresh fruit in order to mark yes.

Frozen fruit

1. Find the frozen food section in the store.

2. Mark "yes" if frozen fruit is available. Package must say "no sugar added" on label. If no frozen fruit is available, select "no" and skip to *question 18f*. If yes, continue to follow steps listed below.

3. Count the number of varieties of frozen fruit (no sugar added).

Canned fruit

1. Find the canned food section in the store.

2. Mark "yes" or "no" if canned fruit is available. Can must say "in light syrup," "in natural juice", or "in water" on label. If no canned fruit is available, skip to *question 19*. If yes, continue to follow steps listed below.

3. Count the number of varieties of canned fruit (packed in light syrup, natural juice, or water).

VEGETABLES (19-19g)

Measurement Procedures

1. Find the produce section in the store.

2. Mark "yes" or "no" if fresh vegetables are available. If no, skip to *question 19c*. If yes, continue to follow steps listed below.

3. Look for the vegetable listed. If it is available whole or cut-up in a **non-single-serve** container and not mixed with any other vegetable, select "whole or cut-up multi-serve." If it is not available, mark "no." If the item is sold out, mark "no" and enter "sold out" beside the "no" bubble. If it is available cut-up in a **single serve** container, and not mixed with any other vegetable, mark "cut-up single serve." (Note: Some vegetables may be available both as whole/cut-up multi-serve, and as cut-up single-serve).

If the vegetable is available but mixed with other veggies in a container, mark "no" for available.

4. Mark how many other types of whole or cut-up (any size container) non-mixed fresh vegetables are available, other than those listed.

5. *Question 19c:* Mark whether single-serving **mixed** fresh vegetable snack packs or single-serve salads are available. These must be **single serving** packs *and* **mixed** fresh vegetables or salad in order to mark yes.

Frozen vegetables

1. Find the frozen food section in the store.

2. Mark "yes" if frozen vegetables are available. Package must be without sauce. If no frozen vegetables are available, select "no" and skip to *question 19f*. If yes,

continue to follow steps listed below.
3. Count the number of varieties of frozen vegetables (without sauce).

Canned vegetables

1. Find the canned food section in the store.

2. Mark "yes" or "no" if canned vegetables are available. Do not count beans. Vegetable must be canned in water and without sauce. If no, skip to *question 20*. If yes, continue to follow steps listed below.

3. Count the number of varieties of canned vegetables (packed in water and without sauce).

GROUND BEEF/GROUND TURKEY (20-20b)

Ground Beef Definition:

Lean ground beef: ≥90% lean, ≤10% fat

Measurement Procedures

1. Find the fresh ground meat case in the store.

2. Mark "yes" or "no" if ground beef or ground turkey is available. If no, skip to *question 21*. If yes, continue to follow steps listed below.

3. Locate the lean ground beef with 10% fat, or lean ground turkey (≤10% fat). Note that lean ground beef may be labeled "ground sirloin", but the label should indicate the % fat. If the label does not include % fat, ask an employee what the % fat of the meat is. If it is impossible to find out, mark no. If available, mark yes. If not available mark no and skip to *question 21*.

4. Count and record the **number of varieties** of lean ground beef/ground turkey available, which includes both different brands and variety of % fat (e.g., 10%, 7%, 3%, etc.). Include any organic varieties as well.

HOT DOGS (21-21b)

Hot Dog Definitions

a. Light (≤7 g fat/serving)
b. Turkey – also considered light (≤8 g fat/serving)
c. Fat-free (≤0.5 g fat/serving)

Measurement Procedures

1. Find the hot dogs in the prepared meats section in the store.

2. Mark "yes" or "no" if hot dogs (any meat or soy) are available. If no, skip to *question 22*. If yes, continue to follow steps listed below.

3. Locate 98% Fat-free wieners (any meat or soy). If available, mark "yes" and skip to *question 22*. If not available, mark "no" and continue to follow steps listed below.

4. Locate light wieners (any meat or soy). If available, mark "yes." If not available, mark "no."

FROZEN DINNERS (22)

Frozen Dinner Definitions:

Reduced-fat frozen dinner: ≤9 g fat/serving (8-11 oz. package)

Measurement Procedures

1. Find the frozen dinners in the frozen food case.

2. Indicate whether reduced-fat frozen dinners are available by marking "yes" or "no".

BAKED GOODS (23-23d)

Measurement Procedures

1. Find the baked goods/pastries section in the store.

2. Mark "yes" or "no" if baked goods (excluding bread) are available. If no, skip to *question 24*. If yes, continue to follow steps listed below.

3. Locate the individually sold bagels. If available, mark "yes" and skip to *question 24*.

4. If individual bagels are not available, mark "no" and look for packages of bagels. If available, mark "yes" and skip to *question 24*.

5. If packages of bagels are not available, mark "no" and look for English muffins (individual or packaged). If available, mark "yes" and skip to *question 24*.

6. If English muffins are not available, mark “no” and look for low-fat muffins. Look for individually sold muffins first before packaged items. If available, mark “yes.” If not available, mark “no.”

BEVERAGES (24-27a)

Beverage Definitions

a. Diet soda - 0 kcal
b. Low calorie drink – 10 kcal or less
c. Sugared soda – Regular
d. 100% juice – Natural fruit juice with no added sugars. Container must say 100% fruit juice on label.
e. Juice drink – Fruit juice with added sugar and water

Measurement Procedures

For soda:

1. Find the chilled beverage section in the store.

2. Locate the cans/bottles of diet soda (any brand) that are ≤24 ounces. If available, mark “yes.” If not available, mark “no.”

For juice:

1. Look for a ≤24 oz bottle (most are 15.2 oz) of 100% juice. If available, mark “yes.” If not available, mark “no.”

For water:

1. Mark “yes” or “no” if bottled water (any size bottle) is available.

For non-carbonated, zero or low-calorie drinks:

1. Mark “yes” or “no” if non-carbonated zero or low calorie drinks (any size) are available (≤10 kcal per serving). Examples of these drinks include Crystal Light – iced tea, Diet Snapple – several varieties).

2. Count the number of varieties (different brands and different flavors) of available non-carbonated zero or low calorie drinks.

BREAD (28-28a)

Bread Definition

100% whole wheat and whole grain bread: Package must state “100% whole wheat,” or the first ingredient listed must be whole wheat or whole grain

Measurement Procedures

1. Find the bread aisle in the store.

2. Mark "yes" or "no" if 100% whole wheat or whole grain bread (in loaves) is available. If no, skip to *question 29*. If yes, continue to follow steps listed below.

3. Count and record the **number of varieties** of 100% whole wheat bread and whole grain bread, which includes both different brands and types (100% whole wheat, 100% honey whole wheat, etc.)

BAKED CHIPS AND SNACKS (29-30b)

Baked Chips Definitions

a. Fat-free: 0 g fat/serving
   4. Low-fat = ≤3 g fat per 1 oz. serving

Measurement Procedures

1. Mark "yes" or "no" if baked chips are available. If yes, find where the smallest size packages of chips are located. If not available, skip to *question 30*.

2. Mark the smallest size that is available. Write in the number of ounces (round to the nearest whole number, e.g., 1 3/8 oz = 1 oz).

3. Count and record the **number of varieties** (any size) of low-fat chips **(≤3 g fat per one ounce serving)**, which includes different brands (Lays, Ruffles, etc.) and flavors (Plain, Ranch, BBQ, etc.) and type of chip (corn, potato, etc). The chips with Olestra count as well. It does **not** include different sizes of the same chip.

100 Calorie Snacks:

1. If individual 100 Calorie Snacks packs are available, mark "yes". If no, skip to *question 31*.

2. Record all types of 100 Calorie Snack packs available (including Lays, Ruffles, Oreos, etc).

3. Count the **number of varieties** of available 100 Calorie Snack packs.

CEREAL (31-31b)

Cereal Definition
Healthier: < 7g sugar per serving

1. Mark "yes" or "no" if cereal (excluding single-serving sizes) is available at this store. If yes, follow the steps below. If no, go to *question 32*.

2. Record the **smallest size** box (excluding single-serving sizes) of healthier cereal available, in ounces listed on the bottom front of the box. If the size is in fraction form, round up or down accordingly (e.g., if it is 22 1/8, then write "22").

3. Count and record the **number of varieties** of healthier cereal (<7 g sugar per serving).

Survey completion
Make sure all page numbers are circled, indicating that each page is complete.
After ensuring all measures are complete, record the **end time**.

Purchasing items
Before leaving the store (anytime; you don't have to wait until completing the survey), purchase 2 items:

a. **Individual size** bag of chips (smallest size you see in the kind you want). Record the size in ounces, and the price
b. **Healthy snack** – piece of fruit or cut-up individual size fruit or veggie that a child or teenager would buy as a snack (e.g., whole or cut-up apple, orange, banana, blueberries, strawberries, grapes; cut up celery, cucumbers, broccoli, cauliflower, bell peppers, watermelon, cantaloupe, pineapple, honeydew, kiwi, mango). Record what you buy, and the price.

APPENDIX D

SCORING SYSTEM FOR NEMS – CORNER STORES

Scoring Systems for NEMS - Corner Stores

Measures for individual stores

Item	Availability	Possible Availability	Price*	Possible Price	Quality**	Possible Quality
1. Milk	YES skim = 2 points If no skim, but YES 2% = 1 points Proportion (least-fat to whole) ≥ 50% = 1 point	3 pts	Lower for lowest-fat = 2 pts Same for both = 1 pt Higher for lowest-fat = -1 pt	2 pts	- inapplicable –	
2. Fruit	0 varieties = 0 pts < 5 varieties = 1 pt 5-9 varieties = 2 pts 10-11 varieties = 3 pts	3 pts		No points	25-49% acceptable = 1 pt 50-74% acceptable = 2 pts 75%+ acceptable = 3 pts	3 pts
3. Frozen & Canned Fruits	YES frozen fruit = 1 pt YES canned fruit (w/o syrup) = 1 pt	2 pts		No points	- inapplicable –	
4. Vegetables	0 varieties = 0 pts < 5 varieties = 1 pt 5-9 varieties = 2 pts 10-11 varieties = 3 pts	3 pts		No points	25-49% acceptable = 1 pt 50-74% acceptable = 2 pts 75%+ acceptable = 3 pts	3 pts
5. Frozen & Canned Vegetables	YES frozen vegetables = 1 pt YES canned vegetables = 1 pt	2 pts		No points	- inapplicable –	
6. Ground Beef	YES lean meat = 2 pts 2-3 varieties < 10% fat = 1 pt > 3 varieties < 10% fat = 2 pts	4 pts	Lower for lean meat = 2 pts Higher for lean meat = -1 pt	2 pts	- inapplicable -	
7. Hot dogs	YES fat-free available = 2 pts Light, but not fat-free = 1 pt	3 pts	Lower for fat-free or light = 2 pts Higher for fat-free or light = -1 pt	2 pts	- inapplicable -	
8. Frozen dinners	YES reduced-fat types = 2 pts	2 pts	Lower for reduced-fat (based on majority of frozen dinners) = 2 pts Higher for reduced-fat = -1 pt	2 pts	- inapplicable -	
9. Baked goods	YES low-fat items = 2 pts	2 pts	Lower for low-fat (per piece) = 2 pts Higher for low-fat (per piece) = -1 pt	2 pts	- inapplicable -	
10. Beverages	YES diet soda = 1 pt YES non-carbonated, no/low-cal beverages = 1 pt YES 100% juice = 1 pt	3 pts	Lower for diet soda = 2 pts Higher for 100% juice = -1 pt	2 pts	- inapplicable -	

Scoring Systems for NEMS - Corner Stores

Measures for individual stores

11. Bread	YES whole grain bread = 2 pts >2 varieties whole wheat bread = 1 pt	3 pts	Lower for whole wheat = 2 pts Higher for whole wheat = -1 pt	2 pts	- inapplicable -	
12. Baked chips &100-calorie snacks	YES baked chips = 2 pts > 2 varieties baked chips = 2 pts YES 100-calorie snacks = 2 pts	6 pts	Lower for baked chips = 2 pts Higher for baked chips = -1 pt	2 pts	- inapplicable -	
13. Cereal	YES healthier cereal = 2 pts	2 pts	Lower for healthier cereal (per box) = 2 pts Higher for healthier cereal (per box) =-1 pt	2 pts	- inapplicable -	
TOTALS:		**AVAILABILITY** 0 to 34 points		**PRICE** -9 points to 18 points		**QUALITY** 0 to 6 points

<u>Total Summary Score</u>: Up to 58 points possible (availability + price + quality)

*** For scoring price, if price is equal for healthy and unhealthy options, no points are granted.**
**** For scoring quality, it is based on the % of acceptable ratings on the total amount of varieties available. For example, if there were 6 varieties of fruit available with 4 items having acceptable ratings, then you would score it with 2 points, as it falls within the 50-75% range.**

APPENDIX E

NJCHS SHORT CORNER STORE SURVEY

Corner Store Assessment Tool

NJCHS corner store phone call script

Hello, is this __(name of store)__? *(This question is not necessary if they answer with the name of the store and it matches the name on the list.)*

If no, ask:
Is your store located at (store address)?

If no, thank them and hang up.

If yes:
What are your store hours?

If they don't understand you or you don't understand them because of a language issue, thank them and hang up. Make a note on the 'Field and call audits' document about the language they spoke (or your best guess).

I'm ________ and I'm doing a 2-minute follow-up on the Rutgers study from (yesterday/earlier today).

If they say something like, "somebody was already in here," say, "we're looking at different ways of getting information – in person and over the phone."

Could you please tell me if your store carries the following food items?

1. Skim or 1% milk?
2. 5 or more different types of fresh fruits?
3. 5 or more different types of fresh vegetables?
4. Any type of frozen vegetables?
5. Ground meat?
6. *(If they answer "yes" to numbers 2, 3, OR 5)* Do you have refrigeration for your fruits, vegetables, or ground meat?
7. Does your store accept WIC?

IF RESPONDENT'S ANSWERS TO THE FRESH FRUIT OR VEGETABLE QUESTION DO NOT MATCH IN-STORE AUDITS, ASK THE FOLLOWING 3 QUESTIONS:

1. What day of the week do you usually re-stock your fresh produce?
2. What time of day do you usually re-stock your fresh produce?
3. When did you last re-stock your fresh produce?
   (Get as specific an answer as possible. e.g., "About what time today?")

Thank you!

Enter the answers in the online Qualtrics survey by following the link below

https://asuhealthpromotion.co1.qualtrics.com/SE/?SID=SV_0ugSReAssgyBHYp

APPENDIX F

CORNER STORE TELEPHONE ASSESSMENT PROCEDURES

NJCHS Corner Store Telephone Assessment
Procedures & Checklist

Follow-up calls will be made to all 100 stores visited in-person during the second round of store audits. These calls must be made either 1) the day of the visit within 2 hours after the in-person visit (a store visited Dec 5th at 2 pm EST, can be called until 4 pm EST Dec 5th), or 2) the day following the in-person visit within 2 hours before or after the time the store was visited the previous day (that store visited Dec 5th at 2 pm EST could be called between noon and 4 pm EST on Dec 6th). If a store cannot be reached within these time windows, continue attempting to reach it at different times, as close to this time window as possible.

<u>When ready to call:</u>

1. Open the 'NJCHS corner store phone call script' in Google Drive.
2. Click on the link at the bottom of the script to open the survey in Qualtrics.
3. Open the 'Field and call audits' document in Google Drive. Keep this document open during the phone audit to see if the respondent's answers to the fruit and vegetable questions match the in-store audit findings.
4. Initial in the 'Plan to call' column beside any stores you will call.
5. Fill in the first four questions on the Qualtrics online survey (rater ID, store ID, date, time [EST]).

<u>Calling:</u>

1. If unable to reach the store, close the survey or replace the store ID and time fields with the appropriate information for the next call. Record in the call notes column of the 'Field and call audits' document the date and time of each call attempt. Initial all of your notes.
2. Follow the NJCHS corner store phone call script. If there seems to be a language barrier after asking about store hours, thank them and hang up. Make a note on the 'Field and call audits' document about what language they spoke (or your best guess). Close the survey or replace the store ID and time fields with the appropriate information for the next call.
3. If there is no language barrier, continue the telephone audit. The refrigeration question will only be shown in the online survey if the respondent answers yes to questions 2, 3, or 5.

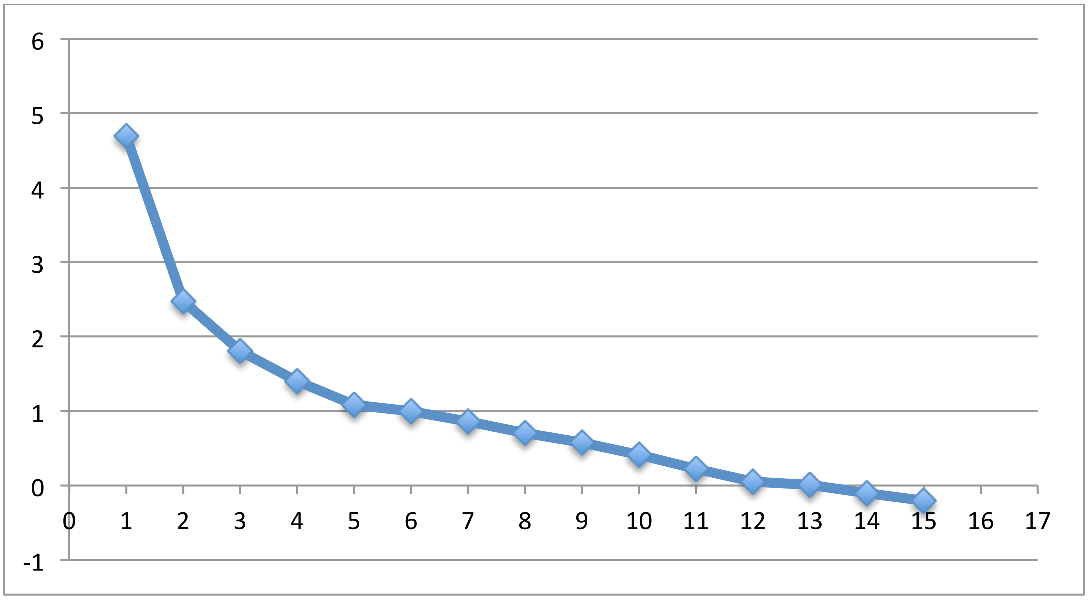
4. If the respondent’s answers to EITHER numbers 2 or 3 do not match the responses entered on the ‘Field and call audits’ document (columns J & K), ask the last 3 questions on the Qualtrics surveys. If BOTH answers match, do not ask the last 3 questions. Click ‘submit’ to submit the survey.
5. If the respondent ends the call before all questions are answered, continue to the end of the survey (leaving the unanswered questions blank) to submit it.

After calling:

1. If you completed all audit questions, initial in the appropriate ‘Call completed’ column. Record the time the call was completed, and any relevant notes from the call.
2. If all questions were not completed (respondent hung up, etc.), record in the appropriate ‘Call notes’ column the result of the call, date, time, and which was the last answered question. Do NOT initial the ‘Call completed’ column and do not complete the ‘Time call completed’ column.

APPENDIX G

ROUND TWO EFA, IRT, AND SENSITIVITY/SPECIFICITY RESULTS

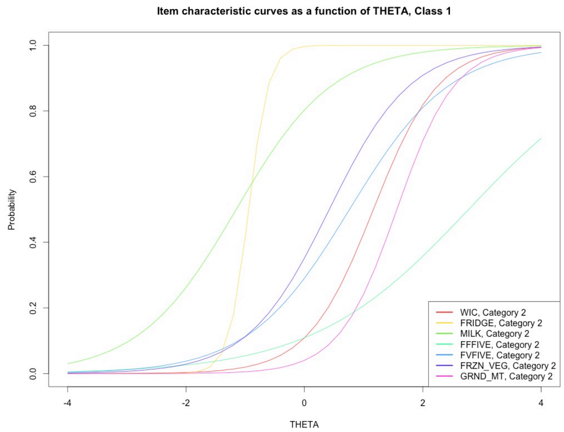


Scree plot showing eigenvalues of the 15 items included in round 2 EFA

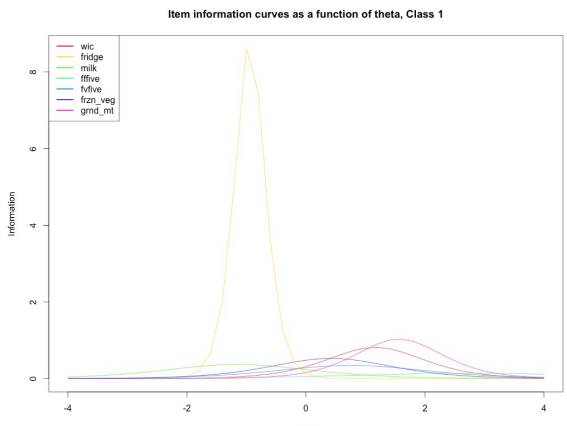
Round 2 EFA factor loadings for 1-factor, 2-factor, and 3-factor solutions

	1-factor solution	2-factor solution		3-factor solution		
	1	1	2	1	2	3
SNAP signs	0.058	0.266	-0.233	0.279	-0.121	-0.315
Accept WIC	**0.752**	0.355	**0.561**	0.380	**0.579**	-0.020
Refrigeration	**0.814**	**0.894**	0.025	**0.888**	0.072	-0.051
Fruit at checkout	0.169	0.303	-0.120	0.301	-0.180	0.152
Lowfat milk	**0.536**	-0.258	**0.897**	-0.278	**0.914**	0.055
Fruit categories (<5/≥5)	0.472	0.031	**0.573**	-0.005	0.420	**0.544**
Canned fruit	0.386	**0.571**	-0.145	**0.571**	-0.144	0.011
Veg categories (<5/≥5)	**0.571**	**0.480**	0.222	0.508	-0.008	0.596
Frozen vegetables	**0.665**	**0.528**	0.295	**0.512**	0.208	0.291
Ground meat	**0.689**	**0.578**	0.271	**0.551**	0.204	0.251
Light hot dogs	0.406	**0.716**	-0.270	**0.724**	-0.313	0.091
Frozen dinners	**0.517**	0.097	**0.563**	0.059	0.449	0.416
Low calorie drinks	0.412	**0.651**	-0.257	0.617	-0.006	-0.584
Bread	**0.713**	0.007	**0.861**	0.007	**0.898**	-0.027
Cereal	**0.547**	**0.551**	0.061	0.514	0.325	-0.471

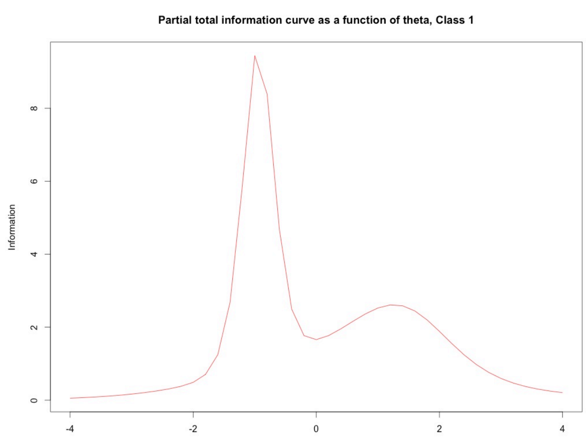
Bolded items are those that seem to measure the same construct in each column



Round 2 item characteristic curves (7 items)



Round 2 item information curves (7 items)



Round 2 total information curve (7 items)

Round 2 sensitivity/specificity analysis comparing 7-item set to NEMS-CS points

		Total NEMS points			
		0-14 points	15-26 points	Total	
7-item set[a]	0-3 points	71 True unhealthy	8 False unhealthy	79	PPV 71/79 = 0.90
	4-7 points	6 False healthy	15 True healthy	21	NPV 15/21 = 0.71
	Total	77	23	100	
		Sensitivity 71/77 = 0.92	Specificity 15/23 = 0.65		Accuracy (71+15)/100 = 0.86

[a]WIC, refrigeration, skim/1% milk, fresh fruit cuts (<5/≥5), fresh vegetable cuts (<5/≥5), frozen vegetables, ground meat