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Evaluating the Influence of the Revised Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) Food Allocation Package on Healthy Food Availability, Accessibility, and Affordability in Texas

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ABSTRACT

Background The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) was implemented to improve the health of pregnant women and children of low socioeconomic status. In 2009, the program was revised to provide a wider variety of healthy food choices (eg, fresh fruits, vegetables, and whole-grain items).

Objectives The purpose of this study was to evaluate (1) the impact of the revised WIC Nutrition Program's food allocation package on the availability, accessibility, and affordability of healthy foods in WIC-authorized grocery stores in Texas; and (2) how the impact of the policy change differed by store types and between rural and urban regions.

Design WIC-approved stores (n=105) across Texas were assessed using a validated instrument (88 items). Pre- (June-September 2009) and post-new WIC package implementation (June-September 2012) audits were conducted. Paired-sample *t* tests were conducted to compare the differences between pre- and post-implementation audits on shelf width and number of varieties (ie, availability), visibility (ie, accessibility), and inflation-adjusted price (ie, affordability).

Results Across the 105 stores, post-implementation audits showed increased availability in terms of shelf space for most key healthy food options, including fruit ($P<0.001$), vegetables ($P<0.01$), cereal ($P<0.001$), and varieties of vegetables ($P<0.001$). Food visibility increased for fresh juices ($P<0.001$). Visibility of WIC labeling improved for foods such as fruits ($P<0.05$), WIC cereal ($P<0.05$), and whole-grain or whole-wheat bread ($P<0.01$). Inflation-adjusted prices decreased only for bread ($P<0.001$) and dry grain beans ($P<0.001$). The positive effects of the policy change on food availability and visibility were observed in stores of different types and in different locations, although smaller or fewer effects were noted in small stores and stores in rural regions.

Conclusions Implementation of the revised WIC food package has generally improved availability and accessibility, but not affordability, of healthy foods in WIC-authorized stores in Texas. Future studies are needed to explore the impact of the revised program on healthy food option purchases and consumption patterns among Texas WIC participants.

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AS A FEDERALLY FUNDED FOOD ASSISTANCE PROgram, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) provides healthy foods, nutrition education, and health care referrals to approximately 50% of infants, 25% of children younger than age 5, 29% of pregnant women, and 26% of postpartum women in the United States.[1] Administered at both federal and state levels since 1972, this food assistance program has been effective in improving birth outcomes and diet-related outcomes, saving health care costs, and improving infant feeding practices.[1]

In October 2009, the US Department of Agriculture (USDA) revised the WIC food allocation package in response to recommendations from the American Academy of Pediatrics, the American Academy of Family Physicians, and the Institute of Medicine.[2-4] The revisions modified qualifying food options to include more nutrient-dense foods and beverages and to limit foods with added sugars or higher saturated fat content. For example, the modified food options included cash value vouchers, which were provided for the purchase of any eligible fresh, frozen, or canned fruit and vegetables. At least half of WIC-approved breakfast cereals

were required to have whole grain as the primary ingredient and to meet labeling requirements, whereas milk purchases were restricted to lower-fat milk for all women and all children older than 2 years of age. Juice was eliminated in the packages for older infants aged 7 to 12 months, to promote healthy dietary patterns.[4]

The revision also provided WIC state agencies greater flexibility in prescribing the food package options to accommodate the cultural food preferences of WIC participants. Across the United States, for example, 41.5% of the WIC participants reported their race as Hispanic or Latino in 2012.[5] Although specific information regarding the racial composition of Texas WIC participants is not available yet, 38.4% of the residents in Texas are of Hispanic or Latino origins, much higher than the national average of 17.1%.[6,7] Therefore, culture-specific food options, such as whole-grain tortillas and yellow or white corn tortillas, preferred over whole-wheat bread or other grain options by Hispanic WIC participants, were added in the new food package in Texas. In other states, such as Pennsylvania and New Hampshire, soy milk and tofu were added as important alternatives for clients with milk allergies and lactose intolerance, a more common problem in African-American and Asian populations.[8]

A few studies have been conducted to investigate the impact of the revised WIC food allocation package on the food-shopping environment. For example, the Altarum Institute completed a pre–post store inventory assessment among 248 small food stores in New Hampshire, Pennsylvania, Wisconsin, and Colorado and reported increased availability of most of the newly approved healthy WIC foods after the implementation of the revisions.[8] Zenk and colleagues[9] conducted a quasi-experimental study in seven northern Illinois counties and found that the availability of commonly consumed fruits and vegetables improved in WIC-authorized stores after the policy change. In another study of five towns in Connecticut, significant improvements in the availability and variety of healthy foods were observed in both WIC-authorized and non-WIC grocery stores.[10] In Philadelphia, PA, Hillier and colleagues[11] found that healthful food availability showed a more substantial increase in WIC stores than non-WIC stores in two low-income neighborhoods. Similarly, Havens and colleagues[12] compared food availability in 45 corner stores in Hartford, CT, and showed that WIC-authorized stores had greater availability of fresh fruits, lower-fat milk, whole-grain bread, and brown rice than did non-WIC stores.

Nevertheless, more studies conducted at the state level are needed to confirm the effects of the revised food package on improving the food-shopping environment in WIC-authorized stores, considering that the WIC program operates through 1,900 local agencies in 50 state health departments, with 47,000 authorized retailers.[1] So far, no state-level work has been published from the southern or western parts of the United States.[13] Furthermore, although previous studies have compared the impact of the policy change by store types or sizes,[9,11] no study has made any comparisons between different geographic locations (for example, rural vs urban regions). Such distinctions are important because segregation by geographic location contributes to food-shopping disparities.[7]

In an attempt to address these research gaps, the current study is an evaluation of the impact of the revised WIC food allocation package on the food-shopping environment in WIC-authorized grocery stores across the state of Texas. The Texas Childhood Obesity Prevention Policy Evaluation (T-COPPE) project evaluates the impact of two national policy changes as they are implemented in Texas: the WIC revised food allocation package administered through the Texas WIC Nutrition Program, Texas Department of State Health Services, and the Safe Routes to School program administered through the Texas Department of Transportation. As one component of the T-COPPE project, this study used a pre–post-test design with one audit before the revised package implementation in 2009 and one post-implementation audit in 2012.

Specifically, we hypothesized that (1) implementation of the revised WIC food package improved the availability, accessibility, and affordability of healthy foods in WIC-authorized stores in Texas, and (2) the impact of the policy change differed by store types, as well as between rural and urban regions.

MATERIALS AND METHODS

The WIC-related research component of the T-COPPE project, described herein, did not involve human subjects and therefore was exempt from requiring approval by the Texas A&M University institutional review board.

SURVEY INSTRUMENT DEVELOPMENT

A new instrument was adapted from the Texas Nutrition Environment Assessment of Retail Food Stores (TxNEA-S) survey tool.[14] The TxNEA-S instrument was adapted from the Nutrition Environment Measurement Survey[15] by including additional foods that are culturally specific to the minority populations of Texas (Hispanic and African American). However, the TxNEA-S instrument is not specific to foods allowed or promoted by WIC. To address this gap, a new instrument was developed. The new tool, hereinafter referred to as the TXNEMS-WIC instrument, was culturally sensitive to Hispanic foods, allowing for the evaluation of the food shopping environment of WIC-authorized stores in predominantly Hispanic regions.[7]

The TXNEMS-WIC instrument was developed and field tested in 2009. Field testing of the instrument provided an opportunity for improvement of the instrument and the refinement of a protocol for the measurement of food displays. Both WIC-authorized and non-WIC foods were included in pilot testing of the original TXNEMS-WIC instrument. In this study, however, only variables that measure the availability, accessibility, and affordability of certain healthy food items for children in the new WIC food package were assessed (eg, fresh produce, grains, reduced-fat milk, and whole-grain cereals), along with certain less-healthy food items (eg, frozen 100% fruit juices and sugared cereals). Foods commonly consumed by the Hispanic population, such as whole-grain tortillas and yellow or white corn tortillas, were also included. In total, 88 food items were assessed in this study, including eight fresh fruits, eight fresh vegetables, seven whole-grain or whole-wheat bread items, and eight milk items.

Constructs and Measures

The TXNEMS-WIC instrument measured three important criteria of the food-shopping environment: food availability, accessibility, and affordability. Details regarding the

operationalization and measurement of the constructs are reported elsewhere.[7]

Availability was assessed by four distinct measures: (1) amount of shelf space dedicated to each product by inches, (2) variety count of fresh fruits and vegetables, (3) stocking of products (carried/stocked or not), and (4) quality of fresh produce. The quality of the fresh produce was considered acceptable when more than 50% of the product displayed good color and was fresh looking, firm, and clean; quality was unacceptable when more than 50% of the product was bruised, old-looking, mushy, overripe, or excessively soft.

Accessibility was measured by food visibility and WIC labeling. Visibility was measured by the display profile of each product; for example, how easily a product could be seen and reached by shoppers. Following the marketing principle that eye-level merchandise sells most successfully,[16-18] visibility was operationalized and measured with the use of a color-coded folding ruler that delineated visibility zones considered high (the best visibility), medium, or low (the worst visibility). The determination of visibility zones was based on an assumption that the height of the average woman in Texas was slightly shorter than the national average of 5'4", considering the steadily increasing Hispanic population over the last 30 years and a documented lower average height among this population.[19,20] Visibility had a scale of 1 to 6, with 6 considered the best visibility.

Accessibility was also measured by the presence or absence of WIC labels on the shelves holding WIC products. Regulations for vendor use of WIC labels vary by state. In Texas, stores are required to label shelves for some, but not all, WIC products to promote cost efficiency, to make identification of eligible WIC foods easier, and to reduce the time needed for WIC food selections.[21]

Affordability was measured by the cost of the least-expensive brand item (LEB) for each product. For milk, juice, and dry bean items, only the LEB is WIC-allowable. For the other products included in the WIC packages (eg, cereals), items of any price are WIC-allowable as long as the package fits the exact description in terms of content and size. In those cases, all prices were reviewed to determine the LEB for that product. Price per ounce was calculated for whole-grain/whole-wheat bread products, and price per pound was calculated for fresh produce, with the LEB being recorded for each item. Special sale items, such as overstocked or damaged products on clearance, were not included in this study.

Store Sampling

Using a list of WIC-authorized stores provided by the Texas Department of State Health Services, a custom web-based mapping application was created to allow random sampling of WIC-authorized stores around the 20 participating T-COPPE schools used as nuclei.[7] Based on their average monthly WIC sales for the previous 12 months as provided by the Texas Department of State Health Services, the WIC-approved stores were categorized as follows: small, $\leq$\$5,999.99; medium, \$6,000-\$19,999.99; and large, $\geq$\$20,000. Two stores from each category were randomly computer-generated by the mapping tool, resulting in a sample of six WIC vendors in each of the 20 communities.

The custom mapping tool searched first for WIC-authorized stores within a 2-mile radius of a community nucleus and randomly selected two stores of each size category. If at least two stores of each size category within the 2-mile radius were not available, the search expanded to a 5-mile radius and randomly selected the number of stores needed to fill the required sample. This procedure continued using 8-, 11-, 14-, and 17-mile radii, as needed. In general, larger radii were required for rural regions than for urban, and the 17-mile radius was the largest needed to complete the entire sample. If at least two vendors of each size category did not exist within the 17-mile radius of a school, another size vendor was randomly selected to fill the sample.[7]

Participation in the study was completely voluntary. In cases in which store participation was declined, another vendor was selected using the WIC mapping tool, and recruitment efforts were made. Whether a store was located in a rural or urban area was determined by the rural or urban designation of schools around which the stores were located. The school locale codes developed by the National Center for Education Statistics were used to categorize rural and urban schools.[22]

Data Collection

Before the pre- and post-implementation data collections, an in-depth training protocol and certification process were created to prepare our team of data collectors. Two different groups of data collectors (graduate research assistants) were recruited for pre- and post-implementation audits and underwent identical training. Training consisted of approximately 3 hours of didactic instruction followed by 2 to 4 hours of field time, during which trainees went to preselected grocery stores to conduct practice audits. To have credible comparison data, the trainers completed surveys in the same training vendor locations as the trainees during the same day. After trainees conducted their practice audits, their TXNEMS-WIC instruments were reviewed by the trainers and checked for accuracy. Trainees achieving a minimum of 95% accuracy were certified and authorized to conduct surveys. For both pre- and post-implementation audits, high interrater percentage agreement was observed ($>$95%). During data collection, all surveys were conducted in pairs, with one person measuring and the other recording the data onto the TEXNEMS-WIC tool. Depending on different sizes of the grocery stores, generally 2 to 4 hours were needed for the data collectors to complete an in-store assessment.

All stores were audited twice, once before (June-September 2009) and once after (June-September 2012) the implementation of the revised WIC food allocation package. The pre-implementation audit took place over a period of 4 months, conducted by a team of 17 data collectors. The post-implementation audit data collection occurred 3 years after the first round, and was completed in 4 months. The post-implementation audit data were intentionally collected during the same season of the year as the baseline data, to minimize the impact of seasonal changes in food availability or cost.

Data Analysis

Before data analysis, all data were cleaned by verifying missing data and checking/completing calculations followed by coding and inputting data into a Microsoft Office Access 2007 database developed specifically for this project. Data reentry was

conducted on 20% of the sample as a quality control check, and greater than 98% accuracy was demonstrated.

For data analysis, differences between the pre- and post-implementation audits were calculated first for each item by store. To detect the differences accurately, different calculation methods were used for different measures of the shopping environment. For example, raw difference was used for the comparisons on food stocking, quality, visibility, and WIC labeling. Percent increase was used for comparisons on shelf space and varieties. Inflation-adjusted percent increase, obtained by subtracting 1 from the ratio of inflation-adjusted post and pre scores, was used for comparisons on price. An inflation rate of 5.01% was used for the period between June 2009 and June 2012.[23] The percent-based calculations were used because they are less likely to be dominated by a single item. For example, if a fruit is expensive, then its price increase or decrease is likely to be large, but the percent change is usually less drastic because of the base price.

Once the differences for each food item were calculated, the mean differences for each food category, including fruits, vegetables, WIC cereals, whole-grain or whole-wheat bread, dry grain beans, frozen fruits, frozen vegetables, frozen juice, WIC fresh juice, reduced-fat milk, and whole milk, were then calculated by combining items under each category in individual stores.

Comparisons of shelf space, variety count, food stocking, quality, visibility, WIC labeling, and price on the food categories were made between pre- and post-implementation audits, using the two-sided paired-sample *t* test. All analyses were performed with SPSS (version 18.0, 2009, SPSS Inc).

RESULTS

Sample Characteristics

At baseline, 126 stores were contacted, of which 12 did not allow the observations, one was out of business, and two had broken freezers, resulting in an analytic sample of 111 stores. In the post-revision audit, six stores that participated in the pre-revision audit either were no longer in business or declined to participate. Our final sample for the pre-and post-implementation audits consisted of 105 WIC-authorized stores from 19 cities and 17 counties in rural and urban regions across Texas.

Table 1 displays general characteristics of the WIC-authorized stores in this study. Among the 105 stores that participated in the pre- and post-implementation audits, 19% (n=20) were from rural regions, and 81% (n=85) were from urban regions. Based on their average monthly WIC sales, 24.8% (n=26) of the stores were small, 34.3% (n=36) were medium, and 41% (n=43) were large.

Table 1. Counts of Texas WIC[a] stores by store type[b] and location[c] (N=105[d])

	Small	Medium	Large	Total
Rural	6 (5.7%)	9 (8.6%)	5 (4.8%)	20 (19.0%)
Urban	20 (19.0%)	27 (25.7%)	38 (36.2%)	85 (81.0%)
Total	26 (24.8%)	36 (34.3%)	43 (41.0%)	105 (100%)

[a]WIC=Special Supplemental Nutrition Program for Women, Infants, and Children.
[b]Stores were distinguished by their average monthly WIC sales for the previous 12 months: small ≤$5,999.99; medium $6,000-$19,999.99; and large ≥$20,000.
[c]Stores were designated as rural or urban using the school locale codes developed by the National Center for Education Statistics.
[d]Percentages were calculated with the denominator N=105.

Availability

Table 2 reports the differences between pre- and post-implementation audits on food availability, measured by shelf space, varieties, food stocking, and quality.

Overall, after implementation of the WIC revisions, WIC-authorized stores had more shelf space (ie, mean percent increase) dedicated to fruits (16%, $P<0.001$), vegetables (10%, $P<0.01$), WIC cereal (14%, $P<0.001$), whole-grain or whole-wheat bread (44%, $P<0.001$), dry grain beans (28%, $P<0.001$), frozen fruits (15%, $P<0.01$), and reduced-fat milk (8%, $P<0.05$). Less shelf space was allocated to WIC fresh juice (−13%, $P<0.01$) and whole milk (−11%, $P<0.001$). Compared with medium and large stores, small stores had fewer foods with shelf space changes. Furthermore, the changes of shelf space were generally larger in urban stores than in rural stores, with significant differences on more food categories that were measured.

Variety count of fruits did not differ from baseline to follow-up, with no significant increase either by store type or by store location. In contrast, variety count of vegetables increased by 7% overall ($P<0.001$), with more varieties of vegetables carried in medium (9%, $P<0.001$), large (8%, $P<0.001$), and urban stores (8%, $P<0.001$) after the revisions, compared with small stores and stores in rural regions.

At baseline, the proportions of food stocking (ie, whether certain food items were carried and in stock) were high for most of the foods that were examined (Table 2). For example, almost all of the stores carried or stocked dairy products (100% for whole milk and 92% for reduced-fat milk), fruits (98%), and vegetables (94%) that were audited. After the revisions, food stocking increased 8 percentage points for whole-grain or whole-wheat bread ($P<0.001$) and 10 percentage points for dry grain beans ($P<0.001$), whereas decreases were revealed across the state of Texas for frozen vegetables (−4 percentage points, $P<0.001$) and WIC fresh juice (−13 percentage points, $P<0.001$). The differences were consistent across stores of different types and in different locations.

The quality of both fruits and vegetables was acceptable at baseline (99% and 98%, respectively). No significant changes in quality were observed after the revisions, either by store type or by store location.

Accessibility

Table 3 presents changes in food accessibility after the implementation of the WIC revisions, as measured by visibility and WIC labeling.

At baseline, all items had good visibility, with visibility scores above 5. The only positive change in visibility across the 105 stores included in this study was for WIC fresh juice (49 percentage points; $P<0.001$). In contrast, significant decreases were noticed on visibility of frozen vegetables (−9 percentage points; $P<0.05$), frozen juice (−17 percentage points, $P<0.01$), reduced-fat milk (−21 percentage points; $P<0.001$), and whole milk (−21 percentage points; $P<0.001$).

Table 2. Food availability change measured by mean percent increases of shelf space, varieties of fresh produce, and mean increase of food stocking and quality of fresh produce in Texas WIC[a] stores (N=111)

			Overall	Increase by Store Type			Increase by Store Location	
	Foods	Baseline (2009)	increase (2012)	Small (n=26)	Medium (n=36)	Large (n=43)	Rural (n=20)	Urban (n=85)
Shelf space[b]	Fruits	—	0.16***	0.16*	0.14*	0.19***	0.04	0.19***
	Vegetables	—	0.10**	0.04	0.16**	0.08	−0.07	0.14***
	WIC cereal	—	0.14***	0.04	0.20***	0.15**	0.08	0.16***
	Whole-grain/whole-wheat bread[f]	—	0.44***	0.81***	0.42**	0.29**	0.49*	0.44***
	Dry grain beans	—	0.28***	0.16*	0.12*	0.50***	0.12	0.32***
	Frozen fruits	—	0.15**	0.21	0.17	0.10	−0.05	0.20***
	Frozen vegetables	—	−0.05	−0.05	−0.08	−0.03	−0.13	−0.04
	Frozen juice	—	0.05	0.02	0.04	0.08	−0.13	0.09*
	WIC fresh juice	—	−0.13**	−0.19*	0.09	−0.28***	−0.01	−0.16***
	Reduced-fat milk	—	0.08*	0.07	0.06	0.11*	−0.08	0.12***
	Whole milk	—	−0.11***	−0.06	−0.05	−0.20***	−0.24***	−0.08*
Varieties[c]	Fruit	—	0.01	0.01	0.02	0.00	−0.02	0.02
	Vegetable	—	0.07***	0.03	0.09***	0.08***	0.03	0.08***
Food stocking[d]	Fruit	0.98	0.00	−0.01	0.01	−0.01	−0.01	0.00
	Vegetable	0.94	0.01	−0.01	0.02	0.01	−0.02	0.01
	WIC cereal	0.70	−0.07***	−0.11**	−0.06**	−0.06***	0.00	−0.09***
	Whole-grain/whole-wheat bread[g]	0.61	0.08***	0.07	0.08*	0.09**	0.11*	0.08**
	Dry grain beans	0.81	0.10***	0.06*	0.14***	0.10***	0.11**	0.10***
	Frozen fruit	0.72	0.01	0.00	0.08**	−0.04	0.00	0.02
	Frozen vegetables	0.93	−0.04***	−0.08*	−0.04	−0.03	−0.05	−0.04**
	Frozen juice	0.79	−0.01	0.00	0.03	−0.06**	−0.02	−0.01
	WIC fresh juice	0.89	−0.13***	−0.16*	−0.15***	−0.10***	−0.02	−0.16***
	Reduced-fat milk	0.92	−0.03	−0.03	0.02	0.01	−0.01	0.01
	Whole milk	1.00	−0.02	−0.02	0.01	0.02	−0.01	0.00
Quality[e]	Fruit	0.99	0.00	0.00	0.00	0.00	0.00	0.00
	Vegetable	0.98	0.00	0.00	0.00	−0.01	0.01	−0.01*

[a]WIC=Special Supplemental Nutrition Program for Women, Infants, and Children.
[b]Shelf space was measured by shelf width in inches. Changes were assessed based on paired-sample *t* test of equality of means with equal variances assumed.
[c]Number of varieties of fruits and vegetables was measured to assess the diversity in availability of each (eg, if Granny Smith, Red Delicious, and Gala apples were present, the total variety count for apples was "3"). Changes between pre and post audits were measured by percent increase.
[d]Proportion of items carried or in stock; increases in percentage points.
[e]Proportion of items of good quality; increases in percentage points.
[f]Culture-specific food options for Hispanics, ie, whole-grain tortillas, yellow corn tortillas, and white corn tortillas, were included in the whole-grain/whole-wheat bread. Statistically significant increases in shelf space were observed for Hispanic foods overall ($P<0.001$), in small ($P<0.001$), medium ($P<0.01$), and large stores ($P<0.01$), and across rural ($P<0.01$) and urban ($P<0.001$) stores.
[g]Statistically significant increases in food stocking were observed for Hispanic foods overall ($P<0.001$), in small ($P<0.001$), medium ($P<0.001$), and large stores ($P<0.001$), and across rural ($P<0.01$) and urban ($P<0.001$) stores.
*$P<0.05$.
**$P<0.01$.
***$P<0.001$.

At baseline, WIC items were not well labeled across the 105 stores. For example, almost no fruits, vegetables, whole-grain or whole-wheat bread, frozen fruits, or frozen vegetables were labeled. After the revisions, WIC labeling greatly increased for fruits (4 percentage points; $P<0.05$), WIC cereal (11 percentage points; $P<0.05$), whole-grain or whole-wheat bread (48 percentage points; $P<0.01$), dry grain beans (13 percentage points; $P<0.01$), frozen fruits (15 percentage points; $P<0.001$), and frozen vegetables (17 percentage points; $P<0.01$). No significant differences were observed on food items that were labeled before the revisions, such as frozen juice, WIC fresh juice, reduced-fat milk, and whole milk. Compared with medium and large stores, small stores demonstrated smaller changes in WIC labeling after the

Table 3. Food accessibility change[a] measured by mean increases of food visibility and the presence or absence of WIC[b] labels in Texas WIC[b] stores (N=105)

	Foods	Baseline (2009)	Overall increase (2012)	Increase by Store Type			Increase by Store Location	
				Small (n=26)	Medium (n=36)	Large (n=43)	Rural (n=20)	Urban (n=85)
Visibility[c]	Fruits	5.99	0.00	−0.01	0.00	0.00	0.00	0.00
	Vegetables	6.00	0.00	−0.16	0.00	0.00	0.00	0.00
	WIC cereal	5.00	0.06	−0.17	0.02	0.23**	0.15	0.04
	Whole-grain/whole-wheat bread[e]	5.23	0.25	0.04	0.19	0.40*	0.49	0.20
	Dry grain beans	5.28	0.07	0.44	−0.03	−0.06	−0.06	0.10
	Frozen fruits	5.59	−0.11	0.02	−0.20	−0.11	−0.44**	−0.03
	Frozen vegetables	5.85	−0.09*	−0.16	−0.06	−0.09	−0.16	−0.08
	Frozen juice	5.67	−0.17**	−0.27	−0.24*	−0.06	−0.14	−0.18*
	WIC fresh juice	5.08	0.49***	0.44	0.44	0.57***	0.17	0.57***
	Reduced-fat milk	5.72	−0.21***	−0.24**	−0.25**	−0.15	−0.39***	−0.16**
	Whole milk	5.71	−0.21***	−0.02	−0.40***	−0.17	−0.48***	−0.15*
WIC labeling[d]	Fruits	0.00	0.04*	0.00	0.03	0.06	0.01	0.04*
	Vegetables	0.01	0.03	−0.03	0.04	0.06	0.02	0.04
	WIC cereal	0.30	0.11*	−0.19*	0.17*	0.23***	0.22	0.08
	Whole-grain/whole-wheat bread[f]	0.00	0.48***	0.44***	0.52***	0.46***	0.58	0.45***
	Dry grain beans	0.78	0.13**	0.07	0.17*	0.13***	0.05	0.15***
	Frozen fruits	0.00	0.15***	0.00	0.23**	0.18**	0.21*	0.14***
	Frozen vegetables	0.00	0.17***	0.04	0.24**	0.19**	0.25*	0.16***
	Frozen juice	0.81	0.03	0.10	0.02	0.00	0.01	0.04
	WIC fresh juice	0.86	−0.01	−0.14	0.03	0.02	−0.12	0.01
	Reduced-fat milk	0.87	−0.03	−0.12	0.02	−0.03	−0.05	−0.03
	Whole milk	0.90	−0.04	−0.23*	0.04	0.00	−0.05	−0.04

[a]Based on paired-sample *t* test of equality of means with equal variances assumed.
[b]WIC=Special Supplemental Nutrition Program for Women, Infants, and Children.
[c]Visibility was operationalized and measured with the use of a color-coded folding ruler that delineated visibility zones considered high (the best visibility), medium, or low (the worst visibility). The scale of visibility ranges from 1 to 6, with 6 being the best. Changes between pre and post audits were captured by differences in visibility score.
[d]Proportion of items with WIC labels; increases in percentage points.
[e]Culture-specific food options for Hispanics, ie, whole-grain tortillas, yellow corn tortillas, and white corn tortillas, were included in the whole-grain/whole-wheat bread. No statistically significant difference was observed in visibility of Hispanic foods overall, by store type, or by store location.
[f]Statistically significant increase in WIC labeling was observed for Hispanic foods overall ($P<0.001$), in small ($P<0.001$), medium ($P<0.001$), and large stores ($P<0.001$), and across rural ($P<0.001$) and urban ($P<0.001$) stores.
*$P<0.05$.
**$P<0.01$.
***$P<0.001$.

revisions. WIC labeling did not differ significantly between rural and urban stores.

Affordability

As listed in Table 4, across the 105 stores, the prices of the least expensive items increased for fruits (8%, $P<0.001$), vegetables (9%, $P<0.001$), WIC cereal (3%, $P<0.01$), WIC fresh juice (14%, $P<0.05$), reduced-fat milk (15%, $P<0.001$), and whole milk (17%, $P<0.001$) after adjusting for inflation. For whole-grain or whole-wheat bread (−10%, $P<0.001$) and dry grain beans (−4%, $P<0.001$), the prices decreased. The differences were consistent across stores of different types and in different locations.

DISCUSSION

The purpose of this study was to evaluate the impact of the revised WIC food allocation package on the food-shopping environment in WIC-authorized grocery stores across the state of Texas. The results from this study demonstrated that, within 3 years, the policy change had generally improved the availability and accessibility, although not the affordability, of healthy foods in WIC-authorized stores. Our results also suggested that the impact of the policy change differed by store type (small, medium, or large) and store location (rural vs urban) in Texas.

The improvement of healthy food availability in WIC-authorized stores was driven primarily by increased shelf

Table 4. Food affordability change[a] measured by percent increase of inflation-adjusted price in Texas WIC[b] stores (N=105)

		Increase by Store Type			Increase by Store Location	
Foods	Mean increase	Small (n=26)	Medium (n=36)	Large (n=43)	Rural (n=20)	Urban (n=85)
Fruits	0.08***	0.11*	0.10***	0.06*	0.15***	0.07***
Vegetables	0.09***	0.09*	0.10***	0.08***	0.12***	0.08***
WIC cereal	0.03**	0.03	0.02	0.03*	0.01	0.03*
Whole-grain/whole-wheat bread[c]	−0.10***	−0.04	−0.10**	−0.13***	−0.11*	−0.10***
Dry grain beans	−0.04***	−0.04	−0.04*	−0.05**	−0.02	−0.05***
Frozen fruits	0.00	−0.05	−0.02	0.04*	0.00	0.00
Frozen vegetables	0.02	0.00	0.07	−0.02	0.00	0.02
Frozen juice	−0.02	−0.04	0.04	−0.05***	−0.01	−0.02
WIC fresh juice	0.14*	0.09**	0.13***	0.17***	0.11**	0.15***
Reduced-fat milk	0.15***	0.14**	0.16***	0.15***	0.15***	0.15***
Whole milk	0.17***	0.16**	0.19***	0.17***	0.17***	0.16***

[a]Based on two-sample *t* test with equal variances assumed; changes in inflation-adjusted percent increase.
[b]WIC=Special Supplemental Nutrition Program for Women, Infants, and Children.
[c]Culture-specific food options for Hispanics, ie, whole-grain tortillas, yellow corn tortillas, and white corn tortillas, were included in the whole-grain/whole-wheat bread. Statistically significant decrease in price was observed for Hispanic foods overall ($P<0.001$), in medium ($P<0.001$) and large ($P<0.001$) stores, and across rural ($P<0.05$) and urban ($P<0.001$) stores.
*$P<0.05$.
**$P<0.01$.
***$P<0.001$.

space and food stocking of healthy foods (fruits, vegetables, WIC cereal, whole-grain or whole-wheat bread, dry grain beans, frozen fruits, and reduced-fat milk), greater variety of vegetables, and decreased shelf space and food stocking of less healthy food (including WIC fresh juice and whole milk). The biggest increase in shelf space was for whole-grain or whole-wheat bread items (44%), which was consistent with findings from the Connecticut study showing the most substantial gains in availability was for whole-grain products.[10] The food stocking of whole-grain or whole-wheat bread items also increased, which was comparable to the results of the Philadelphia study in which the percentage of stores carrying whole-grain breads increased from 33.0% to 52.0%.[11] For the first time, the 2005 Dietary Guidelines for Americans recommended consuming three or more ounce-equivalents of whole-grain products per day.[24] Following the recommendation, manufacturers began to produce more whole-grain products. The revised WIC food package established a requirement for whole-grain foods and added new whole-grain products, including whole-grain or whole-wheat bread, tortillas, and bulgur.[4] The improved availability of whole-grain products identified in our study indicated that the WIC-authorized stores in Texas were complying with the requirement of the new WIC food package.

The stores' compliance with the new policy change was further evidenced by the increased shelf space for reduced-fat milk, and reduced availability of WIC fresh juice and whole milk. The new food package required that milk purchases be restricted to lower-fat milk for all women and all children older than 2 years of age, with no whole milk except for 1-year-old children and no juice for infants younger than 12 months.[4] In our study, the shelf space dedicated to reduced-fat milk increased by 8%, whereas those of WIC fresh juice and whole milk decreased by 13% and 11%, respectively. Furthermore, compared with baseline, the proportion of stores that carried WIC fresh juice decreased by 13 percentage points at follow-up. These results were generally in agreement with evidence from the literature. For example, Rose and colleagues[13] surveyed 93 WIC stores and non-WIC stores in New Orleans and found that from 2009 to 2010, the odds of improving the availability of lower-fat milks were 5 times greater for WIC stores than non-WIC stores. In the Philadelphia study, 77% of the surveyed WIC and non-WIC stores in two low-income neighborhoods carried reduced-fat milk after the policy change, compared with 50% at baseline.[11]

The availability of fruits and vegetables also increased, as indicated by the increased shelf space for fresh fruits, vegetables, and frozen fruits, and greater varieties of fresh vegetables. In a northern Illinois study, Zenk and colleagues[9] also found increased availability of fresh fruits and vegetables in WIC vendors after the policy change. In another study, researchers detected increased availability of fresh fruits in all three of the states examined (New Hampshire, Pennsylvania, and Wisconsin) and frozen fruits in two states (Pennsylvania and Wisconsin).[8] Given the high proportions of fruit and vegetable items (98% and 94%, respectively) carried or stocked at baseline in the Texas stores, and their overall good quality, that no significant changes were found at follow-up is understandable.

The presence of WIC labels greatly improved after the policy change, and many food items not labeled previously were labeled after the revisions, including WIC cereal, whole-grain or whole-wheat bread, frozen fruits, and frozen

vegetables. In Texas, the WIC program has strict rules regarding the labeling of WIC foods in stores. Specifically, a store's declared LEB of milk, juice, whole-wheat or whole-grain bread, and dry bean products are required to be labeled with the "WIC-approved item" pink sticker or store-developed stickers or signage if preapproved by the state WIC program.[21] For other non-LEB WIC foods such as cereal, frozen fruits, and vegetables, grocery stores may choose to tag these foods with the Texas WIC Smart Choices Healthy Families logo for easier recognition.[21] The improved labeling of both LEB and non-LEB products in our study confirmed the efforts that WIC-authorized stores in Texas undertook in observing the state requirements and promoting cost efficiency and easier identification of WIC foods.

Considering the evaluation was conducted 3 years instead of shortly after the policy change, the improvements in WIC foods accessibility reported here seemed to be integrated into the food-shopping environment, rather than being a short-term reaction to the policy change, and the improvements were likely to be maintained in Texas WIC-authorized stores. To our knowledge, no study has examined the changes in WIC labeling before and after the policy change. To gain a better understanding of how the policy change benefited WIC participants nationwide, particularly in WIC food accessibility, more studies are needed in more states, especially those that examine the effects of the labels on purchasing decisions made by WIC participants.

As another important measure of food accessibility, visibility did not change for most of the foods audited, including fruits, vegetables, WIC cereal, and whole-grain or whole-wheat bread. Because the high visibility score for each item at baseline left little room for improvement, the overall food visibility was considered to have remained favorable at follow-up, despite the sporadic significant increases and decreases in certain items, by either store type or store location.

In general, food affordability did not change after the policy change. Reductions in prices were found only for whole-grain or whole-wheat bread and dry grain beans, and higher prices were observed for other healthy (fruits, vegetables, WIC cereal, and reduced-fat milk) and less-healthy products (WIC fresh juice and whole milk). Among all of the WIC foods, the increased prices of fruits and vegetables affected WIC participants most directly. In Texas, the revised WIC food package offered cash-value vouchers ($8 to $10) to participants for purchase of fruits and vegetables. Understandably, when the prices of fruits and vegetables increased, the amount of fruits and vegetables WIC participants could purchase with the vouchers decreased. For the other items, the new WIC package specifies quantities instead of total price; for example, children aged 2 years and older receive 36 oz of WIC-allowable cereal regardless of the price. Therefore, the increased prices of these items did not affect the benefits that WIC participants received from the new food package. Nevertheless, because designated WIC foods are accessible in public shopping outlets and, thus, readily available to the general public, improved affordability of WIC products will benefit both WIC and non-WIC participants.[7]

To our knowledge, few studies have assessed the influence of the policy change on food affordability. The only such study was conducted by Andreyeva and colleagues,[25] who surveyed 252 convenience and non-chain grocery stores in Connecticut and found that the WIC food package revisions had no effect on price changes for three of the most commonly available foods: eggs, whole milk, and canned vegetables. Although the policy change did not target food prices directly, the importance of affordability as a critical aspect of the food environment needs to be considered in more studies.

The positive effects of the policy change on food availability and visibility were observed in stores of different types and in different locations, although smaller or fewer effects were noted in small stores and stores in rural regions. Compared with medium and large stores, small stores showed fewer improvements in food availability (eg, shelf space of healthy foods and varieties of vegetables), and accessibility (eg, WIC labeling). These findings were roughly consistent with a previous study showing a positive association between store size and increased availability of vegetables and fruits after the policy change in Hartford, CT.[12] Of note, although WIC labeling generally improved across the 105 stores, small stores did not demonstrate any positive changes, except for whole-grain or whole-wheat bread items. In the state of Texas, a store's failure to label WIC foods appropriately is cause for termination of the store agreement. Therefore, our results highlighted additional assistance that small stores may need to improve WIC labeling and maintain their authorization status.

Stores located in rural and urban regions were primarily delineated by improvement in food availability, particularly in shelf space and varieties of vegetables. At baseline, no difference was found between rural and urban stores on food availability.[7] After the revision of the WIC food package, urban stores devoted greater shelf space to almost all of the healthy foods that were examined. In great contrast, rural stores did not demonstrate any increase in shelf space, except for whole-grain or whole-wheat bread. Moreover, variety improvement was detected for vegetables in urban stores, but not in rural stores. This disparity cannot be explained solely by the smaller sample size of the rural subgroup ($n=20$) that might have limited the statistical power. In fact, the disparity is better explained by effect size.

There are several limitations of this study. First, our sample size, especially for small and rural stores, was not very large. Consequently, some significant improvements in these two subgroups might not have been detected. Second, our study was limited to WIC-authorized stores in Texas; therefore, the findings may not generalize to non-WIC stores in Texas, or to WIC-authorized stores in other states differing in the implementation of the revised WIC package (eg, WIC labeling requirements and authorized culturally specific foods). Third, we conducted many comparisons in this study, but we chose not to adjust for multiple testing because we considered this study exploratory and focused on general patterns instead of on any single test. Accordingly, significance should be considered with caution, and replication of results is needed. Also because of the descriptive nature of our analysis, we did not test the interaction effect between store size and location. Future studies using regression or more advanced analysis strategies are needed to assess this potential effect.

Despite the limitations, the study has a number of unique strengths. First, our study represents one of the most comprehensive statewide assessments of the effects of the revised WIC food package in WIC-authorized stores. Stores of different characteristics from different regions within the

state of Texas were surveyed, which provided representative data for accurate evaluation of the policy change in an ethnically and socioeconomically diverse population. Second, the TXNEMS-WIC instrument is comprehensive and measures multiple dimensions of the food environment, including shelf space, variety, quality, WIC labeling, and price. In particular, it has for the first time introduced marketing principles to measure food visibility.

CONCLUSIONS

The availability and accessibility of healthy foods in WIC-authorized stores have generally improved 3 years after the implementation of the revised WIC food package in Texas. Future studies need to explore the impact of the revised program on healthy food option purchases and consumption patterns among Texas WIC participants, how WIC labeling influences participant purchasing behaviors, and how this might vary by store type and location.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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