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A Picture of the Healthful Food Environment in Two Diverse Urban Cities

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Abstract

Background: Local food environments influence fresh produce purchase and consumption, and previous research has found disparities in local food environments by income and ethnicity. Other existing studies have begun to quantify the distribution of food sources, but there has been limited attention to important features or types of healthful food that are available or their quality or cost. Two studies assessed the type, quantity, quality and cost of healthful food from two diverse urban cities, Kansas City, Kansas and Missouri and Honolulu, Hawaii, and evaluated differences by neighborhood income and ethnic composition.

Method: A total of 343 food stores in urban neighborhoods were assessed using the one-page Understanding Neighborhood Determinants of Obesity (UNDO) Food Stores Assessment (FSA) measuring healthful foods. US Census data were used to define median household income and ethnic minority concentration.

Results: In Study 1, most low socioeconomic status (SES), high ethnic minority neighborhoods had primarily convenience, liquor or small grocery stores. Quality of produce was typically lower, and prices of some foods were more than in comparison neighborhoods. In Study 2, low SES neighborhoods had more convenience and grocery stores. Farmers' markets and supermarkets had the best produce availability and quality, and farmers' markets and pharmacies had the lowest prices.

Conclusions: Messages emphasizing eating more fruits and vegetables are not realistic in urban, low SES, high ethnic concentration neighborhoods. Farmers' markets and supermarkets provided the best opportunities for fresh produce. Increasing access to farmers' markets and supermarkets or reducing prices could improve the local food environment.

Keywords: public health, environment, fruits, vegetables, African American, Asian continental ancestry group

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Introduction

Access, type and quality of food sources in urban neighborhoods

Over 75% of US adults do not eat the recommended 5–9 daily servings of fruits and vegetables, including a disproportionate number of low-income individuals and ethnic minorities.[1] Residence in socioeconomically deprived neighborhoods can mean access to fewer supermarkets but more convenience and small grocery stores than wealthier neighborhoods,[2–4] that in turn may lead to unhealthful dietary patterns.[3,5–6] Lack of access to healthful food may contribute to overweight and obesity.[7–11]

People tend to make dietary choices based on the quality of food that is available and economical.[12] Residents of deprived neighborhoods report eating fewer fruits and vegetables and more foods high in fat, even after adjusting for individual socioeconomic status (SES).[13–16] Residents who rely on convenience, liquor or "mom and pop" small grocery stores, may have a more limited selection of healthful foods available at higher costs,[6,17] because larger supermarkets typically stock a wider variety of items.[2,18]

Price also impacts dietary habits, including fruit and vegetable consumption, due to higher costs for many healthier foods.[18] Differential pricing in stores found in impoverished neighborhoods, suggests that small groceries, pharmacies, and convenience stores, may be more expensive than supermarkets.[6,19] It is plausible that residents who only have access to small stores are doubly jeopardized when fewer available fruits and vegetables are sold for higher prices. Although it cannot be assumed that people purchase the majority of their food in their neighborhood of residence,[20] residents in impoverished areas may have few individual capital resources, such as personal transportation, making it reasonable to assume that there may be greater reliance on proximal food sources.[21]

This manuscript describes two studies that systematically examined food stores in urban neighborhoods in two US cities and evaluates the access, type, quality and cost of available healthful foods in consideration of neighborhood sociodemographic factors. Other existing studies have begun to quantify the distribution of food sources, but there has been limited attention to important features or types of healthful food that are available or their quality or cost. It is critical to directly evaluate the available food sources in diverse neighborhoods in order to produce sustainable improvements in dietary habits. These two studies present a story of two ethnically, economically and geographically diverse cities to investigate these issues.

Study 1 (Kansas city)

Kansas City is a landlocked city spanning two states, but is seamless visually and practically. At the time of this study, Kansas City, Missouri covered 314 square miles and had about 440,000 residents with a median household income of $37,198. About 61% of residents were white and 31% African American, with a handful of Hispanic, Asian and mixed residents. Kansas City, Kansas, covered 124 square miles, had about 145,000 residents with a median household income of $33,011, and of whom about 56% were white, and 30% were African American, with 16.7% Hispanic and less than 3% Asian and mixed ethnicity residents.[22] In Study 1, we 1) developed an assessment instrument and protocol to describe food stores, 2) assessed the type, quantity, quality and cost of all available food stores in urban neighborhoods available to public housing residents, and 3) compared the food stores in public housing neighborhoods to less deprived, urban neighborhoods.

Study 2 (Honolulu)

Honolulu, Hawaii is home to about 400,000 citizens, comprising the highest non-Hispanic multiracial population percentage of any US Metropolitan area. The population is 45% Asian, 25% White, 8.6% Native Hawaiian and Other Pacific Islander, and 3.2% Black (only 7% of the population claims Hispanic or Latino origin). Over 17% report two or more races.[23] Honolulu has the highest priced standard basket of grocery items in the USA.[24] In 2007, grocery prices rose 6.1%, partially due to rising oil costs.[25] The reliance on imported goods results in most produce items being priced by the pound, with consumables costing up to 66% more than the national average.[26] In Study 2, we extended the work of Study 1 to examine the downtown Honolulu local food environment in order to determine whether the cost, availability and quality of fresh produce varied by store type, area income, and ethnicity.

Method

Kansas city neighborhoods

Seventeen urban neighborhoods, defined as the area within an 800 meter radius buffer around a centroid structure, were selected; thirteen had a public housing development (HD), and four had a similar type of multiunit housing as the center. HDs are affordable rental housing for families, seniors, and persons with disabilities federally-funded and managed by the Kansas City Housing Authority. All HD neighborhoods were located in urban areas that were predominantly lower SES, with higher proportions of ethnic minorities. The other four neighborhoods were similarly urban, had similar population density and connectivity, but were higher in income with low proportions of ethnic minorities. These comparison neighborhoods were selected to have high numbers of goods and services in order to provide an adequate comparison of the types, quality and cost of available healthful foods. Selection criteria and neighborhood characteristics have been described previously.[27,28]

Honolulu store selection and area characteristics

A listing of all food retailers was created using the 2005–2006 Yellow Pages and the 2007 online version of Yellowpages.com. Key Yellow Pages subject listings included"conveniencestores,""grocers-retail,""market-public," and "sundries store." Yellowpages.com queries included "convenience store," "grocer-retail," and "grocery store," in Honolulu, Hawaii. Fruit and vegetable suppliers, wholesale stores, and stores requiring a membership card were excluded. A farmers' market listing on the Honolulu city and county website was used; all were screened to be within specific downtown Honolulu zip codes.

Convenience stores comprised 63% of food stores, with a distribution of 181 convenience stores, 12 farmers' markets, 53 grocery stores, 12 pharmacies, and 19 supermarkets. Due to the large number of convenience and grocery stores, up to 30 of each store type were selected for assessment.

Each store address was linked to its census tract from the 2000 U.S. Census, for a total of 64 tracts (33). Census tracts were chosen rather than census block groups to more closely match the size of the HD areas from Study 1. Median household income was used as a proxy for SES. We used census data to determine the percent of non-white residents (hereafter termed minority).

Measures

Kansas city neighborhood level variables

United States' 2000 Census data were used to compute the aggregate median household income, population density and percentage of ethnic minorities for each neighborhood with variables created at the census block group level. A census block group is a cluster of census blocks within a census tract which is designed to be homogeneous with respect to population characteristics, economic status, and living conditions.[29] Street connectivity[30] was calculated by counting the number of three or more street intersections in each neighborhood that form a "T" or a "+" or a star-like shape.

The census of food stores available to the general public was identified using a three step strategy. First, internet and telephone book searches were performed to generate an initial list of all food stores in each neighborhood. Database search terms included *store*, *convenience store, grocery, liquor store, supermarket,* and *pharmacy*. Stores were mapped using ArcView and confirmed by phone their location and whether they were still in business. Next, trained field coders conducted windshield drive-by surveys to confirm food store locations and to identify additional stores not identified by existing databases.[23,31]

Kansas city store assessment

Stores were classified as "supermarket", "grocery", "convenience", "pharmacy", "liquor", "ethnic specialty" (primarily selling foods used in the preparation of meals characteristic of a particular ethnicity such as Ethiopian, Indian, Mexican, or Vietnamese) or "other" (e.g. discount/variety store). Supermarkets were defined as "large franchise or chain grocery store." Grocery stores were defined as "stores that sold groceries that were smaller than supermarkets," typically not having as large a selection as the large franchise stores. Convenience stores were "stores selling convenience foods that may have had several gas pumps and sell limited foods, drinks and toiletries." Liquor or liquor/convenience stores sold "predominantly liquor, but also carried some food items (not just soda)." A pharmacy was "a drug

store which had food in at least one aisle or section." Other types of stores were defined as "any other store which sold food; one example would be a video rental store that carried popcorn and soft drinks."

Each store was assessed on type, overall appearance, whether it was open 24 hours, and available quality and cost of specific foods. Appearance was assessed by indicating observation of trash outside (loose trash not in a dumpster), dirt on floors (inside the building), dirt elsewhere (dirt or mess in the bathroom, around a food display, unclean counters), or foul odors (noticeable unpleasant smell in any section of a store).

Store inventories were evaluated for twenty-three common foods that were either nutritionally dense, reduced calorie versions of commonly eaten foods in the US, or of specific interest to the investigators. Foods included fruits, vegetables, dairy products, and grains. Fresh vegetables and fruit were rated for quality, using standard definitions of poor, mediocre or good. Expiration dates of perishable foods (dairy products and meats) were verified. Most products were rated on cost per pound, except that nearly all of the (Kansas City) stores sold fruit by the unit (i.e. one apple, banana, or orange), which was calculated to price per pound. Figure 1 shows the quality and cost ratings of each food.

When multiple brands were available for general category products (e.g. eggs), the least expensive brand was selected. A specific size was assessed for each food. If that size was not available, the cost per available size was recorded and converted to reflect the specified size cost. For example, Cheerios was assessed at the 10 oz box size; however, if the 15 oz box was the only size available, that price was recorded, then converted to the 10 oz price.

Honolulu assessments

The instrument used in study 1 was adapted for use in this study by adding nine produce items to reflect Hawaii's food environment (Fig. 1). Due to the lack of fresh produce at liquor/convenience stores, farmer's markets (collective market where local farmers sell their produce) were instead assessed. The few items not priced by the pound were weighed to calculate the price per pound. Hours of operation on weekdays and weekends were also recorded.

Kansas city procedures

The store assessment instrument was developed, pilot tested and revised. The census of stores was determined by neighborhood; 10% of the sample was randomly selected for reliability analyses. Teams of two conducted the assessments during daylight hours from March to November 2003 following safety protocols in case of imminent perceived danger. Raters only disagreed on store type once, for 88% agreement. Reliability tests for item presence showed 92.02% agreement (K = 0.81 [CI = 0.71–0.91] SE = 0.05). Quality ratings on fruits and vegetables showed 89.08% agreement (K = 0.60 [CI = 0.31–0.89] SE = 0.15), since item unavailability by time conflicted with quality ratings. Agreement on quality ratings was 100% when the item was present each assessment time. Expiration dates showed a 91.94% agreement (K = 0.80 [CI = 0.63–0.97] SE = 0.08). And item price showed 84.38% agreement (K = 0.60 (CI = 0.46–0.74) SE = 0.07), possibly resulting from day-to-day price fluctuations.

Analyses

Data were entered and proofed by trained graduate assistants. Analyses were conducted using SPSS v 12.0.[32] Comparisons of the number or type of stores in HD neighborhoods with comparison neighborhoods were not conducted, because the neighborhood selection strategy was somewhat different. Comparison neighborhoods were included solely to compare the type, quality and cost of available foods.

Honolulu procedures

Trained surveyors completed all audits in teams of two or three. For the first ten assessments, one audit was completed by each surveyor with inter-rater reliability co-efficient per item ranging from k = 0.67–1.0 (median k = 1.0). Once observations were found to be reliable, only one audit was completed per store.

Farmers' markets that were open only before 8:00 am or on weekends were excluded and data collection was refused at two groceries and one convenience store. Eighty-five stores (96% of those attempted) were assessed during the summer of 2007, including 30 convenience stores, four farmers' markets, 25 grocery stores, 10 pharmacies, and 16 supermarkets. One convenience store and one grocery had no available items from the assessment form.

Food Product		Quality			Price
	0	1	2	3	Cost/Unit
Salad/lettuce (dark)	Poor = produce appears very old or very unripe, several pieces are damaged, quality of firmness is too firm or too soft. Color may indicate extreme unripeness or general low quality.	Poor = produce appears very old or very unripe, several pieces are damaged, quality of firmness is too firm or too soft. Color may indicate extreme unripeness or general low quality.	Mediocre = produce appears to be a little old, some pieces may be damaged (spots or dents), but have the appropriate firmness and the appropriate color.	Good = produce appears to be fresh, undamaged, have the appropriate firmness and the appropriate color. Bananas may be less than ripe.	Pound (lb)
Leaf lettuce (romaine)					lb
Grean beans					lb
Carrots					lb
Greens					lb
Green peppers					lb
Cucumbers (field)					lb
Edamame (fresh)					lb
Broccoli					lb
Mushrooms (button)					lb
Tomatoes (full size)					lb
Sweet potatoes					lb
Onions (yellow)					lb
Avacados					lb
Apples					lb
Oranges					lb
Bananas					lb
Pineapple					lb
Papaya					lb
Milk- Lowfat					½ gallon
Milk-Lowfat (Skim)		Outdated = Product was past its expiration date			½ gallon
Milk -Soy (Plain)					½ gallon
Eggs					dozen
100% Whole wheat bread					loaf
Ground beef (lean)					lb
Skinless chicken breast					lb
Turkey franks					8-pack
Tofu					ounce (oz)
Canned light Tuna in water					6 oz
Frozen (light) Meal					package
Vanilla frozen yogurt					pint
Cereal-Cheerios (plain)					10 oz
Cereal-Fruit Loops					10 oz
Bottled water					liter
100% Fruit juice					½ gallon
Cola					2-liter
Potato chips (plain)					13 ½ oz
M & M's (plain)					3.27 oz

Figure1. Food, quality and cost assessment ratings.

Results

Kansas city

HD and comparison neighborhoods differed on dimensions of income, $t\,(14) = 5.058$, $p < 0.001$, and ethnic concentration, $t\,(14) = 9.439$, $p < 0.001$, but were similar in density, urban design and age. HD neighborhoods had a median household income range of \$11,930–\$34,303, (M = \$22,871, SD = \$7,004) compared to \$38,099–\$48,383, (M = \$42,364, SD = \$4,493) in comparison neighborhoods, $t(14) = -5.058$, $p < 0.001$. HD neighborhoods had an ethnic minority population range of 50.7%–98.1% (M = 71.4%, SD = 14.3%) compared to 9.1%–18.2% (M = 13.2%, SD = 4.1%) in comparison neighborhoods, $t(14) = 9.439$, $p < 0.001$. HD and comparison neighborhoods did not differ in population density, $t(14) = -0.965$, $p = 0.351$, or in connectivity, $t(14) = 0.092$, $p = 0.928$.

Fifty-one stores were assessed in HD neighborhoods and 26 in comparison neighborhoods. Figure 2 presents the frequencies and types of stores available to HD

residents and the types of stores assessed in comparison neighborhoods. About 10% ($n = 8$) of stores were open 24 hours, and all were convenience stores ($p = 0.068$). Nearly all HD neighborhoods ($n = 12$; 92%) had one or two convenience stores ($M = 1.3$; range = 0–2). The majority of HD neighborhoods ($n = 8$; 62%) had a liquor store that also sold food. Few HD neighborhoods had supermarkets or small grocery stores, although five had ethnic specialty stores. Comparison neighborhoods had similar store availability. For store appearance, nearly half (44%, $n = 34$) of all stores had trash outside, with convenience stores most likely to have trash outside, $\chi^2 = 16.38$, $p = 0.012$.

Hononlulu

Census tract median household incomes ranged widely (range = $11,758–105,223, M = $37,000, SD = $16,540) and were transformed to quartiles with 16 tracts each. The mean percent of minority residents was 77.6% (±18.3%, range = 29%–98.9%); quartiles were created with 16 tracts each. Quartiles were used to generate comparisons similar to those between the HD and comparison neighborhoods in study 1. The largest non-white ethnic groups were Asians (n = 61 tracts), Blacks ($n = 2$ tracts), and Laotians ($n = 1$ tract). Ethnic minority population density was evenly distributed across income quartiles (range = 79.2 to 82.5).

Sixteen percent of stores ($n = 14$) were open 24 hours. This included seven supermarkets, four convenience stores, and three pharmacies located in 10 different census tracts. Statistically significant differences were found between all store types for the average hours of operation per weekday, $F(4,67) = 20.03$, $p < 0.001$. Tukey post-hoc analysis indicated that all store types were open longer than farmers' markets ($M = 3.0$, $SD = 2.4$, $p = 0.003$), and that convenience stores ($M = 17.6$, $SD = 4.8$), pharmacies ($M = 17.4$, $SD = 5.2$), and supermarkets ($M = 20.4$, $SD = 3.9$) were open longer than grocery stores ($M = 11.8$, $SD = 3.0$, $p = 0.01$). Statistically significant differences also existed for store weekend hours of operation, $F(3, 44) = 10.74$, $p < 0.001$, with convenience stores, pharmacies, and supermarkets open longer than grocery stores ($p = 0.017$). No statistically significant difference existed for store hours by SES or ethnicity.

Nearly all census tracts ($n = 54$) had at least one convenience store. Convenience and grocery stores were most prevalent in the lowest income quartile, supermarkets were most prevalent in the 2nd income quartile, and pharmacies were most prevalent in the 3rd income quartile. Farmers' markets were most prevalent in the 2nd and highest income quartiles. These differences were not statistically significant ($p = 0.053$). The fewest total stores were found for the highest percent minority quartile ($\chi^2 = 38.05$, $p < 0.001$). Table 2 presents urban Honolulu store type distribution by neighborhood income and ethnic minority population density.

For store appearance, dirt on floors was the most frequent item (15% of assessed stores), with grocery stores being significantly more likely to have dirt on their floors than any other type of store, $\chi^2 = 22.75$,

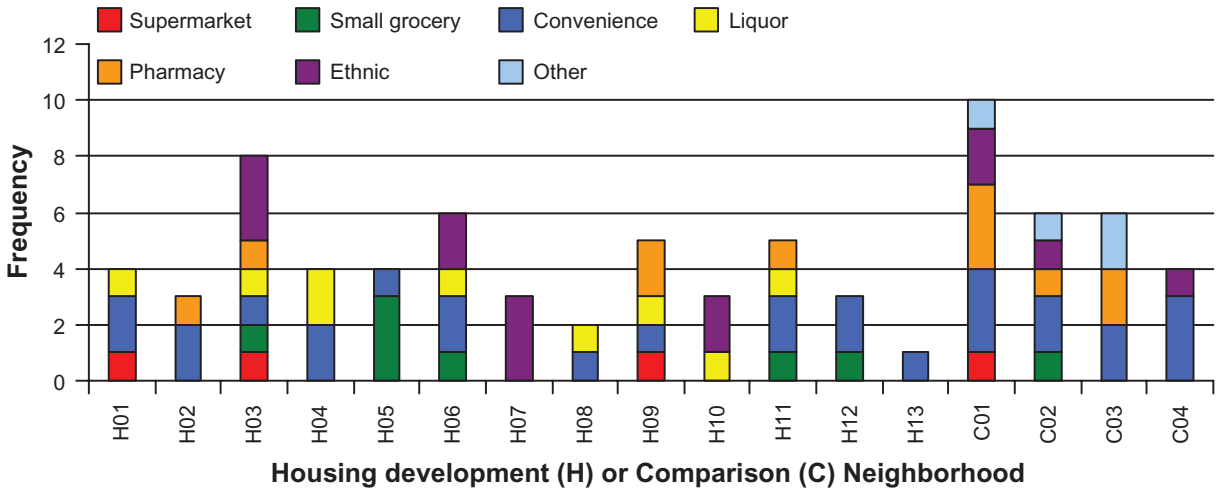

Figure 2. Types of Stores in Study 1, Kansas City Neighborhoods.

$p < 0.001$. Eleven percent of assessed stores had trash outside; over half were grocery stores ($n = 5$ stores).

Availability, quality and cost of fresh fruits and vegetables

Kansas city

All but one of the HD neighborhoods had stores that sold fruit and half of HD neighborhoods had stores that sold fresh vegetables, typically one store per neighborhood. The availability of each kind of fresh fruit or vegetable in HD neighborhoods is presented in Table 1. Half of the comparison neighborhoods had stores that sold fruits and one comparison neighborhood had stores that sold vegetables. Average availability of the 8 fruits and vegetables was divided into none, low (≤4), and high (>4). All supermarkets ($n = 4$) and 1/4 of grocery stores ($n = 2$) had high availability. A few grocery, convenience, and ethnic stores had low availability ($n = 2$–6), with convenience stores most likely to carry apples, bananas, and oranges. Liquor/convenience, pharmacies, and other stores did not sell fresh produce. Differences between HD and comparison neighborhoods were not statistically significant, perhaps attributable to the small sample size.

Average quality ratings were lowest at ethnic stores ($M = 2.20$, $SD = 0.84$) and highest at supermarkets ($M = 2.79$, $SD = 0.34$). These differences were not statistically significant between HD and comparison neighborhoods. However, as presented in Figure 3, quality and cost of available fruits and vegetables were typically lower in HD than in comparison neighborhoods.

Purchasing one apple, orange and banana at a convenience store would cost a consumer 38% more than at a grocery store or 34% more than at a supermarket.

Honolulu

Of the 42 census tracts in which stores were assessed, over 80% had stores that sold fresh vegetables and stores that sold fresh fruit; typically one store per census tract. Differences in the availability of fresh fruits and vegetables did not vary significantly by income quartiles. Average availability of the 16 fruits and vegetables was divided into none, low (≤8), and high (>8). All farmers' markets and supermarkets had high availability, while grocery stores had either high or low availability. Convenience stores and pharmacies had none or low availability. Apples, oranges, bananas, onions and papayas were available in over 50%, and tomatoes, carrots, and green peppers were available in at least 40% of stores. The remaining eight produce items were available in at least 30% of all stores.

Table 1. Availability of fresh fruits and vegetables in housing development neighborhoods.

Item	Frequency of neighborhoods that sold item		Average number of stores per neighborhood that sold item	
	#	%	#	%
Apple	9	69	1	24
Orange	8	62	1	20
Banana	9	69	1	35
Lettuce	5	38	1	22
Green beans	1	8	1	33
Carrots	5	38	1	19
Greens	4	31	1	19
Sweet potatoes	4	31	1	19

Average quality ratings were lowest at convenience stores ($M = 2.34$, $SD = 0.79$), and highest at supermarkets ($M = 2.75$, $SD = 0.14$). These differences were not statistically significant by store type, income or ethnicity. Costs varied by ethnic and income quartiles for only a few produce items. The costs per pound of apples and oranges were inversely related to ethnic minority quartiles ($r = -0.43$, $p = 0.001$ and $r = -0.68$, $p < 0.001$, respectively) and the cost per pound of onions was positively related to income quartiles ($r = 0.32$, $p < 0.05$).

The cost of buying one pound of the following produce items that were available at all store types (i.e. apples, carrots, green peppers, onions, oranges, tomatoes) was lowest at pharmacies ($8.35) and farmers' markets ($8.36), followed by grocery stores ($9.53), supermarkets ($10.97), and convenience stores ($11.05). Purchasing these six items at a convenience store would cost a consumer 32% more, at a supermarket 31% more, and at a grocery store 14% more than at a farmers' market or pharmacy.

Table 2. Honolulu store type distribution by neighborhood income and ethnic minority quartiles.

	Census tracts	Convenience	Farmers' market	Grocery	Pharmacy	Supermarket	Total
Median income quartiles							
1 (≤$31,799)	16	76	2	31	2	6	117
2 ($31,800–37,100)	16	38	4	17	2	8	69
3 ($37,101–52,000)	16	43	2	9	5	2	61
4 (≥$52,001)	16	24	4	5	3	3	39
Ethnic minority quartiles[a]							
1 (≤75%)	16	74	4	5	4	1	88
2 (76.1%–86.2%)	16	44	1	21	4	9	79
3 (86.3%–94%)	16	42	4	27	3	4	80
4 (>94%)	16	21	3	9	1	5	39
Total quartiles	64	181	12	62	12	19	286

[a]$\chi^2 = 38.05$, $p < 0.001$.

Availability and cost of selected dairy, meat and grain foods

Kansas city

Low fat milk was available in all HD and comparison neighborhoods. Non fat milk was available in five HD and all comparison neighborhoods. Soy milk was available in one third of HD ($n = 4$) and one fourth of comparison neighborhoods. Eggs were found in all but one HD and comparison neighborhood, and canned tuna in water was found in all neighborhoods. Low fat milk, non-fat milk, soy milk, eggs and canned tuna were typically found, on average, in 2 stores per neighborhood. Skinless chicken breasts were found in three HD and two comparison neighborhoods, turkey franks were found in four HD and one comparison neighborhood, and tofu was only found in two HD neighborhoods. Skinless chicken breasts, turkey franks and tofu were predominately found in supermarkets. Cereal and whole grain bread were found in most neighborhoods, but usually only in one store. Seven HD and three comparison neighborhoods carried frozen reduced calorie meals, and only one HD neighborhood sold frozen yogurt. Low fat milk and eggs were $.09–$.12 more expensive in HD than in comparison neighborhoods, while sugary cereal was $.40 cheaper in HD than in comparison neighborhoods. There were no other consistent differences in quality or cost between HD and comparison neighborhoods.

Honolulu

Dairy, meat and grain foods availability varied by store type (none of these items were present at farmer's markets). Low fat milk, skim milk, and soy milk were available in stores in all income quartiles. Skinless chicken breasts were found in all income quartiles, but only at supermarkets. Ground beef was also found in all income quartiles, but only at supermarkets and grocery stores. Cereal, whole grain bread, and frozen light meals were found in all income quartiles and all store types. No statistically significant differences existed by income or ethnicity quartiles for the cost of these items.

Discussion

Despite the geographic, ethnic and cultural differences in these two diverse urban cities, we saw a number of commonalities that reflect a need for continued attention to improving access to healthful food. Across both cities, supermarkets typically provided the best variety and quality of fruits and vegetables for a comparable or lower price, underscoring the importance of access to supermarkets for healthful foods. Convenience stores had the highest prices in both cities, and were more common in more deprived areas.

Honolulu census tracts included in the study tended to be higher income and more ethnically diverse than the Kansas City neighborhoods. Consistent with Kansas City and previous research, Honolulu store types varied

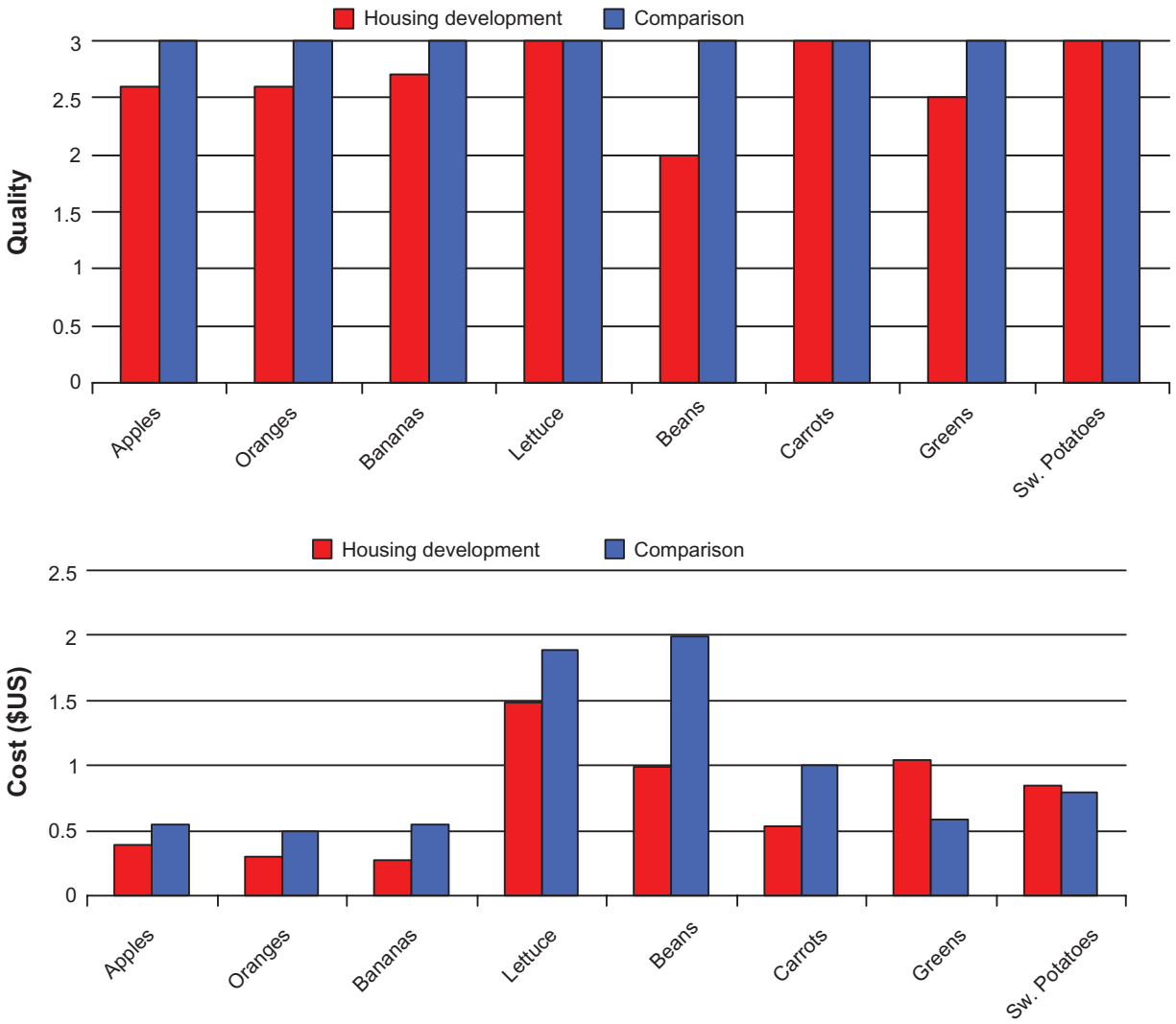

Figure 3. Quality and cost of available fruits and vegetables in Study 1 Kansas City Neighborhoods.

by income, with more convenience and small grocery stores in the lowest income quartile.[2,33] Incivilities such as trash and dirt on floors were more likely at these types of stores. In contrast to Kansas City, and previous research,[2] the lower two income quartiles in Honolulu contained most of the supermarkets. Unlike Kansas City, Honolulu did not have a proliferation of liquor stores that sold food in lower income areas. In both Honolulu and Missouri, liquor can be sold in any commercial store with a liquor license; however, in Kansas, beer, wine, and spirits can only be sold at a retail liquor store, except for on Sundays, when no liquor is sold in stores.[34,35] As might be expected from these policies, the majority (78%) of the liquor/convenience stores in the Kansas City study were on the Kansas side of the study area. A greater number of pharmacies were found in the higher income areas in both studies. Although they had a low availability of healthful food, their produce was reasonably priced in Honolulu. It is unclear why pharmacies had lower prices, a question for further inquiry. Farmer's markets were more evenly distributed across income quartiles but had infrequent hours of operation, and may only provide limited access to fresh produce.

Only 25% of Kansas City's ethnically dense HD neighborhoods had a supermarket, similar to what others have found.[36] In contrast, Honolulu had the second highest number of supermarkets in the census tracts with the highest percentages of minority residents. At the same time, these areas also had the fewest convenience stores and pharmacies. Produce availability was higher at farmers' markets, small grocery stores, and supermarkets than at conveniences stores and pharmacies in Honolulu.

Supermarkets also had significantly higher availability than grocery stores. Previous research has shown similar high availability for supermarkets and low availability for pharmacies and grocery stores.[18,19]

Fewer than 20% of stores in both cities were open 24 hours. In Kansas City, these were all convenience stores, whereas in Honolulu, they also included supermarkets and pharmacies. This picture may have been different if all Honolulu convenience stores were assessed in all census tracts rather than a sample. Rather than simply indicating whether a store was open 24 hours as in the Kansas City Study, in Honolulu we assessed the opening and closing hours of each store both on weekdays and on weekends. We found that grocery stores were open significantly fewer hours than supermarkets, pharmacies, and convenience stores. Although residents might have access to healthful foods in a nearby grocery store in Honolulu, there were only limited hours within which to make purchases.

The availability of fruit was similar for both studies, but the availability of fresh vegetables was lower in Kansas City neighborhoods than Honolulu census tracts (25%–50% as compared to 81%). The quality of fruit in Kansas City was typically lower for HD neighborhoods. Although this result was not found for the lower income quartiles in Honolulu (i.e. most farmer's markets and supermarkets had high quality produce),[37] in both cities, produce ratings were highest at supermarkets and lowest at ethnic (Kansas City) or convenience (Honolulu) stores. Perhaps the lower quality of fruits and vegetables contributes to lower demand and a longer shelf life for the produce items. This might explain the slightly lower costs for fruits. It is impossible to know whether this reflects resident demand, although availability has been associated with greater consumption.[38] The lack of availability in Kansas City may reflect more global issues such as *perceived* lack of interest among residents that in turn contributes to lack of marketing to urban stores in low income areas. Perhaps merchants of small stores prefer to stock items that are accompanied by slotting fees or other promotional strategies. Ecologic remedies at multiple levels are needed to produce sustainable access to healthful foods. Taken together the current two studies and previous findings underscore the importance of supermarket access for high quality fruits and vegetables.

We found some direct support for the notion that residents in deprived, high ethnic concentration Kansas City neighborhoods may pay more for commonly eaten foods in that milk and eggs tended to cost about $.25 more on average in these areas compared to more affluent areas. On the other hand, sugary cereal was cheaper in the HD neighborhoods. Skinless chicken breasts and lean ground beef were only available at supermarkets in both cities. Access to low fat, skim and soy milk was much greater in Honolulu, possibly reflecting a statewide social marketing campaign to reduce the consumption of whole and 2% milk.[39] Further, convenience stores, the most commonly seen store in both cities' impoverished neighborhoods, consistently had the highest prices on produce. Consider that if one pound of the six fruits and vegetables measured were purchased every week for one year, then shopping at a convenience store in Honolulu would cost $575 as compared to $434 at a pharmacy or farmers' market.

The direct cost of food may influence food preferences and purchase patterns.[42,43] Lack of conveniently available high quality, healthful foods suggests that residents have to pay more *indirectly* in terms of travel related costs, including time, especially costly if one has limited transportation opportunities. The indirect costs may be even greater barriers to affording a ready supply of healthful foods above and beyond measurable differences at the cash register. Taken together, the results from the two studies indicate the best produce scenarios are at farmers' markets and supermarkets, although access to both places may be limited. Prices may be higher at supermarkets compared to farmers' markets, particularly as fuel prices associated with transportation increase. The average supermarket vegetable travels many miles compared to farmers' market produce that is typically locally grown and processed.

These studies used different sampling strategies that may have contributed to variability in the findings. However, many commonalities were found across the studies in terms of cost and availability suggesting that triangulation of methods is strength of this work. Broader geographic sampling would help determine whether these findings are generalizable to other locations, and longitudinal work is needed to determine the dynamic nature of the food environment. These studies only provide a cross-sectional picture of the food environment, and rely on census data to determine ethnicity and income.

As census data are only collected once a decade, it is possible that migratory patterns may change the demography of neighborhoods. These studies were not able to assess these longitudinal factors. The Food Stores Assessment was developed for broad applicability while still providing a brief assessment suitable for a range of assessment needs; however, it did not access the full range of potential products and was only able to capture a relatively limited assessment of quality and price. Future efforts may compare how pricing per item, per pound or other quantity may impact consumer behavior. Further research might examine of culturally relevant factors that influence food preferences and available food options. Surveyors in both cities reported that grocery stores in more deprived areas with higher immigrant populations sold additional vegetables that were obviously popular items as shown by their quantity. Future research is needed to understand the relationship between available healthful foods and food purchasing habits.

These two studies tell two stories. The first is that of relatively poor access to fresh fruits and vegetables and other healthful foods in urban settings, regardless of the underlying mechanism of accessibility. The second is story of the development of an instrument and protocol. Despite a growing interest in research focusing on an obesogenic environment, there has been little attention to developing widely acceptable protocols for systematically assessing the food environment that can be used to compare across settings and document progress. This study demonstrates an assessment tool and protocol that have been adapted and tested in two unique urban settings, and thus may be more easily used in other settings as well. These findings suggest that an optimal food environment providing ready access to attractive, available and low cost fruits and vegetables was not found in either city, resulting from lack of stores selling products, lack of sufficient hours of operation, or higher costs in the available stores. Public health interventions and messages that emphasize eating a variety of foods, including 5 to 9 fruits and vegetables every day,[1] will have little impact if there continue to be the same problem of limited access to these foods, even if the underlying cause is different. Increasing the availability of fresh fruits and vegetables might be enhanced by working directly with local Farm Bureaus and store merchants to enhance offerings. Given the complexities involved in availability, access and cost, a coordinated approach that capitalizes on regional strengths is important for sustained availability.

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Conflict of Interest Disclosure

This manuscript has been read and approved by all authors. This paper is unique and is not under consideration by any other publication and has not been published elsewhere. The authors and peer reviewers of this paper report no conflicts of interest. The authors confirm that they have permission to reproduce any copyrighted material.

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